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Cover: Desert-adapted elephants in Damaraland, Namibia

Photo: Gene Eckhart

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CHAIR REPORTS
RAPPORTS DES PRESIDENTS

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

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There are many achievements to report since the last time I sat down to write my Chair's report. These include the production and dissemination of the *African elephant status report 2002* and the *IUCN/SSC AfESG guidelines for the in situ translocation of the African elephant for conservation purposes*, another successful meeting of the African Elephant Specialist Group, major progress with the listing of the African elephant by the IUCN Red List criteria, as well as the continued development of national and subregional elephant conservation strategies across the continent. Details of these developments are provided below.

However, despite these successes, the search for funding to support AfESG's core activities remains a major challenge. Herculian efforts have been undertaken by the AfESG Secretariat in the past few months to raise enough money to continue operations beyond November 2004, when our core support from the European Commission ends. Unfortunately, so far these efforts have not borne any fruit and our hopes now rest on a few crucial proposals, currently under consideration by various donors.

The Sixth AfESG members meeting

The sixth meeting of the African Elephant Specialist Group took place in Mokuti Lodge in Namibia from 4 to 8 December 2003. The meeting was attended by 34 out of the current 48 AfESG members and was funded by the European Commission.

Il s'est passé beaucoup de choses depuis la dernière fois que je me suis assise pour rédiger mon rapport de présidente. Parmi elles, on peut compter la rédaction et la publication du *African elephant status report 2002* et des *IUCN/SSC AfESG guidelines for the in situ translocation of the African Elephant for conservation purposes* (Lignes directrices du GSEAf / CSE/IUCN relatives au transfert *in situ* d'éléphants d'Afrique à des fins de conservation), une autre réunion fructueuse du Groupe des Spécialistes de l'Eléphant d'Afrique, des progrès considérables dans l'inscription de l'éléphant africain selon les critères de la Liste Rouge de l'UICN, et la poursuite du développement de stratégies nationales et sous-régionales pour la conservation de l'éléphant dans tout le continent. Des détails sur ces développements se trouvent plus bas.

Malgré ces succès, la recherche de fonds pour couvrir les activités de base du GSEAf reste un challenge de chaque instant. Le Secrétariat du GSEAf a produit des efforts herculéens ces derniers mois pour pouvoir poursuivre ses activités au-delà de novembre 2004, date à laquelle notre support principal fourni par la Commission européenne vient à échéance. Hélas, jusqu'à présent, ces efforts n'ont pas porté de fruits, et nos espoirs reposent désormais sur quelques propositions cruciales qui sont actuellement entre les mains de divers donateurs.

The meeting was a great success with significant progress made on the listing of the African elephant using the IUCN Red List criteria, the establishment of a special task force to develop a technical document on the options for dealing with local overpopulation of elephants, and the initial exercises in a scenario-planning approach to explore possible futures for the African elephant over the next 30 to 50 years. Other key developments included drafting a statement on the capture of African elephants from the wild for captive purposes, updating AfESG's statement on elephant taxonomy, and rich technical discussions on human–elephant conflict, and illegal killing and trade. A summary of these discussions is provided on pages 136–138 of this issue.

The African Elephant Database

After a four-year-long 'labour of love', AfESG's Data Review Working Group finally produced the long-awaited *African Elephant Status Report 2002* **(**Blanc et al. 2003). Containing the latest information on the continent-wide status of the African elephant, *AESR 2002* was officially launched on 26 November 2003 and a press release was issued and posted on the Environmental News Network and IUCN websites. Articles about the report were published in *Mmegi/The Reporter* (Gaborone), BBC News Online and the Canadian journal *Quebec Science,* and interviews were given to radio stations in South Africa and Spain. Many favourable responses have been received, along with a few critical comments for good measure and to keep us on our toes for future updates. The report has now been widely distributed to wildlife authorities and conservationists throughout the African continent and beyond. A pdf version of the full report is available for download on the website http://www.iucn.org/afesg/aed/index.html, free of charge. Hard copies can be purchased from the IUCN Bookstore in Cambridge, England, and through http://iucn.org/bookstore.

Currently, Julian Blanc, the African elephant database (AED) manager, is focusing his efforts on implementing new innovations and fully documenting the AED, in preparation for the next African elephant status report, which, it is hoped, will be published in 2006. This, however, will be possible only if funds can be secured to take us through the next database update cycle.

La Sixième réunion des membres du GSEAf

La sixième réunion du Groupe des Spécialistes des Eléphants d'Afrique s'est tenue au Mokuti Lodge, en Namibie, du 4 au 8 décembre 2003. 34 des 48 membres actuels du GSEAf ont participé à la réunion qui était financée par la Commission européenne.

Ce fut un grand succès : on a réalisé des progrès significatifs vers l'inscription de l'éléphant africain, qui répond aux critères de la Liste Rouge de l'UICN ; il y eut aussi la création d'une force spéciale chargée de préparer un document technique sur les différentes options possibles pour pallier les surpopulations locales d'éléphants et les premiers exercices d'une approche qui utilise divers scénarii pour envisager différents futurs pour l'éléphant africain dans les 30 à 50 prochaines années. Parmi d'autres développements substantiels, il y eut la préparation d'une déclaration sur la capture d'éléphants africains dans la nature pour les mettre en captivité, la mise à jour de la déclaration du GSEAf sur la taxonomie de l'éléphant, et de fructueuses discussions techniques sur les conflits hommes–éléphants, sur les massacres illégaux et sur le commerce. Un résumé de ces discussions se trouve dans les pages 136–138 de ce numéro.

La Base de Données de l'Eléphant Africain

Après quatre années d'un travail « accompli avec plaisir », le Groupe de travail du GSEAf chargé de la révision des Données a produit le tant attendu *African Elephant Status Report 2002* (Blanc et al. 2003). Ce document contient les dernières informations sur le statut de l'éléphant sur tout le continent africain et il a été lancé officiellement le 26 novembre 2003, alors qu'un communiqué de presse était publié sur le *Environmental News Network* et sur les sites de l'UICN. Il y a eu des articles sur le rapport dans *Mmegi/The reporter* (Gaborone), sur les *News online* de la BBC, et dans le journal canadien *Québec Science,* et des interviews ont été diffusées sur certaines radios sud-africaines et espagnoles. Nous avons reçu de nombreuses réponses très positives mais aussi quelques commentaires critiques pour faire bonne mesure et pour nous obliger à rester vigilants lors des prochaines mises à jour. Le rapport a été largement distribué auprès des autorités chargées de la faune sauvage et

African elephant translocation guidelines

The *IUCN/SSC AfESG guidelines for in situ translocation of the African elephant for conservation purposes* are now available in English, French and Portuguese, in both hard copy and CD format and as a freely downloadable pdf file on the following website: http://www.iucn.org/afesg/tools/index.html.

The document provides guidance on various technical, practical and political considerations that need to be tackled by those planning to translocate African elephants in the wild. Such considerations are many and range from correct budgeting procedures and staffing requirements to behaviour, complexities of elephant genetics, veterinary aspects and community consultation. Advice on when translocations should not be undertaken and a list of factors necessitating their discontinuation are also given as well as key lessons learned from elephant translocations across the continent.

We hope that this document will encourage future translocation practitioners to reflect on the many complexities involved in carrying out successful elephant translocations before considering such moves and thus help avoid some of the many potential pitfalls.

Listing of the African elephant by the IUCN Red List criteria

Taking full advantage of the expertise present at the recent members meeting, AfESG carried out a new assessment of the African elephant by the revised IUCN Red List criteria, version 3.1. This assessment resulted in a *Vulnerable* listing for the species. A full account of the listing process is provided in the detailed report on the AfESG members' meeting on pages 136–137 of this issue. The official submission of the listing to the IUCN Red List Committee was made in made in April, in time for inclusion in the 2004 Red List.

National elephant conservation and management strategies

To date, 8 of the 37 African elephant range states have complete national elephant conservation strategies, 5 are being developed and another 5 are being planned.

Directives pour le transfert d'éléphants africains

Les « Lignes directrices du GSEAf /CSE/IUCN relatives au transfert *in situ* d'éléphants d'Afrique à des fins de conservation » sont maintenant disponibles en anglais, en français et en portugais, aussi bien sous forme imprimée qu'en CD, et on peut les décharger gratuitement en format pdf sur le site suivant : http://www.iucn.org/afesg/tools/index.html.

Ce document fournit des conseils sur des questions techniques, pratiques et politiques que doivent se poser ceux qui envisagent de déplacer des éléphants africains dans la nature. Ces questions sont nombreuses et elles vont des procédures correctes de budgétisation et des besoins en personnel aux complexités comportementales de la génétique des éléphants, aux aspects vétérinaires et à la consultation des communautés. On y trouve aussi des conseils sur les périodes où il ne faut pas entreprendre de transferts et une liste de facteurs qui demandent leur interruption ainsi que les leçons clés apprises au cours de précédents transferts dans tout le continent.

Nous espérons que ce document encouragera ceux qui prévoient de procéder à des transferts à réfléchir à la grande complexité du processus avant d'envisager d'y recourir et qu'il aidera à éviter certains des si nombreux écueils possibles.

In December 2003, the key players in elephant conservation in Côte d'Ivoire met in Abidjan to discuss a strategic plan for the country's elephants. The main threats to the Ivorian elephant population were identified and a series of conservation recommendations were made. These will be used to draft a national elephant strategy document, currently under review by relevant experts.

Elsewhere, Kenya, Liberia and Nigeria have recently been in touch with the AfESG Secretariat regarding the need for technical assistance in developing national elephant strategies, and funding has been secured from the US Fish and Wildlife Service for workshops to develop national elephant conservation strategies in Benin and Niger.

Looking into the future, the government of South Africa in conjunction with the Elephant Management and Owners Association (EMOA) has also begun to discuss developing a national policy for managing elephants in South Africa. As a first step in this process, EMOA under the able leadership of long-time AfESG member Dr Marion Garai will be hosting an elephant symposium from 13 to 17 September 2004 to discuss priority issues and current research on all aspects of management of free-ranging and semi-wild elephant populations. I have been invited to deliver the keynote address at this symposium and plan to report on the symposium outcome in my next Chair's report to *Pachyderm*.

Subregional strategies

Progress on securing support to undertake the planned strategic planning for central Africa has been disappointingly slow. However, we appear to be close to a breakthrough and are most grateful to the Netherlands committee of IUCN for agreeing to contribute EUR 30,000. The Wildlife Conservation Society has also earmarked a further USD 16,500 towards this initiative. We hope that these commitments will help catalyse the additional funds needed.

In a collaborative effort initiated by the African Wildlife Consultative Forum (an informal group comprising the directors of southern Africa's wildlife management authorities) and the IUCN/SSC Southern Africa Sustainable Use Specialist Group, AfESG will assist in developing a strategy for elephants in the subregion in the coming months. Funds are currently being sought to support the work ahead. Management of local overpopulation, translocation and

Classement de l'éléphant africain en fonction des critères de la Liste Rouge de l'UICN

Profitant pleinement de toute l'expertise présente à la dernière réunion de ses membres, le GSEAf a réalisé une nouvelle évaluation de l'éléphant africain selon les Critères de la Liste Rouge de l'UICN, version 3.1. Cette évaluation a abouti au classement de l'espèce dans la catégorie *Vulnérable*. Un compte-rendu complet du processus se trouve dans le rapport détaillé de la réunion des membres du GSEAf, aux pages 136–137 de ce numéro. La soumission officielle de ce classement devant le Comité de la Liste Rouge de l'UICN a été faite en avril, à temps pour l'intégrer dans la Liste Rouge de 2004.

Conservation et stratégies de gestion nationales pour les éléphants

À ce jour, 8 des 37 aires de répartition de l'éléphant africain disposent de stratégies complètes pour la conservation de leurs éléphants, cinq sont en train de les mettre au point et cinq autres prévoient de le faire.

En décembre 2003, les acteurs clés de la conservation des éléphants en Côte d'Ivoire se sont réunis à Abidjan pour discuter d'un plan stratégique pour les éléphants de ce pays. Ils ont identifié les principales menaces qui pèsent sur leur population d'éléphants et ont fait toute une série de recommandations pour leur conservation. Celles-ci serviront à la préparation d'un document de stratégie nationale qui est actuellement soumis à la révision d'experts compétents.

Ailleurs, le Kenya, le Liberia et le Nigeria ont récemment contacté le Secrétariat du GSEAf au sujet de leur besoin d'assistance technique pour développer des stratégies nationales pour l'éléphant, et le *Fish and Wildlife Service* américain a promis de fournir les fonds nécessaires pour la tenue d'ateliers afin de mettre au point des stratégies nationales pour les éléphants au Bénin et au Niger.

Envisageant l'avenir, le gouvernement d'Afrique du Sud, en union avec la *Elephant Management and Owners Association* (EMOA), commence aussi à parler de développer une politique nationale pour la gestion des éléphants d'Afrique du Sud. En guise de premier pas dans ce sens, l'EMOA, sous la guidance éclairée d'un membre de longue date du GSEAf, le Dr Marion Garai, accueillera un symposium sur

re-introduction, human–elephant conflict and elephant counting techniques will feature high among the considerations to be included on the agenda for this planning exercise.

Update on the CITES MIKE programme

Obtaining the required baseline information on elephant numbers and levels of illegal killing, as defined by the 49th meeting of the CITES Standing Committee, continues to be the main focus of the MIKE programme. By the end of this year, all 45 African MIKE sites are expected to have the required 12-month baseline data on illegal killing levels and law enforcement efforts. A descriptive report on the influencing factors should be achieved by mid-2004. In Asia, particularly in South-East Asia, the rate of progress has been slower, largely due to the delay in recruiting the MIKE support officer for that subregion. It is anticipated that the baseline data there may not be in place until early 2005.

The MIKE Dung Count Task Force met in Washington, DC, in October 2003 to try to achieve consensus on the theoretical basis for elephant surveys using dung count methods. After lengthy debate, the task force recommended application of the line transect method using a unified approach to transect design, layout and estimation of dung decay rates. However, it was noted that under certain circumstances (low elephant numbers and densities) other methods might be more appropriate. These recommendations were subsequently adopted by the MIKE TAG and are being incorporated into a 'Standards' document to assist elephant dung count practitioners.

African Elephant Library

In close collaboration with Save the Elephants, a comprehensive updating exercise of the African Elephant Library (AEL) was carried out in late 2003. Thanks to the tireless efforts of Mary Rigby, a professional librarian dedicated to developing the AEL, all new documents collected since the last updating exercise were catalogued and annotated. The library now has an impressive 4540 references, a number that keeps growing almost daily. The AEL continues to provide valuable service to African elephant researchers, management authorities and the public at large. The

l'éléphant du 13 au 17 septembre 2004, pour discuter des questions prioritaires et des recherches actuelles sur tous les aspects de la gestion de populations d'éléphants sauvages et demi-sauvages. Je suis invitée à prononcer le discours d'ouverture de ce colloque et je prévois d'en faire le compte-rendu dans mon rapport de Présidente dans le prochain *Pachyderm.*

Stratégies sous-régionales

Les progrès dans l'obtention de fonds pour entreprendre le planning stratégique pour l'Afrique Centrale ont été terriblement lents. Cependant, il semble que nous approchions du but et nous remercions chaleureusement le Comité néerlandais de l'UICN qui a accepté d'y contribuer à hauteur de 30.000 $. La *Wildlife Conservation Society* a aussi affecté 16.500 $ supplémentaires à cette initiative. Nous espérons que ces promesses vont catalyser l'obtention des fonds encore nécessaires.

Dans un effort commun initié par le *African Wildlife Consultative Forum* (un groupe informel qui comprend les directeurs des autorités de gestion de la faune sauvage en Afrique australe) et par le Groupe des Spécialistes pour l'Utilisation Durable de la CSE/UICN, le GSEAf va aider à développer ces prochains mois une stratégie pour les éléphants de la sous-région. On cherche actuellement des fonds pour soutenir le travail à faire. La gestion de la surpopulation locale, la translocation et la réintroduction, les conflits hommes–éléphants et les techniques de comptage figureront en bonne place parmi tous les sujets qui devront être mis à l'agenda pour cet exercice.

Mise à jour du programme MIKE / CITES

Le programme MIKE conserve comme objectif principal d'obtenir les informations de base nécessaires sur le nombre d'éléphants et sur l'intensité des massacres illégaux, comme cela a été défini lors de la 49^{ième} réunion du Comité Permanent de la CITES. À la fin de cette année, les 45 sites africains de MIKE devraient disposer des données de base sur 12 mois sur l'intensité des massacres et sur les efforts en matière d'application des lois. Un rapport descriptif sur les facteurs d'influence devrait être terminé vers la mi-2004. En Asie, et particulièrement dans le Sud-Est, les progrès ont été

full bibliography can be accessed online through the AfESG website http://iucn.org/afesg.

The AfESG website

In addition to the *African elephant status report 2002* and the English, French and Portuguese versions of the *Guidelines for the in situ translocation of the African elephant for conservation purposes*, new additions to AfESG's website http://iucn.org/afesg include a fully digitized version of the African Wildlife Foundation's *Studying elephants* handbook in English and French, a recent successful case study on human–elephant conflict mitigation in the Red Volta region of Ghana, copies of the national elephant conservation strategies for Ghana and Togo, updated English and French versions of the West African Elephant Conservation Strategy and the action plan for managing transfrontier elephant conservation corridors in West Africa. Receiving over 1500 hits a day from users all over the world, this site is quickly becoming a highly effective, low-cost platform for disseminating information about conservation and management of the African elephant.

The funding situation and outlook for the future

As mentioned in my introductory comments, AfESG currently has sufficient funds to support all its core activities (including the production and dissemination of *Pachyderm*) only up to the end of November 2004. As we receive no core funding from IUCN or the Species Survival Commission, we are solely dependent on our own ability to raise funds. Consequently, much of the time of the AfESG Secretariat in recent months has been devoted to drafting proposals to various donors. In March, two large-scale proposals were submitted, one to the European Commission Programme on Environment in Developing Countries, and the other to the United States Fish and Wildlife Service. The Dutch government and the UNEP and UNDP implementing agencies for the Global Environment Facility and many others have also been approached. It is my fervent hope that some of these approaches will be successful, to avoid a serious disruption of our activities and to support continuity of the significant progress we have been making in conserving and managing the African elephant over the past decade and longer.

plus lents, principalement à cause du délai nécessaire pour recruter le responsable du support de MIKE dans la sous-région. Les données de base ne devraient pas être prêtes là-bas avant le début de 2005.

La force de travail de MIKE responsable du comptage des crottes s'est réunie à Washington, DC, en octobre 2003, pour essayer d'atteindre un consensus sur la base théorique des études des éléphants par la méthode de comptage des crottes. Après de longues discussions, la force de travail a recommandé l'application de la méthode des transects linéaires, en utilisant une méthode unifiée pour désigner les transects, et pour présenter et estimer le taux de décomposition des crottes. Cependant, on a remarqué que, dans certaines circonstances (petit nombre d'éléphants, faible densité), d'autres méthodes pourraient être plus appropriées. Ces recommandations ont ensuite été adoptées par le TAG de MIKE et sont actuellement intégrées dans un document de « Standards » destiné à aider ceux qui doivent pratiquer des comptages de crottes d'éléphants.

Bibliothèque de l'éléphant d'Afrique

Un exercice général de mise à jour de la bibliothèque de l'éléphant d'Afrique (BEA) a été mené à la fin de 2003, en étroite collaboration avec « *Save the elephants* ». Grâce aux efforts incessants de Mary Rigby, une bibliothécaire professionnelle qui s'est consacrée au développement de la BEA, tous les nouveaux documents récoltés depuis la dernière mise à jour ont été catalogués et classés. La bibliothèque dispose aujourd'hui de 4.540 références, chiffre qui ne cesse de s'accroître presque chaque jour. La BEA rend toujours de grands services aux chercheurs qui s'intéressent à l'éléphant africain, aux autorités de gestion et au public en général. Toute cette bibliographie est accessible en ligne sur le site du GSEAf : http://iucn.org/afesg.

Le site du GSEAf

En plus du *African elephant status report* et des versions anglaise, française et portugaise des *Lignes directrices relatives au transfert* in situ *d'éléphants d'Afrique à des fins de conservation*, les nouveaux ajouts au site du GSEAf : http://iucn.org/afesg comprennent une version en anglais et en français, entièrement digitalisée, du manuel « L'étude des

Eléphants » (*Studying elephants*), une étude de cas récente de la mitigation réussie dans un conflit hommes–éléphants dans la région de la Volta Rouge, au Ghana, et aussi les stratégies nationales de conservation des éléphants du Ghana et du Togo, les nouvelles versions anglaise et française de la Stratégie ouest-africaine de Conservation des Eléphants et le plan d'action pour la gestion des coulloirs transfrontières de conservation des éléphants en Afrique de l'Ouest. Avec 1500 visites par jour, en provenance du monde entier, ce site est très rapidement devenu une plate-forme efficace et peu coûteuse pour diffuser les informations au sujet de la conservation et la gestion de l'éléphant africain.

Situation financière et perspectives d'avenir

Comme je l'indiquais au commencement de mon rapport, le GSEAf dispose actuellement d'assez d'argent pour financer ses activités de base (y compris la production et la diffusion de *Pachyderm*) jusqu'à la fin novembre 2004. Comme nous ne recevons pas de financement de base de l'UICN ni de la Commission de Sauvegarde des Espèces, nous ne dépendons que de nous-mêmes pour récolter des fonds. C'est pourquoi le Secrétariat a consacré une grande partie de son temps à préparer des propositions pour divers donateurs. En mars, nous avons soumis deux importantes propositions, l'une au Programme de la Commission européenne pour l'environnement dans les pays en développement et l'autre au *Fish and Wildlife Service* américain. Le gouvernement néerlandais et les organes exécutifs du PNUE et du PNUD pour le Fonds pour l'environnement mondial (FEM) ainsi que beaucoup d'autres ont aussi été contactés. J'espère de tout cœur que certains de ces contacts seront positifs et nous permettront d'éviter l'interruption de nos activités. Nous pourrions ainsi poursuivre les progrès significatifs que nous avons déjà réalisés dans la conservation et la gestion de l'éléphant africain depuis plus de dix ans.

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

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The African Rhino Specialist Group (AfRSG) members and more than 20 invited observers met for the seventh AfRSG meeting at Kilaguni Lodge, Tsavo West, in Kenya from 6 to 11 June 2004. Fifteen current and former African rhino range states reported on their programmes; rhino numbers and performance were reviewed; and there were numerous presentations on rhino conservation issues, techniques and support programmes. In addition, six workshops were held to address regional conservation strategies and programmes.

Of great concern is the recent escalation in poaching of the *Critically Endangered* northern white rhino *Ceratotherium simum cottoni* in Garamba National Park, Democratic Republic of Congo: the only wild breeding population in the world. With the current population down to between 22 and 30 animals, possibly fewer, the fate of this taxon hangs in the balance. Particularly worrying is that organized poaching for ivory and rhino horn has emerged in the core southern area of the park, facilitated by pack donkeys to transport horns and tusks north through the Domaine de Chasse Azande towards Sudan. Increased field support and political intervention to ensure that foreign elements around the park are removed are urgently required, and any such support for ICCN Garamba and the Garamba Project will be greatly appreciated.

Another range state experiencing significant difficulties is Zimbabwe. By the end of 2003, the number of black rhinos in the Save-Limpopo lowveld conservancies was about 260, representing more than half the national total. However, by early 2004 the land resettlement programme had caused many rhinos to shift their home ranges, and between about 15 and 25 had died due to snaring and other causes related to land invasions. At least 20 others had been treated for snare wounds and more than 30 translocated to safer areas. Currently, highly sensitive and complex discussions are being held that will decide the future

Les membres du Groupe des Spécialistes des Rhinos d'Afrique (GSRAf) et plus de 20 observateurs invités se sont retrouvés pour la Septième Réunion du GSRAf au Kilaguni Lodge, dans le Tsavo-ouest, au Kenya, du 6 au 11 juin 2004. Quinze états anciens et actuels de l'aire de répartition des rhinos africains ont rapportés sur leur programme ; le nombre et les performances des rhinos sont passés en revue et il y avait de nombreuses présentations sur les problèmes, les techniques et les programmes de support de la conservation des rhinos. Il y avait aussi six ateliers qui se sont penchés sur les stratégies et les programmes nationaux de conservation.

Nous sommes très inquiets de la récente poussée de braconnage du rhino blanc du Nord (*Ceratotherium simum cottoni*) *gravement menacé d'extinction,* dans le Parc National de la Garamba, en République Démocratique du Congo ; c'est la seule population reproductrice sauvage au monde. Etant donné que la population actuelle a été réduite à un nombre situé entre 22 et 30, peut-être moins, c'est le sort de ce taxon qui est en jeu. Il est particulièrement inquiétant de constater que ce braconnage organisé pour l'ivoire et la corne de rhino a fait irruption dans la partie sud du parc, facilité par des ânes bâtés qui transportent cornes et défenses vers le nord à travers le Domaine de Chasse Azandé, jusqu'au Soudan. Il faut d'urgence augmenter le support sur le terrain et faire une intervention politique pour s'assurer que les éléments étrangers qui rôdent autour du parc sont éloignés ; tout support en ce sens de l'ICCN Garamba et du Projet Garamba serait apprécié au plus haut point.

Un autre Etat de l'aire de répartition connaît pour le moment de sérieuses difficultés : le Zimbabwe. Fin 2003, le nombre de rhinos noirs dans les *conservancies* de la plaine du Save/Limpopo était d'environ 260, c'est-à-dire plus de la moitié du total national. Mais au début de 2004, le programme de réinstallation national avait poussé de nombreux rhinos à déplacer leur domaine vital, et entre 15 et 25 d'entre eux avaient

of these conservancies and hence of a significant proportion of Zimbabwe's black rhinos.

On a more positive note, the small re-established population of black rhino in Zambia's North Luangwa National Park is doing well. Efforts are now being made to increase the number of founders from the original 5 to 20, the recommended level for long-term viability. Also the WWF/Ezemvelo KwaZulu-Natal (KZN) Wildlife Black Rhino Range Expansion project is progressing well. A number of properties in KwaZulu-Natal, a province within South Africa, have been assessed, and Ezemvelo KZN Wildlife has made 16 black rhinos available for the first introduction, providing the National Treasury approves the public–private partnership application. Another initiative is that a SADC Regional Programme for Rhino Conservation (RPRC) technical mission to Angola has recently been undertaken to evaluate possible rhino conservation options, given that rhinos are currently extinct in that country, and a similar mission to Mozambique is planned.

Following the successful Scene of the Crime Investigation training courses held in Namibia, Kenya and Zimbabwe, SADC RPRC has funded additional courses, held in Swaziland and Botswana. These will assist in gaining convictions in poaching cases. The WILDb rhino database and WILDxl spreadsheet were reviewed at a workshop in Namibia. Modifications were identified to make WILDb suitable for use in Namibia, as well as ensuring it will be fully compatible with the black rhino reporting requirements in South Africa and Zimbabwe and the needs of population estimation using RHINO. The new RHINO 2 mark-recapture population estimation software has undergone extensive testing, and the AfRSG Scientific Officer has given short courses on it in Namibia and Zimbabwe and a longer one in KwaZulu-Natal in South Africa.

The course modules for AfRSG's successful Sandwith rhino-monitoring training course for field rangers have been revised in light of experience at the trainers courses held in South Africa and Kenya, and they are now available in pdf format. The new trainees' booklet has also been converted into pdf format. We hope to produce this booklet in a number of local languages during the next reporting period. Finally, a successful stakeholders workshop was convened in the Kunene region in Namibia in March 2004, with 60 participants from community conservancies, traditional chiefs, local NGOs, tourist con-

été tués à cause de pièges et pour d'autres raisons liées aux invasions des terres. Au moins 20 autres ont été traités pour des blessures causées par des pièges, et plus de 30 ont été transférés vers des zones plus sûres. Pour le moment, il y a des discussions très délicates et complexes qui vont décider de l'avenir de ces *conservancies* et par-là même, de l'avenir d'une proportion significative des rhinos noirs du Zimbabwe.

Nouvelle plus positive, la petite population de rhinos noirs réintroduite dans le Parc National de Lwangwa-nord, en Zambie, se porte bien. On fait le nécessaire pour porter le nombre de reproducteurs de 5 à 20, chiffre recommandé pour une viabilité à long terme. Le projet du *WWF/Ezemvelo KwaZulu-Natal (KZN) Wildlife* pour l'expansion de l'aire du rhino noir avance bien. On a évalué un certain nombre de propriétés au KwaZulu-Natal, une province sud-africaine, et *Ezemvelo KZN Wildlife* a mis 16 rhinos à disposition pour la première introduction, pour autant que le Trésor National approuve l'application du partenariat publique/privé. Une autre initiative est celle qu'une mission technique d'un programme régional SADC pour la conservation des rhinos (PRCR) a entreprise pour évaluer diverses options possibles pour la conservation des rhinos en Angola, sachant que les rhinos sont aujourd'hui éteints dans ce pays. Une mission similaire est prévue au Mozambique.

Suite aux cours de formation « Enquête sur les lieux du crime » qui se sont tenus en Namibie, au Kenya et au Zimbabwe, le PRCR du SADC a financé d'autres sessions au Swaziland et au Botswana. Celles-ci vont aider à obtenir des condamnations dans les cas de braconnage. La base de données des rhinos WILDb et le tableau WILDxl ont été révisés lors d'un atelier en Namibie. On a identifié des modifications à faire pour rendre WILDb utilisable en Namibie, tout en s'assurant qu'il serait tout à fait compatible avec les exigences en matière de relevés en Afrique du Sud et au Zimbabwe, et avec ce qui est nécessaire pour les estimations de population utilisant RHINO. Le nouveau logiciel RHINO 2 pour l'estimation des populations par marquage et recapture a été soumis à des tests très complets, et le responsable scientifique du GSRAf a donné quelques cours à ce sujet en Namibie et au Zimbabwe et un cours plus long au KwaZulu-Natal, en Afrique du Sud.

Les modules pour le cours de formation Sandwith sur le contrôle continu des rhinos du GSRAf destiné

cessionaires and government representatives. This workshop reviewed biological management, and agreement was reached on requirements and priorities for rhino translocations.

The Namibian Ministry of the Environment and Tourism (MET), as part of a joint MET/WWF-funded project, undertook another successful block count of black rhino in Etosha National Park. A follow-up workshop was held in Etosha (with assistance of the AfRSG Scientific Officer) to discuss the results of the 2002 and 2003 counts, and future block counts, and determine how estimate precision can be further improved. Following on from the successful application of this method in Etosha, plans are currently being made to undertake a trial block count in Kruger National Park.

Finally, it is with deep sadness that I have to report the death in early December 2003 of the official Tanzanian representative on AfRSG, Mr Matthew Maige, following gunshot wounds sustained during a robbery at his house in Dar es Salaam. He was an active member of the group, and African rhinos have lost one of their champions.

Once again, AfRSG would like to thank WWF's Africa Rhino Programme, WWF-US and WWF-SA for their continued support of the AfRSG Secretariat.

aux gardes de terrain ont été revus à la lumière de l'expérience passée, lors des cours pour formateurs qui ont eu lieu en Afrique du Sud et au Kenya, et ils sont maintenant disponibles en format pdf. Le nouveau fascicule pour les stagiaires a aussi été converti au format pdf. Nous espérons produire ce fascicule dans un certain nombre de langues locales au cours des mois qui viennent. Enfin, un atelier a réuni les partenaires dans la région de Kunene, en Namibie, en mars 2004 ; il y eut 60 participants venus des *conservancies* communautaires, des chefs traditionnels, des ONG locales, des agents du tourisme et des représentants du gouvernement. Cet atelier a procédé à la révision de la gestion biologique, et on est arrivé à un accord sur les exigences et les priorités en matière de transferts de rhinos.

Le Ministère namibien de l'Environnement et du Tourisme (MET), en tant que partie d'un projet financé conjointement par le MET et le WWF, a entrepris un autre comptage par secteur des rhinos noirs du Parc National d'Etosha. Un atelier de suivi a eu lieu à Etosha (avec l'assistance du Responsable scientifique du GSRAf) pour discuter les résultats des comptages de 2002 et 2003 et des futurs comptages par secteur, et pour déterminer comment on peut encore améliorer la précision des estimations. Comme cette méthode a été appliquée avec succès à Etosha, on prévoit d'entreprendre un essai de comptage par secteur dans le Parc National Kruger.

Enfin, c'est avec une profonde tristesse que je dois vous annoncer le décès, début décembre 2003, du représentant officiel de la Tanzanie auprès du GSRAf, M. Matthew Maige, suite aux blessures par balles dont il a été victime lors d'un vol dans sa maison de Dar es Salaam. C'était un membre actif du groupe, et on peut dire que les rhinos africains ont perdu un de leurs champions.

Une fois encore, le GSRAf voudrait remercier le Programme du WWF pour les rhinos africains, le WWF-US et le WWF-SA pour le soutien continu qu'ils apportent au Secrétariat du GSEAf.

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

Mohd Khan bin Momin Khan, Chair/Président, with/avec Thomas J. Foose and Nico van Strien, Programme Officers/Responsables de Programme

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Peninsula Malaysia

Catastrophe at Sungai Dusun

A catastrophe occurred in late October and early November 2003 at the Sumatran Rhino Conservation Center at Sungai Dusun. All five (one male and four female) Sumatran rhinos in this captive propagation facility died within a period of 18 days in what veterinarians described as a triphasic (3-episode) epidemic. The first animal to die, on 28 October, was a female that had been in a large (4-ha, or 10-acre) enclosure away from the other four rhinos. She died within 24 hours of being moved back into the main complex of enclosures where the other rhinos were located. She manifested no clinical signs when moved on the 27th but was discovered dead the morning of the 28th. The gross necropsy initially suggested that intestinal torsion might have been the cause of this death. However, on 6 November, two other rhinos (the male and another female) became ill. Clinical signs included initial depression and anorexia with rapidly progressing lack of coordination, muscle tremors, nasal haemorrhage, recumbency, laboured breathing, and finally death, on 8 and 9 November. The last two females developed acute symptoms a week later and died on 16 and 17 November. Broad-spectrum antibiotic and other supportive therapy had been provided to all five rhinos.

Initial reports from the necropsy suggested that this epidemic was caused by a highly pathogenic *E. coli* outbreak. Subsequent evidence, however, points away from such a conclusion and suggests the isolation of the *E. coli* was more consistent with secondary post-mortem overgrowth.

Instead, evidence implicates a blood-borne parasitic disease, trypanosomiasis, as the primary cause of death. Haemoparasitic organisms identified as *Trypanosoma evansi* were isolated from wet blood

Péninsule malaise

Catastrophe à Sungai Dusun

Une catastrophe est arrivée fin octobre, début novembre 2003, au Centre de Conservation des Rhinos de Sumatra, à Sungai Dusun. Les cinq rhinos de Sumatra (un mâle et quatre femelles) de ce centre de propagation en captivité sont morts en l'espace de 18 jours de ce que les vétérinaires ont décrit comme une épidémie en trois phases. Le premier animal mort le 28 octobre fut une femelle qui vivait dans un grand enclos (4 ha) à l'écart des quatre autres. Elle est morte dans les 24 heures qui ont suivi son transport dans le principal complexe d'enclos où étaient les quatre autres. Elle n'avait manifesté aucun signe clinique lorsqu'on l'avait transportée le 27, mais on l'a trouvée morte le matin du 28. L'autopsie grossière pratiquée alors suggéra une torsion intestinale qui aurait pu causer la mort. Cependant, le 6 novembre, deux autres rhinos (le mâle et une autre femelle) sont tombés malades. Les signes cliniques présentaient une dépression initiale et de l'anorexie qui ont rapidement évolué vers une perte de coordination, des tremblements musculaires, une hémorragie nasale, une position couchée, une dyspnée d'effort et enfin la mort, les 8 et 9 novembre. Les autres femelles ont commencé à développer des symptômes aigus une semaine plus tard et sont mortes les 16 et 17 novembre. Les cinq rhinos avaient reçu des antibiotiques à large spectre et une autre thérapie de soutien.

Les premiers rapports d'autopsie suggéraient que cette épidémie pouvait être causée par le très pathogène *E. coli*. Mais de nouveaux indices semblent écarter cette conclusion, et suggèrent que la mise en évidence d'*E. coli* a plus à voir avec une invasion secondaire post-mortem.

Les preuves impliquent au contraire une maladie parasitaire du sang, la trypanosomiase, qui serait la

smears taken from the last two animals just before death. Gross pathology was non-specific; however, histopathologic examination revealed multisystemic disease compatible with historical reports of trypanosomiasis (also known as 'surra') in other animals. Three animals had evidence of intralesional trypanosome organisms and extravascular haemolysis; three of four animals from which spleen was available had characteristic splenic lesions consisting of marked enlargement of peri-arteriolar sheaths with lymphoid depletion. Trypanosome organisms were identified in the brain of one animal in association with endothelial hypertrophy.

A herd of water buffalo occupied an area adjacent to the Sumatran Rhino Conservation Center. Indeed, there was a common fence with the 4-ha reserve where the first animal to die had resided for the two weeks immediately before its death. These buffalo are suspected to have been the reservoir of infection. Further analyses of the trypanosomes are being conducted by one of the world's foremost trypanosome laboratories, at Murdoch University in Australia. Full necropsy reports will be provided when all analyses are completed.

Interestingly, African rhinoceros species are known to acquire subclinical infection with trypanosome organisms but appear to develop the disease only in times of stress (such as during translocation). Trypanosomes evolved in Africa and presumably the African rhino species have innate acquired resistance to infection through long periods of host–parasite coadaptation. In contrast, trypanosomes did not migrate to South-East Asia until late in the 19th century (Dieleman, E.F. 1986. Trypanosomiasis in Indonesia. *Veterinary Quarterly* 8(3):250–256). Therefore, the Sumatran rhino would be considered a naïve host with high susceptibility. Horses, a related domestic perissodactylid, also experience nearly 100% mortality from surra infection. This outbreak represents the first report of surra in the Sumatran rhinoceros.

Despite this major setback of losing all the captive rhinos in Peninsula Malaysia, many of the Sumatran rhino conservationists believe a viable programme of managed propagation is vital as a supplement and back-up to the primary programme of protecting the species in the wild against ever-increasing odds. Hence, the managed propagation programmes at the Cincinnati Zoo (see below), the Sumatran Rhino Sanctuary in Way Kambas National Park on Sumatra in Indonesia, and Sepilok in Sabah

cause première de ces morts. On a identifié des organismes parasites du sang, des *Trypanosoma evansi*, qui ont été isolés dans des échantillons sanguins prélevés chez les deux derniers animaux juste avant qu'ils meurent. La pathologie globale n'était pas spécifique, mais l'examen histo-pathologique a révélé une maladie multi-systémique compatible avec des rapports antérieurs de trypanosomiase (appelée aussi Surra) chez d'autres animaux. Trois animaux montraient des signes de trypanosomes intra-lésionnels et d'hémolyse extra-vasculaire ; trois des quatre animaux dont on a pu prélever la rate présentaient des lésions caractéristiques de cet organe consistant en un élargissement marqué de la gaine entourant les artérioles accompagné d'une diminution lymphoïde. On a identifié des trypanosomes dans le cerveau d'un animal, en association avec une hypertrophie endothéliale.

Un troupeau de buffles d'eau occupaient une zone adjacente au Centre de conservation des rhinos de Sumatra. Il y avait même une clôture commune avec l'enclos de 4 ha où le premier animal était resté pendant les deux semaines qui ont précédé sa mort. On suspecte ces buffles d'avoir été le réservoir de l'infection. De nouvelles analyses sont en cours dans un des laboratoires les plus réputés pour la trypanosomiase, à l'Université de Murdoch, en Australie. Des rapports d'autopsie complets seront fournis lorsque toutes les analyses seront terminées.

Il est intéressant de remarquer que les rhinocéros africains sont connus pour être atteints d'infections par des trypanosomes qui restent sub-cliniques, infections qui ne se développent qu'en période de stress (comme, par exemple, en cas de transfert). Les trypanosomes ont évolué en Afrique, et on suppose que les rhinos africains ont acquis une résistance innée à cette infection au cours de longues périodes de coadaptation hôte–parasite. Par contre, les trypanosomes n'ont atteint le Sud-Est asiatique que vers la fin du 19ième siècle (Dieleman, E.F. 1986. *Trypanosomiasis in Indonesia*. *Veterinary Quarterly* 8(3):250–256). C'est pourquoi on pourrait considérer que le Rhinocéros de Sumatra est un hôte innocent très sensible. Les chevaux, périssodactyles domestiques apparentés, connaissent aussi une mortalité qui frôle les 100% en cas d'infection par le Surra. Cette épidémie représente le premier cas de surra rapporté chez le rhinocéros de Sumatra.

Malgré ce très malheureux coup dur que représente la perte de tous les rhinos captifs dans la Péninsule malaise, de nombreux protecteurs des rhi-

will continue. For now, the conservation programme for the Sumatran rhino in Peninsula Malaysia will concentrate on the rhino protection units.

Colloquium on in situ conservation of the Sumatran rhino

To improve the in situ conservation of Sumatran rhinos in Peninsula Malaysia, a major colloquium convened in Kuala Lumpur on 15–16 March. Over 40 persons participated including representatives from the Department of Wildlife and National Parks, the state wildlife departments, which are integral to Malaysia's federalized wildlife conservation system, the Malaysian Rhino Foundation, WWF-Malaysia, the Malaysian Nature Society, Zoo Negara, the US Fish and Wildlife Service Rhinoceros and Tiger Conservation Fund, the International Rhino Foundation, the IUCN/SSC Asian Rhino Specialist Group, the Cincinnati Zoo, the Indonesian Rhino Conservation Program, and the Asian Rhino Project. The objectives of the colloquium were to reassess the data on abundance and distribution of rhinos in Peninsula Malaysia and to adaptively modify the conservation action plan for the species. Information indicates a probable range of 59–78 rhinos distributed over three major protected-area complexes as well as a number of smaller remnant areas. A major result of the colloquium was the decision to intensify activities of the rhino protection units and concentrate them on three major areas: the Taman Negara Complex, the Belum Complex, and the Gunung Inas-Bintang Hijau Complex. Rhinos in other areas will become candidates for translocation to one of these three areas or to other sanctuaries. Further details are available from the Malaysian Rhino Foundation (mohdkhan@mail.com) or the International Rhino Foundation (irftom@aol.com).

Sabah

A major workshop on conservation of the Sumatran rhino also occurred in Sabah on 29–30 April. The workshop on Sumatran rhino conservation was jointly organized by the Sabah Wildlife Department, SOS Wildlife (Borneo), Carlota's Borneo Holidays and SOS Rhino. The workshop was officially launched by Y.B. Datuk Hj. Karim Hj. Bujang, Assistant Minister of Tourism, Culture and Environment, Sabah; 42 participants attended. The first session covered

nos de Sumatra croient qu'un programme viable de propagation assistée est vital pour suppléer et appuyer le programme initial qui consiste à protéger l'espèce dans la nature face à des dangers toujours plus nombreux. C'est pourquoi les programmes de propagation assistée du Zoo de Cincinnati (voir plus bas), du Sanctuaire des Rhinos de Sumatra dans le Parc National de Way Kambas, à Sumatra, en Indonésie, et Sepilok à Sabah, vont continuer. Maintenant, le programme de conservation du Rhinocéros de Sumatra sur la Péninsule malaise va se concentrer sur les unités de protection des rhinos.

Colloque sur la conservation in situ *du rhino de Sumatra*

Pour améliorer la conservation *in situ* des rhinos de Sumatra sur la Péninsule malaise, un colloque très important a eu lieu à Kuala Lumpur les 15 et 16 mars. Plus de 40 personnes y ont pris part, y compris des représentants du Département de la Faune sauvage et des Parcs nationaux, les départements de la faune sauvage de l'Etat, qui font partie intégrante du système fédéralisé de la conservation de la faune en Malaisie, la *Malaysian Rhino Foundation*, le WWF-Malaisie, la *Malaysian Nature Society*, le Zoo de Negara, le Fonds pour la Conservation des Rhinos et des Tigres du *Fish and Wildlife Service* américain, l'*International Rhino Foundation*, le Groupe des Spécialistes des Rhinos d'Asie de la CSE/UICN, le Zoo de Cincinnati, le Programme indonésien pour la Conservation des Rhinos et le *Asian Rhino Project*. Les objectifs du colloque étaient de réévaluer les données sur l'abondance et la distribution des rhinos sur la Péninsule malaise et de modifier en conséquence le plan d'action pour la conservation de l'espèce. Les informations disponibles permettent de penser qu'il y a encore entre 59 et 78 rhinos répartis entre trois grands complexes d'aires protégées et d'autres zones plus petites. Un des principaux résultats du colloque est la décision d'intensifier les activités des unités de protection des rhinos et de les concentrer sur trois aires principales : le complexe de Taman Negara, le complexe de Belum et le complexe de Gunung Inas-Bintang Hijau. Les rhinos des autres zones deviennent candidats au transfert vers une de ces trois aires ou vers d'autres sanctuaires. On peut obtenir plus de détails auprès de la *Malaysian Rhino Foundation* (mohdkhan@mail.com) ou de l'*International Rhino Foundation* (irftom@aol.com).

topics on the current status of Sumatran rhino conservation in Malaysia (West Malaysia and Sabah) and in Sumatra, Indonesia. The second session covered the progress and current activities of SOS Rhino in Sabah. Two working groups were formed to discuss the in situ and ex situ components of the Sumatran rhino conservation programme.

The workshop identified three major goals for in situ conservation of the Sumatran rhino in Sabah and Borneo.

- Short term: preserve the current population (< 50 rhinos, mainly in Tabin Wildlife Reserve and Danum Valley), and create conditions for increase in numbers
- Mid term: establish contiguous habitat covering about 3000 km^2 capable of sustaining over 300 rhinos (Tabin Wildlife Reserve with 1200 km^2 has an estimated carrying capacity of 120 rhinos)
- Long term: restore viable rhino populations in all historical and suitable habitats throughout Borneo

In terms of ex situ conservation, the workshop recommended continuing and improving the breeding programme at Sepilok. Further information on this programme is available from SOS Rhino-Borneo (ejbosi@pc.jaring.my).

Cincinnati Zoo, USA

The female Sumatran rhino Emi that produced a calf at the Cincinnati Zoo in 2001 continues to progress well in her second sustained pregnancy. As of 28 May 2004, Emi was in her 414th day of pregnancy. The gestation period for the last calf was 475 days.

Australia

The Asian Rhino Project in Australia is a new 'non-profit, volunteer organization raising awareness of and support for the three Asian rhinoceros species'. Kerry Crosbie, a keeper at the Perth Zoo, is the founder of this organization. Peter Hall is a major patron and a trustee is Nicholas Duncan, whom many readers will know as president of SAVE-Australia, which has provided much support for rhino conservation in Zimbabwe and southern Africa. The Asian Rhino Project has already contributed significantly to conservation programmes for the Sumatran rhino in Sabah, Peninsula Malaysia and Indonesia and has goals for even more in the future. More information is available at: http://www.asianrhinos.org.au.

Sabah

Un atelier important sur la conservation du rhino de Sumatra s'est tenu à Sabah les 29 et 30 avril. Il était organisé conjointement par le Département de la Faune de Sabah, *SOS Wildlife* (Bornéo), *Carlota's Borneo Holidays* et *SOS Rhino*. Il a été inauguré officiellement par Y.B. Datuk Hj. Karim Hj. Bujang, vice-Ministre du Tourisme, de la Culture et de l'Environnement de Sabah. Il y avait 42 participants. La première session s'est intéressée au statut actuel de la conservation du rhino de Sumatra en Malaisie (Malaisie-ouest et Sabah), et à Sumatra, en Indonésie. La seconde séance a couvert les progrès et les actuelles activités de *SOS-Rhino* à Sabah. Deux groupes de travail étaient chargés de discuter les composantes *in situ* et *ex situ* du programme de conservation du rhino de Sumatra.

L'atelier a identifié trois objectifs majeurs pour la conservation *in situ* du rhino de Sumatra à Sabah et à Bornéo :

- Court terme : préserver la population actuelle (< 50 rhinos, principalement dans la Réserve de Faune de Tabin et la Vallée de Danum), et créer de bonnes conditions pour en augmenter le nombre ;
- Moyen terme : créer un habitat contigu couvrant environ 3000 km^2 capable de suffire à plus de 300 rhinos (la Réserve de Faune de Tabin, avec ses 1200 km^2, a une capacité de charge estimée à 120 rhinos) ;
- Long terme : restaurer des populations viables de rhinos dans tous les habitats où ils ont vécu et ceux où c'est possible, dans tout Bornéo

En ce qui concerne la conservation *ex situ*, l'atelier a recommandé de poursuivre et d'améliorer le programme de reproduction à Sepilok. Plus d'informations sur ce programme sont accessibles auprès de *SOS-Rhino-Borneo* sur ejbosi@pc.jaring.my.

Zoo de Cincinnati, USA

Emi, le rhino de Sumatra femelle qui a eu un petit au Zoo de Cincinnati en 2001, poursuit avec succès sa deuxième gestation. Le 28 mai 2004, Emi en était à son 414 jour de gestation. La durée de la gestation pour le premier jeune avait été de 475 jours.

Australie

Le *Asian Rhino Project* d'Australie est une « organisation sans but lucratif et bénévole, de sensibilisation et de support aux trois espèces de rhinos asiatiques ». Kerry Crosbie, qui est un gardien du Zoo de Perth, est le fondateur de cette organisation. Peter Hall en est Président d'honneur et Nicholas Duncan, administrateur, lui que de nombreux lecteurs connaissent comme président de SAVE-Australie, qui a apporté beaucoup de support à la conservation des rhinos au Zimbabwe et en Afrique australe. Le *Asian Rhino Project* a déjà contribué de façon significative à des programmes de conservation du rhino de Sumatra à Sabah, en Péninsule malaise et en Indonésie et veut faire encore davantage à l'avenir. Pour plus d'informations, consultez : http://www.asianrhinos.org.au.

Buy elephants and get your Eden free

Habitat Himalaya, vol. 10, no. 2, has a write-up entitled 'Buy Elephants and Get Your Eden Free' by Pralad Yonzon. This paper is about the wildlife market connected with ecotourism, elephant safaris and Nepalese policy on managing elephants. The core of Chitwan is saturated with seven concessionaires and their 70 elephants. Outside the park, four different operators handle 25 elephants. The more recent development is about tourism infrastructural activities of Kathmandu-based entrepreneurs, as locals sold entrepreneurs 33 large plots suitable for hotels and lodges. Once these infrastructures are built outside the park, the bottleneck for them would be park access for their clients riding elephants. For these operators, the domestic elephant management policy brings help in many ways. The park, however, may suffer from the onslaught of captive elephants. It is disappointing to note that Nepal has a wild population of only 108 elephants in its entire stretch while 147 captive elephants are packed into Royal Chitwan National Park, a World Heritage site. Unless we learn more about the ecological damage that captive elephants can cause in the park and act on that information, any move could be serious and costly. The full story in this publication is available in electronic form through www.resourceshimalaya.org. Or you may write to Resources Himalaya, GPO Box 2448, Kathmandu, Nepal.

RESEARCH

Monitoring law enforcement and illegal activities in the northern sector of the Parc National des Virunga, Democratic Republic of Congo

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Abstract

The Parc National des Virunga in the Democratic Republic of Congo, is emerging from a period of civil strife during which it has been difficult for the park management authority to undertake any meaningful conservation activities. Of particular importance in the struggle for survival of the elephant is the threat that poachers pose. During this difficult time, the Congo National Parks Institute had to adopt a low-key survival strategy, as it was not staffed or equipped to carry out its mandate. This paper focuses on a law-enforcement project carried out in the northern sector of the park. It presents systematically conducted law enforcement as an effective way of ensuring that protected area regulations are observed and that wildlife offenders are deterred. It points out current ecological threats that face the park. During the project period, the deterrence effect was equally important for both conventional and investigative operations. The paper emphasizes that increased effectiveness in anti-poaching can be achieved only by appropriate law enforcement as a deterrent by providing information that site managers can use to determine how to allocate resources optimally to improve protection and management of elephants and other wildlife. Optimizing law enforcement can lead to optimizing the level of deterrence and reducing illegal offtake to predetermined acceptable levels.

Résumé

Le Parc National des Virunga se reconstitue peu a peu de la période difficile pendant laquelle il était peu aisé pour le gestionnaire du parc d'entreprendre des activités de conservation. D'une façon particulière, la lutte engagée pour la survie de l'éléphant suite a la menace résultant du braconnage demeure vivace. En cette période, l'Institut Congolais pour la Conservation de la Nature (ICCN) a adopté un profil bas en terme de stratégie de protection du parc au regard du nombre limité de gardes et l'équipement insuffisant pour assurer avec succès la mission lui dévolue. Dans la présente étude, nous présentons un aperçu global sur l'application effective de la loi en tant qu'un moyen efficace pour le respect de la réglementation de la loi en vigueur dans l'aire protégée en même temps qu'elle fournit aux gestionnaires d'une aire protégée l'information utile pouvant lui permettre de prévenir les infractions tout en réduisant sensiblement e prélèvement illégal des éléphants. L'optimalisation en terme de l'application effective de la loi réglementant la gestion de la faune sauvage peut conduire à l'optimalisation du niveau de détection et du reste, à la réduction de prélèvement illégal à un niveau acceptable.

Introduction

Parc National des Virunga (PNVi) is emerging from a period during which it was difficult for park management to undertake any meaningful conservation activities. The period represents a phase of lost opportunities, unfulfilled objectives, reduction in wild animal populations, destruction of forests, human encroachment on protected areas, creating yet more ominous threats in the elephant's struggle for survival. Some of these threats are the direct result of chaotic park management. Of particular importance is the threat that poachers pose (Talukdar 2002). Recent data show that it is not deforestation but defaunation that poses the greatest immediate threat to animal conservation (Bennett Hennessay 1995). In addition, chronic civil strife spawned guns in wrong hands, a situation that has taken a heavy toll on wildlife. There have been movements of people and economic hardship, all of which have led to increased pressure on protected areas. During this difficult time, the Congo National Parks Institute (ICCN) adopted a low-key survival strategy, as it was unable to carry out its mandate while renegade people took the law into their own hands. The particular sociopolitical context of the region presents complex problems for managing protected areas.

Against this background parks could not be expected to run themselves. Comprehensive monitoring, which indicates the rate of encounter in the field with various types of illegal wildlife use, can help steer field operations in a manner that will optimize their level of efficiency. Optimizing law enforcement leads to optimizing the level of deterrence and reducing illegal offtake to predetermined acceptable levels. It helps determine how best to invest limited funds to deter illegal activities. For both conventional and investigative operations the deterrence effect is important.

This paper focuses on a law-enforcement project carried out in the northern sector of PNVi, a project mainly funded by the Small Grants Fund of the IUCN/SSC African Elephant Specialist Group for the period from 1 July 2002 to 31 July 2003. The project made a preliminary study of background factors affecting elephant poaching and other illegal activities by using a state-of-the-art geographic information system (GIS).

Our aim is to present an overview that assesses the current extent of law-enforcement efforts as an effective way to ensure that protected area regulations are being observed, to deter wildlife offenders and to reduce steeply the illegal offtake of elephants. The study identified the types of illegal activities while emphasizing current ecological threats facing the park along with possible baseline conservation strategies, and paves the way for further research.

Study area and habitat description

PNVi's varied habitats cover one of the most important bio-geographic areas of the first national park in Africa, created in 1925. The rich biodiversity of this natural ecosystem makes it a backbone and the showpiece of the biological diversity in the protected areas network of eastern Democratic Republic of Congo (DRC). It remains a natural crossroads where dense human population and fascinating wildlife have lived in historic harmony for years as a result of a combination of several factors, including widely varying altitudes, the overlap of several bio-geographic areas, fertile soils, a lake and heavy rainfall.

The 3500-km^2 northern sector of the PNVi ecosystem falls within the sudano-guinean savannah and montane forest biome between latitudes 0°95' N and 0°26' S and longitudes 28°9' E and 29°5' E. The alluvial Semliki Plain essentially dominates the northern sector of PNVi; it lies where the Semliki River, coming from Lake Edward, flows into Lake Albert (fig. 1). It is part of the Albertine rift valley, a bio-geographic region important for its biological diversity as it contains a high proportion of endemic plants and animals. The region is also ecologically important as a portion of the watershed for two main African river systems—the Congo and Nile basins—and culminates at Marguerite Peak (5119 m) in the Ruwenzori Mountains.

Methods and analytical framework

Data collection and navigation

Law-enforcement methods the project used were of a hierarchical design that fell into two classes: conventional in the form of foot patrols within the study area, and non-conventional in the form of investigation operations following up information supplied through a recently developed system of informants outside the study area (Jachmann and Billiouw 1997). Patrolling involved routine inspection inside the park, checking the boundaries, sometimes patrolling outside the park, and visiting local villages neighbouring the park. Although guards were put on patrol with little training or

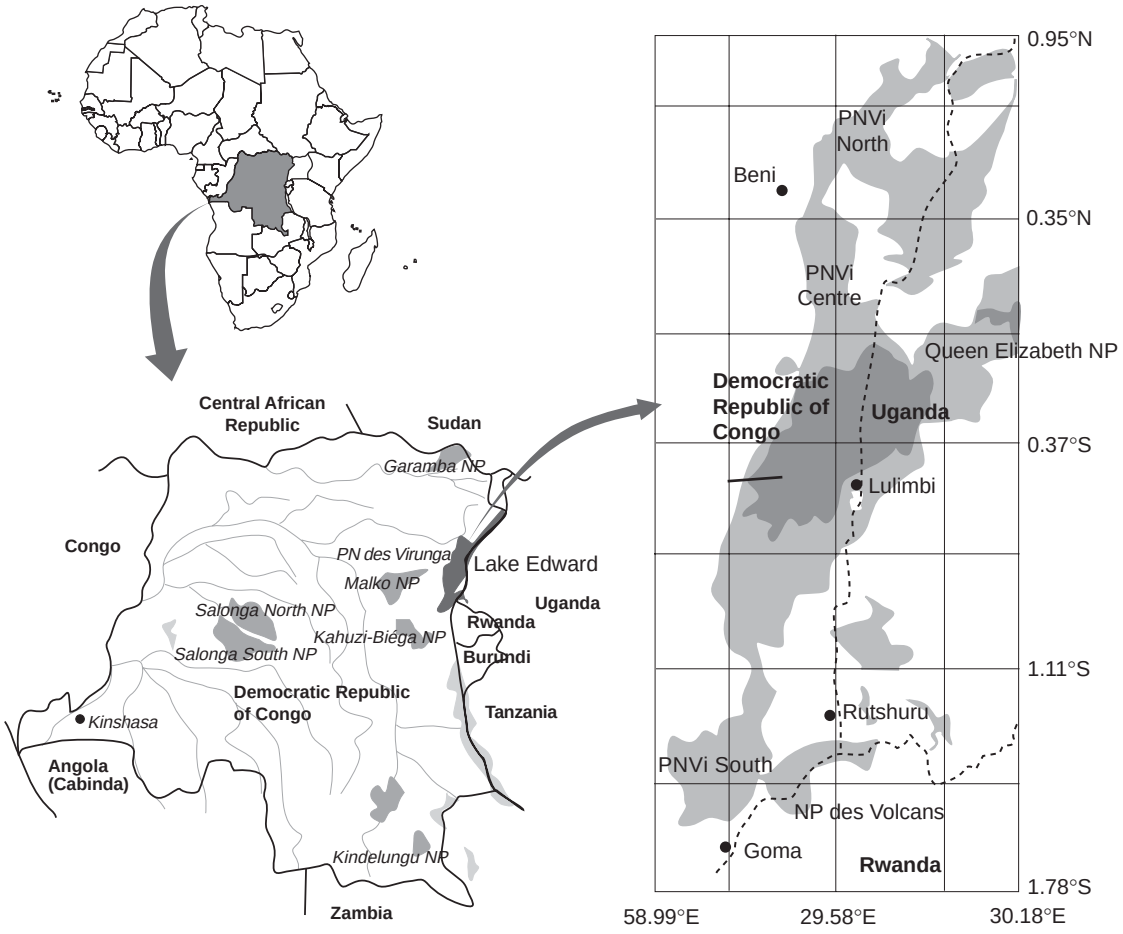

Figure 1. Parc National des Virunga (PNVi, right) and its location in the Democratic Republic of Congo (left) (NP = national park).

scientific background, even those with the lowest educational standards were able to achieve a high level of reliability in recording patrol information during regular monthly patrols. Law enforcement data were analysed to allow better deployment of patrols, the collation of intelligence, and an assessment of the effectiveness of patrols in curbing poaching.

A survey technique for guards designated and trained to record observations made while on patrol was used regularly. They recorded all information on actual encounters with poachers such as poachers observed or arrested and indications of their presence such as poachers' camps found, poached carcasses, active snares and gunshots heard. Data entry sheets included field maps, and the dense network of rivers and streams in the park together with the pronounced local knowledge of the guards ensured relatively accurate positioning of observations made. Spatial precision of the recordings was enhanced with the use of the global positioning system (GPS). They also recorded 'effective patrol days', that is, days spent actively pursuing illegal activity while on conventional foot patrol (Bell 1985a,b). They used a standardized patrol form for each conventional patrol, which included general information on the patrol, information on animal sightings and carcasses, encounters with illegal activity or indicators of it, and information relating to the patrol route followed.

On return from patrol, the patrol leader and the patrol recorder were debriefed to ensure comprehensiveness and accuracy. The patrol route and any incidents of illegal activities were indicated on a grid map of the

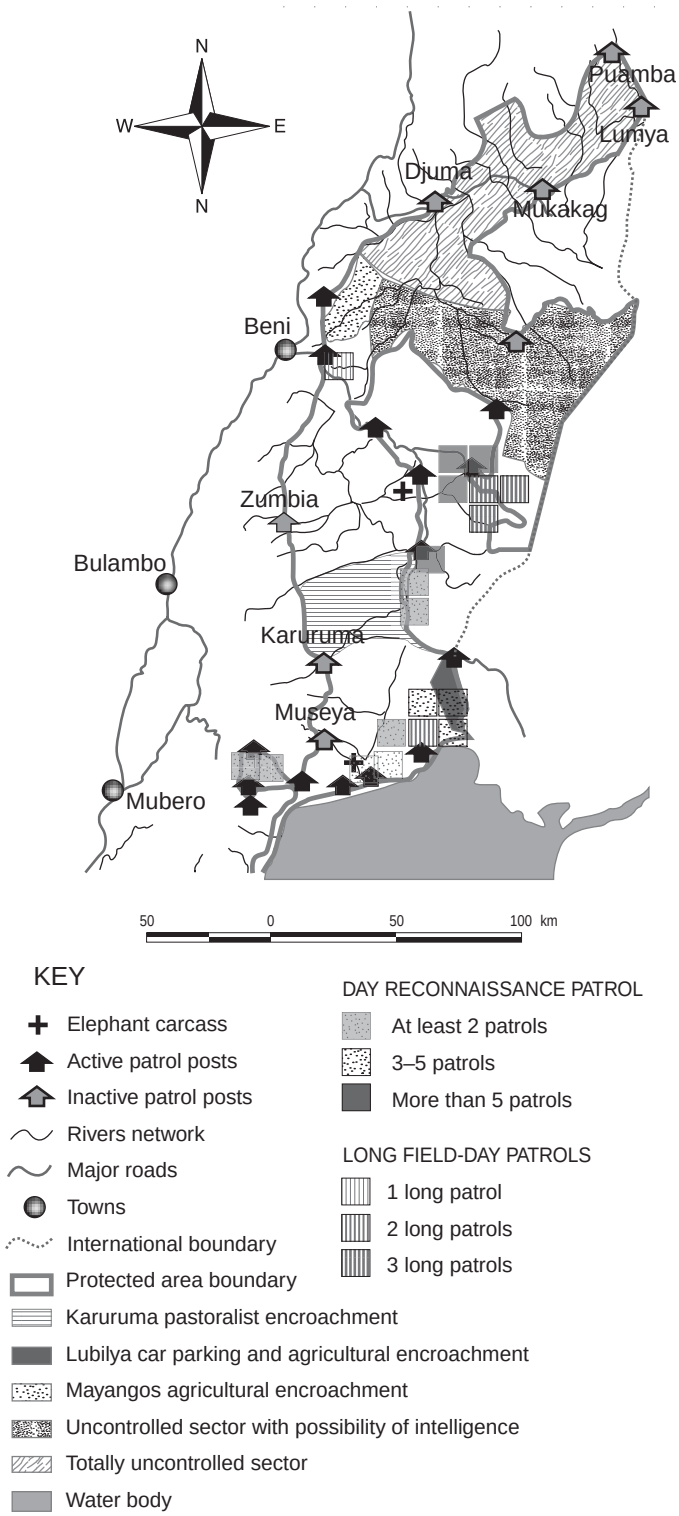

Figure 2. Sectors showing law enforcement and those covered by patrols in northern Parc National des Virunga.

5 x 5 km area (fig. 2). This information became part of monthly feedback reports (Jachmann 1998).

It was important to be realistsic and practical about areas to be covered, distances to be walked, and how and by whom the patrol would be conducted and supervised. If for any reason it was not possible to cover an area fully or even partially, the fact was reported unambiguously. From the outset, it was made clear to the entire armed patrolling squad that if such facts were not reported, the survey data would be rendered invalid. For selected sample units, detectability could then be estimated using either the multiple-observer approach or the approach of a single observer making multiple visits. Under the multiple-observer approach, two different field teams were sent to the same sample unit (sector) on different days. The time separating the two visits was short, but long enough that the human sign left by the first field team did not lead the second team to detect it and interpret it as animal sign. Under the single-observer approach, a single field team would revisit for a second time sample units (sectors) in which no sign was detected the first time. Under both multiple- and single-observer approaches, the information resulting from patrol efforts was a list of species that were detected or not detected on each field trip. These presence–absence lists collected on the repeat visits then formed the basis for estimating detectability, and hence the total proportion of sample units (sectors) that was more or less patrolled. At least one member of the team was given the task of writing down the information and later transferring it to the maps.

The first step towards monitoring law enforcement and illegal activities was to measure patrolling effort. First, staff time was divided into categories according to likelihood of contact with poachers, such as base time, off time, placement time and effective patrol time. 'Placement time' was defined as time spent moving between base and the location of the investigation and 'effective investigation time' as time spent


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Community schemes have proved effective elsewhere in deterring local poaching. However, poaching by organized gangs may not be as successfully tackled through community schemes when heavily armed gangs come from outside the park. Here at the Epulu headquarters checkpoint, manpower is directed into law-enforcement patrols, ready for immediate deployment.

actively investigating information about illegal activity. Only the last category is used in calculating patrol effort, while the ratio of effective time to the other categories is a useful index of the efficiency and motivation of field staff. Effective time is time spent on foot in the bush, away from roads and certain footpaths. The most useful measure of patrol effort was the number of *effective patrol days* and the distance patrolled (coverage). For patrol reports, the standard recording forms developed by the CITES/MIKE programme were used (Hunter 2002).

The system was intended first to quantify patrolling effort by various measures; second to quantify illegal activity encountered by patrol according to a set of standardized categories; and third to derive indices of the amount of illegal activity recorded per unit of patrolling effort. This gave a 'catch per effort' index of the quantity of illegal activity.

Use of informers

Investigation operations were mainly carried out in the villages and cities surrounding the park, following back to its source information supplied by informers or guards. Much of the information was provided using pygmies living at a village near the patrol post. These dedicated people managed to gain access to parts of the uncontrolled area due to their knowledge of it. As more than 60% of the park is open canopy, detecting carcasses was not a problem, and observing the presence of birds of prey helped.

GIS modelling

State-of-the art GIS served as a powerful tool for creating maps, making measurements, examining spatial relationships, and undertaking predictive modelling. It can greatly assist wildlife managers in decision-making. Spatially linked law-enforcement data can easily be entered in the GIS and plotted on base maps. Spatial–temporal data on law-enforcement effort (patrol routes, patrol frequency, and so on) and law-enforcement results (indicators of illegal killing of wildlife, poacher arrests, and so on) are among the most important correlates of elephant distribution. Our GIS-produced map provided a strong visual and analytical aid for this assessment and helped identify priority areas and resource and management needs. GIS was useful in mapping locations of patrol routes and illegal activity indices and in calculating patrol effort in different zones. This information was then related to sighting and poacher-detection data to evaluate the performance or success of law enforcement (Leader-Williams et al. 1990; Leader-Williams 1996).

Results and discussion

Relating illegal activity to patrol effort

Law enforcement is a fundamental management activity. It involves more than just controlling poaching even though this might be the core activity of the corps of guards and rangers involved. The commonly used term 'anti-poaching' is therefore inadequate and is replaced here by 'law enforcement'.

During the study period, 2 elephants out of the 21 counted following a recent aerial survey (Hillman Smith et al. 2003a,b) were known to have been killed. Obviously not all the project area could be covered by foot patrols, and consequently some elephants killed illegally may have been missed, particularly in the far northern Watalinga area, including Djuma, Mukakati, Lamya and Puemba, where three former patrol posts remain inaccessible for security reasons (fig. 1). Information available from these areas comes from informant sources building upon limited information of the operations carried out within the park. Occurrence books and reports from park headquarters during the study period show only two documented cases of human–elephant conflict in the agricultural settlements. Although conflict between people and elephants seems little documented, it is important to note that some crop depredation might have gone unreported, often because it occurs in remote areas with poor patrol coverage (fig. 2). Better quantitative data on crop damage are required as little is currently known about the extent of damage in specific areas.

The number of guards the park employs has not increased since June 2001. Out of the 17 patrol posts park management currently runs, only the headquarters in Mutsora and the Ishango subheadquarters were equipped with 25 recently acquired weapons, thanks to the park warden's invaluable diplomatic initiative. The guards in the remaining patrol posts were unarmed and thus had necessarily adopted a passive 'eyes and ears' role. Most poachers were aware of this reality and not surprisingly showed scant respect for rangers (Mubalama 2000). The reduced law-enforcement operations that ICCN maintained were still having a slight positive effect: in June 2003, 10 people were arrested, 28 snares destroyed, and in Mayangos, Makisabo and Nyaleke areas 9 saws for pit sawing, 2 axes, 4 spades and 12 machetes were seized (fig. 2); in a raid carried out by guards less than 24 hours later, armed guards seized another chain saw. The average guard density of one guard per 36 km^2 in the northern sector was much less than the density of one guard per 10 km^2 in the central and eastern PNVi sectors (Mubalama 2000).

Poaching and park security

This study found that poaching elephants for their ivory has increased; hunters prefer going after larger species because they provide higher returns for the cost of hunting (Leader-Williams et al. 1990). From 1997 until 2001, more than 60 elephants were poached in various parts of the park exclusively for their ivory (Mushenzi 2002). The civil conflict in DRC, which has continued since 1997, precipitated an upsurge, because guards were disarmed and anti-poaching was curtailed for several months following the spread of loose guns. Record keeping was poor throughout the park before 2002. It is thus possible that, because records on elephants were poorly maintained and undercover informant sources were lacking, poachers might have killed many more elephants in the park than the park staff realized, especially in uncontrolled areas of relatively broad-leafed woodland (Mubalama 2000) with possibly poor coverage through inadequate patrol effort (fig. 2).

Poaching remains the major threat facing elephant conservation. Whenever animals are poached staff morale drops, and whenever staff morale is low, poaching levels rise. However, whenever morale of the guards is high, poaching is slightly reduced, as 2002 data show. This situation was consistent with Talukdar's striking findings following his recent study on rhino poaching in Assam, where poaching fluctuated according to the local situation such as the degree of social instability, political and administrative support, and quality of intelligence (Talukdar 2002). In addition, security in the park remained precarious, especially where small, isolated anti-poaching teams were constantly at risk of being attacked by poachers, notably in the more remote northern sector of the park where the severe lack of workforce was basically linked to the insufficient budget allocated to these areas. Moreover, current infrastructure was not adequate to support distant patrols efficiently. Despite their tough anti-poaching stance and motivation, the lightly armed and outnumbered park rangers were powerless to oppose the well-armed and determined poachers, who were largely elements of the military.

Lucrative prices offered by ivory traders have increased the financial gains of the illegal trade, resulting in a large number of mafia-like operations, which the guards with their limited organizational set-up find difficult to counter. In addition, the judiciary and the police have shown little sensitivity towards quick apprehension and timely prosecution of elephant- poaching offences (Boshe 1986; Talukdar 2002).

Various criteria affect the price of ivory in the market: weight of the tusk (those over 8–10 kg have a special price, a kilogram of ivory fetching USD 10

on the local market); colour (white is preferable); depth of the fissure (varies according to age and sex of the animal); whether the tusks come from the same animal or not (a pair sells for a higher price than two single tusks).

Three categories of traffickers were identified: 1) military and bigwig political store owners, who got ivory by providing weapons and ammunitions to well-identified poachers and took their loot to Kampala; 2) wealthy Congolese store owners, who organized their trade in collusion with ivory traffickers; and 3) small-scale traffickers who bought from hunters and went to Beni or Butembo areas (fig. 1) to sell or who found that sometimes it was more profitable for them to exchange tusks for ammunition directly. For a village man, owning a gun was thus a sure means of obtaining food and good housing. Earnings from ivory poaching enabled some traditional chiefs and successful hunters to own houses built of permanent materials. Meat was plentiful for those living in the neighbourhood of the park on the border with Uganda where they undertook cross-border trade; some was consumed locally but most was sold.

Illegal human activity and park encroachment

Observations showed that large herds of livestock were concentrated in the Karuruma area with about 4500 cattle (Mushenzi, pers. observation) and an undetermined number of sheep and goats brought in by Ugandan herdsmen of the Hema tribe. The most telling indication was that 26 km^2 of the Karuruma area and 9 km^2 of Mayangos area had been encroached on (Mubalama, pers. observation) while 7 km^2 of encroached land with a car park measuring 68 m^2 was established in the park at Lubiriya (fig. 2), countering all common sense (Les Coulisses 2000). These figures signify a high level of illegal human activity, including boundary demarcation issues, as a direct result of park encroachment. This interaction involved competition for limited resources such as water and grazing areas. With the presence of so many illegal firearms in the hands of these foreign herdsmen, who were often seen carrying them while herding their livestock, incidents of elephant mortality will continue to increase. It is thought that the Hema pastora-

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A poacher after killing an elephant, caught red-handed by a long field-day patrol team in Lulimbi sector.

lists use *Euphorbia candelabrum*, so characteristic of much of the park, to make their cattle stockades because it is abundantly available.

A major challenge emerged in attempting to develop sufficiently rigorous demographic data, as there was no precise, current population census for these areas given the evident logistical difficulties and political turmoil. Remote-sensing techniques could provide a viable alternative to traditional demographic surveys in areas of limited accessibility and would improve our understanding of elephant interactions with other wildlife (De Merode et al. 2000). Some of the digital data may not be georeferenced, and ground control points will have to be obtained. Digitizing by hand is laborious and error prone, but often we found it to be the only way to incorporate certain types of data sets into a GIS. To digitize from hard copy successfully, at least four, and preferably more, ground control points were needed to georeference the digitized information properly.

Law-enforcement budget and elephant mortality

Two of the three predictor variables relating to the budget—the total law-enforcement budget and personal emoluments per guard per month—did not significantly influence the numbers of elephants found killed illegally (table 1). The optimum law-enforcement budget, which should result in no elephants being killed, is projected to be USD 97.33/km^2. This surprising result strongly contrasts with the USD 200/km^2 frequently cited in the literature (Cumming et al. 1984; Bell and Clarke 1985; Leader-Williams and Albon 1988). It is, however, consistent with the optimum law-enforcement budget obtained in the central Luangwa Valley, Zambia (Jachmann and Billiouw 1997).

The park went through a difficult time from 1997 to 2001 when there was no performance-related bonus scheme. The number of elephants found killed illegally varied from 19 in 1999 to 4 in 2000 (Mushenzi 2002). The number found then rose sharply to 18 in 2001, due basically to the previous chief park warden and senior staff being dismissed and a new and experienced protected-area manager taking over. He firmly got his teeth into curbing elephant poaching and took stringent measures to protect wildlife. Despite the harsh conditions, dedicated game scouts continued their struggle and in recent times they managed to stop the amount of elephant poaching in ICCN-controlled sectors.

The first and most important predictor variable, the number of bonuses paid, did not increase from 2001, when the performance-related bonus was introduced, to 2003. Due to the one-year time lag, the average bonus did not appear to have a significant influence on the number of elephants found killed illegally.

The number of effective patrol days per square kilometre increased from 1.03 in January–June 2002 to 1.54 in January–June 2003. There was no significant difference in the number of elephants found killed illegally from 2000 to 2003, and poor coverage of the sector in June (fig. 2) was evident. Only one elephant killed illegally was detected in 2002 and another in June 2003. The large number of scout days carried out in 2002 slightly reduced poaching, through improved morale of the guard force and an increased amount of workforce during conflicts. This is the period when the performance-related bonus scheme from the United Nations Foundation and UNESCO project was at its height. As recommended by Jachmann (1998), efforts should be made to keep an acceptable minimum of between 10 and 13 effective days per scout per month to increase the patrol efficiency and frequency in the park.

Table 1. Variables relating to law-enforcement input, budget and number of elephants found killed illegally

Year	Elephants found killed	Budget (USD)		Law-enforcement input[a]	
		Law-enforce. expend./km^2	Personal bonuses/guard mo.	Effective patrol days/ km^2	Effective investigation days
2000[b]	4	—	—	1.03	—
2001	18	73.22	24.01	2.06	—
2002	1	139.38	24.01	2.08	29
2003[b]	1	79.39	0.00	1.54	47

[a] 36.08 km^2 per guard
[b] figures are from January to July

Elephant hunting situation after the 1989 ban

Building upon the monitoring results, the CITES ban on the trade in African ivory and subsequent price decreases have had a limited deterrent effect on the level of poaching in the northern sector of PNVi as a whole. There is an economic argument for why the ban did not totally halt poaching during the armed conflict. Many guns were in wrong hands, and poachers could take elephants for free. Elephants represented considerable capital, and traders were still paying for ivory. At the same time the country was in the throes of a terrible economic slump; thus any activity would have a low profit margin but still have participants. For years after the 1989 ban, the park was run on a hand-to-mouth basis before NGOs filled a vital gap covering material and technical aid that included transport, uniforms, food, aerial support, training and operational backup. The PNVi elephant population went from 830 animals in 1989 to about 650 in 2001 (Sikubwabo and Mubalama 2003).

Because of the severely deteriorating economy in eastern DRC people were willing to work for very low profit margins, significantly lower than in 1990, soon after the African ivory ban. During the study period, the cost to a poacher of taking an elephant was still extremely minimal, costing only for such items as shells and porterage.

In addition, the effects of automatic weapons on PNVi's elephants is probably one of the best-documented case histories of a population collapse caused solely by poaching for both meat and ivory after the CITES ban. Qualitative reports suggest that the increase in elephant poaching following the wars and civil strife has been massive. It would be reasonable to assume that during the decade the number of men serving in the armed forces has more than trebled in the region. On several occasions, weapons were reported lost, stolen, taken from defeated soldiers, issued to militias, channelled secretly to *Mai Mai* militia movements, or simply traded by soldiers for money or goods. The result was that the price of an automatic rifle dropped drastically. A gun could cost from USD 100 to 120, cartridges from USD 0.80 to 1.00 each. Hundreds of rifles came into the hands of local people in that area and they began to poach. Many hunters used AK-47s obtained from the military barracks for which ammunition was in plentiful supply and difficult to control, especially during armed conflict.

The PNVi's elephant population cannot withstand a resurgence of the onslaught of the 1980s. Elephants need time to recover, not just in terms of overall numbers but also in terms of restoring their capability to fulfil their ecological function. Such a recovery might be rapid in some areas of the park but could take 10 to 20 years in areas that have suffered heavy poaching like the far northern sector, not yet under park management control.

Economic crisis and management constraints

Officially the economy of the region is in a state of disaster: exports cannot keep up with imports, industry barely functions and production lags, scarcities are rife, the infrastructure has deteriorated drastically, wages are at starvation level, and nothing works as it should. The reality is that despite the severe economic crisis, the population still finds the means to survive, often by slaughtering wildlife. Some people have thrived and become wealthy. Clearly the picture is not in the official reports; a great deal of economic activity is taking place outside the official system, as people take matters into their own hands, seeking to find ways to subsist. The illegal take of natural resources has expanded; such is the case with ivory (MacGaffey 1991).

Given the scale and unpredictability of the illegal exploitation of wildlife within the park, most of the park's resources are allocated to controlling poaching through armed patrols in the park, and providing the logistical support and infrastructure needed to maintain these patrols. The objectives of the strategy are to reduce the level of poaching and by doing so, enable wildlife populations to recover. Strategy effects cannot yet be measured given the lack of data on the status of faunal distribution and trends in wildlife populations on the whole ecosystem since the beginning of the civil war. About 51% of the protected area was under full control of park management, 26% was uncontrolled and 23% was accessible only through undercover expeditions (fig. 2).

Factors limiting the curbing of poaching

Several factors limit the curbing of poaching. There are two types of constraint; one is related to the lack of institutional support (political support), and the other includes everything that requires funding.

LACK OF INSTITUTIONAL AND ADMINISTRATIVE SUPPORT FROM GOVERNMENT

A concept of operation effective today might have to be adjusted to a changing situation. Offenders will likely adapt their method of operation according to the countermeasures law-enforcement personnel use. Increasingly illegal hunters operating in the park do not hesitate to attack law-enforcement personnel whenever they meet. Therefore, it is difficult to approach suspects, identify and question them, and take them into custody if there is reason to believe that they have committed an offence. Consequently, the threat has to be neutralized to ensure the safety of the investigating officer, and existing legal provisions may not cover such action. The ease of obtaining firearms and ammunition and the reported immunity from prosecution of big buyers because they enjoy political protection makes prosecution of poachers unlikely.

LACK OF MEANS OF LIVELIHOOD FOR LOCAL PEOPLE

The lack of cash income in the local economy, due to a massive decline in coffee production, the main economic activity, over the past two decades, had an immediate effect on local people. They need clothing, food and household goods, all of which are difficult to obtain under current economic conditions. Although a conservation policy exists, it has not been easy for park management to implement it because of political limitations and corruption. It is therefore a tragic twist of fate that poaching has been the easiest way to fill the vacuum.

LACK OF LOGISTICAL SUPPORT

A technical standard has been established for conducting field operations. How well it can be put into operation will depend on the capability of logistical support. This affects the type and duration of missions, which missions can be carried out, and the radius of their operation. If available resources are not sufficient to ensure reasonable logistical support, a reduction of the radius of operation must be accepted. Ensuring effective loss control within a reduced area is preferable to trying to cover a large area ineffectively. Lack of adequate logistical support will lead inevitably to a breakdown of operations or even to mutiny. No matter how well trained and equipped the personnel, they cannot be effective if they cannot be deployed at the right time in the right place and if they cannot be backed up, due to lack of access. Constructing and maintaining infrastructure to ensure the mobility of surveillance units must be addressed. The cost for such projects is often prohibitive and implementing them technically difficult. Now is the time, with peace coming to DRC and more chance of support, to focus resources on combating these threats and rebuilding effective conservation measures for these outstanding and scenic areas of PNVi.

Opportunities and short-term perspectives

Questions are still being asked as to what are the most appropriate measures to counteract the decline in elephant numbers, what international support should be provided, and for how long. While attempts are being made to find the most viable solution both internationally and locally, what is undoubtedly true is that if the present rate of decline remains unchecked, the bulk of north PNVi's elephant populations will drop to unsustainable levels. If we want to close the time gap between international agreements taking effect and elephant survival, it is urgent that national and international efforts be redirected against these particular gangs and raiders.

NGO SUPPORT

Over the past 20 years or so, the number of elephants in the PNVi ecosystem has dropped from an estimated 800 in 1971 to fewer than 650 in 2001. While accepting that the present status of the elephant is alarming, we should also acknowledge the efforts that have been and continue to be directed in the parks towards conserving the species. Non-governmental organizations have recently placed appreciable emphasis on elephant conservation by helping ICCN strengthen law-enforcement units. More severe penalties are being imposed on convicted poachers. Looking at these efforts, one wonders why the species continues to become endangered. The explanation is simple: poaching. In addition, the high human population density puts great pressure on the protected area. Positive behaviour towards conservation needs to be cultivated among local communities living near the park.

STRENGTHENING THE 'STRIKE FORCE'

The strike force is a patrolling team that comes from headquarters to reinforce the anti-poaching effort at any particular patrol post when the limited force there needs help. Its efficacy depends on good communication and mobility. While the Zoological Society of London is providing radio capability adequate for the force's own operations, this facility must be supplemented by other radios, including hand-held VHF sets, to keep outposts in easy and reliable contact with the strike force. The strike force mounts armed patrols on a regular but unpredictable basis throughout the park. The expenditure of USD 97.33/km^2 is basically covered by partners, including the Dian Fossey Gorilla Fund-Europe, the Zoological Society of London and recently by a small grant from the IUCN/SSC African Elephant Specialist Group. Traditionally, laws have been enforced through a comprehensive array of ranger posts scattered strategically throughout the park, from which armed and unarmed guards mount patrols. The strike force consisting of different sections is based at park headquarters in Mutsora. Following recent training for the strike force, park management has decided that the Ishango subheadquarters will be reinforced with the various units being seconded there on a rotational basis.

REDESIGNING PRIORITIES

Elephants can be saved if a large portion of money now being used for research and counting is directed to law-enforcement activities. We are well aware of the limited operational capabilities of guards and the risks facing them out there in the bush due to lack of adequate equipment. In addition, they are subjected to poor living conditions in a harsh environment. A large portion of both donations and the government budget for conservation should be used to provide the equipment needed for law-enforcement operations: reliable field vehicles, two-way radios, modern automatic weapons and uniforms. A comprehensive training and recruitment programme for rangers and their field officers must be given priority and funded, given the current lack of expertise. The social welfare of these people needs to be improved by providing them with good housing, clean water and health care. Remuneration packages should give them good prospects and provide an incentive to do the work well.

We are in no way opposed to scientific research or regular surveys of wildlife populations. We need such information to demonstrate trends over time and thus to formulate appropriate conservation and management strategies to secure elephants' future. But given the present appalling situation, continuing the annual population surveys will deplete the limited resources that otherwise can be used to save the elephants. With so many firearms currently concentrated within and outside the park and the general lack of security, the future of these pachyderms is bleak unless far more stringent law enforcement is put in place. Because conservation strategies for the PNVi elephant populations are underfunded, attention must focus on the single devastating factor—poaching—or else our surveys will simply compile information that will be used to write a history of a once abundant but now extinct keystone species.

NEED FOR POLITICAL WILL

Together with this appeal to spend more on law enforcement and less on fundamental research and population surveys, there is a need to look more deeply into the entire issue of poaching. At the moment, poachers once arrested are prosecuted as individuals. In reality, elephant poachers do not operate singly, and other figures behind the scenes, often key members of the operation from the initial planning stage to the final selling of the ivory, are neither investigated nor subjected to judicial proceedings. If elephant poaching is to be eradicated, law-enforcement efforts must also aim at bringing these people to book. Wardens and park guards alone cannot achieve this. Other government departments must be involved, such as the general police force, the criminal investigations department, the judiciary, customs and excise, the intelligence services and the general public. As Boshe (1989) pointed out, 'If our anti-poaching efforts capture the "artillery-men" of the enemy in this war, then their "infantry" will be paralysed, and we will have won the battle'.

The current situation in northern PNVi is being actively and urgently addressed by an emergency strategy developed jointly at the park and approved by ICCN headquarters in Kinshasa. The main objectives are to tackle poaching, prevent any more deaths of *Key* species and allow numbers to rebuild before it

is too late, then gradually gain control of the whole park by

- developing and implementing a full-scale effective training and retraining operation from the training base at Ishango
- revising and implementing an effective law-enforcement strategy to protect the elephant population in the immediate term and to regain control of the whole park in the long term
- providing technical, logistical, maintenance, equipment and ration support necessary, increasing aerial support, raising awareness and support on the basis of successful actions such as detailed intelligence work outside conservation areas
- carrying out a major diplomatic and pressure initiative to inform the Uganda hierarchy and UN peacekeeping forces of the true situation and request their action and appropriate support
- ensuring the availability of continuous information on elephant status and numbers, which is vital for the effective conservation and management of PNVi's remaining elephant population
- increasing communication and collaboration with the surrounding communities and encouraging local diplomatic initiatives (Hillman Smith et al. 2003b).

Until these objectives are achieved the onus remains with the NGOs to continue their vigilance and monitoring of the law-enforcement survey work.

Conclusion and recommendations

Monitoring illegal activity and relating it to patrol effort makes it possible to assess which sectors or areas and which seasons are most affected by which types of illegal wildlife use. Since the three most important variables considered in the search area—visibility, habitat and weather—can change many times on a single patrol, we recommend recording them regularly and including them in the observations table of the form. Given the project time limitation of one year, we did not collect enough information to allow us to establish trends per area and season statistically or to make major distinctions in illegal killing of wildlife between serious offences that were directly related to the illegal killing of elephants and minor offences that may or may not have been related to the illegal killing.

Ideally each patrol should use a GPS to record its movements and observations, as an important measurement is patrol coverage and patrol frequency. Therefore, we recommend that the GPS units used for the pilot project be taken to PNVi north to be used for the standardized data reporting system and that data be analysed on population trends, patterns of effort, and factors that influence illegal killing.

Wildlife conservation laws have become stricter and increasingly more difficult to enforce during the last few decades due to three major factors: 1) a decline in the number of wild animals as a result of overexploitation and the destruction of their habitat by humans; 2) the attractive market prices offered for some trophies; and 3) an increasing shortage of human food, particularly meat.

Poaching in the northern sector of PNVi cannot be stopped simply by increasing the number of uniformed wildlife law-enforcement officers or by supplying them with more automatic weapons and ammunition. Evaluation of law-enforcement methods indicates that for serious offences the most effective method is investigation based on detailed intelligence work outside the park. A high intensity of regular patrolling in priority areas is required to curb minor offences. Increased effectiveness in anti-poaching can be achieved only by appropriate law enforcement as a deterrent. The site manager needs information that can be used to determine optimum allocation of resources and improve the protection and management of elephants and other wildlife. An important point is that elaborate equipment such as 4-wheel-drive vehicles, hand-held VHF sets, aircraft and even tents can increase the effectiveness of a field force by synergizing and increasing mobility of troops on the ground. This fact remains important in assessing project submissions in the near future.

If CITES and the DRC government do not improve and enforce wildlife laws and decrees, ivory markets and buyers will continue to claim the lives of many African elephants. Because of the threats faced, more resources should be set aside by the re-emerging nation for wildlife protection, and intensive air and ground patrols should be carried out continuously to monitor the status of keystone species, including elephant. In addition, we urge the national government to consider signing the Lusaka Agreement on Cooperative Enforcements Directed at Illegal Trade in Wild Fauna and Flora to combat from top to bottom and ultimately eliminate illegal international trafficking in African wildlife, all the more so since this agreement provides a legal basis for co-

operative law enforcement so far achieved nowhere else in the world. From that prospect, there is also a clear need for coordinated surveillance efforts across PNVi and Queen Elizabeth National Park in Uganda, to identify the true range and size of the elephant population within these two protected areas.

Lastly, we applaud the recent statement in Conf.10.10 (Rev. CoP 12) that the monitoring system should encompass capacity building in range states to provide information that will facilitate elephant management, and to prioritize enforcement initiatives and protection. The objectives are to measure and record levels and trends of illegal hunting and trade and to establish an information base to support appropriate management, protection and enforcement needs.

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Impact of dam construction on two elephant populations in northern Cameroon

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Abstract

The impact of dam construction projects on two elephant subpopulations in the Waza and Lagdo areas in northern Cameroon was studied between 1994 and 2002. Both subpopulations were affected by dam construction projects, in 1979 in Waza and 1980 in Lagdo. In the Waza area a pilot flooding in 1994 attempted to restore conditions of the original floodplain. Total (dry season) elephant numbers in Waza had significantly increased from an estimated 465 in 1978, one year before the dam was constructed, to an estimated number of 1140 in 2001. In the Lagdo area the number of resident elephants (dry-season numbers) increased from zero in the years before the dam was constructed to 250–300 in 2000. Maximum distance travelled ranged from 147 km for the Waza elephants to 5.1 km for the Lagdo elephants. Average home range of the Waza elephants was 2546 km^2 and of the Lagdo elephants 119 km^2, which reflects the differences in maximum distance moved. In both areas crop raiding seriously increased after the dam was constructed. Movement, home range and habitat use of three elephants in each subpopulation were monitored, using satellite and VHF telemetry. Data on Lagdo elephants' use of habitat in the dry season showed that they spent significantly more time in the floodplain than in the savannah woodland in the years after dam construction. But contrarily, in the years after dam construction, the Waza elephants showed a reverse pattern, spending more time in the savannah woodland and less in the floodplain. This pattern changed suddenly after the pilot flooding in 1994, when they consistently spent more time in the floodplain. Habitat conditions of the Lagdo elephants did not deteriorate after dam construction, because water and vegetation were abundant, whereas habitat conditions of the Waza elephants deteriorated severely until they were restored to a semi-natural state after artificial flooding in 1994. It is concluded that these differences can be explained by the different effects of the dams—the Lagdo and the Maga constructed at Waza.

Additional key words: crop raiding, floodplain, habitat conditions, savannah woodland

Résumé

On a étudié l'impact de la construction de barrages sur deux sous-populations d'éléphants dans les régions de Waza et de Lagdo, au nord du Cameroun, entre 1994 et 2002. Les deux sous-populations ont été affectées par des projets de construction de barrage, en 1979 à Waza et en 1980 à Lagdo. Dans la région de Waza, une mise sous eau pilote a tenté, en 1994, de restaurer les conditions de la plaine inondable originale. Le nombre total d'éléphants (en saison sèche) à Waza avait augmenté significativement : alors qu'il était estimé à 465 en 1978, soit un an avant la construction du barrage, il était d'environ 1140 en 2001. Dans la région de Lagdo, le nombre d'éléphants résidents (en saison sèche) est passé de zéro avant la construction du barrage à 250–300 en 2000. La distance maximale parcourue allait de 147 km pour les éléphants de Waza à 5,1 km pour ceux de Lagdo. L'espace vital moyen des éléphants de Waza était de 2546 km^2, pour 119 km^2 pour ceux de Lagdo, ce qui reflète bien les différences des distances maximales parcourues. Dans les deux régions, le pillage des cultures a augmenté sérieusement après la construction des barrages. Les déplacements, l'espace vital et l'utilisation de l'habitat ont été contrôlés pour trois éléphants de chaque sous-population, par satellite et

télémétrie VHS. Les données concernant l'utilisation de l'habitat par les éléphants de Lagdo en saison sèche ont montré qu'ils passaient significativement plus de temps dans la plaine inondable que dans la savane boisée dans les années qui ont suivi la construction du barrage. Par contre, après la construction du barrage, les éléphants de Waza ont présenté un comportement inverse, passant plus de temps dans la savane boisée et moins dans la plaine inondable. Ce comportement a changé soudainement après la mise sous eau en 1994, quand ils ont commencé à passer plus de temps dans la plaine inondable. L'habitat des éléphants de Lagdo n'a pas été détérioré après la construction du barrage parce que l'eau et la végétation étaient abondantes, alors que les conditions de l'habitat des éléphants de Waza s'étaient gravement détériorées jusqu'à ce que l'on restaure un environnement semi-naturel après l'inondation artificielle de 1994. On conclut que ces différences peuvent s'expliquer par les effets différents des barrages—le Lagdo et le Maga construit à Waza.

Mots clés supplémentaires : pillage des cultures, plaine inondable, conditions de l'habitat, savane boisée

Introduction

The present article covers the impact of two dams constructed in the home range of two separate elephant subpopulations in northern Cameroon. Maga dam is located in the area around Waza National Park in the extreme north of the country and Lagdo dam in North Province, farther south (fig. 1).

Details of both dams and their reservoirs are given in table 1. In 1979 Maga dam was constructed near the village of Pouss on the Logone River, creating a lake of 180–250 km^2 (fig. 2). In addition the

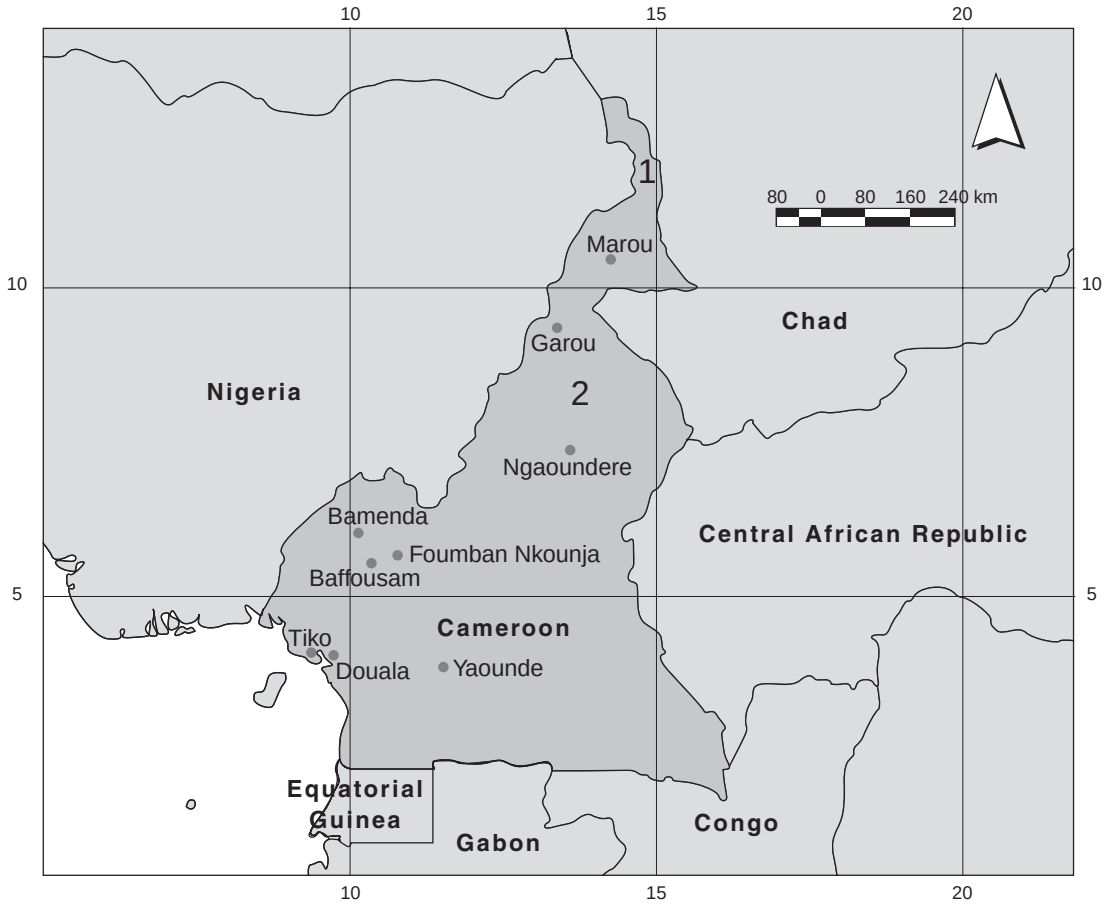

Figure 1. Map of Cameroon with the location of Maga dam (1) and Lagdo dam (2).

Table 1. Details of Maga and Lagdo dams

Dam	Year constructed	Type	Length	Purpose	Surface reservoir (km^2)	Surface impact floodplain (km^2)
Maga	1979	earthen	20 km	irrigation	180–250	3500
Lagdo	1980	concrete	800 m	power supply and irrigation	250–697	2000

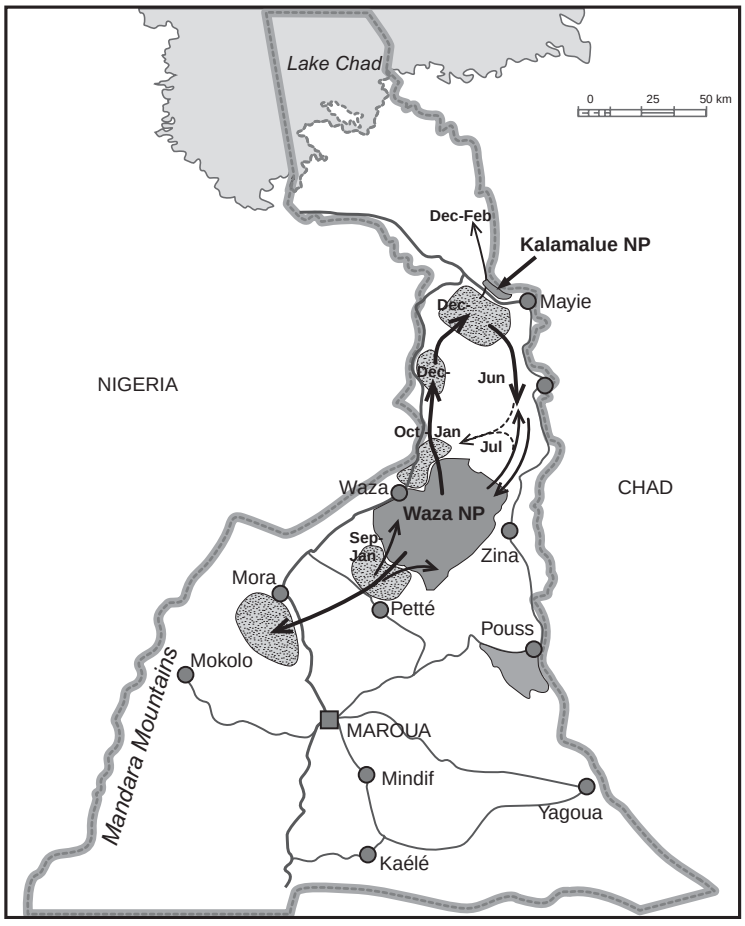

Figure 2. Map of the extreme norhtern part of North Province of Cameroon, with the location of Waza National Park and movements of the subpopulations to the north and to the south (after Loth 2004)

Cameroon government developed an irrigated rice scheme near the dam. In 1980 the Cameroon government constructed a concrete dam at the village of Lagdo for both power generation and development of a rice scheme in the Bénoué Valley, creating the Lagdo reservoir of 250–540 km^2 (fig.3). The variability of the surfaces of both reservoirs is due to seasonal fluctuations.

Effect of Maga dam

Both dam construction projects severely affected the floodplain ecosystems downstream. Maga dam disrupted the natural floodplain system of the Chari–Logone river systems, with a surface area of an estimated 4600–6000 km^2 (Van der Knaap 1994; Loth 2004). After construction of the dam, fisheries production decreased and the vegetation cover of perennial grasses in the floodplain was replaced by annual grasses (Scholte et al. 1996; de Iongh et al. 2001; Loth 2004).

Both livestock and wildlife from the nearby Waza National Park suffered from the degradation of the vegetation (Scholte et al. 1996; Loth 2004). The Waza Logone Project, financed by the Netherlands government and implemented jointly in cooperation among the government of Cameroon, the World Conservation Union (IUCN), the Netherlands Development Cooperation (SNV) and the Institute of Environmental Sciences, Leyden University in the Netherlands, was initiated in 1990 with the main objective of restoring the natural floodplain functions. In 1994 the project initiated an artificial reflooding, called 'pilot flooding', by opening a trench 30 m wide in one of the river embankments north of the village of Pouss (fig. 2), which resulted in flooding of an additional ap-

proximately 300 km^2, restoring some 30% of the original natural floodplain.

Waza National Park was devoid of elephants until 1947, when the first groups crossed the Logone River from Chad, stopped in Kalamaloué and later travelled to Waza National Park, where they became resident (Flizot 1948). Since then the population has steadily increased to over 1100 elephants, due not only to natural growth through reproduction but also to subsequent immigration from Chad and Nigeria (Loth 2004).

Tchamba (1996) identified three elephant subpopulations in Waza National Park. Figure 2 shows migration patterns of two. The first resides in the northern part of the park and migrates to Kalamaloué National Park in the northernmost tip of Cameroon at the beginning of the dry season (January–June). The second resides year-round inside Waza Park. The third subpopulation uses the central and southern part of the park and migrates south at the onset of the rains (June–July). These elephants cause extensive damage to crops throughout the wet season and return to Waza only in November–December. All populations reside in the park for at least a part of the year.

Effect of Lagdo dam

Lagdo dam created a large reservoir and associated fisheries, with catches initially increasing to almost 14,000 tonnes in 1987. But fish production collapsed to below 5000 tonnes in the 1990s and the dam severely affected the floodplain by drastically reducing the natural flooding, as well as the associated fish production and wet-season millet cultivation, over some 2000 km^2 downstream (Haskoning 1989; Van der Knaap 1994; Mayaka 2002). Before construction of the dam no resident elephants were found in the Lagdo area, but small groups of up to 60 elephants used to migrate between August and September from Bénoué National Park into Hunting Zone 7, situated north of this park. These elephants would leave the zone after a few months, in December, migrating further towards the River Bouki, around 70 km north of

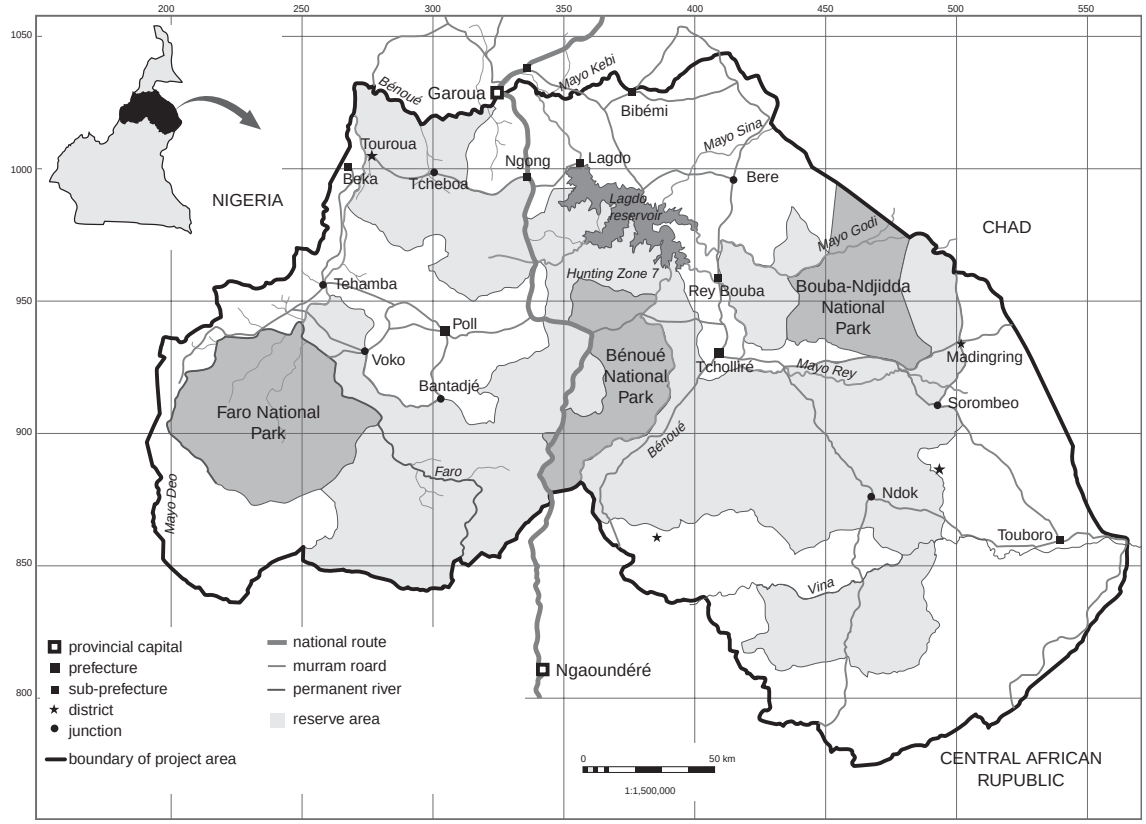

Figure 3. Map of North Province of Cameroon with the location of Bénoué National Park, Hunting Zone 7 and Lagdo reservoir (after Bekker et al. 2003).

Hunting Zone 7. After 1980, the year the dam was constructed, elephants were no longer observed in the hunting zone, mainly because they were heavily poached (Verhage and Wielinga 2001). Not until 1993, when new management took over the zone with a greater focus on conservation, did the elephants return to the hunting zone. From then on they have remained resident in the area (Verhage and Wielinga 2001), the population gradually increasing to an estimated number of between 250 and 300 by 2002.

The Waza study area

The study area is situated in the Sahel zone of northern Cameroon; it extends from Lake Chad southwards as far as 10°N and covers 36,000 km^2 (fig. 1). It includes the following distinct vegetation communities (Wit 1975):

- Periodically flooded grasslands of the Logone Chari and Lake Chad floodplains with *Hyparrhenia rufa, Oryza longistaminata, Echinochloa pyramidalis* and *Pennisetum ramosum* as the dominant grasses
- Thorny grasslands with *Acacia* spp., *Tamarindus indica, Balanites aegyptiaca, Calotropis procera* and *Ziziphus* spp.
- Savannah woodland with *Terminalia laxiflora, Isoberlinia doka, Anogeissus leiocarpa* and *Monotes kerstingii* as common species interspersed with fire-resistant species like *Borassus aethiopum, Lophira lanceolata* and *Daniella oliveri*

All three vegetation zones are represented in Waza National Park. Rainfall in the study area is 350 mm in the north, increasing to more than 800 mm in the south. The dry season lasts from January until June, the wet season from July to December.

The Lagdo study area

The Lagdo study area is situated inside Elephant Camp, a private hunting zone (number 7) just north of Bénoué National Park at around 8°N; it is located in North Province of Cameroon (figs. 1,3). The area lies on the boundary of two distinct vegetation zones, which White (1983) classified as the Sudanian regional centre of endemism in the north and the Guinea-Congolia/Sudania regional transition zone in the south. The four most important vegetation types in the study area are *Terminalia macroptera* and *Terminalia laxiflora* savannah woodland, *Isoberlinia doka* woodland savannah, and dense forest. *Terminalia laxiflora, Combretum glutinosum, Piliostigma thonningii* and *Anogeissus leiocarpa* are the dominant species in the browse stratum of the study area. The monocotyl vegetation is dominated by Andropogonea and *Hyparrhenia* (Stark 1986).

The research area is a terrace-shaped pediplain with interspersed inselbergs. The main rivers drain into the Lagdo reservoir and the Bénoué River.

The climate in the study area is characterized by a wet season (May to October) and a dry season (November to April). Mean annual rainfall varies between 900 and 1250 mm, and temperatures are high throughout the year (Stark 1986). The mean annual temperature is 28°C; in the dry season daily temperatures sometimes exceed 40°C; the humidity is relatively low.

Materials and methods

Equipment

Elephants of the Waza population were collared with an ST-3 platform transmitter terminal (PTT) for satellite transmission and a VHF transmitter in each collar (purchased from Telonics, Mesa, Arizona, USA). Elephants of the Lagdo population were collared with VHF radio transmitters only (also from Telonics). All collars were of four-layered black plastic belting, secured with eight bolts. VHF and PTT transmitter boxes and dipole antennas were sandwiched between the belting layers on opposite sides of the collar.

FREQUENCIES PLATFORM TRANSMITTER TERMINAL TRANSMITTERS

The PTTs of the Waza elephants used a frequency of 401.650 MHz with a 24/72 hour on/off duty schedule to extend battery life. During one 24-h on-duty period a maximum of five guaranteed locations could be received (Argos 1987). A mercury switch incorporated in the PTT registered elephant activity.

VHF TRANSMITTERS

The VHF transmitters of both the Waza and the Lagdo elephants were continually transmitting a 15-ms pulse with 1-s intervals between 150.080 MHz and 150.550 MHz frequencies. For reception, a Telonics TR-4 and RA-14 receivers were used, in combination with a three-element Yagi antenna. The antenna was usually hand-

held but could also be attached to a 5-m telescopic antenna pole. One- and 5-m antenna cables with 50 impedance were used to connect the antenna to the receiver. VHF locations were confirmed with a global positioning system (Garmin GPS-50 and Garmin GPS-12).

Capture

Three elephant cows in Waza National Park were equipped with PTT/VHF collars: one female from the northern subpopulation (E1) in January 1993, and two females from the southern subpopulation, in January 1994 (E2) and January 1996 (E3). For specific information on the Waza elephants, see table 2. Two elephant cows (E4 and E5) and one male (E6) in Elephant Camp were immobilized: E5 and E6 in January 2000 and E4 in March 2000. For specific data on the Lagdo elephants see table 3.

The selected elephants in Waza were immobilized: E1 with the anaesthetic M99 and E2 and E3 with Imobilon®, after which the collars were fitted and various body measurements taken. The Lagdo elephants were immobilized using Etorphine and Azaperone (E4, E5 and E6). The process lasted about 45 minutes, during which the animals were kept cool by spraying them with water. After completing all procedures, antidotes were injected and the revived animals were followed until they rejoined their herds.

Field surveys

From 1986 to 2002, before and after dam construction, researchers and students carried out field surveys to monitor elephant movements of the Waza population. Field research in the Lagdo area was restricted to the period after dam construction and started in 1995, since no resident elephant population was present before then (Aarhaug 1998). Radio tracking took place as from 2000 (Verhage and Wielinga 2001).

Before 1996 methods used in the Waza area included regular waterhole counts, which covered 12-hour observations by a large number of observers (from 0600 to 1800) at all waterholes filled with water in Waza National Park, carried out in April/May (Bos and Bus 1992; Tchamba 1996; Saleh 2002).

Added after 1993 were regular triangulation and direct observations on elephants tracked down by VHF (Bauer 1993; Hunia 1995, Tchamba 1996; Van

Table 2. Biological and technical information of the three Waza elephants with satellite/VHF radio-collars

Elephant number	E1	E2	E3
Name	Helias	Marie Louise II	Fatimé
Sex	female	female	female
Overall body length (cm)	637	646	619
Shoulder height (cm)	258	254	243
Neck circumference (cm)	236	240	230
Estimated age (years)	15–20	20–35	18–20
Date of capture	25 Jan 1993	09 Jan 1994	19 Jan 1996
Location of capture	waterhole Anane 11° 21'/14° 37'	waterhole Tchikam 11° 23'/14° 73'	Sudre village 11° 37'/14° 92'
Transmitter ID	03273	05352	03273
Max. distance from capture site (km)	98	143	147
Max. distance from Waza NP (km)	80	101	108
Total min. distance travelled (km)	2973	1451	1645
Average calculated speed km/h (± SD)	0.6 (0.65)	0.76 (1.5)	0.55 (1.2)
Mean 95% home range per annum (km^2)	3066	2093	2090
Tagged period (days)	633	561	650
Number of 24-h cycles	160	125	131
Mean no. of locations per 24-h cycle (± SD)	4.6 (1.8)	2.7 (0.2)	1.6 (0)
Number of locations	741	864	653

Table 3. Biological and technical information of the three VHF radio-collared Lagdo elephants

Elephant number	E4	E5	E6
Sex	female	female	male
Overall body length (cm)	422	545	645
Shoulder height (cm)	245	235	264
Estimated age (years)	30–35	30–35	20–25
Date of capture	03 Mar 2000	22 Jan 2000	18 Jan 2000
Location capture	Elephant Camp 8°40'/13°42'	Elephant Camp 8°46'/ 13°41'	Elephant Camp 8°5'/13°41'
Frequency VHF	150.08	150.36	150.55
Max. distance from capture site (km)	4.6	4.9	5.1

Average calculated speed (average day–night km/h) overall home range minimum convex polygon in km^2 = 0.4–0.6119
Overall home range, 95% harmonic mean = 54
Overall home range, 50% harmonic mean; mean min in km^2 = 4
Total number of locations = 878

Ormondt and Van der Hoeven 1996; Zwaal 1995; Aarhaug 1998; de Iongh et al. 2001; Verhage and Wielinga 2001; Loos and Quinten 2002). During all observations the group size and group structure were registered on standardized forms (Laws 1966). Time budgets were calculated noting behaviour every 15 minutes during 12-hour observations at waterholes (Van Ormondt and Van der Hoeven 1996; Loos and Quinten 2002).

In the Lagdo area, methods used were triangulation and direct observations after tracking down the elephants (Aarhaug 1998; Verhage and Wielinga 2001; Loos and Quinten 2002). Here also group size and group structure were registered on standardized forms (Laws 1966).

Triangulation

Triangulation and homing techniques were used to locate the VHF transmitters (Kenward 1987; White and Garrott 1990). The range of the VHF transmitter was 5–10 km for bearings taken at ground level. For the Lagdo elephants mainly homing techniques were used, confirmed by GPS locations. Due to the limited range and to decreased accessibility during the rainy season, VHF-radio telemetry could be used only under dry-season conditions.

Satellite telemetry

Location of the PTTs was calculated by CLS Service Argos, Toulouse, France, when identifier signals were received by the NOOA 10 and 11 Tiros-N weather satellites. One successfully received identifier signal is called an uplink. Multiple uplinks are combined to calculate one location, based on the angle of reception. This is calculated from the Doppler shift in the PTT carrier signal frequency, caused by the speed (28,000 km/h) with which the satellites orbit at 820 km above the earth's surface (Argos 1987; Fancy et al. 1988). For this study only guaranteed locations were used.

Crop raiding

Crop-raiding patterns in the Kaelé region were based on annual crop-raiding reports of the provincial delegate of Agriculture and interviews with local villagers during the reported period. These represented rough estimates of the agricultural area affected by elephants. Crop-raiding data in Hunting Zone 7 were also obtained from the local delegate and from additional field surveys carried out during the wet season (July–October 2001) to verify these reports. During these surveys a more sophisticated classification of damage assessment was used, but in this paper only the total areas affected are reported.

Analyses

The quality of location data from the satellite PTTs was assessed by system criteria before downlink transmission (Argos 1987; Fancy et al. 1988). Locations with a quality lower than class one were excluded from calculations on home ranges, movement patterns and habitat utilization (Tchamba et al. 1994). Information on habitat type was obtained from SPOT satellite images of

1987 for Waza and Landsat MSS images of 2000 for Waza and Lagdo (Loth 2004) (fig. 4), and from ground truthing. Minimum convex polygon home ranges were calculated using a harmonic mean computer program (MCPAAL) and mapped using the geographical information system IDRISSI. In addition 95% and 50% harmonic mean calculations were made using HARMEAN software (de Iongh et al. 2001).

The measure of habitat use was the number of locations in each habitat type (or the surface area of the home range falling in the habitat type), assuming an equal distribution of the three vegetation zones over the park.

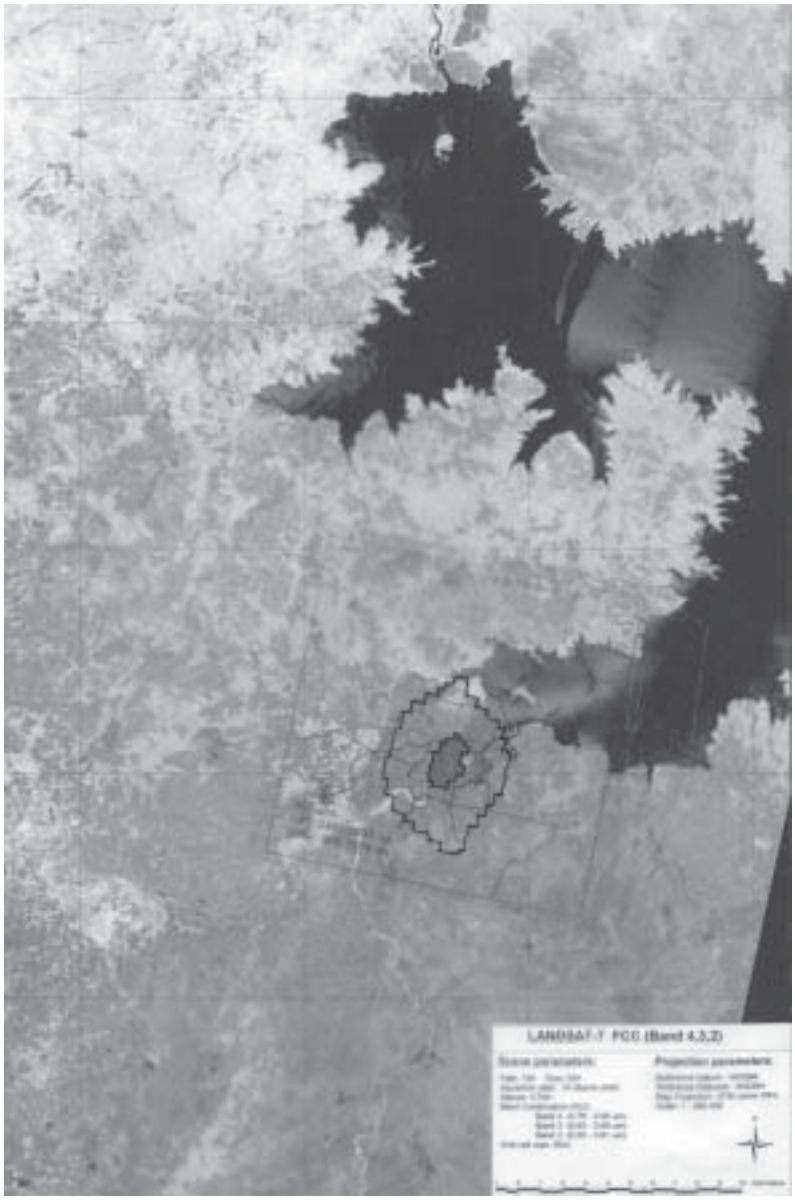

Figure 4. Landsat Multi Spectral Scanner satellite map of 2000, with the home range of the Lagdo elephants projected (95% and 50% harmonic mean).

Results

Biological and technical information

The biological information of the tagged elephants and technical information of the PTT and VHF collars from the Waza population are summarized in table 2. The three female elephants from the Waza population were all about the same size. The biological information of the tagged elephants and technical information of the VHF collars from the Lagdo population are summarized in table 3. The female Lagdo elephants were considerably smaller than the Waza females, and the male was in the same size range as the Waza females.

Elephant numbers before and after dam construction

Figure 5 shows the maximum and minimum estimates and projected trend of elephants present in Waza National Park during 1962 and 2002. The elephant population in Waza National Park had been estimated at 465 in 1978 by Van Lavieren and Esser (1979). Dry-season counts at waterpoints resulted in maximum estimates of 750 elephants in 1988, 808 in 1994, 964 in 1998 and 1140 in 2001 (fig. 5).

Before the construction of Lagdo dam, groups of up to 60 elephants used to migrate from Bénoué National Park into the Elephant Camp hunting zone.

After the dam was built, creating the Lagdo reservoir and associated settlements, the former migration routes were blocked. Since management of the hunting zone was focused more on elephant protection in 1993, the numbers had increased to between 250 and 300 by 2000. Densities, calculated over the dry-season home range (minimum convex polygon) had reached 1.6 elephant/km^2 in the Lagdo area in 2000 and 0.5 elephant/km^2 in the Waza area in 2003.

Movements

Summarized information in tables 2 and 3 shows the maximum recorded distance from the capture site was much higher for E1, E2 and E3 ((98–147 km) than for E4, E5 and E6 (approximately 5 km). Maximum recorded distance from the capture site was also larger for E2 and E3 than for E1, which is related to their migration south (see fig. 2). E1 had a lower maximum recorded distance due to its northern migration route (fig. 2).

Home range and habitat use

Mean annual home range (minimum convex polygon) of the Waza elephants was 2546 km^2 (SD = 400) (table 2). All three Lagdo elephants moved in the same family group and therefore showed the same home range (minimum convex polygon) of 119 km^2 (table 3). Dry-season habitat use of E2 and E3 inside Waza National Park showed a shift after 1994. In 1994 most dry-season locations were inside the *Acacia* zone, while in 1995–1997 most were inside the floodplain (table 4, fig. 6).

Data on dry-season habitat use by the Lagdo elephants showed that they spent significantly more time in the floodplain than in savannah woodland in the years after dam construction (fig. 6). But in the years after dam construction, the Waza elephants of the southern subpopulation showed a reverse pattern, spending more time in the savannah woodland and less in the floodplain. This is confirmed by one sequence of satellite data in 1994, just before the pilot flooding (table 4), but it was also confirmed by earlier field observations (see Discussion).

Crop raiding

The number of Waza elephants crop raiding in Kaelé has increased gradually from 10 in 1980 to 200 in 1991 and around 350 in 1993 and 400 in 1998, while also the area of crop raiding has increased. In spite of disturbance by firing shots in 1994 and 1995, the number of elephants annually raiding crops in Kaelé has fluctuated between an estimated 300 to 350 during 1994–1997.

Crop-raiding patterns of the Waza elephants during 1992/93 showed a consistent pattern with peaks in crop raiding during August and September, coinciding with the crop maturation cycle of sorghum and maize (fig. 7).

The area raided by Waza elephants increased from 10 ha in 1980 to approximately 10,000 ha in 1998, Surface areas raided in Hunting Zone 7 during 2001 were estimated at less than 5 ha near three villages, and 1500 ha for the whole Lagdo/Rey Bouba Districts, surrounding the artificial lake of Lagdo.

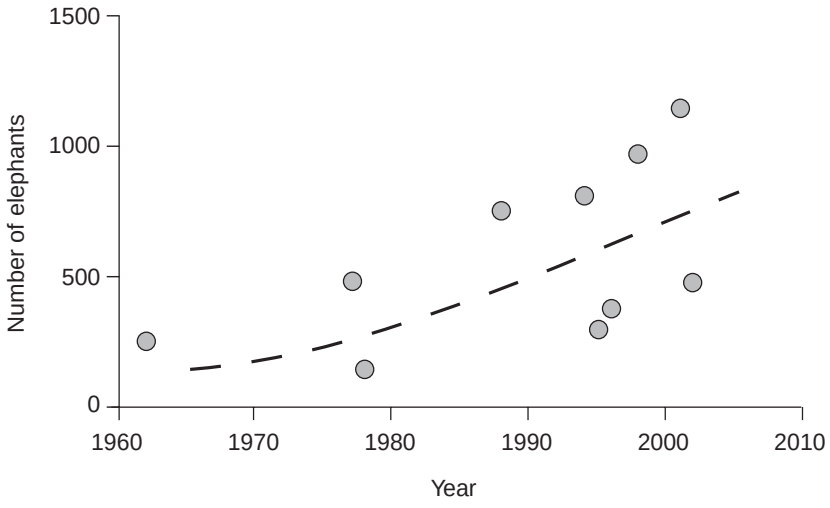

Figure 5. Estimated minimum and maximum elephant numbers (projected trend by visually fitted line) in Waza National Park between 1962 and 2002.

Discussion

The results of this study should be interpreted with some care. In the first place they represent only a small sample of each subpopulation, in spite of the fact that regular field observations during the years of dif-

Table 4. Number and percentage of guaranteed locations of the Waza elephants per vegetation zone in Waza National Park during the dry season

	E2, Marie-Louise				E3, Fatimé			
	1994		1995		1996		1997	
	No.	%	No.	%	No.	%	No.	%
Outside to the north	10	5	55	34	9	7	32	28
Outside Waza Park to the south, north of 11° latitude	1	1	0	0	0	0	2	2
Outside Waza Park to the south, south of 11° latitude	0	0	0	0	0	0	6	5
Floodplain	73	35	82	51	93	69	49	43
Acacia	116	56	9	6	11	8	10	9
Woodland	7	3	15	9	22	16	15	13

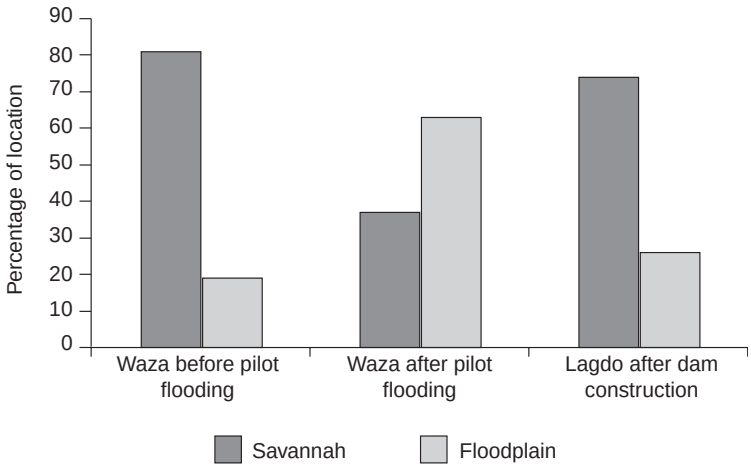

Figure 6. Dry-season habitat use of elephants in the Waza area before and after the pilot flooding and in the Lagdo area after dam construction, based on the distribution of satellite and VHF locations.

ferent studies by master's degree students in the Waza and Lagdo areas had confirmed the continued presence of the tagged elephants in larger herds. However, the satellite data of the Waza elephants are the first on the movements and habitat use of individual elephants making long-distance migrations. The VHF data of the Lagdo elephants are the first on the movements and habitat use of three resident elephants, showing no long-distance migration at all.

Elephant numbers

In both areas elephant numbers increased after the dam was constructed, but in Waza no causal relationship can be established between the increasing numbers and the effect of the dam. The increase there is probably mainly due to the relative security of Waza National Park attracting elephants from outside and growth by natural reproduction, in spite of deteriorating habitat conditions (Loth 2004). However the Lagdo elephants are likely to have been attracted by a combination of improved security and improved habitat.

The improved habitat comprised year-round availability of water in the Lagdo reservoir and the rich gallery forest and semi-permanent floodplain that developed after dam construction. After 1993, conservation-focused management in the hunting zone of Elephant Camp in the Lagdo area coincided with the permanent presence of a resident elephant population, which reached an estimated number of 250 to 300 elephants in 2000 (Verhage and Wielinga 2001).

Movements and home range

The Lagdo population had migrated over long distances before the construction of the dam, when their routes became blocked by the reservoir and the associated human settlements The migration of the Waza

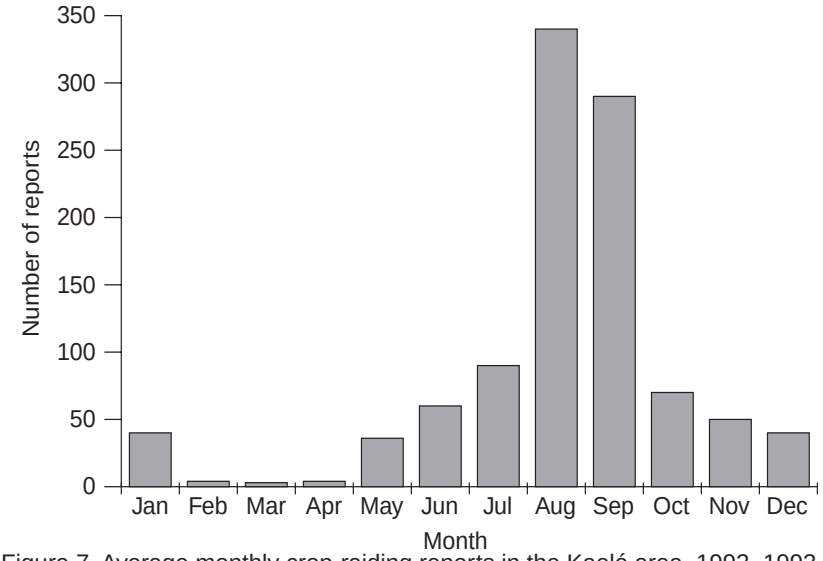

Figure 7. Average monthly crop-raiding reports in the Kaelé area, 1992–1993 (modified after Tchamba 1996).

elephants was not blocked but on the contrary an increased number of elephants migrated over 100 km to the south after the Maga dam was constructed. The maximum distance moved from the place of capture was 147 km for the Waza elephants and 5.1 km for the Lagdo elephants. As a consequence of these larger migrations, the Waza elephants had a much larger overall home range (2546 km^2), compared with the resident Lagdo elephants (119 km^2). The home range of the Lagdo elephants mainly covered the dry-season distribution and only two months of rain (May/June), which may have biased the comparison, but field observations confirm that also during the remaining wet months, Lagdo elephants did not leave Hunting Zone 7, although they were more difficult to VHF radio track, due to the terrain conditions (Loos and Quinten 2002). Before the construction of the Maga dam only incidental elephant migration to the south had been recorded (Tchamba 1996). In 1991 a small group of 50 elephants migrated south. These numbers had increased gradually to some 400 in 1998. Research on elephants in the period after the construction of the Waza dam confirmed that numbers of elephants migrating to the north had decreased while the number of elephants migrating to the south was on the increase (Esser and Van Lavieren 1979; Tobias and Vanpraet 1980; Meijvogel and Ekobo 1986; Eijs and Ekobo 1987; Steehouwer and Kouahou 1988; Tchamba 1993, 1995, 1996).

Habitat use

The available satellite PTT and VHF location data indicate that the construction of both dams had a decided effect on habitat use of the Lagdo and the Waza elephants, but in a completely different way (fig. 6).

Data on dry-season habitat use of the Lagdo elephants showed that they spent significantly more time in the floodplain than in savannah woodland in the years after dam construction. No pre-dam data are available, because resident elephants were not present before the dam was constructed.

Previous research had already confirmed that the elephants in Waza National Park consistently foraged in the floodplain before Maga dam was built (Flizot 1948; Meijvogel and Ekobo 1986; Eijs and Ekobo 1987; Steehouwer and Kouahou 1988; Tchamba 1996), which was supported by satellite location data in 1994 (just before the pilot flooding) obtained from this study.

Based on dung pile surveys Tchamba (1996) concluded that the elephants in Waza National Park were more frequently encountered in *Acacia seyal* scrubland during the dry season in the period after the dam-construction than before.

Before the pilot flooding in 1994 two artificial waterholes inside Waza National Park were the only depressions holding water by the end of the dry season, since the natural waterholes and depressions dried out completely. These two waterholes are located inside the *Acacia* zone of the park and are probably an important explanation for the intensive use of this zone in the dry season, during the years before the pilot flooding was started in 1994. It is generally accepted that the availability and distribution of water is a major factor limiting elephants' use of habitat. However, previous studies in the area indicated that resident elephants in Waza National Park preferred the floodplain during the wet season, even when water was not a limiting factor (Tchamba 1996). The

observation that after the start of the pilot flooding, several natural waterholes in the floodplain were filled with water during the whole dry season may indicate that the availability of water induced the shift in habitat use.

Seasonal changes of habitat use by elephants is well documented (Williamson 1975; Barnes 1982; Viljoen 1989; Tchamba 1993). In areas with different habitat types these changes have been attributed to food preference, when water is not a limiting factor. Several authors reported a shift of habitat use of elephants from the floodplain to the *Acacia* zone after Maga dam was constructed.

Tchamba (1996) concluded that the *Acacia* zone in Waza National Park was under heavy pressure from elephants after the dam was built. Steehouwer and Kouahou (1988) had earlier concluded that elephants spent more time in the *Acacia seyal* habitat after the dam was constructed and stated that damage to more than 25% of the shrubs exceeded the critical level, more than double the amount in 1978 (one year before the construction of Maga dam), when 11% was browsed at that level.

Tchamba (1996) concluded that 38% of the shrubs were browsed to a critical damage level during 1992/93. He also concluded that *Acacia seyal* might come under even greater pressure with the increasing elephant numbers and local changes in hydrological conditions. After the pilot flooding in 1994 the weight percentage of perennial grasses in the floodplain gradually increased in the period from 1994 to 1997 (Loth 2004). It is obvious that the longer dry-season presence of elephants in the floodplain after 1994 coincides with a larger supply of perennial grass forage and water in the floodplain. The change of habitat by the Waza elephants has released the *Acacia* zone from excessive pressure of exploitation.

Crop raiding

Before Maga dam was constructed there were only incidental records of elephants from Waza National Park migrating to the south and no records of elephants raiding crops. In 1991 a small group of 50 elephants migrated south and crop raiding was recorded, their numbers had increased gradually to some 400 by 1993 (Tchamba 1996).

Crop-raiding patterns of the Waza elephants during 1992/93 showed a consistent pattern (fig. 7) with peaks in crop raiding during August and September coinciding with the crop maturation cycle of sorghum and maize. Similar patterns, with a peak in crop raiding between August and October, have been observed in the Lagdo population (Loos and Quinten 2002).

After Waza was flooded, the crop area that elephants raided annually did not decrease; it fluctuated between 8000 and 12,000 ha annually (Loth 2004). In the Lagdo area crop raiding before dam construction was very low or non-existent as elephants were absent most of the year. It increased gradually from 1993 after the elephant population became resident, until 2001 when some 1500 ha of maize and cotton crops were estimated damaged in the whole Lagdo/Rey Bouba Districts surrounding the manmade Lake Lagdo and less than 5 ha in three villages situated within Hunting Zone 7 (Loos and Quinten 2002). The estimated damage in the Lagdo/Rey Bouba Districts may not all be attributed to the Lagdo subpopulation, since also other subpopulations have been reported in the area (Aarhaug 1998). The Lagdo population showed expanding home range during the start of the wet season, but not as spectacular as the Waza population. Expanding home ranges and large-scale movement of crop-raiding elephants at the beginning of the wet season have been reported by several authors (Taylor 1983; Hoare 1999; Osborn 2004).

Conclusions

The observed changes in habitat use by the elephants in Waza imply a reverse in a trend and can be considered a positive contribution of the Waza Logone Project to the ecological management of the park and its elephant populations. It is recommended that the habitat use, migration and crop-raiding patterns of this subpopulation are followed in the coming period. The Lagdo population will remain a threat to local agriculturists and anti-crop-raiding measures are necessary if human encroachment continues to expand and if the existing high densities of elephants in the area remain unchanged.

Acknowledgements

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Elephant numbers, group structure and movements on privately owned land adjacent to Tsavo East National Park, Kenya

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Abstract

The aim of the research was to study the African elephant *Loxodonta africana* at group and individual level, within private land adjacent to the south-western boundary of Tsavo East National Park, Kenya. The number of elephants sighted per month ranged between 65 and 292 individuals, and almost half of all sightings were of groups of bulls and lone bulls. A photographic identification file was created of 165 individually identified elephants.

Nine known adults had tips or sections of the trunk missing, two had deep slash wounds across the trunks, one had a snare embedded around the trunk, two had a snare embedded around the leg and two died from poisoned arrow. Fewer than half of the identified individuals were re-sighted on two or more occasions. Fourteen identified elephants crossed the national park boundary into private land. The low frequency of re-sightings of identified individuals and the boundary crossings of recognized individuals suggest that this private land is part of a much larger range for the majority of the elephants. The time at which elephants used water points was due in part to conflict with herdsmen over access to water.

Additional key words: conflict, photographic identification, water points

Résumé

Le but de cette recherche était d'étudier l'éléphant africain (*Loxodonta africana*) au niveau du groupe et individuellement, dans une propriété privée voisine de la limite sud-ouest du Parc National de Tsavo-est, au Kenya. Le nombre d'éléphants aperçus par mois allait de 65 à 292 individus, et presque la moitié des observations étaient des groupes de mâles ou des mâles solitaires. On a créé un dossier de photos d'identification, et 165 éléphants ont été identifiés individuellement.

Neuf adultes connus avaient la pointe ou une partie de défense manquante, deux avaient une profonde coupure en travers de la trompe, un avait un lacet incrusté autour de la trompe, deux en avaient un autour d'une patte, et deux sont morts empoisonnés. Moins de la moitié des individus observés ont été revus à deux reprises ou plus. Quatorze éléphants identifiés ont franchi la limite du parc vers la propriété privée. La faible fréquence des ré-observations d'individus connus et le franchissement de la limite du parc suggèrent que cette propriété privée fait partie d'un territoire beaucoup plus vaste pour la majorité des éléphants. L'heure à laquelle les éléphants fréquentaient les points d'eau était due en partie à des conflits avec des pasteurs pour l'accès à l'eau.

Mots clés supplémentaires : conflit, identification photographique, points d'eau

Introduction

Elephants play a major role in the Tsavo ecosystem, where they form the largest elephant population in Kenya. The considerable pressures on elephants, other wildlife and the habitat in this region include loss of habitat when trees are felled to clear areas for settlements, agricultural activities, charcoal making; overgrazing by livestock and subsequent soil erosion (Wijngaarden 1985); electrical fencing (Kasiki 1998);

frequent fires both past and present (Leuthold 1996); and periodic drought. Further pressures include the increasing frequency of snaring for bushmeat, poaching for ivory and rhino horn, and finally the increase and encroachment of the human population (Vogt and Wiesenhuetter 2000). There is a growing need in this semi-arid environment to identify compatible land uses to conserve the habitat and wildlife and to support local communities.

The Tsavo ecosystem (40,000 km^2) is a vast semi-arid bushland in southern Kenya, comprising Tsavo East and West National Parks (21,000 km^2), Mkomazi Game Reserve in north-eastern Tanzania and private land. Within the ecosystem is Taita Taveta District, located between the two national parks and consisting of private ranches, wildlife sanctuaries, sisal plantations, farming, settlements and ecotourism enterprises. The human population in this region has steadily increased over the past 30 years, from 90,000 in 1962 to 245,000 in 1999 (average population density was 14 people per km^2), and has been estimated at 252,000 by 2000 (Vogt and Wiesenhuetter 2000).

Within the Tsavo ecosystem, the elephant population was estimated to be 35,000 in 1967 (Laws 1969). A prolonged drought claimed an estimated 9000 elephants in the 1970s (Corfield 1973). After intense poaching for ivory throughout the 1970s and 1980s the population was reduced to 5363 by 1988 (Olindo et al. 1988). In 1999, 8068 elephants were counted within the ecosystem (Kahumbu et al. 1999). The number of elephants counted outside national park boundaries ranged from 15.5% to 24.3% of totals during aerial counts conducted between 1988 and 1999 (Kahumbu et al. 1999). Many studies have shown that the dispersal behaviour of Tsavo elephants is related to rainfall and the subsequent green vegetation (Leuthold 1977;Wijngaarden 1985; Ottichilo 1986) and the provision of artificial water sources (Spinage 1998).

One region that is an elephant-dispersal area and is possibly a corridor between the two national parks is Rukinga Wildlife Sanctuary (RWS) and Taita Ranch (TR), privately owned land adjacent to the south-western boundary of Tsavo East National Park (TENP) and about 25 km east of the Tsavo West National Park boundary. During aerial counts in 1989, 1991 and 1994, all dry-season surveys, no elephants were sighted in the RWS/TR region; however, in 1988 (dry season) there were 119 elephants, and in 1999 (wet season) 235 individuals were counted (Douglas-Hamilton et al. 1994; Kahumbu et al. 1999).

Objectives

The Tsavo Elephant Research Project began in 1989 and continues today (McKnight 1992, 1996, 2000). Research is based on a photographic file of known individuals, used to monitor their population dynamics. Although the elephants in TENP, south of the Galana River, have been studied for over a decade, very little is known about the elephants outside the national park boundaries. The objectives of this study were to expand the Tsavo East Elephant Research to include a sample of the population of elephants that used land adjacent to the national park and complement the periodic aerial surveys. This study, conducted between July 1999 and November 2001, was approached at two levels: at the population level to survey the number of elephants, group structure and group sizes, and to identify elephant paths across ranch boundaries and the national park; and at the individual level, to create a photographic identification card file of individual elephants in this area to facilitate future research on demography and ranging behaviour and to determine if they were known individuals from TENP (McKnight 1996, 2000). Therefore, two data sets are presented: long-term records of known individuals from within the national park and data collected on elephants sighted in the RWS/TR region.

Study area

The RWS/TR region (750 km^2), located in the southern region of the ecosystem, is an arid environment with sporadic and patchy rainfall (fig. 1). The habitat is primarily dense *Commiphora–Acacia–Lannea* bushwoodland (Wijngaarden 1985). For many years, ranch management cut down trees in many areas for livestock *bomas* (circular enclosed corrals formed by interlocking trees), which has created grassland areas. There are numerous scattered waterholes, some scooped out by ranch management. There are 10 reservoir water tanks, open at the top with adjacent open troughs, constructed between 1977 and the 1990s; they are filled from the main water pipeline (Mzima Springs, Tsavo West) for livestock and humans, which wildlife also use. The average height of the tanks is 271 cm and of the troughs 51 cm. During the dry season, the water in these tanks is the only water available for wildlife in the immediate area. During the present research, Taita Ranch had between 4000 and 6000 head of livestock. At the onset of

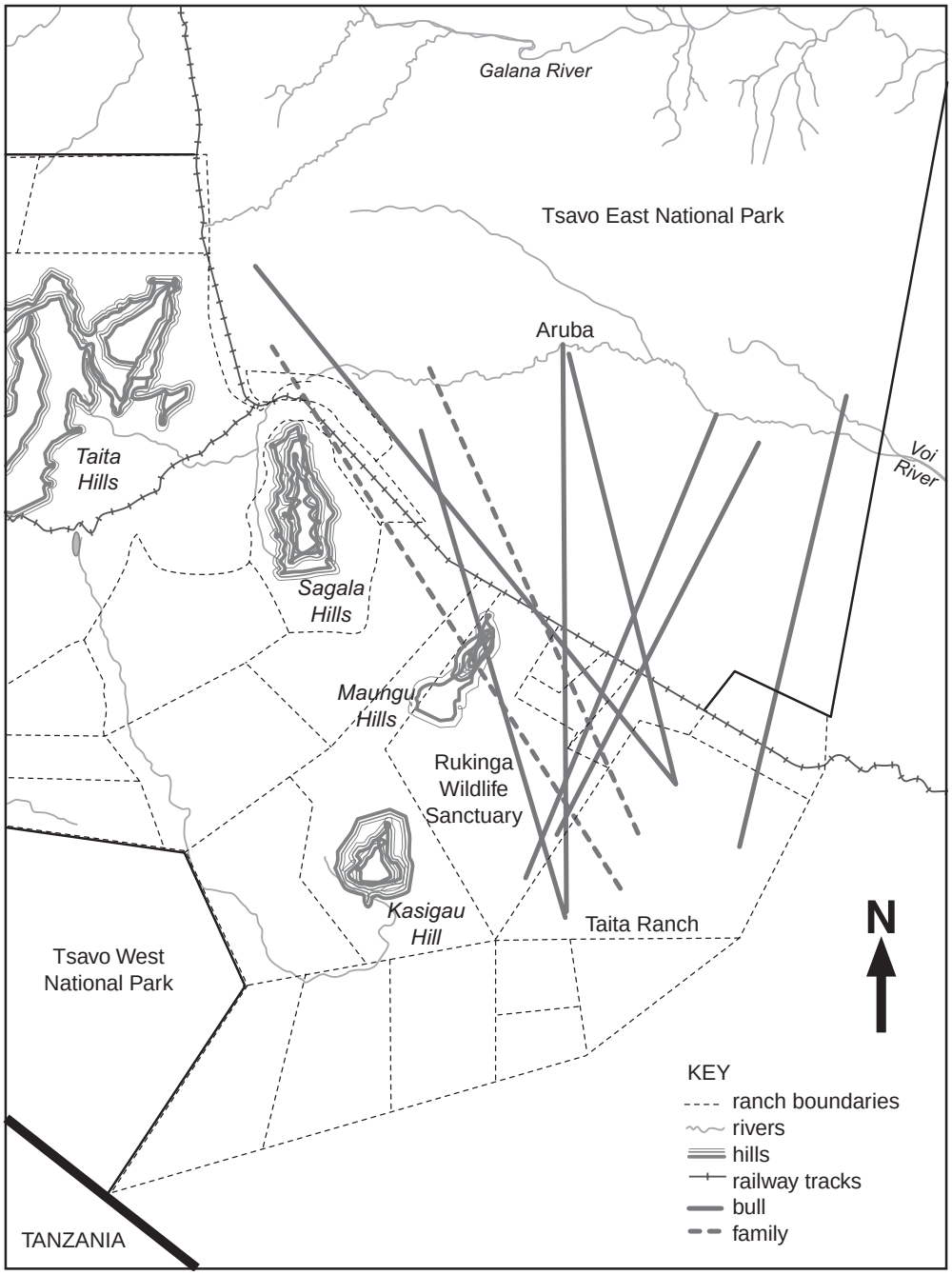

Figure 1. The study area, showing Rukinga Wildlife Sanctuary, Taita Ranch, Tsavo National Parks and the surrounding privately owned land. Solid lines (bulls) and dashed lines (families) indicate extreme points of sightings and boundary crossings for recognized individuals.

the research, RWS was a livestock ranch with approximately 4000 cattle, but by January 2001, all of the livestock and herdsmen had been removed and the area was converted to a wildlife sanctuary.

Methods

Two survey techniques were used to collect data: road surveys and stationary surveys at water points. Once

a month, two vehicles surveyed different locations of the entire study area for seven consecutive days between 0715 and 1300. Each vehicle was stationed at different water sources from 1630 until dark (1900) according to the location of elephant sightings, footprints, amount of dung and water level at waterholes and tanks as found in the morning survey. The elephants were more relaxed if observers were quiet and the vehicle was parked in a relatively open area, some 60 metres from the water source, regardless of the direction of the wind.

Data collection

Data collected during the surveys included date, time, GPS (geographical positioning system) location, group size and composition, age and sex, individual identification (photographs taken), activity (feeding, travelling, mud wallowing, drinking). In addition, the amount of water available was recorded (natural waterholes: full, half-full, all mud; tanks and troughs: empty, filling, half-full, full).

Elephant group composition

A group was defined as an association with all members feeding, resting or moving as a coordinated unit. The elephant groups were divided into four categories: 1) family: females and their offspring; 2) mixed group: family with a potentially reproductive bull (older than 20 years); 3) bull group: two or more bulls in the absence of families; and 4) lone bulls: a single bull with no other elephant in sight.

Identified elephants

As a base from which to start the research in this region, a photographic identification file system was created identical to the system incorporated in the national park (McKnight 1996). Each individual has a card with a photograph and sketch of ears and tusks, noting the following characteristics: 1) tusk: broken, one-tusked, tuskless; 2) trunk: section missing, 'fingers' torn; 3) tail: broken, no hair, half or no tail; 4) ears: tattered, holes, notches, broken, vein pattern; and 5) body: scars, growths. These photographs facilitated re-sighting of individuals and were used to make comparisons with the 748 identified elephants within the national park (McKnight 1996, 2000).

Results

Results of the road surveys showed that only 6.2% of the elephant sightings were during the morning surveys, the remainder being at water points in the late afternoon. Almost all (91.4%) of the elephants arrived at water points after 1700. With the exception of a few bulls, most elephants gathered at the edge of the bush at the water point, especially at the tanks, and then moved through an open area to the water in tight, discretely formed groups. The total number of individual elephants recorded during one month, when the two vehicles were at different waterholes, ranged from 65 (wet season, April 2001) to 292 (dry season, August 2000) (fig. 2).

Group composition and size

Almost half of the 1535 groups sighted were groups of bulls (n = 361 groups, 23.6%) or lone bulls (n = 351, 22.8%). Groups of females with their offspring accounted for 43.7% of the sightings, while mixed groups accounted for 9.9%. There was a wide range of group sizes for all of the grouping patterns: females with offspring (n = 671 groups) had 2–46 individuals and mixed groups (n = 152 groups) had 3–196 individuals. Bull group sizes (range 2–28 bulls) tended to be relatively large, with seven groups containing more than 12 bulls and three groups with 24–28 bulls.

Identified elephants and re-sightings

A total of 165 elephants (72 adult males, 43 adult females and 50 offspring) were individually identified with photographs. The frequency of re-sighting identified elephants was relatively small; 37.5% of identified males and 60.5% of identified females were re-sighted on two or more occasions (fig. 3). The re-sighting interval was from the following evening to as long as one year. This was especially true of the bulls in musth. For example, three identified bulls (30–40 years of age) were first recorded when they were in musth and the subsequent sightings did not occur until the following year, at the same time of year, when they were in musth again.

Elephants snared and speared

One of the striking features of the identified elephants in this region is the frequency of trunk injuries: slash

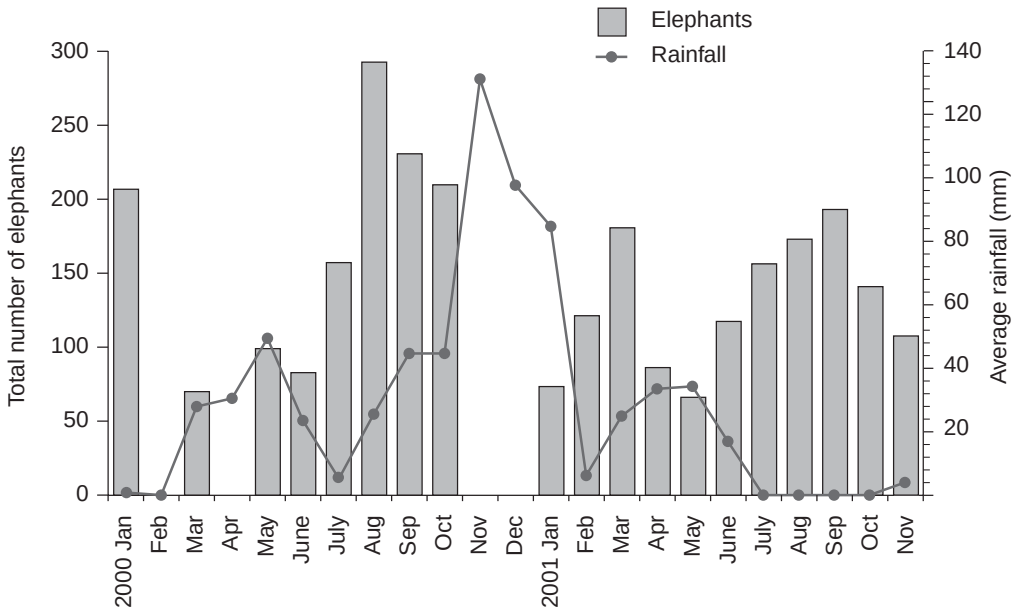

Figure 2. Total number of individual elephants counted per month compared with the average monthly rainfall. Surveys were not conducted in February, April, November or December 2000.

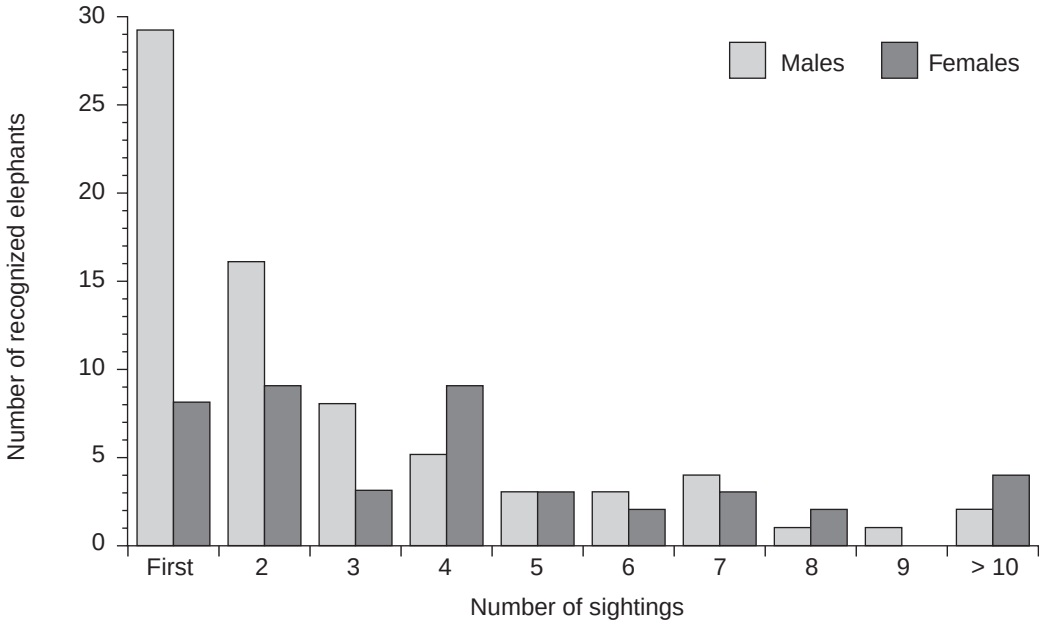

Figure 3. Frequency distribution of the total number of sightings of identified adult males and females.

wounds, the tip of the trunk missing or the 'fingers' torn from the tip. Of the identified individuals, seven adult males and two adult females were missing sections of their trunk, which appeared to have been caught in snares. Three were missing a quarter to a half of the trunk. Two elephants were recorded with a snare wrapped around the leg. One bull (20–25 years old) was missing approximately a quarter of his trunk and also had a snare wrapped around his trunk, midway from the damaged tip. Further, an adult male and

an adult female had a horizontal slash wound across the middle section of the trunk that went halfway through it, suggesting a knife or spear wound. These injuries made it very difficult for these elephants to drink, since much of the water sucked into the trunk seeped through the slash wound. During this study, one known bull (20–25 years old) was killed by a poisoned arrow and another bull (15–20 years old) was seriously wounded by a spear and subsequently shot by the Kenya Wildlife Service (KWS).

Boundary crossings

Fourteen known elephants crossed the boundary between the national park and private land. Thirteen individuals (6 bulls and 2 families including 5 offspring), first identified in TENP, were sighted within the study area, and one bull sighted on private land was subsequently sighted in TENP. The average distance between points of sighting for the bulls was 54.5 km (range 45.5–68.4 km). The extreme point of sighting for the two families was 52.3–68.2 km. Although, the boundary crossing routes could not be confirmed during this study, all of these individuals at some point in their movement crossed the Mombasa–Nairobi main road and railway line.

Discussion

Tsavo elephants in the early 1970s (drought years) were mobile and had large home ranges, in some cases extending 3000 km^2 (Leuthold 1977). Results from the present study suggest that the RWS/TR region is part of a much larger range for these elephants; indicated by the fluctuating number of elephants sighted per month, the relatively low frequency of re-sightings of identified elephants, and cross-boundary movements of known individuals.

The data suggest that many different elephants used this region for the fresh water in the tanks. During the dry season when the waterholes were dry, the only water available for wildlife was in tanks and troughs, which Rukinga Wildlife Sanctuary provided for all. However, in Taita Ranch during the dry season, the only water available for elephants was in one or two tanks and rarely in troughs. A tank had to be at least half full for an adult elephant to be able to reach the water in it. Adult bulls had little difficulty in reaching the water and the older adult females also were generally able to do so, but their offspring could not reach the water with their trunks. If the trough was empty, individuals younger than 15 years would drink the small amount of water that pooled at the base of the tank or they could not drink at all.

The low frequency of elephant sightings during the day and the time of day when they used the water sources are attributed to lack of visibility due to the thick vegetation and conflict with herdsmen in Taita Ranch. Elephants were threatened if they came to the tanks during the day when the herdsmen and their cattle were there. In addition, herdsmen on occasion set fires near the tanks and natural waterholes at night to keep elephants away from the water sources.

Except for a few bulls, most of the elephants, therefore approached a water point after the herdsmen and their livestock were in their bomas for the night.

Boundary crossings

During the 1970s, the results of ranging patterns of six visually identified elephants and radio-collared individuals showed that the majority moved within the national park boundaries (Leuthold and Sale 1973; Leuthold 1977). Leuthold (1977) postulated that the factors that most likely influenced the movements of these elephants at that time included the prolonged drought years of the early 1970s, poaching for ivory, the railway line and main road that acted as a barrier for some elephants and the hunting blocks adjacent to the national park. None of these elephants was recorded within the RWS/TR region, which is not surprising since it was a hunting block until the ban on trophy hunting in 1977.

Most of the elephants that have been observed crossing the railway tracks and the main road have been moving at night, and numerous times elephants have been hit and killed by vehicles and trains (KWS 1999–2001). The sighting of six known bulls and two families originally identified in the national park and subsequently in RWS/TR and one bull first sighted in TR and then in TENP provide empirical evidence that Tsavo East elephants cross the main Nairobi–Mombasa road and railway tracks between the national park and private land.

Elephant paths across national park boundaries to privately owned land have been documented in some areas of Tsavo and most if not all of these paths are thought to be traditional routes that were originally free of human encounter (Leuthold 1977; Kasiki 1998; Low 2000). With the exception in some areas

of livestock ranches, elephants using these traditional routes now must pass close to or through human settlements. Consequently, the frequency of human–elephant conflict during particular times of the year is high (Kasiki 1998).

Bushmeat hunting

The frequency of poaching wildlife with snares and spears for bushmeat throughout Africa (Bowen-Jones and Pendry 1999), in Kenya (Trade Review 2000) and in particular in this region is increasing (Kasiki 1998). Elephants are caught in snares that are set for dikdik, giraffe, lesser kudu, buffalo, impala, zebra and waterbuck (this study; McKnight 1996; KWS 1999–2001).

In addition to the 14 identified elephants in the RWS/TR region caught in snares or speared, an adult giraffe was observed during this study with a snare around its neck and a second giraffe was killed by spears. During one of the road surveys, bushmeat poachers were encountered with a box containing 33 dikdik skulls, 4 kg of wildlife meat, one impala skull and a large torch with a horn attached (a tool bushmeat poachers commonly use to stun wildlife).

Conclusion

There is a growing trend within some areas of the Tsavo ecosystem for groups of private ranches and landowners to combine their land, creating wildlife sanctuaries for tourism, removing snares, and developing conservation-based community enterprises, the aim being to decrease negative effects on the wildlife and the habitat (MGM 1999; CORE-net 2001). The habitat and other wildlife in these areas will benefit from elephants moving through this region. Elephants play a critical role within an ecosystem by creating and expanding waterholes, opening trails for other wildlife (Jarman 1972; Ayeni 1975), dispering seeds (Muoria et al. 2001; Waithaka 2001) and interacting with woody vegetation. Excluding elephants from regions by fencing and by closing traditional routes between areas by human encroachment could have a negative impact on long-term ecological processes (Waithaka 2001). Elephants moving through areas contribute to animal species and vegetation diversity (Waithaka 2001).

Identifying elephant temporal and spatial grouping patterns and locating the routes they use to cross national park boundaries and private land will assist KWS in making decisions about providing corridors for elephants to have safe access to their dispersal range and in implementing ways to protect local communities and their crops from elephants.

Mapping the routes, seasonal range and movement patterns of elephants in neighbouring Taita Taveta private land would help landowners and communities make management decisions on land use and implement initiatives to protect the habitat, including providing water, sinking boreholes, fencing, livestock ranching, and addressing conflict issues. A solution to the conflict in Taita Ranch would be to cover the top of the water tanks and allow the elephants to use the natural waterholes.

Future tracking of identified bulls, families and grouping patterns will provide more baseline data to determine if elephants use the southern region of the ecosystem as a corridor between Tsavo East and West National Parks.

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Elephants (*Loxodonta africana*) of Zoba Gash Barka, Eritrea: Part 2. Numbers and distribution, ecology and behaviour, and fauna and flora in their ecosystem

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Abstract

Today, elephants in Eritrea are confined only to portions of Zoba Gash Barka in the south-west where they are geographically, and possibly genetically, isolated. Data collected during 2001–2003 include direct observations of live elephants in the watersheds of the Gash and Setit (Tekezze) Rivers, and information from spoor and from eyewitnesses. We provide data on a large herd of elephants, unheard of since 1955. Observations indicate that there are no hybrids between African and Asian elephants in Eritrea. Elephants are active in portions of day and night. It appears that a symbiotic relationship exists between elephants and doum palms and between elephants and baboons, and a commensal relationship may exist between elephants and helmeted guinea fowls. We started a new method using soleprints as a possible character for reliably identifying individual elephants. Data on plants and animals help evaluate the biodiversity in Gash Barka and the role elephants play as keystone species in their ecosystem. The estimated number of elephants in Eritrea is about 100 during the dry season; in the wet season they migrate to northern Ethiopia. Further, we observed young and adults with calves less than one year old.

Additional key words: biodiversity, ecosystem, human–elephant conflict, individual identification, keystone species, soleprints

Résumé

Aujourd'hui, en Erythrée, les éléphants sont confinés dans quelques portions de Zoba Gash Barka, dans le sud-ouest, où ils sont géographiquement, et peut-être génétiquement, isolés. Les données récoltées entre 2001 et 2003 incluent des observations directes d'éléphants vivant dans le bassin des rivières Gash et Setit (Tekezze), des informations sur des traces et venant de témoins oculaires. Nous donnons des informations sur un grand troupeau dont on n'avait plus entendu parler depuis 1955. Les observations indiquent qu'il n'y a pas d'hybrides entre éléphants africains et asiatiques en Erythrée. Les éléphants sont actifs à certaines périodes, de nuit comme de jour. Il semble qu'il existe une relation symbiotique entre les éléphants et les palmiers doum et entre les éléphants et les babouins, et il pourrait y avoir une relation commensale entre les éléphants et les pintades casquées. Nous avons inauguré une nouvelle méthode, en nous servant de l'empreinte plantaire comme élément peut-être fiable pour identifier les éléphants individuellement. Des données sur les plantes et les animaux aident à évaluer la biodiversité à Gash Barka et le rôle d'espèce clé que les éléphants jouent dans leur écosystème. On estime que le nombre d'éléphants en Erythrée est d'environ 100 en saison sèche. En saison des pluies, ils migrent vers le nord de l'Ethiopie. De plus, nous avons observé des jeunes et des femelles avec petits de moins d'un an.

Mots clés supplémentaires : biodiversité, écosystème, conflits hommes-éléphants, identification individuelle, espèce clé, empreintes plantaires

Introduction

In our first paper on elephants (*Loxodonta africana*) in Eritrea we provided background information on the physical and climatic settings of Eritrea, general description of elephant habitat, and a historical perspective on elephants in Eritrea (Hagos et al. 2003). In this second part of our findings, we discuss the numbers and distribution, ecology and behaviour, and fauna and flora in the ecosystem of elephants in Eritrea.

Materials and methods

Observations reported here include those made in 2001 through early 2004. Direct observations of elephants were the preferred method of investigation. Interviewing local residents has been an extremely important aspect of this research, since the elephants are rarely seen during the day. Dung and footprints or other spoor, such as chewed vegetation and scratching posts, provided indirect data. Some dung samples were dissected in search of seeds of trees and bushes to help identify plant species on which elephants feed. Dung samples were sent to two laboratories in the United States for DNA analysis. Skin and other samples of a stillborn foetus found near the Gash River were also sent for isolation of DNA. A large number of plant samples were collected for the herbarium at the University of Asmara.

Counting elephants was done such that only the minimum number of individuals is reported. Duplication was reduced to a minimum or avoided by applying any combination of these exclusion criteria: 1) if the time and distance passed between observations could allow elephants from the nearest previous location to travel that distance, 2) if herd or group composition was identical or similar, 3) if their individual markings were the same.

Individual recognition was made using ear markings, tusk characters, body marks, or any combination of these characteristics (Douglas-Hamilton 1972; Moss 1996). In addition, we noticed that newly born and juvenile elephants have relatively flat soleprints with few distinguishing features. With age soleprint features become more evident; in adult elephants, soleprints are unique for the individual. Thus, we began a file of soleprints; but in this initial stage, it must still be used along with other characters when identifying individual elephants.

To estimate general shoulder height of an elephant from a footprint we employed the formula of Sukumar et al. (1988), that is, 2.03 times the circumference of the front foot gives the approximate shoulder height (this is a modified version of Boyle 1929—twice the circumference of the front foot gives the approximate shoulder height). We also measured the hind foot length as applied by Western et al. (1983) and Lee and Moss (1995). Scat and chewed vegetation were collected and their provenances recorded. All observations were documented in the field notebook or photographed, or both.

Results

Numbers and distribution

1996 AND 2000

Results obtained in 1996 and 1999 were summarized by Shoshani et al. (2000). Litoroh (1997) reported on 8 elephants sighted from the air, 2 in Eritrea and 6 on the Ethiopian side of the border. Yacob (1998, p. 6) reported on 20 to 50 elephants in Eritrea; Marchant et al. (2000, p. 11), however, estimated a lower minimum number, between 8 and 50.

2001–2002

On 25 December 2001, 28 elephants were observed entering a doum palm forest at 1650 near Amneyet, about 14 km upstream from Haicota (table 1). There were around 10 juveniles, some less than one year old. All appeared in good condition and some carried tusks less than one metre long. This group, which may have included others already hidden in forest, is the largest reliably documented record of elephants in Eritrea in recent times. We found the remains of a stillborn foetus and took them to the University of Asmara. Many olive baboons (*Papio anubis*) were in close association with the elephants.

2003

From 24 January to 11 February 2003 we launched an expedition to investigate information received on large numbers of elephant in the vicinity of Haicota. On the third day we found fresh footprints of adults and young close to the Gash River near the village of Ugumu. We pursued our search in the riverine forest but came too

Table 1. Elephant observations in Zoba Gash Barka, Eritrea (see fig. 2 for locations)

ID no.	Date	No. elephants	Description; observed by Observed by	Location
0a	ca.1998	—	elephants observed; one dead, tusks collected	at about Weldezghi farm, near Alebu
0b	pre 2000	—	elephant observed several years previously	Adi Omar
0c	ca. 2000	—	elephant observed three years previously	Gursub Drip Irrigation Project
	2000			
1	15 Dec	4	4 live elephants: 2 large, 2 small, seen from the air; other possible sightings at 20 km SW; observed by UN	between Kuluku and Shambiko ~15 km south of Shambiko
2	15 Dec	—	possible elephant sightings; observed by UN	
	2001			
3	1 Apr	1	one 'very large' elephant [p]; observed by UN	between Antore and Om Hager
4	18 May	3	in doum palm forest [p]; observed by UN & JS	near Ato Solomon's farm
5	1 Aug	1	calf about 1 year probably swept by river [p]; observed by YY	near Om Hager near Setit R
6	19 Sep	15	family of ~ 10 [p], 5 bulls [p]; observed by UN	Setit R 20 km east of Om Hager
7	24 Dec	2	adult elephant placenta and stillborn foetus in riverine forest; observed by JS, MG & students	near Ato Solomon's farm
8	25 Dec	>28	adults, young, newly born [p]; observed by JS, MG & students	junction of Gash R and Bayaye wadi, near Amneyet
	2002			
9	2 Feb	1	adult elephant carcass in riverine forest; observed by EK	Tekezu village in vicinity of Setit R
10	14 Mar	1	young elephant carcass in riverine forest; observed by EK	Debero village in vicinity of Gash R
—	5 Apr	~30	herd of elephants filmed [p]; observed by Mahmud M. Osman	near Awgaro
11	21 Apr	—	elephant dung of adult; observed by ET	Antore R near Awgaro–Antore Road
12	13 Jun	1	calf carcass [p]; observed by ET	Cikaba near Ugumu
13	21 Jun	1	live adult male elephant in riverine forest; observed by ET & UN	Setit R
14	22 Jun	1	one observed, others nearby; observed by ET & UN	near Antore; 3.4 km SW of dry riverbed
15	22 Jun	1	one observed, others heard nearby; observed by ET & UN	near Antore
16	23 Jun	1	adult observed; pictures taken [p]; observed by ET & UN	~7.1 km N of Antore
—	~ Oct	~40	aerial photographs [p]; observed by UN	near Setit R
17	8 Nov	1	adult elephant carcass; reported date of death; observed by EK	Tekezu area near Enda Hargeste
18	22 Nov	1	subadult elephant carcass; reported date of death; observed by EK	Awtate R, an Antore R tributary
	2003			
19	7 Jan	~40	elephants move towards Haicota [p]; observed by Tedros Kebbede, Travel House International	near Gogne, Kurkuji vicinity
—	10–11 Jan	?	live elephants, fresh footprints and scat [p]; observed by EK & JS	near Antore and Awgaro
20	26 Jan	> 83 (for ID 20–36)	footprints of 5 elephants, one calf; one elephant in dense riverine forest; observed by ET	Ugumu vicinity
21	26 Jan	1	live male elephant observed crossing Gash R from SE to NW [p]; observed by ET	Ugumu vicinity
22	27 Jan	—	fresh elephant dung and footprints; observed by ET	Adi Merig vicinity
23	27 Jan	3	observed in dense riverine forest on floodplain of Gash R; observed by ET	Kurkuji vicinity
24	28 Jan	42	all ages, in 7 subgroups; many fresh footprints and much dung; observed by ET	Musse water well
25	31 Jan	27	in ~ 4 subgroups; observed by ET	Near Amneyet
26	1 Feb	—	old footprints and dung; observed by ET	Duluk water well
27	1 Feb	3	observed in daylight; observed by ET	Banegar
28	1 Feb	4	live elephants; many dung piles of all ages; observed by ET	Kurbahebaye
29	2 Feb	1	live elephant; many dung piles of all ages; observed by ET	Kurbahebaye

Table 1. (continued)

ID no.	Date	No. elephants	Description; observed by Observed by	Location
306	Feb	—	footprints; dung piles of all ages, old and fresh; observed by ET	Mekonat
31	6 Feb	> 6	live elephants; footprints, many dung piles of all ages, old and fresh; observed by ET	Mekonat
32	6 Feb	31	observed in dim to very dim light; observed by ET	Mekonat
33	7 Feb	—	footprints adult, fresh; observed by ET	Kurkuji vicinity
34	8 Feb	4	observed in cultivated area; many dung piles of all ages; observed by ET	Musse water well
35	9 Feb	—	old elephant dung; observed by ET	Ugumu watering area
36	10 Feb	—	footprints and dung, old and fresh; observed by ET	Near Antore R
37	21 Apr	1	carcass, young, fell and died in a water well; footprints observed [p]; observed by ET	Sefera Sona water well near Awgaro
38	7 May	1	carcass, calf, fell and died in a water-well; footprints observed [p]; observed by ET	Musse water well near Ugumu
39	9 May	45	all ages, observed in twilight [p]; observed by ET	Sefera Sona water well near Awgaro
—	19 July	many	fuzzy aerial photo [p] ; observed by UN	between Om Hager and Barentu
40	25 Oct	90–100	all ages, photographed from air [p]; observed by JS & Mark Bent	near Setit R south of Antore Tahtai
41	6 Nov	~ 40	one 5-year-old killed; observed by *Haddas Eritrea* newspaper staff	Kurbayo-Dekishehay near Antore Tahtai
42	1 Dec	> 20	Observed by farmers	near Haicota
—	26–28 Dec	3–5	2–4 live, 1 carcass; observed by JS & students	Haicota vicinity
2004				
—	4 Feb	1	subadult, dead; observed by Dessalegn Hadgembes	Menderot, near Antore

Data for previous centuries were provided by Hagos et al. (2003). For completeness, some observations for the 21st century are repeated and new entries added for 2003 and 2004. Details in the text.
Setit River – also known as Tekezze River; [p] – with photograph(s)
Observers: EK – Emun Kebrom; ET– Elephant Team; JS – Jeheskel Shoshani; MG – Medhanie Ghebrehiwet; YY – Yohannes Yacob; UN – United Nations personnel

close to an elephant (possibly a female with a calf), which charged us. This incident almost ended in the death of the senior author, had he not been saved by a soldier who shot in the air (Nicholson-Lord 2003). All in all, we visited 18 localities, which included either an encounter with live elephants or finding their spoor, usually footprints and dung (details on 12 of these localities are given in table 2).

Table 2. Observation on number of elephants from 26 January to 10 February 2003

Date	Locality	No.	Notes
26 January	Ugumu vicinity	5	1 elephant seen, 5 total reported;
26 January	Ugumu vicinity	1	male crossed the Gash River in daylight
27 January	Kurkuji vicinity	3	chased by children in daylight; ?all males
28 January	Musse	42	elephants seen in seven subgroups, at sunset[a]
31 January	Amneyet	27	elephants seen in four subgroups, at sunset
1 February	Banegar	(3)	seen in daylight, possible duplicate
1 February	Kurbahebaye	4	seen in daylight; ?all males
2 February	Kurbahebaye vicinity	(1)	male, seen close to sunset
6 February	Mekonat	(6+)	seen in daylight in forest, possible duplicate sighting
6 February	Mekonat	(31)	seen after sunset, possible duplicate
8 February	Musse vicinity	(4)	chased by children in daylight; ?all males, duplicate
10 February	Antore vicinity	1	based on fresh dung and observation by locals[b]

[a] Details in table 3.
[b] 128 elephants were observed between 26 January and 10 February 2003 in 12 localities; 45 are possible duplicate counts. Thus the minimum number of individuals is 83 elephants in seven localities. There is no way of verifying if the 45 elephants observed on 9 May 2003 were part of the elephants observed during the January–February survey, and thus they are not included in these totals.

Taking a minimum conservative approach, in 16 days we saw 83 live elephants in seven places (table 2). Thus the estimated number of elephants in Eritrea is between 83 and 100. The higher estimate (100 elephants) is a guarded estimate for the number of elephants in Eritrea during the dry season (approximately from October–November through March–April); during the wet season they are said to migrate into Ethiopia. Following the criteria given under 'Materials and methods', we excluded 45 elephants from our total count of 128, as we suspected we had already counted them (see table 2). The largest number of elephants we saw from the ground in one place, where possibly there were also unseen herd members, was 31 elephants (the 42 elephants noted below were observed in seven subgroups). Most of the observations were under crepuscular (twilight) conditions, and most were either in the Gash River or in its floodplains and vicinity. All the elephants looked healthy (no bones such as scapulae or ribs seemed to be protruding from the body contour). The adults were accompanied by young of all ages, some very tiny, possibly newborns. The males in particular were in prime condition. Some were observed browsing on vegetation in an oasis-like, semi-desert habitat of doum palms, acacia, and ziziphus riverine forest.

Of particular interest were observations we made near a waterhole called Musse, where the depth of water was 100 cm below the riverbed. There were, in fact, two waterholes close to each other, one large and one small. Like many other waterholes excavated for livestock, the local herdsmen had made a trough of mud and filled it with water, usually drawn with goatskins. Late in the afternoon of 28 January 2003, we counted 42 elephants in about seven subgroups (table 3).

We counted the 42 elephants twice—once as a general count and a second count conducted with binoculars in dim light following the field method de-

Table 3. Subgroups of elephants observed at Musse locality (GPS = N 14°52.874'; E 37°17.955', elevation: 754 m), 28 January 2003

No.	Composition[a]	Estimated ages[b]	Totals
1	5 adult males[c]	20–35+ years old	5
2	3 adults, 2 young	10–30 years	5
3	1 reaches elbow of adult next to it 1 reaches anal flap of adult next to it 3 reach eye level of adult next to it	8–9 months 4–5 years 7-8 years	5
4	5 adults 2 subadults[d] 1 reaches anal flap of adult next to it	20–35+ years 10–15 years 3–4 years old	8
5	2 adults 1 subadult[d] 2 reach anal flap of adult next to it 1 reaches below belly of adult next to it	20–35+ years old 10–15 years 4–5 years less than 1 year old	6
6	2 adults 2 subadults[d] 1 reaches anal flap of adult next to it 1 reaches below belly of adult next to it	20–35+ years old 10–15 years 4–5 years less than 1 year old	6
7	A mixture of ?adults, subadults and young	10–30 years	7 42[e]

[a] As described in the field. Some descriptions after Moss (1996:67–68). Elephants in these seven subgroups may or may not have been associated as herd members; congregation may have resulted as they came together to drink.
[b] Estimated age assignment after Moss (1996:67–68).
[c] Sex identification after Sikes (1971), Hanks (1979), and Moss (1996). In profile view males have a round sloping forehead and are wider between the eyes; females have an angular forehead, narrower between the eyes. Also, male bellies slope downwards from the front legs towards the genitalia; in females the bellies are nearly parallel to the ground. According to Poole (1987), bulls, especially those in musth, walk differently from cows, but we were unable to ascertain this difference.
[d] Body seemed square rather than rectangular (after Moss 1966:68).
[e] Breakdown of the 42 elephants in these seven subgroups: 17 adults, 5 subadults, 13 aged 1–10 years, 7 mixed young and subadults.

veloped mostly by Moss (1996) on counting elephants in Amboseli National Park in Kenya.

Most recent elephant sighting (2003, 2004)

While on a survey trip during May 1993 to report on a dead calf that slipped and fell into a water well, we learned that a large herd of elephants was close to the village of Awgaro. On 9 May 2003, at about 1900 near the Sefera Sona water well we observed 45 live elephants of all ages in close proximity (that is, not all in one general location). At least 30 elephants were observed in dim light as they were marching in a file on the north-east bank of the dry riverbed of the Gash River. We observed an additional 14 elephants on the west side, plus one large adult on the far east side drinking water. These 45 elephants were not added to the minimum number of 83 individual elephants summarized in table 2, because there is no way of verifying they were or were not some of the same elephants observed during the January–February 2003 survey.

From this and previous observations, as well as from reports by local residents, it appears that the elephants avoid coming to drink during daylight. Reasons could include avoiding the heat, avoiding competing with livestock, avoiding human contact, or some combination of factors. Regardless of the reason, elephants seem to have adopted cathemeral behaviour, that is, being active partly in the daytime and partly at night.

On 25 October 2003, Mark Bent and the senior author flew towards Gash Barka in search of elephants. At 0945, south of Antore Tahtay, near the Setit (Tekezze) River lying inside Eritrea, we spotted a large herd of elephants of all ages and sizes in a deciduous woodland. It is possible that these elephants had crossed the Setit not long before we saw them, as they were close to it and also the calves were darker in colour, possibly from crossing the river. The elephants, in two major subgroups, were moving northwards. One subgroup had about 70 to 90 individuals—a figure confirmed later when we viewed photographs. The other subgroup was smaller, of perhaps about 20. We circled above a few times as we attempted to count and photograph them.

Judging from the location where the elephants were sighted, the direction in which they were moving (north towards Antore) and the time of the year we observed them, we now have corroborating evidence for the hypothesis that elephants migrate into Eritrea during the dry season. We still need to collect data on whether elephants migrate out of Eritrea and into Ethiopia during the wet season. Yet the observation made by United Nations personnel on elephants sighted on 19 July 2003 between Om Hager and Barentu (table 1) provides some evidence that some elephants are still present in Eritrea during the early summer. The Ministry of Agriculture is planning an elephant survey in June 2004.

Population structure

SHOULDER HEIGHT AND AGES CALCULATED FROM FOOTPRINTS

Data on spoor measured in 2001 and 2003 are provided in table 4. Shoulder heights were calculated using the Sukumar et al. (1988) formula only when measurements of forefeet were available (2001 data). From these heights we estimated the ages after graphs in Hanks (1979) and illustrations in Eltringham (2000). In 2003 we also collected data on hind-foot length and from that, employing the Western et al. (1983) formula and data from Lee and Moss (1995), we were able to estimate the ages of these elephants. The height for 15 elephants (given in table 4) ranges from 0.8 to 3.51 m, and the ages range from 1 or 2 years to about 40+ years of age. These results from footprints correspond to the observations we made on live elephants; we saw very small calves, less than one year old, to very tall adult females and males. Our tallest elephant was calculated at 3.51 m at the shoulder, likely a bull; the record is 4+ m (Martin 1963).

SOLEPRINT PATTERNS AS UNIQUE SIGNALS FOR ELEPHANT IDENTIFICATION

Identification of individual elephants is imperative for sound, long-term research, where data can be accurately recorded and followed for any morphological or behavioural changes over time. Douglas-Hamilton (1972) pioneered the method of recognizing elephants by their ear characters, a method widely used in elephant studies. Moss (1996) summarized the methods used in recognizing individual elephants, the reasons, and other parameters, in the section 'Individual recognition'. We started a new method, to the best of our knowledge, hitherto not employed in elephant or any other mammalian studies.

Table 4. Data on forefoot diameters and hind-foot lengths, and estimated height and age based on these data

Locality	Forefoot diameter (cm)	Hind-foot length (cm)	Estimated height (m)[a]	Estimated ages (years)[b]	Notes
December 2001					
Amneyet	22	not taken	1.40	4–6	juvenile, spoor in semi-firm sand
Amneyet	34	not taken	2.17	15–20	young, in semi-firm sand
Amneyet	53	not taken	3.38	25–30+	?female, in semi-firm sand
Amneyet	55	not taken	3.51	35–40	?male, in semi-firm sand
2 January 2002					
Michael farm, near Haicota	55	—	3.51	35–40	?male, in ?semi-firm sand
January–February 2003					
Musse	40	46.5	2.55/2.79	~30	male, in firm sand
Amneyet	46	51.5	2.93/3.09	~40	?male, in semi-firm sand
Mekonat	12.5	17.5	0.80/1.05	~1–2	newborn, in semi-firm sand
Mekonat[c]	17.5	21	1.12/1.26	~3	juvenile, in semi-firm sand
Mekonat	22	25	1.40/1.50	~5	juvenile, in semi-firm sand
Mekonat	23	28	1.47/1.68	~7	juvenile, in semi-firm sand
Mekonat	32	37	2.04/2.22	~20	subadult, in semi-firm sand
Mekonat	33	38	2.11/2.28	~24	subadult, in semi-firm sand
Mekonat	42	46	2.68/2.76	~29	adult, in semi-firm sand
Hadamdame	48.5	52	3.09/3.12	~40+	?male, in semi-firm sand

[a] Estimated shoulder height based on the forefoot diameter (after Sukumar et al. 1988; see under Methods). Numbers are rounded to 2 decimal places. For comparison, for the last 10 measurements, we calculated the estimated height from the forefoot diameter (to the left of the slash), and from the length of the hind-foot diameter (to the right of the slash), following Moss's (1996, p. 72) note: 'The shoulder height increases at roughly six times the [hind] foot length.' The numbers on the right are larger than the numbers on the left by about 16 cm on average.
[b] For the first four entries, the estimated ages are based on the forefoot diameter, using illustrations and graphs in Eltringham (2000), Hanks (1979). In the other entries, age is based on hind-foot length (after Western et al. 1983).
[c] At this site we also collected data on the size of dung of adult (length 25 cm x width 20 cm x height 14 cm) and young (11 cm x 11 cm x 8 cm).

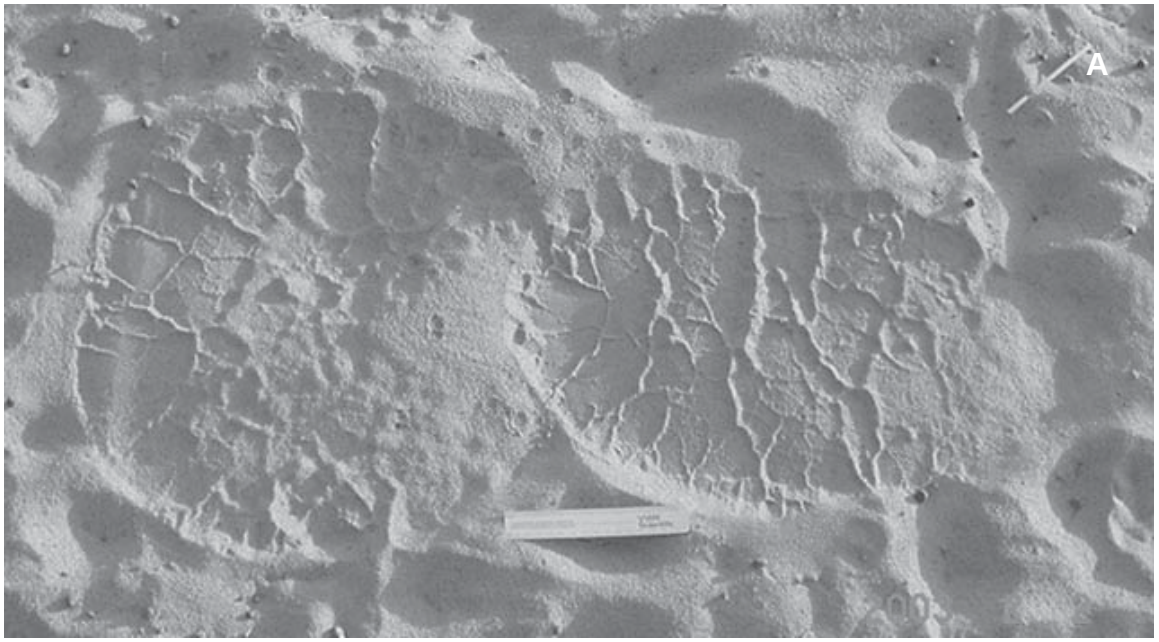
We began with a digital photograph file of footprints of elephants, depicting the unique crease pattern, something similar to fingerprints in humans. Figure 1 gives examples of soleprints, showing differences in the architecture of these individuals. We observed, for example, that newly born and juvenile elephants have flat, featureless soles. With age, the crease pattern and architecture of the sole increasingly become distinct and individualized. That is, as the elephant grows older, the pattern is unique for the individual elephant. We are only beginning to employ this method. With time, we hope to be able to include soleprints as a reliable character, along with characters such as ear features, tusk appearance and body scars. Such character recognition would be especially useful in riverine forested areas where it is difficult to see elephants, but their spoor could identify the individuals who left it.

Ecology and behaviour

LOCAL AND REGIONAL ELEPHANT MOVEMENTS

Based on data presented in tables 1 to 3 we learned that local movements of elephants are within the Setit River and the Gash River water catchment areas (watershed), especially along their floodplains where

J. Shoshani



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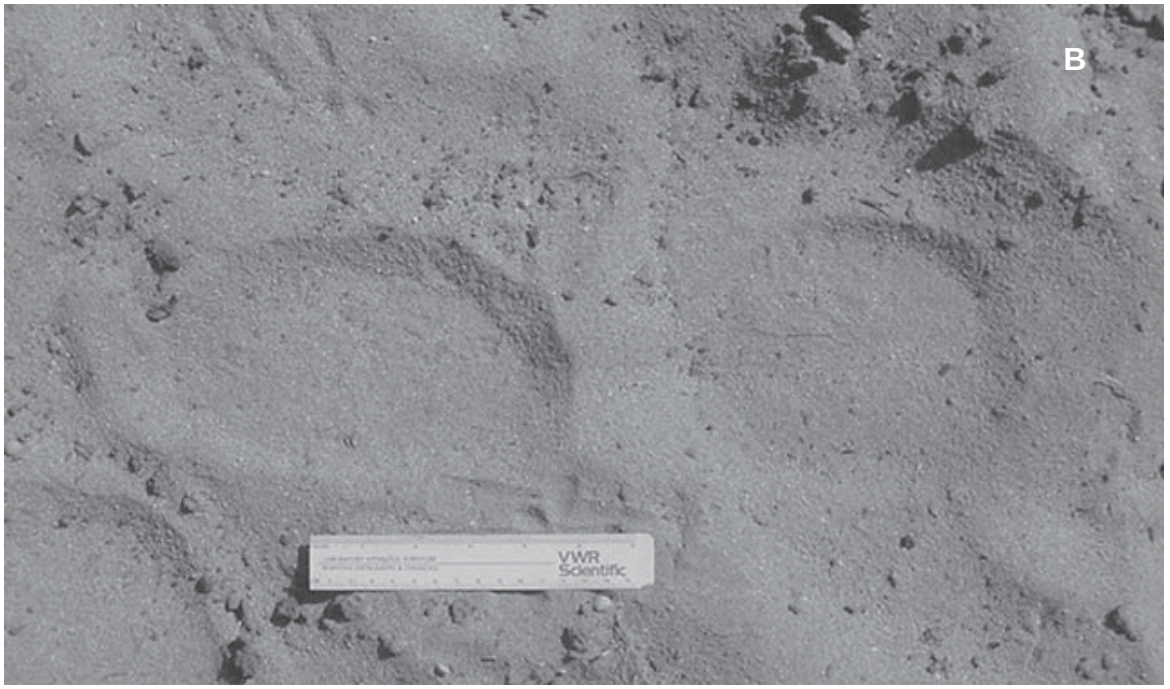

Figure 1. Soleprints of elephants in the Gash River. A) Soleprints of adult elephant (circular footprint on left is of the front foot, elongated footprint is of the hind foot). Direction of walking is towards the right. B) Soleprints of a calf elephant (circular and elongated footprints as for A). Direction of walking is towards the left (ruler is 16 cm). As elephants grow older the architecture and pattern of the creases becomes increasingly distinct and unique. This new identification method, combined with ear, tusk and other characters, we hope will prove to be a reliable one, especially in riverine forested areas where although it is difficult to see elephants, they could easily be recognized by their spoor.

doum palm trees are plentiful and water is not too distant (fig. 2). There are no records of elephants north of the Barentu–Tesseney road (fig. 2). Figure 3 gives the names of Eritrean villages and places between Tesseney and the Setit River that elephants are believed to frequent during the dry season. At present, our data indicate that elephants in Eritrea do not move into Sudan, possibly because there are no doum palms in that part of the country. If this observation turns out to be correct, this would imply that elephants and doum palms are obligate symbionts, rather than facultative ones. That is, the elephants migrate to places where there are palms rather than visiting them coincidentally. In figure 3 the distances between places are rough estimates in a straight line between two points along the terrain as calculated from the map (fig. 2). The two-headed arrows indicate that the elephants move in both directions, generally within the watersheds and floodplains of major rivers.

All the data that we, United Nations staff and local residents have collected thus far on the whereabouts of elephants confirm the general times of their movements. Thus, elephants migrate from Ethiopia into Eritrea from the south during the dry season—October–November through March–April or longer—and return southwards in the wet season—May–July through October–November (fig. 4). It is not yet understood why they migrate in this pattern. The phenomenon could be tied to old migratory routes when elephant habitats between the two areas they visit were contiguous. Yacob (1998) noted that during the wet season elephants move southwards into the Setit River valley and possibly cross the river into the adjacent Shire Wildlife Reserve of Ethiopia. This reserve, according to Blanc et al. (2003, p. 83–87) is devoid of elephants. Maps in Blanc et al. (2003) indicate that the elephant population closest to the Gash–Setit in Eritrea is in the Dabus Valley Controlled Hunting Area in western Ethiopia, some 500 km south to southwest. Elephants in Sudan are mostly in the southern part of the country; the remaining population in the eastern sector of Sudan (for example, in Dinder National Park) is adjacent to Ethiopia and could migrate back and forth into Ethiopia (Blanc et al. 2003). Available information implies that the elephants in Eritrea are geographically isolated. They are the northernmost population in eastern Africa; only Mali's elephants are found farther north, and only by about one degree latitude (Blanc et al. 2003). Certainly more research is needed, perhaps with the use of GPS satellite collars, to better understand elephant ecology and migratory patterns.

Flora and fauna

FLORISTIC ELEMENTS OBSERVED

We collected samples, especially of plants browsed by elephants, to learn about the ecosystems of the area with focus on finding what plant species elephants eat and how their feeding will affect the biodiversity. Based on our observations, either direct or by dissecting dung, and from information from local residents, we note that elephants eat 11 plant species, of which 7 are classified in the family Fabaceae, subfamily Mimosoideae, which includes acacias. They also eat parts of baobab trees (*Adansonia digitata),* family Bombacaceae, and desert dates (*Balanites aegyptiaca),* family Balanitaceae (Bein et al. 1996). Depending on local conditions, each region has its specific tree species from which elephants choose their favourites. Perhaps the most favoured food species in the Gash Barka zone is the doum palm (*Hyphaene thebaica*, family Arecaceae, known as 'arkokobai', fig. 5) found in the floodplains of rivers and wadis. Doum palm is followed in choice by ziziphus or Christ's crown of thorns (*Ziziphus spini-christi*, family Rhamnaceae, locally known as 'gaba'), by the thorn tree (*Acacia tortilis*, with the Tigrigna name 'alla' or 'akba'), and by blackthorn or hookthorn shrub (*Acacia mellifera,* fig. 6).

FAUNISTIC ELEMENTS OBSERVED

Summarizing the animals or their spoor, observed on trips to Gash Barka (1998–2003) minimum counts were 1 amphibian, 10 reptiles (3 orders, 10 families), 104 birds (15 orders, 42 families), and 38 mammals (9 orders, 17 families). References consulted include Kingdon (1997), Largen (1997) and van Perlo (1995). The Gash Barka zone, we quickly learned, is richly diverse in its fauna and flora.

Of particular interest was the presence of helmeted guinea fowl (*Numida meleagris)* almost everywhere we saw elephants in an open area, such as a dry riverbed, not necessarily close to a water well. Flocks stayed about 50 to 100 m from the elephants. They moved fast, sometimes hopping or jumping off the ground in areas elephants visited. These flocks can clearly be seen running about in the background of a

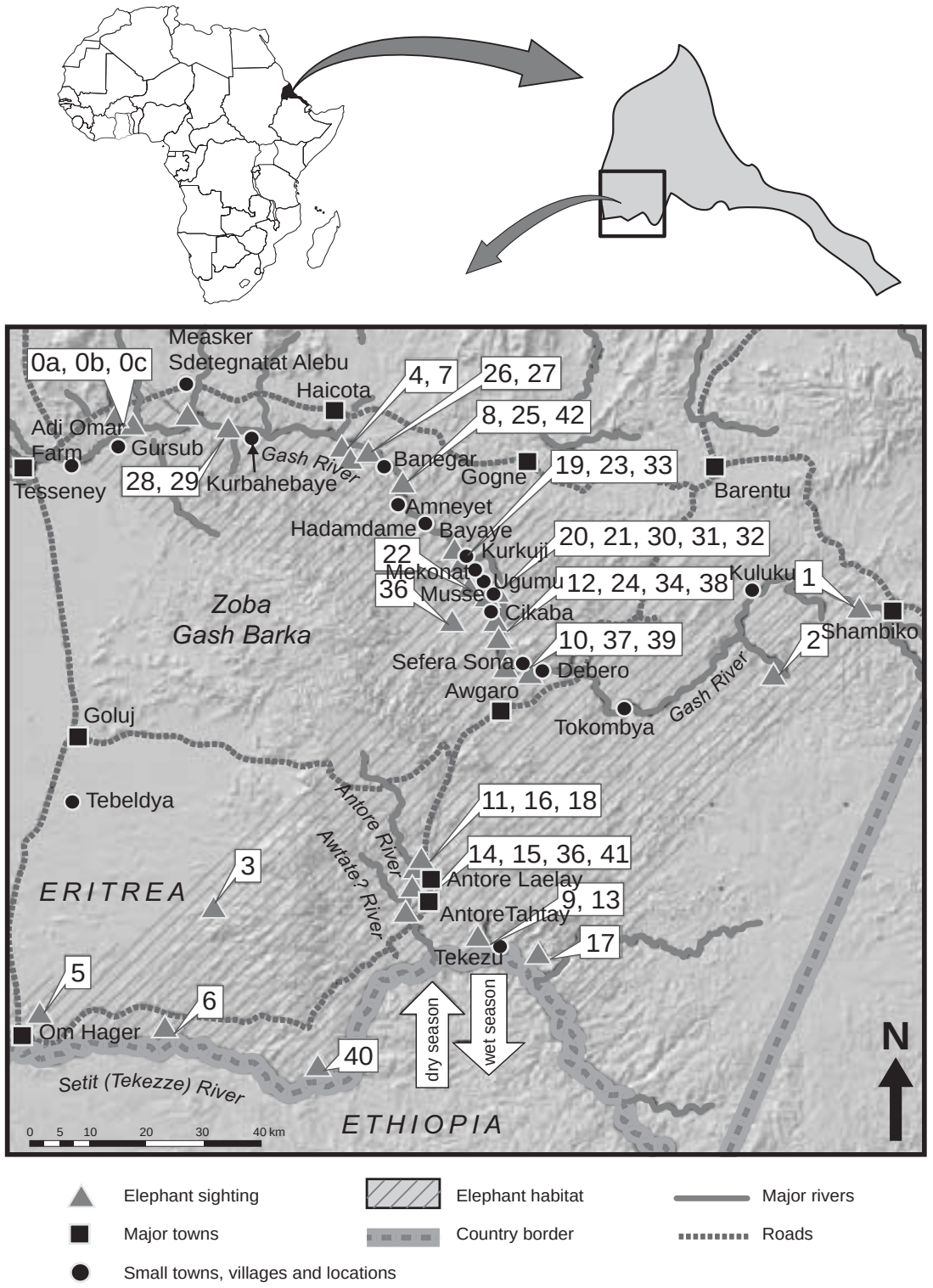

Figure 2. Location map of Eritrea in Africa and distribution of elephants in Zoba Gash Barka, based on data presented in table 1 (technical and artwork by Maria Christine Hill).

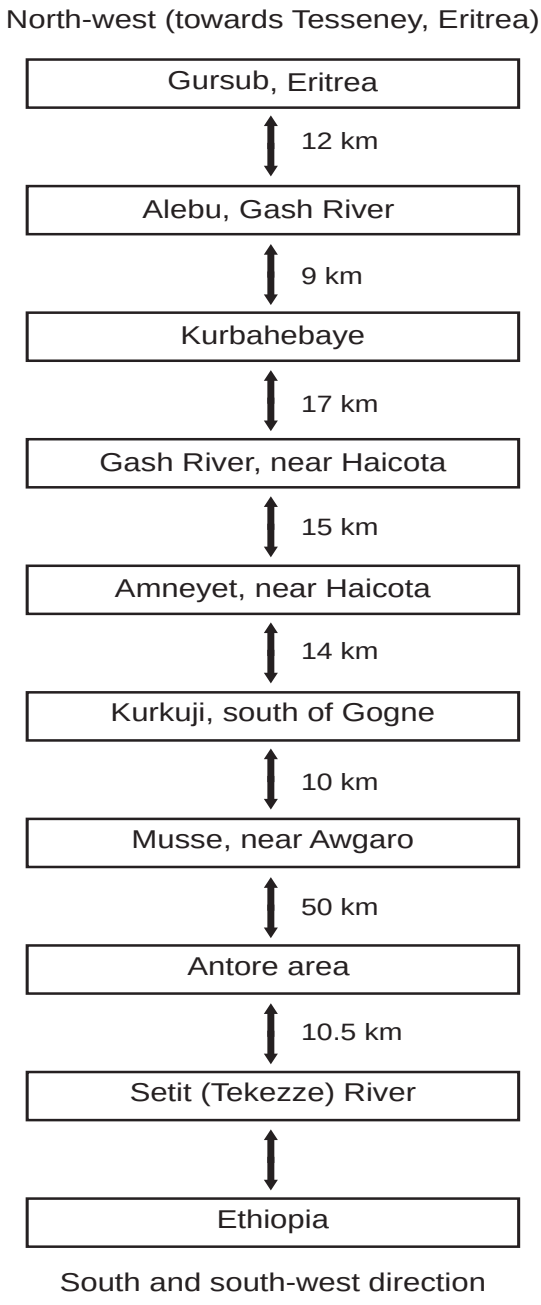

Figure 3. A simplified chart with names of villages and places between Setit River and Tesseney in Eritrea where elephants were observed during the dry season. The two-headed arrows indicate movement in both directions, within the watersheds of the Setit and Gash Rivers. Distances in kilometres are straight-line estimates between places, obtained from the map.

video taken at Musse of a male elephant next to the water well. A possible interpretation for this association follows.

Discussion

Estimated number of elephants in Eritrea

According to our 2003 data, the minimum number of elephants for Eritrea during the dry season is 83. This is a conservative estimate. In all probability, there were additional elephants deep in the riverine forest that were missed. In addition, we might have been overly cautious by subtracting 45 elephants from the total we observed, apprehensive that they were duplicate counts (table 2). From these data we may thus restate that our guarded estimate for Eritrea is about 100 elephants. Based on aerial photographs (fig. 4), the possibility exists that this number may even be as high as 150. Regardless of the exact number, it is the highest estimate since the estimate of 100 to 200 made by Leuenberger in 1955 (table 1 in Hagos et al. 2003).

Herd composition

As noted, of the 28 elephants counted on 25 December 2001, about 10 were newly born, some less than one year old. This is a healthy herd composition. Most of our observations were under crepuscular conditions, and only for relatively short times. Thus, we are not able to provide a detailed breakdown of the elephants observed, except for the 42 we saw at Musse on 28 January 2003 (table 3). We infer that these 42 elephants were not members of one herd but a congregation that gathered at a water well. The ratio of young and newly born to other members appears high. There were three newly born elephants (less than one year old), an additional seven calves aged 3 to 10 years, a minimum of five subadults, and at least five adult males; the rest were of mixed ages and sexes.

The other large group we observed (on 31 January at Amneyet; table 2) also had young calves, but we could not ascertain their numbers as there was constant movement among 12 elephants near the water well. Based on photographs from our observations of 45 elephants on 9 May 2003, we estimated that about one-fourth to one-third of the elephants were between 1 and 10 years old.

Despite these meagre observations, there appears to be enough data for a preliminary assessment that

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Figure 4. Herd of elephants photographed from the air (25 October 2003) near the Setit River, south of Antore Tahtay, in a deciduous woodland.

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Figure 5. Doum palm (*Hyphaene thebaica)* forest on the floodplain of the Gash River at Banegar, where we observed three elephants close to noon, 1 February 2003. As our observations were usually at dusk, this was an unusual sighting, possibly because these were three subadult to adult males. Elephants and doum palms appear to have a symbiotic relationship—elephants feed on the fruits and use the trees for shade and concealment; in turn the elephants help distribute the palm seeds.

Figure 6. Blackthorn or hookthorn (*Acacia mellifera),* a favourite tree consumed by elephants. Here, on a hill near the Gash River, one such tree, with Emun Kebrom standing to show its size, has been stripped, presumably by elephants; dung was found close by. A similar shrub (*Acacia oerfota),* which has a strong, pungent odour, grows in the same habitat as *A. mellifera,* but elephants and other wildlife do not feed on it.

in at least half of the total elephants in Eritrea (42 out of 83) the number of calves between 1 and 10 years old is 13, that is, about 31%—definitely a reproductively active population.

From aerial photographs provided by the United Nations (19 September 2001; see table 1), we know that there were at least 5 adult males in the southwestern part of Eritrea in 2001. Of the 83 elephants observed in early 2003, about 16 (~19%) were identified as males. Is this proportion high? It is difficult to assess this situation, because if the assumption is true that the elephants in Eritrea are geographically isolated, then their movements are restricted and they cannot disperse to neighbouring elephant populations. It appears, therefore, that the movement of male elephants from one deme or subpopulation to another is restricted to within Eritrea (in elephant societies when a male reaches sexual maturity, his mother and other females force it out of the herd, presumably to avoid inbreeding; cf. Sikes 1971; Douglas-Hamilton and Douglas-Hamilton 1975; Moss 1988). In other countries where it is possible for elephants to mix with neighbouring populations (for example, those in the Masai Mara Game Reserve in Kenya might mix with elephants in the Serengeti in Tanzania), males have the opportunity to disperse, and thus avoid inbreeding. Assuming this hypothesis is valid, wildlife management authorities will be eager to learn what will happen in the coming years, and what measures should be taken if any.

Ecological considerations

CATHEMERAL BEHAVIOUR

Elephants may be classified as cathemeral, that is, they are or can be active in portions of both day and night. From interviews of wildlife scouts and farmers in 1991, we learned that elephants invaded crops at night, possibly to avoid human harassment. We also learned that elephants drink from excavated wells late in the afternoon or in the evening when livestock movements are reduced. In 2003, most the observations we made were under dim light conditions. During the day, as was observed in Banegar (1 February 2003), they are in the riverine forest to avoid the heat. Even though the elephants are elusive and avoid humans, they are more diurnal and crepuscular than nocturnal. These changes in behaviour are testimony to the elephants' ability to adapt to a changing environment.

HYBRIDIZATION

As noted by Hagos et al. (2003) there have been rumours that some of the elephants (*Elephas maximus*) brought from India in 1868 to Eritrea by the British General Sir Robert Napier (in pursuit of the Ethiopian King Theodore of Magdala, Myatt 1970) escaped from camps and mated with the native African elephants. Thus, descendants of these supposed matings would be hybrid elephants that roam Ethiopia and Eritrea. All the elephants observed in Eritrea appeared typical African elephants (*Loxodonta africana*). Further, initial genetic results confirm our field observations.

HUMAN–ELEPHANT INTERACTIONS

Elephants are not the only animals that cause damage to farmers and their crops. Rodents (especially rats and porcupines), monkeys and wild boars also damage them. The loss to farmers is high. Inhabitants informed us of conflict between them and the elephants that destroy or uproot crops. In recent years angry farmers have shot and killed elephants on their cultivated fields (see photos in Shoshani et al. 2000). These human–elephant conflicts have stimulated discussion, and plans to erect electric fencing to prevent elephants from invading plantations are being considered. Hoare (2003) discussed some of the problems arising from electric fences, especially the problem of maintaining them. Monetary compensation to victim farmers was also considered or relocating the farmers to areas where elephants visit less frequently (Hagos 2000). Both compensation and relocation are complex issues, for they require detailed assessments of the damage to farmers and building trust that the translocated farmers will not end up suffering a loss. Some of these issues are discussed in a publication of the IUCN African Elephant Specialist Group Human–Elephant Conflict Task Force (2003).

From a global and historical perspective, long before humans arrived in the area known today as Zoba Gash Barka, elephants and other animals roamed the area freely. Once people started to cultivate the floodplain of the Gash River, elephants found it irresistible to taste the fruits and vegetables that people planted. Bananas and citrus are the most favoured. Eritrea is not unique in the respect that both animal and humans compete for the most fertile lands. Strictly speaking, using the word 'damage' by elephants to human crops is not correct since the damage is simply what happens when the elephants seek food in a land where their forebears foraged for generations.

Traditional methods used by the Kunama and Nara farmers to chase elephants and reduce crop damage include making noise with empty cans or by cracking whips, and lighting fires in various places or gently waving lit torches. Aragai Haileselassie, the Ministry of Agriculture representative, however noted, 'Elephants will adapt to any threat. Integrated and controlled measures are better than repeating the same method; innovations are needed.' Another approach to avoid damage to crops is 'preventive medicine'. Thus, as soon as the arrival of elephants has been detected, it is suggested that farm produce be collected, ripe or not, and sold or stored before the elephants get to it.

Elephant conservation and management in Eritrea

Should translocation of farmers be necessary (in case the electric fence is ineffective), the approach would be unique, and it is hoped that it would be an example for future similar programmes. Most field observations on elephants deal with aspects of ecology and ethology (such as Douglas-Hamilton and Douglas-Hamilton 1975; Moss 1988; Sikes 1971). We are not aware of any conservation-related projects on elephants in which wildlife authorities are recommending translocating the people with goodwill and cooperation from a previously inhabited elephant range (Hagos 2000), rather than translocating the elephants, as discussed in the literature. Nonetheless, long-term management plans to protect elephants and their ecosystem in Eritrea will, undoubtedly, necessitate the cooperation of three governments: those of Eritrea, Ethiopia, and possibly Sudan.

Interspecific relationships

By definition, a keystone species is an animal that modifies its habitat and other animals benefit from this change (as in Western 1989). Elephants are good examples of keystone and super-keystone species (Shoshani 1993). An example of the role the elephant plays as a keystone species in the Gash Barka zone is the symbiotic relationship it has with the doum palms that are present in the Great Rift Valley and the Levant. The fruit of these palms, about the size of a pear, is called 'akat'. In season it sweetens and attracts many wild and domestic

animals—monkeys, elephants and humans included. Elephants use their foreheads to shake trees and then feast on the fallen fruits. They chew only the sweet outer coat; the rest of the digestion is done in the stomach. It is possible that the sweet outer coat evolved to attract animals to eat it and then dispose of the inner portion, the seed, and thus disperse the species. After several hours or more, the inner portion containing the seed is dropped in dung 5 to 10 km away from the original feeding site. Elephants thus are important seed dispersers of this palm. They also eat the leaves and use the trees to shelter from the heat and as hiding places and scratching posts.

In more than one locality we observed elephants and olive baboons in close association. One hypothesis proposed is that the elephants and the baboons have a symbiotic relationship. Deep in the forest, high in the trees, the baboons have a better visual advantage and from them the elephants quickly learn of human presence. In return baboons benefit from elephants, especially when water is scarce—they follow the elephants to the riverbed where they take advantage of the waterholes the elephants dig.

A possible commensal relationship may exist between elephants and helmeted guinea fowls (*Numida meleagris)*. We observed in a few locations that guinea fowls were in close association with the elephants (see 'Faunistic elements observed'). Perhaps they pick up seeds from the dung, or possibly catch insects attracted to the dung or that the elephants disturb. Additional observation would help to shed light on this newly reported association. Commensal relationships between elephants and cattle egrets and piapiac have been reported in the literature (Quick 1965).

Recommendations

We present two suggestions here; they are interrelated but it is easier to treat them separately. From previous discussions with staff of the Wildlife Conservation Unit, Ministry of Agriculture, and from the map presented in the report of Yacob (1998, p. 6), it appears that the current plan of the ministry is to establish one reserve area of about 500 km^2, south of Haicota. No human activities will be allowed inside the reserve. The other part of this plan is to create a corridor that will connect the proposed reserve area to the Setit River through Antore. Such a corridor will allow free movements of elephants between the Haicota area and the Setit River and Ethiopia. In all likelihood the human population in Zoba Gash Barka will continue to increase. Thus should it be possible, we recommend that the creation of this reserve area be expedited because more and more elephants and other wildlife are being killed (mostly as defense against crop raiding), and wildlife will soon learn where it is safe. This proposed protected area will perhaps be named the Gash-Setit Reserve, as suggested by Hagos (2000).

Our second recommendation is to install a few artificial watering sites along the path of elephant movement. Based on measurement of the depth of water in five wells in the Gash River (three wells around Musse, one each in Kurbahebaye and Mekonat), we noted that the depth ranges from 75 to 150 cm below the riverbed, with an average depth of 121 cm. With careful planning, pools with a low water level could be excavated. Alternatively, water could be supplied with a pump into pools in a convenient location. Some southern African countries are using this technique of supplying water into artificial pools to keep elephants in designated areas, rather than have them wander outside park boundaries and into human settlements (Conybeare 1991).

We are hopeful that implementing these suggestions and constructing an elephant-proof fence powered by solar energy, as mentioned above, will encourage ecotourism. These ideas and recommendations are interrelated and will require careful planning and funds.

Conclusions

Previous attempts to collect ecological data on elephants in Eritrea produced important information, but there is a desperate need for additional data on a broad scale to better understand the biodiversity, ecology and behaviour of these elephants to suggest long-term management programmes. Local people as well as indigenous students should be involved and benefit from these conservation programmes. Should erecting the electric fence be a successful pilot project, it will not only provide protection and security for these elephants but will, it is hoped, reduce conflict between humans and wildlife in the area.

Data collected during past years have added significantly to the existing pool of knowledge about elephants in Eritrea. The estimated number is close to 100; those observed in the Gash River constitute a healthy, fecund and viable population.

Based on initial assessment and comparing this population to other elephant populations in Africa, we believe that the number of males relative to females is high. Elephants inhabit areas where doum palms dominate, and a symbiotic relationship seems to have developed between these two species that may be critical to their mutual survival. Baboons and elephants also have a symbiotic relationship.

Throughout Africa, the estimated total population of *L. africana* and *L. cyclotis* combined is less than 500,000 elephants in the wild (Blanc et al. 2003). The small population of elephants in Eritrea may be isolated, although it appears that these elephants have been crossing into Ethiopia but not to Sudan (as reported by farmers and others in the area). Isolation of elephants results in islands of demes or separate subpopulations, developing their own behaviour and 'cultures' (Redmond 1986). These islands, if not well monitored and protected and depending on their size, may soon lose genetic diversity and be engulfed by the growing human population. The elephants in Eritrea may be a classic example of isolation; they are relict, confined to a small area of about 100 by 50 km.

Thus only a fraction of what has been documented as elephant habitat in historical times is currently available for them. The vulnerability of the elephants in Eritrea, their keystone-species role in the ecosystem, and their value as part of the international wildlife heritage cannot be overstressed. If elephants in Eritrea cross the border to Ethiopia, then the only possible broad exchange of genes would be with the elephants in Ethiopia, but even this possibility appears to be remote. International efforts must be made to protect this relict population. Their value cannot be expressed only monetarily; it is also in their ecological integration within their ecosystem, both as keystone or super-keystone species and in the context of ecotourism. We emphasize that saving elephants will automatically save large areas that will also protect other wildlife in the same ecosystem.

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Impacts humains sur les aires de distribution et couloirs de migration des éléphants au Togo

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Résumé

Le rapport concerne l'étude des populations d'éléphants au Togo. Elle s'est déroulée en deux étapes. La première est axée sur les enquêtes de terrain réalisées dans 34 villages concernés par la conservation des éléphants et la deuxième l'identification des couloirs de migration et l'inventaire de l'espèce. Pour ce dernier, la méthode de comptage direct au sol a été utilisée. Les couloirs des éléphants ont été identifiés dans deux régions : la région des Savanes et la région Centrale. Dans la région des Savanes le couloir suit la forêt de Doungh, la rivière Koulougouna, la Fosse aux Lions, la Réserve de Galangashie, la Kéran, la Vallée de l'Oti et l'Aire de Kpendjal et dans la région Centrale le secteur de Binako, le fleuve Mô, la piste Fazao-Malfakassa passant par Boulohou ; la voie reliant Fazao à Abdoulaye traversant la forêt d'Aou Mono vers le Bénin. Trois groupes d'éléphants ont été observés dans le Fazao et des indices fraîches dans la Réserve d'Abdoulaye. Les principales menaces qui pèsent sur les éléphants sont les occupations humaines, la transhumance, la déforestation et le braconnage. Une évaluation des mesures de conservation des éléphants montre des lacunes évidentes, tant dans la compétence des gestionnaires de la faune que dans l'intégration des populations à leur gestion.

Mots clés supplémentaires : aires protégés, conflits homme–éléphant

Abstract

This study of elephant populations in Togo was carried out in two stages in 2002–2003. The first focuses on a survey in 34 villages where elephant conservation is conducted; the second identified the migratory corridors and makes an inventory of the species using the direct counting method. The study identifies two migratory corridors used by elephants in two regions: savannah and central. In the savannah region, the corridor follows the Doungh forest, Koulougouna River, Fosse aux Lions, Galangashie Reserve, Keran, Oti Valley and the Kpendjal area; and in the central region, Mô River, the Malfakassa trail passing through Boulohou, the way linking Fazao Abdoulaye crossing Aou-Mono forest towards Benin. Three groups of elephants have been observed in Fazao and fresh trails in Abdoulaye Reserve. The main threats facing these elephants are human occupation, transhumance, deforestation and poaching. An evaluation of the elephant conservation measures in use shows obvious shortcomings both in the competence of wildlife administrators and in management of the animals.

Additional key words: protected areas, human–elephant conflict

Introduction

Au dernier recensement au Togo, la population d'éléphants de savane (*Loxodonta africana africana)* était estimée à 200 individus dans les parcs nationaux de la Fosse aux Lions, de la Kéran et de Fazao Malfakassa (MET 1991). Ils sont également rencontrés dans les Aires protégées de Kpendjal, d'Abdoulaye et de Galangashie où ils passent la plupart du temps.

Aujourd'hui, la surexploitation des pâturages et l'occupation humaine et physique des aires protégées ont contribué à une diminution drastique de l'effectif des éléphants, de leurs domaines vitaux et la disparition de certains couloirs de migration. Ainsi les populations d'éléphants au Togo sont actuellement fragmentées et géographiquement isolées les unes des autres, phénomène menaçant sérieusement leur survie.

Le plus grand défi est de limiter le fléau par une approche devant amener les collectivités locales à renouer avec la conservation de la diversité biologique en générale et des éléphants en particulier. Pour ce faire, la connaissance des populations d'éléphants elles-mêmes est utile. C'est à ce titre que cette étude est menée avec pour objectifs de :

- déterminer les différents groupes d'éléphants au Togo et leur distribution ;
- évaluer leur statut de conservation ;
- déterminer les zones de parcours et leurs mouvements saisonniers ;
- identifier les éléments de relations homme–éléphants ; et
- représenter la carte de distribution des éléphants.

Zone d'étude

L'étude est réalisée dans les aires protégées des régions septentrionale et centrale du Togo y compris les zones environnantes estimées à 11.000 km^2 en 1991. Cette étendue a été considérablement réduite et modifiée par les activités anthropiques (défrichements, feu de brousse, installations humaines…). C'est ce qui explique la dissociation de l'Oti–Mandouri et l'obstruction de certains couloirs de migration.

La région septentrionale est constituée de la Kéran, la Fosse aux Lions, la Forêt classée de Doungh, la Réserve de faune de Galangashie, la vallée de l'Oti et le Kpendjal. Elle est caractérisée par la présence de deux saisons contrastées : une longue saison sèche d'octobre à avril et une saison de pluie de mai à septembre. La température moyenne mensuelle oscille entre 24,7°C et 31,7°C. Les extrêmes thermiques sont de 18,1°C en décembre et de 38,7°C en mars. Les formations savanicoles et arbustives de la zone soudanienne y sont rencontrées avec une faune typique. La région Centrale comprend le Parc Fazao-Malfakassa, la Forêt classée d'Aou-Mono et la Réserve de faune d'Abdoulaye. Les données climati-ques montrent une pluviométrie moyenne de 1300 mm de pluie par an accompagnée d'une température variant entre 20 et 32°C et décrivent une formation végétale de forêt semi-décidue, les forêts claires, les savanes boisées et arbustives. La faune est diversifiée et composée d'espèces inféodées.

Matériel et méthodes

Matériels

Les principaux matériels utilisés comprennent : 12 boussoles pour l'orientation ; 2 GPS pour l'enregistrement des coordonnées de waypoints ; 15 paires de jumelles ; 2 cartes IGN à 1/200.000 ; 3 appareils photos pour la prise des images thématiques ; et 3 guides de terrain.

Méthode

ENQUETES DE TERRAIN

Les enquêtes de terrain sont menées dans les villages riverains des aires désignées sur l'approche de la Méthode active de recherche et de planification participative (MARP) qui a permis de collecter les informations en rapport à l'histoire des éléphants dans leurs aires de distribution. Plusieurs réunions sont organisés avec les groupes villageois dans les concessions des chefs avec la participation des différentes couches sociales (fig. 1).

PARCOURS DES COULOIRS DE MIGRATION

Les résultats d'enquêtes ont fourni d'utiles renseignements pour identifier les différents couloirs et voies de passage des éléphants existant. Le parcours est fait soit à pied, soit à moto. Parfois le véhicule est utilisé au cas où les conditions topographiques le permettent. Les guides de terrain (chasseurs et agents forestiers) ont été déployés pour couvrir leur territoire de compétence. Les données intéressantes relevées concernent les activités anthropiques et les zones de menace et d'étranglement.

Figure 1. Une des réunions d'enqûete avec la Méthode active de recherche et de planification participative.

INVENTAIRE

Choix de la méthode et approches. Le recensement direct au sol utilisant les lignes transects a été adopté pour cette étude. Les transects ont été posés de façon aléatoire sur les fonds de cartes IGN au 1/200.000 des régions Centrale et Savane. Ces transects sont équidistants de 3 km en raison de la distribution des éléphants dans les aires concernées associées aux paramètres écologiques et aussi en raison d'absence d'aménagements appropriés. Les raisons financières ont également orienté vers ce choix.

Une équipe de deux personnes parcourent le transect l'un avec le GPS ou la boussole à la main oriente la marche, l'autre enregistre les données sur la fiche. Cependant les deux membres de l'équipe recherchent simultanément les informations dans la zone du transect.

Sur le parcours, les observateurs collectent les données sur les éléphants :

- les indices de présences (passage, bouses, émondages, maraudages des cultures …) ;
- la structure des groupes (adultes, jeunes, mâles, femelles) ;
- l'effectif observés dans chaque groupe ;
- la distance estimée de l'animal par rapport à l'observateur ;
- l'angle d'orientation lu dans la boussole par rapport au centre estimé du groupe ;
- la distance radiale du transect au centre estimé du groupe ;
- l'heure de l'observation ; et
- la nature et l'état des habitats.

TRAITEMENT DES DONNEES

Première phase. Les réponses aux questionnaires de l'enquête sont regroupées par thématique et par aire protégée. Elles prennent en compte les zones rurales et les zones urbaines périphériques ainsi que les couloirs de migrations. Elles regroupent :

- la présence et la distribution des éléphants dans et autour des aires protégées concernées ;
- les zones de parcours et de migration des éléphants au Togo ; et
- les conflits hommes–éléphants au Togo.

Deuxième phase. Les paramètres tels que la densité, la population et l'indice kilométrique d'abondance

(IKA) des éléphants ont été déterminés pour chaque aire à partir des fiches techniques de terrain. Les calculs ont été effectués suivant la formule de Léopold et al. (1951) qui est une variante de celle de King (1930).

Pour la densité et la population d'éléphants, les observateurs balaient un couloir de largeur 2*l* *(l* étant la moyenne des distances radiales de vue des éléphants) et parcourent une longueur *L*.

Dans la zone, un certain nombre *(n)* d'éléphants est observé, la densité d'éléphants *(d)* se détermine par la formule :

$d = n / 2lL$

La population d'éléphants *(P)* dans chaque zone est obtenue par le modèle mathématique :

$P = dS = Sn / 2l\ L$

où *S* correspond à la surface totale de l'aire.

A l'échelle de chaque zone les observateurs ont parcouru un nombre connu de transects. La longueur de chaque transect est déterminée au GPS sur le terrain. Ainsi l'IKA est calculé par rapport au nombre total d'éléphants observés dans la zone *(n)* sur la longueur totale des transects parcourues *(L)*.

$IKA = n / L$

Les logiciels tels que Mapinfo, Adobe Photoshop, Word, Excel ont été utilisés pour les traitements statistiques et cartographiques.

DIFFICULTES DE TERRAIN

En dehors des problèmes liés à la peur des populations de répondre aux questions, les difficultés majeures rencontrées concernent :

- l'accès et le parcours des couloirs de migration ;
- la traversée des transects liée aux longueurs de certains d'entre eux ;
- le relief accidenté et du Parc national de Fazao-Malfakassa ;
- l'absence d'aménagement adéquat devant faciliter les liaisons dans les différentes aires ;
- la présence de végétation dense par endroit des zones du projet rendant la visibilité faible ;
- la présence de cours d'eau et d'importantes zones humides à traverser ;
- l'étendue très vaste de l'aire du projet.

Résultats

Distribution des éléphants

Au total 34 localités sont visitées et où 40 réunions villageoises sont organisées. Les éléphants sont distribués dans les parcs nationaux, les réserves de faunes et les forêts classées des régions des savanes. Ils y font des incursions entre septembre et novembre (période des récoltes). Dans la région Centrale et la partie sud de la Kara, ils sont permanents dans les Parc national de Fazao-Malfakassa et la Réserve de faune d'Abdoulaye (fig. 2).

Conflits homme–éléphants

Les conflits homme–éléphants (CHE) existent au niveau des deux zones de concentration permanente des éléphants (Fazao et Abdoulaye) et au niveau des couloirs de migration dans la région des savanes (l'Aire protégée de Kpendjal, Doungh, Galangashie et

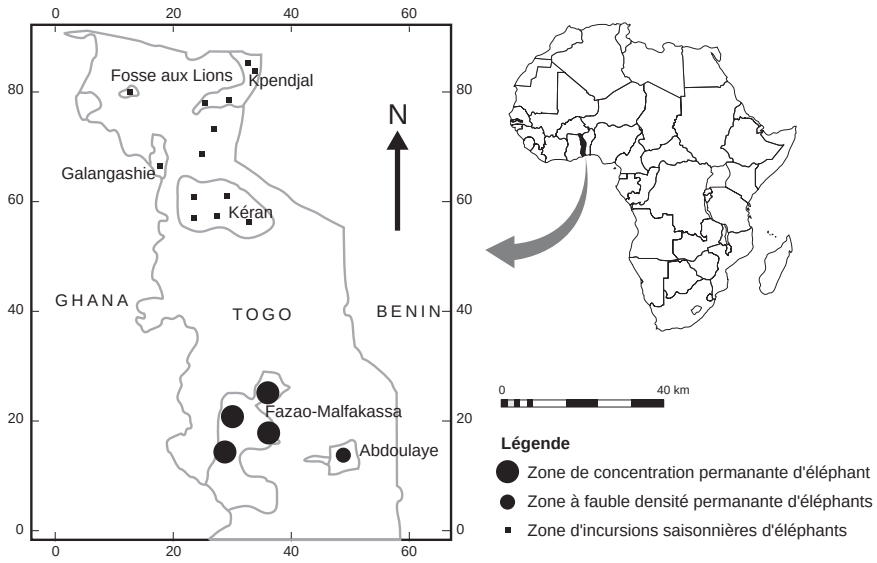


Figure 2. Distribution des éléphants au Togo.

le vallée de l'Oti) (figs. 3 et 4). Les éléphants s'aventurent à proximité des zones d'occupation humaine, maraudent les cultures, souillent les sources d'eau et tuent occasionnellement les habitants en cas d'agression. En réponse, les populations humaines tentent de les éliminer soit directement par le braconnage, soit indirectement par des méthodes dissuasives ou contres mesures (tableau 1).

CARACTERISTIQUES DU CONFLITS HOMME–ELEPHANT AU TOGO

Importance et distribution des conflits homme–éléphants (CHE). L'évolution annuelle du CHE est connue de façon qualitative : il apparaît dès les premières pluies, et plus généralement dès que les cultures céréalières arrivent à maturité, soit en février pour les tomates (*Lycopersicum esculentus*) ou en août pour le maïs (*Zea mays*) et l'igname (*Dioscorea bulbufera)*. Les éléphants maraudent pendant toute la saison des cultures à Abdoulaye, le long du couloir Fosse de Doungh–la Vallée de l'Oti et l'Aire de Kpendjal ; mais dans le cas de Fazao le CHE est permanent (fig. 3). Les éléphants s'attaquent aux jeunes pousses et aux semenciers.

Les limites géographiques globales des zones de conflits sont connues et matérialisées. Les lieux de conflits sont concentrés dans les périphéries immédiates des aires protégées mais les éléphants étant très mobiles parcourent de grandes distances pour se nourrir, utilisant les bosquets denses et les bas fonds ombragés comme zone de refuge temporaire lorsqu'ils s'éloignent trop des limites des aires protégées.

L'ampleur des dégâts n'est pas objectivement connu au Togo (exagération dans l'évaluation des dégâts par les victimes, oublis de certaines zones). Il est difficile de pouvoir comparer l'impact des éléphants par rapport aux autres animaux nuisibles appartenant à la faune sauvage et aux autres facteurs influençant le milieu, aucune étude n'ayant été menée dans ce sens.

Vision des riverains vis à vis des CHE. Certains paysans préfèrent généralement abandonner leurs champs aux éléphants et réclamer des mesures com-pensatoires des dég,ts plutôt que de tenter de les repousser. Pour d'autres le passage des éléphants porte préjudice à la quiétude

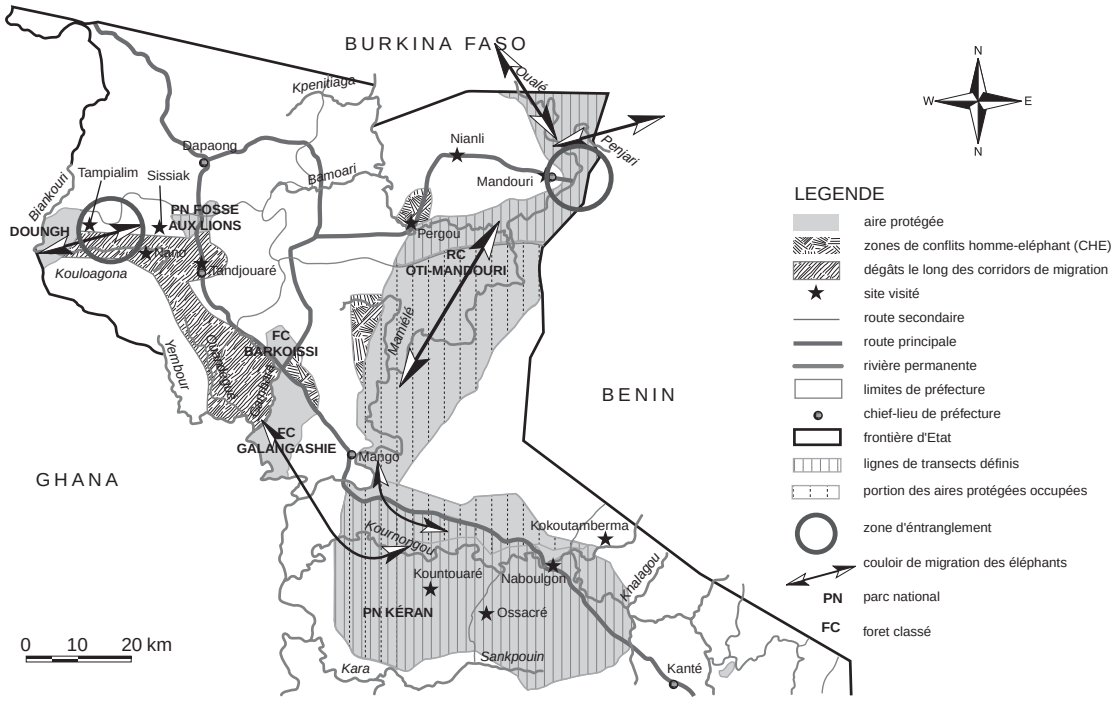


Figure 3. Répresentation des zones de conflits homme–éléphants, les lignes de transects, les couloirs de migration et les zones d'étranglement dans la région des Savanes.

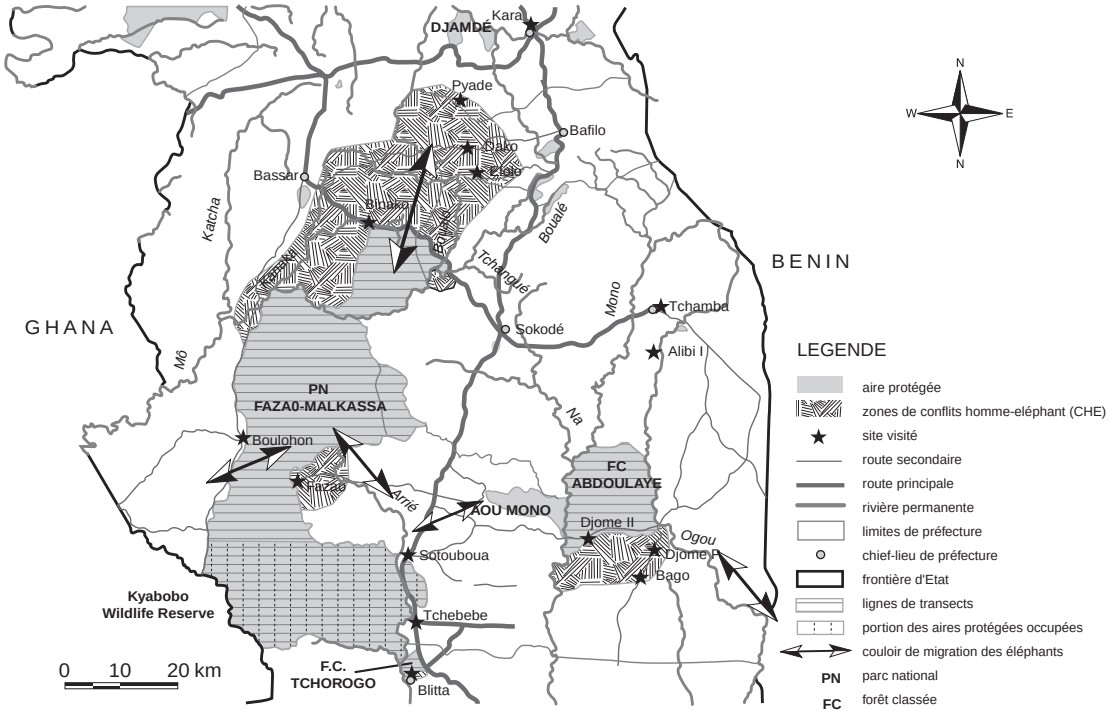


Figure 4. Répresentation des zones de conflits homme–éléphants, les lignes de transects et les couloirs de migration dans la région Centrale.

et modifie leurs comporte-ments : surveillance et veillée nocturne afin de pré-server leurs récoltes.

Ceux qui se plaignent le plus des intrusions des éléphants dans leurs champs sont bien évidemment ceux qui sont à la périphérie des parcs. Les terres agricoles sont souvent acquises de manière frauduleuse ne respectant pas les limites des aires protégées. Le concept de concession de ces terres en rapport à leur productivité et à leur coût ne sont jamais mis en balance avec les dégâts causés par la faune sauvage considérés comme un coût d'opportunité.

Valeur traditionnelle des éléphants. Seuls les habitants de Pana (région des savanes) vénèrent les éléphants et les considèrent comme leurs ancêtres. Certains groupes ethniques utilisaient autrefois des amulettes et bracelets en ivoire, notamment dans la périphérie de la Réserve de faune d'Abdoulaye. En ethnomédecine, les fecès des éléphants sont utilisés pour soigner des maladies telles l'anorexie infantile et les faiblesses musculaires. Dans les pratiques animistes en région Centrale, la queue et la trompe de l'éléphant sont utilisées.

LES MENACES

Elles concernent les caractéristiques physiques et les activités anthropiques menées dans les aires protégées. Deux zones d'étranglement ont été relevées dans la région des savanes ; la première correspond au prolongement de l'escarpement de Gambaga (Ghana) en direction du village de Tampialim. Du village vers l'escarpement sont installés des champs qui obstruent le couloir Fosse aux Lions–Doungh (fig. 3). De vastes rizicultures y sont installés jusque dans le lit de la rivière Koulougouna. Plus à l'Est de la région des Savanes, un point d'étranglement est situé entre la ville de Mandouri jusqu'à la frontière du Bénin où d'importants mouvements humains sont enregistrés. Ce phénomène est beaucoup plus accentué, au bord du fleuve Oti, au point de traversée (10°50'26.9'' N et 0°51'19.3" E) situé exactement dans l'étranglement (fig. 3).

A la rive Est, est implanté le village Kpentali avec de vastes exploitations agricoles et des concession installées ça et là obstruant le passage des éléphants. A

Tableau 1. Les contres-mesures adoptées pour les conflits homme–éléphant

Contre mesures	Initiatives	Conséquences
Méthodes		
Gardiennage des cultures	paysans	ignorance, rarement agressive
Bruitage : cris, tambours, claquement de boîtes métalliques, cor traditionnels	paysans	fuite puis habituation
Feu autour du champ	paysans	fuite ou contournement
Fumée à partir des crottes sèches d'éléphants	paysans	évitement
Faire brûler de la poudre à canon	paysans, chasseur	évitement : méthode de regroupement et de concentration des éléphants
Projectiles : pierres, lances	paysans	peu pratiquée car rend les éléphants très agressifs
Dérangement d éléphants nuisibles		
Fusillade par des armes à feu	villageois	fuite et agressivité spontanée à la vue d'une arme
Braquer des lampes sur les éléphants	paysans	agressivité, intimidation
Pousser les éléphants hors des zones à risque avec des hélicoptères	préfecture	fuite temporaire
Barrières physiques		
Les clôtures conventionnelles non électrisées autour des cultures et maisons : cordes d'écorces avec boîtes, cloches, tissus, câble à filins uniques	directeur du programme	arrache et détruit les clôtures
Cultures tampons (thé, tabac, bois, piment…) autour des cultures	village	les plantations d'anacardium repoussent les éléphants
Les programmes de dédommagement		
Direct : monétaire (lié au dégâts) - non monétaires (vivres (PAM)	FFW	échec ; insatisfaction générale
Fond d'assurance comprenant cotisation et indemnisation	PAM/ UNICEF	succès pendant sa mise en oeuvre (fin en 1998)
Les programmes d'utilisation de la faune dont les populations tirent un bénéfice		
Tourisme local, international lié à la présence des éléphants	FFW	pas d'éco-tourisme mais profit indirect lié à la fréquentation des touristes de l'hôtel
Les modifications de l'usage des terres qui puissent réduire la concurrence pour l'occupation de l'espace		
Restituer les limites des aires protégées	UE/DFC	redélimitation consensuelle en cours dans le nord

deux kilomètres du village de Mandouri à l'Est se trouve la limite de l'aire protégée installée sur un bassin inondable propice à la riziculture et au pâturage.

Pour la région Centrale, les menaces ne sont pas différentes que celles rencontrées dans la partie septentrionale (fig. 4). Les plus importants obstacles sont le développement des cultures d'igname, de céréales, ainsi que l'extension et l'implantation de nouveaux villages au sein même des aires protégées (cas du sud Parc national de Fazao et la partie Est et Sud de la Réserve de faune d'Abdoulaye) .

INVENTAIRE

Les résultats de dénombrement des éléphants sont regroupés dans le tableau 2. Sur l'ensemble des aires inventoriées trois groupes d'éléphants ont été dénombrés dans le Parc national de Fazao (fig. 5). La strucuture des groupes est composée essentiellement d'adultes mâkes et femelles. La structure des groupes est composée essentiellement d'adultes mâles et femelles (tableau 3). Au sein de ce dernier on distingue trois mâles, cinq femelles et un jeune.

L'analyse des données montre une densité de 0,85 éléphants au km^2 soit une population de 13 éléphants. Ces données indiquent la faible population des éléphants observés dans les aires protégés due à l'ampleur des menaces dont les parcs font l'objets.

Discussion

Le projet d'étude des impacts humains sur les aires de distribution et couloir de migration des populations d'éléphants au Togo est réalisé pour fournir les informations sur l'état de conservation de cette espèce en raison des changements significatifs intervenus au cours de ces dix dernières années dans l'aménagement des aires protégées.

Menaces sur l'habitat

Au point de vue démographique, la densité de population est d'environ 201 hbts/km^2 avec une forte dégradation des terres. Une étude du PNUD/FAO (1991) a montré que 23% des terres de cette région sont très dégradées et que les terres arables sont circonscrites uniquement dans les aires protégées. C'est ce qui explique les revendications et l'envahissement des aires protégées en terme d'occupation humaines et physiques depuis 1990. Dans le Parc National de la Kéran, 16.750 personnes se sont installées (Dansomon 1995), 15 % de l'aire de Fazao sont délimitées pour freiner la progression des occupations anarchiques (Tchètiké 1997).

Tableau 2. Evolution de la population d'éléphants de 1990 à 2003

Aire protégée	Population en 1990	Population en 2003
Fazao-Malfakassa	50	13
Kéran	20	0
Kpendjal	–	0
Abdoulaye	–	0
Fosse aux Lions	128	0

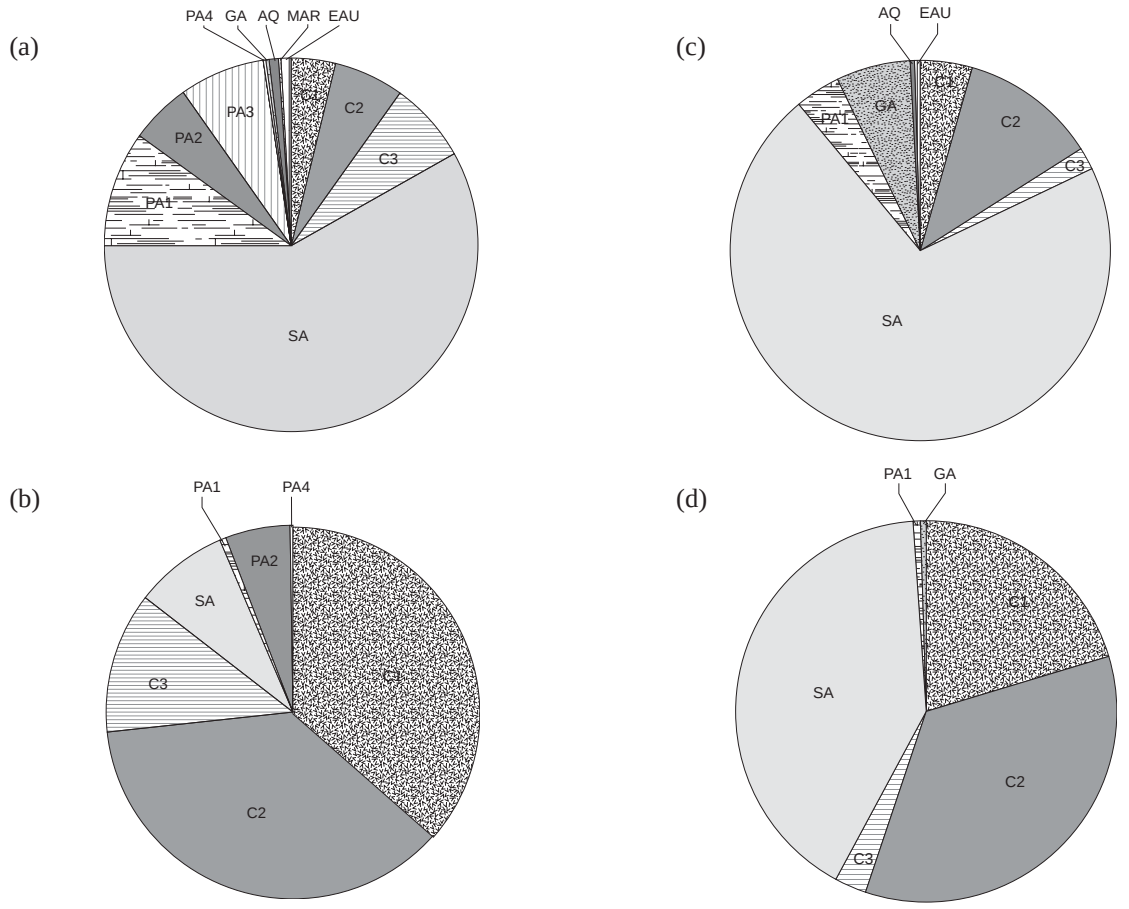
Tableau 3. Structure des groupes d'éléphants observés

Groupe	Effectifs	Sexes		Age
		mâles	femelles	juvenile
1	3	1	2	
2	4	2	2	
3	9	3	5	1

Sur le terrain, les observations ont montré que la Réserve de faune Abdoulaye est fortement occupée avec l'installation des villages tels Djomé et Agoumana dans la partie sud.

Dans le cadre de la mise en úuvre du programme de réhabilitation des aires protégés au Togo, Parnot (2002) a conduit une mission d'appui en télédétection et SIG. Au terme de cette mission les cartes des Aires protégés de la Kéran et de Kpendjal ont été mises en forme par rapport aux différentes occupations des sols.

Figure 5. Un troupeau d'éléphants observés dans le Parc National de Fazao-Malfakassa pendant l'étude.



C1 – culture dense ; C2 – culture moyennement dense ; C3 – culture peu dense ; SA – savane et jachère ; PA1 – plaine inondable ; PA2 – plaine hétérogène ; PA3 – dépression inondable ; PA4 – terasse peu inondable ; GA galorie ripicole ; AQ – végétation aquatique ; MAR – mare ; EAU – cours d'eau

Figure 6. Superficie des unités relatives à la surface (a) physique totale et (b) cultivée totale de l'Aire protégée de Kpendjal; et (c) physique totale et (d) cultivée totale de l'Aire protégée de Kéran.

Les données statistiques sur les superficies de la Kéran et de Kpendjal en relation aux taux d'occupation se présentent dans le figure 6.

Ainsi, les habitats des éléphants pour l'Aire de la Kéran, sont constituées essentiellement de savanes et de jachères (plus 70 % de la surface physique totale) contre 18,1 % pour les zones cultivées et 11,5 % pour les zones humides. Les superficies cultivées sont réparties dans les zones cultivées C1 à C3 (58,1 %) mais aussi dans les savanes/jachères (40,7 %).

Concernant l'Aire de Kpendjal plus de 57 % de la surface physique totale est constituée de savanes et de jachères, contre 16,29 % pour les zones cultivées et 27,14 % pour les zones humides. Les portions cultivées sont réparties à 85,74 % dans les zones cultivées et seulement 7,7 % en savanes et jachères.

Ces données montrent l'importance de l'empiètement des populations humaines sur ces habitats avec pour conséquence la régularités des conflits. La situation est similaire pour la Fosse aux Lions et le couloir de Doungh, malheureusement aucune expertise cartographique n'est faite pour quantifier le niveau des menaces.

Distribution et population des éléphants au Togo

Les menaces constituées essentiellement des occupations humaines et physiques nées des troubles socio-politiques ont contribué à la réduction considér-

able des effectifs et de la distribution des éléphants. Le nombre d'éléphants est passé de 200 individus estimés en 1990, à environ 55 (dénombrement aérien) en 2000, puis 13 (dénombrement au sol) en 2003 (tableau 2).

Les chiffres mentionnés pour la Kéran, Kpendjal, Abdoulaye et Fosses aux Lions ne signifient pas l'absence totale des éléphants dans ces aires. En réalité, il existe environ 50 éléphants dans le Parc national de Fazao et 5 éléphants dans la Réserve de faune d'Abdoulaye ; des incursions saisonnières d'éléphants sont notées dans les aires protégées de l'extrême nord. La réduction de l'effectif des populations d'éléphants enregistrée en 2003 serait liés aux différentes méthodes employées, aux périodes de dénombrement et à la distribution des éléphants. De plus les bouses et autres indices relevés sur le terrain n'ont pas été prises en compte dans l'évaluation actuelle.

La stratégie nationale de conservation des populations d'éléphants au Togo

Il a été organisé en octobre 2002 un atelier d'élaboration d'une stratégie nationale de conservation des éléphants dont le but est d'assurer la conservation des populations d'éléphants et leurs habitats au Togo. L'objectif global, celui de réduire le niveau de vulnérabilité des éléphants au Togo inclue :

- l'amélioration des informations scientifiques sur les éléphants ;
- la meilleure implication des populations dans la gestion de l'espèce ;
- la réduction des conflits homme–éléphants ;
- la réduction du braconnage ; et
- le renforcement des capacités.

Cette étude répond en partie au premier résultat de l'objectif 1 : celui de la meilleure connaissance des populations d'éléphants au Togo.

Conclusion et recommandations

Toutes les informations recueillies et consignées dans ce rapport proviennent des populations riveraines, des services compétents, des revues bibliographiques et de l'expertise des missions de terrain inscrits dans le cadre de cette étude. La combinaison de toutes les données minutieusement traitées a permis de faire la lumière sur les populations d'éléphants au Togo, un des grands objectifs de ce projet.

Deux populations d'éléphants existent au Togo mais géographiquement séparées. Les populations d'éléphants du Nord utilisent les Parcs nationaux de la Kéran et de la Fosse aux Lions et l'Aire protégée de Kpendjal y compris les couloirs de migration associés, et les éléphants du centre observés dans et autour du Parc national de Fazao-Malfakassa et la Réserve de faune d'Abdoulaye. Au sein de ces deux populations un changement significatif s'est opéré durant les dix dernières années en raison de la fragmentation de l'habitat, de la dégradation de l'environnement et de la disparition de certaines essences forestières entravant le cycle de vie de l'espèce. Ces fléaux ont conduit à l'obstruction de certains couloirs de migration, à la concentration de petites populations d'éléphants dans des zones de plus en plus réduites et à l'augmentation des dégâts dans les cultures environnantes.

L'effectif des éléphants est considérablement réduit par les diverses menaces relevées. Au nombre de 200 individus estimé en 1990, cet effectif est passé à 13 en 2003. Cette réduction est la conséquence de la révolte des populations riveraines qui ont remis en cause tous les symboles de la conservation conduisant à la colonisation des aires protégées et la fréquence des CHE. Les mesures appliquées contre les CHE sont traditionnelles et restent des expériences très localisées.

Le braconnage constant, le mécontentement des populations riveraines de l'aire de répartition des éléphants et la persistance du CHE dans certaines zones toute l'année, montrent l'urgence des actions à entreprendre pour la conservation de cette espèce. Entre autres :

- le développement d'un programme de sensibilisation de tous les partenaires (populations riveraines, les gestionnaires de la faune, autorités politiques) à la conservation des éléphants ;
- la création d'une base de données fiables et le suivi de l'évolution des populations d'éléphants au Togo;
- l'introduction de plantations susceptibles d'éloigner les éléphants des zones de culture et d'habitations ;
- le renforcement des capacités des différents acteurs concernés sur les différents outils de gestion des éléphants ;
- la réhabilitation des aires protégées, dans un cadre consensuel avec les populations riveraines.

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Managing human–elephant conflicts: the Kenyan experience

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Abstract

An understanding of the interaction between wildlife and people is important for conservation. If the two are to co-exist, conflicts must be minimized by decreasing the costs and increasing the benefits that come to the local communities as they interact with wildlife. In Kenya, the elephant has had the greatest effect on human activities and has led to severe human–elephant conflicts, mostly as a result of elephant habitats being fragmented and reduced. The major consequences of conflict have been an increased number of human deaths and injuries, and of elephant deaths and injuries, and habitat degradation. Kenya Wildlife Service has tried various strategies to minimize conflict and increase tolerance. Electric fencing, translocation, establishment of sanctuaries and problem-animal control activities have all been applied at various pressure points.

Résumé

Il est important pour la conservation de bien comprendre l'interaction entre la faune sauvage et les gens. Si les deux doivent coexister, il faut minimiser les conflits en diminuant les coûts et en augmentant les bénéfices qui reviennent aux communautés locales dans leurs interactions avec la faune sauvage. Au Kenya, ce sont les éléphants qui ont toujours eu le plus grand impact sur les activités humaines et qui ont entraîné de sévères conflits hommes–éléphants, ce qui était dû, dans la plupart des cas, au fait que l'habitat des éléphants a été fragmenté et réduit. Les principales conséquences de ces conflits sont des morts et des blessures humaines en nombre croissant, des morts et des blessures d'éléphants aussi, et une dégradation de l'habitat. Le *Kenya Wildlife Service* a testé différentes stratégies pour minimiser les conflits et augmenter la tolérance. Des clôtures électriques, des translocations, la création de sanctuaires et le contrôle des activités des animaux à problèmes, tous ces moyens ont été utilisés à différents points de friction.

The emergence of human–elephant conflicts in Kenya

The population of the African elephant (*Loxodonta africana africana* Blumenbach) has increased substantially in the past 20 years. The impact of poaching for ivory has been well described (Douglas-Hamilton 1987). Fortunately, since the ban on ivory trade and the absence of illegal commercial poaching, elephant populations have continued to increase. Hand in hand with this increase has been an increase in human population (from 8.6 million in 1962 to the current estimate of over 30 million) leading to human encroachment into dispersal areas, corridors and available ranges. Human–wildlife conflict can thus be referred to as land-use conflict, which has become a common phenomenon in Kenya. This land-use conflict can be traced back to the early 1970s when large-scale farms were subdivided into small individual parcels. This was particularly evident in Laikipia, where lack of land-use zoning brought people and wildlife together. Other factors that have contributed to these conflicts include the collapse of the agricultural sector, especially of large-scale commercial livestock farms and the subsequent subdivision of that rangeland, climatic changes, and the present political and socio-economic environment.

When elephants live close to people, conflicts such as destruction of crops, damage to property and even loss of life are bound to occur (Bell 1984; Kiiru 1995;

Tchamba 1995). The proximity of human settlements to parks and other elephant ranges makes humans subject to conflict with elephants (Bhima 1998). A whole range of countermeasures to mitigate the problem of human–elephant conflict is required as no one system can be completely effective (Hoare 2001). In Kenya, competition between elephants and people for limited resources has intensified as elephants move out of parks and reserves in search of water and food. With lack of a national policy to deal with human–elephant conflict, it is evident that if the situation is not dealt with it could pose a threat to the conservation of Kenya's elephant population.

Figure 1 shows the major conflict zones and elephant dispersal areas in Kenya. In Kenya 79% of the land is semi-arid or arid, and there is great pressure on land with high agricultural potential. Due to agricultural development, many of the protected areas have become isolated or semi-isolated. The resulting isolation has contributed to the increase in human conflict with wildlife. The park network covers 8% of the area of the country, and a major portion of the country's biodiversity falls outside parks and sanctuaries. Most conflict zones are concentrated in the central part of the country where agriculture is the mainstay of the economy. Due to lack of a national land-use policy that has resulted in changes in types of land use, conflict incidents are increasing in the southern regions.

Strategies used in conflict management

In its efforts to address the escalating problem of human–elephant conflict, Kenya Wildlife Service (KWS) has tried various strategies such as creating sanctuaries; sensitizing communities; using physical barriers (electric fences, vegetation barriers, moats, ditches, stone walls and high tensile fences); deterring animals through problem-animal control activities (PAC); translocating elephants; and conducting elephant drives. These strategies are discussed in detail here.

Physical barriers

ELECTRIC FENCING

Kenya has over 1200 km of game-proof fences in various elephant and wildlife ranges and plans to develop another 1300 km in the future. Kenya Wildlife Service maintains three major categories: simple, intermediate and comprehensive fences. The simple fences have only two or three strands of wire and are designed to restrict a few species of wildlife, such as elephants; the intermediate fences are multistranded and are ideal for confining a number of species in savannah ecosystems; the comprehensive fences are designed for high-potential agricultural areas and can contain 98% of wildlife species. The electric Mwea fence has been successful in reducing conflicts. It is a simple fence, which carries an average voltage of 5.5 kV. Its success is attributed mainly to the community's active participation in maintaining it and to the presence of a full-time fence attendant, whom KWS provides.

Conflict incidents before and after fence construction. Mwea had 48 elephants in 1995. The situation had deteriorated to the extent that some had to be translocated to Tsavo East National Park to minimize conflicts. As this alone did not solve the problem, an electric fence was identified as an option to minimize conflicts related to elephants (76% of all human–wildlife conflicts). Before its construction, most human deaths caused by wildlife were attributed to elephants with an average of three people killed yearly. Immediately after the fence was completed, incidents of human–elephant conflict plummeted (fig. 2) in number, and no elephant-related death has been reported since.

VEGETATIVE BARRIERS

The cactus species *Opuntia dillenii* has been tried in some parts of Laikipia and Narok. Its potential to spread as a weed, however, is a major limitation. Another species, Mauritius thorn (*Caesalpinia decapetala*), has also been tried in Transmara, albeit with little success.

MOATS AND DITCHES

Ditches and moats have been tried in the past in Laikipia, Mt Kenya and Aberdares. However, due to lack of proper maintenance, they have not been successful in containing the elephants in protected areas. This method is ideal only for small-scale sites of 3 or 4 km and is not recommended for high-potential agricultural areas as moats or ditches may cause considerable soil erosion. They are prone to siltation and refilling, hence costly to maintain.

STONE WALLS

Building stone walls has been an experiment in parts of Laikipia. This method is feasible only where stones

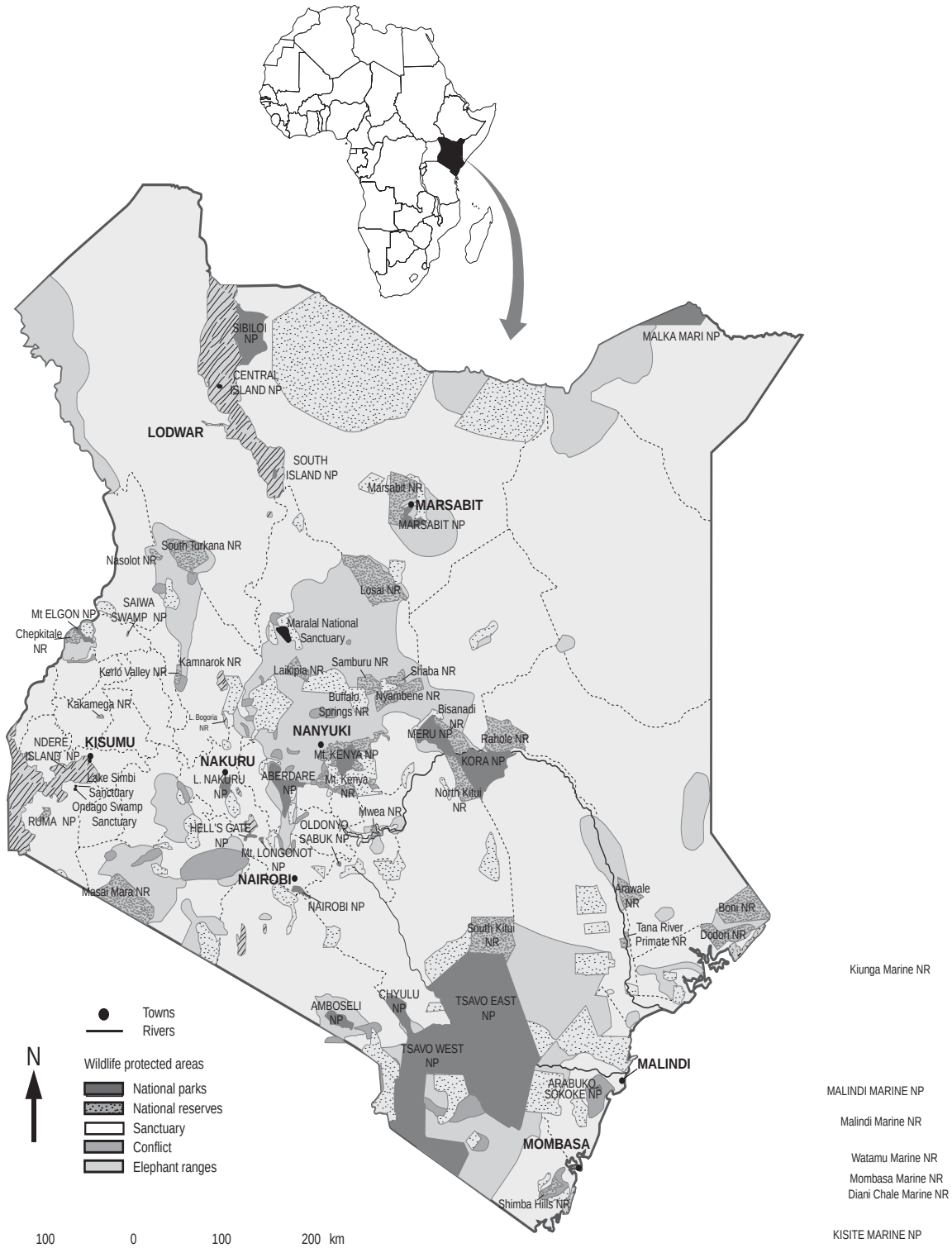

Figure 1. Elephant ranges and conflict zones in Kenya.

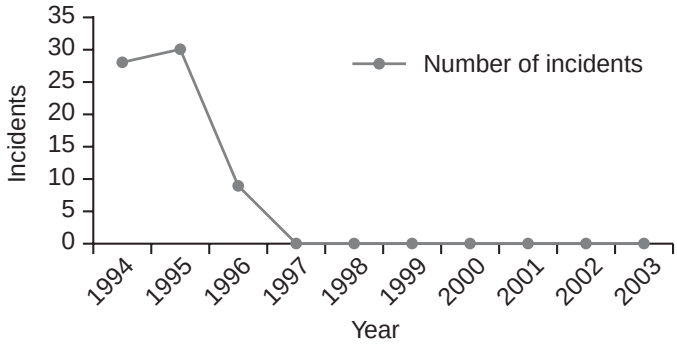

Figure 2. Human–elephant incidents in Mwea National Reserve, Kenya.

are available on site and the size of the area to be fenced is not extensive. The method is not effective for containing elephants, as they soon learn to break the wall down by removing the rocks. Stone walls are effective principally for containing gazelles, hippos and crocodiles.

Creation of sanctuaries

Creating a sanctuary involves delineating land outside protected areas for wildlife conservation. As a strategy in mitigating conflict, it increases the available elephant range. In addition to solving seasonal human–elephant conflicts, community wildlife sanctuaries potentially can generate revenue from eco-tourism activities for local people. Combined with fencing, this strategy envisages empowering communities economically so that they can benefit from conservation. Fifteen sanctuaries have been established in Kenya and more are being established. This strategy appears to be the best option for mitigating conflicts, particularly in areas with low agricultural potential.

Community sensitization

The primary objective of sensitizing a community is to lead local communities in or around wildlife conservation areas to increasingly view the elephant as a useful and manageable animal. Vigorous community conservation programmes in most ranges have been a priority, and wildlife management committees or conflict-resolution committees have been formed. These committees become a medium for discussing conflict issues. Their members include representatives of the local community, local NGOs and the Forest Department, and provincial administrators, politicians, and local Kenya Wildlife Service wardens. Other programmes that create conservation awareness in the community are supporting local self-help groups in projects that enhance survival of the elephant and give economic and social gain, such as providing water and constructing dispensaries and schools. It is important to note that future conservation of elephants outside protected areas hinges on the support of local communities, which have long been marginalized economically.

Problem-animal control activities

Kenya Wildlife Service has a well-trained PAC team that specializes in driving away persistent problem or rogue elephants and other wildlife. The disadvantage of this approach has been that it risks destabilizing the social structure of the herd, which may lead to haphazard movements that even increase the chances of killing or injuring people. PAC activities have been mainly related to repulsing elephants by scaring them using

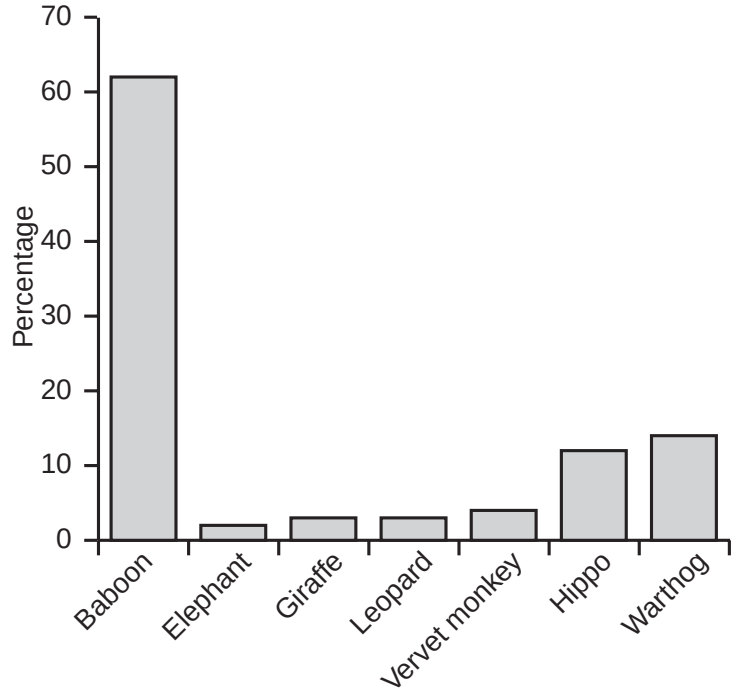

Figure 3. Conflict species reported for the year 2002 in Kenya.

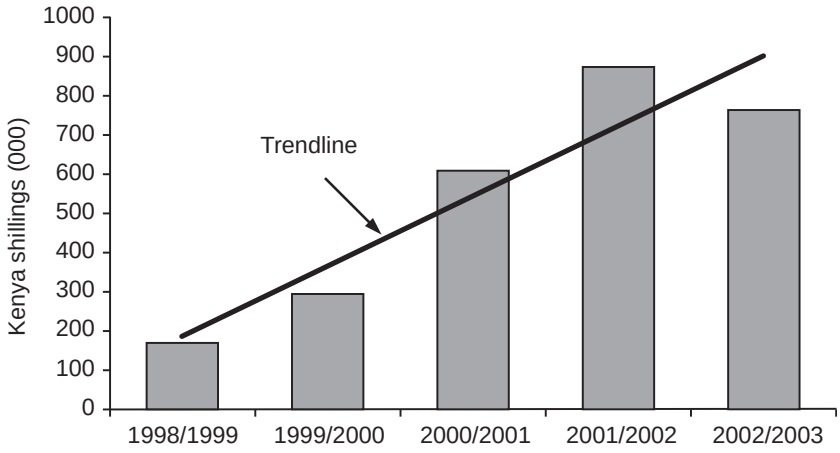

Figure 4. Expenditure related to problem-animal control activities in Laikipia District, Kenya (USD 1 is approximately 75 Kenya shillings).

blank bullets and thunder flashes. Elephants are shot only when human life is in danger and other options are not available. Most PAC activities are related to elephants, which are the leading conflict species (fig. 3), and costs involved in these activities continue to increase (fig. 4).

Kenya Wildlife Service has tried to shift its policy away from PAC activities to other management options such as translocation to manage problem elephants (fig. 5). However, in light of the ever-increasing incidence of conflicts, it has not been possible to abandon the method completely. Despite the costs involved and the deleterious effect PAC has on elephant behaviour, KWS will continue to combine it with other appropriate options as a short-term strategy to minimize conflicts.

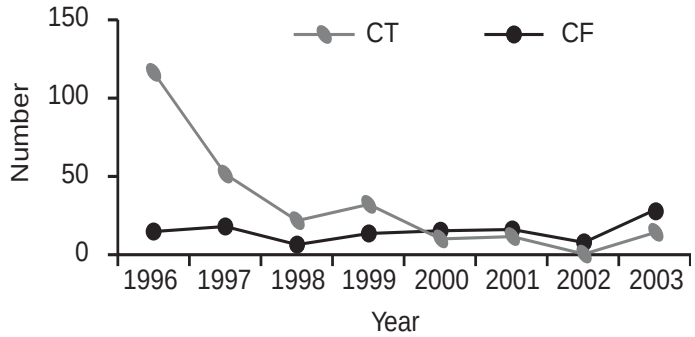

Figure 5. Elephants killed under PAC and through conflicts with local residents. CT – control, elephants shot during problem-animal control activities; CF – conflict, elephants killed or speared by local residents.

Translocation

Translocation has been used in various elephant ranges as a conflict-management strategy as well as to minimize the habitat destruction caused by an over-concentration of elephants. For example, in Mwaluganje and Sweetwaters Rhino Sanctuary the habitat was degraded when elephants were confined by an electric fence. Most of these translocations have been carried out after intensive pretranslocation studies have been done.

Table 1 lists some of the translocations that have been carried out to ease human–elephant conflicts in Kenya (Omondi et al. 2002).

Elephant drives

With change in land use from pastoralism to sedentary agriculture in elephant dispersal areas, elephant drives have been employed in some ranges as a short-term strategy to minimize conflicts. The drives are normally done using a helicopter, fixed-wing aircraft, vehicles and men. The drive is carried out after the elephants have been sighted and a ground crew has established the group composition. Elephant drives have been made to ease the level of conflict in Narok-Siyapei, Kibwezi and Laikipia. This option is not feasible as a long-term strategy because of the migratory nature of elephants.

Recommendations

- Proper land-use planning that includes zoning will make it possible to reduce the number of conflicts to a less significant level.
- Land for wildlife conservation, especially community-based wildlife sanctuaries, should be delineated outside protected areas. Such sanctuaries will increase available elephant range, thus mitigating conflict.

Table 1. Recent translocations to reduce human–elephant conflicts in Kenya

Translocation	Objective	Pretranslocation monitoring	Mvd	Mortality	Post-translocation monitoring	Measure of success
Mwea National Reserve to Tsavo East National Park, 1996	Reduce human–elephant conflict by reducing population by 50%; reduce numbers before fencing entire reserve	Distribution, numbers, age, sex and family structure of the population done	21	5	Radio tracking for one year	No reports of conflicts since translocation
Lewa Downs Conservancy to Kora National Park, 1997	Reduce habitat destruction, human–elephant conflict; restock Kora NP	Well-known bulls identified by conservancy managers	10	0	Ground and aerial monitoring	Reduction in *Acacia xanthophlea* destruction; reduced number of conflict incidents
Mwaluganje to Tsavo East National Park, 1999	Reduce habitat destruction; reduce conflict	Individual identification done	29	2	Individual identification and ground monitoring	Minimized number of conflict incidents
Shimba Hills to Tsavo East National Park, 2000	Reduce conflict	Rogue bulls identified by park managers	4	0	Ground monitoring	Minimized number of conflict incidents
Laikipia to Meru National Park, 2000	Reduce habitat destruction; reduce conflict	Individual identification of problem bulls done	10	0	Ground monitoring	Reduced number of human–elephant conflicts
Ongata Rongai to Amboseli National Park, 2001	Move stray elephant	Not available	1	0	Ground monitoring	Monitoring continued by Amboseli Elephant Project
Nakuru to Aberdares National Park, 2001	Move stray elephants	Not available	2	1	Ground monitoring	Not available
Sweetwaters Rhino Sanctuary to Meru National Park, 2001	Reduce habitat destruction; reduce conflict; restock Meru Park	4 months of monitoring; 120 identified, 16 family units and 20 lone bulls, 9 families and 9 bulls; 56 selected for translocation	51	5	Ground and aerial tracking ongoing	Reduced habitat destruction; no conflict incidents reported so far
Lewa Downs Conservancy to Meru National Park, 2003	Reduce conflict; restock Meru Park	Well-known bulls identified by conservancy managers	4	0	Ground and aerial monitoring	Reduced number of conflict incidents
Total			131	13		

Adapted from Omondi et al. 2002
Mvd – moved

- Resolving human–elephant conflict requires an integrated approach, combining management strategies such as translocation, fencing, PAC activities and creating sanctuaries.
- Protecting humans and their property from wildlife menace has become a priority for KWS. The focus is to improve the conditions and resources of field stations in affected ranges to achieve this objective. PAC activities will continue to be carried out to help reduce conflicts.
- Plants popularly believed to offer some resistance as barriers against elephants, such as Mauritius thorn, should be encouraged.
- Local communities should be offered thunder flashes and trained in using them to scare away raiding animals.

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Rhino poaching in Nepal during an insurgency

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Abstract

Nepal's rhino conservation has been one of the most successful in the world. Rhino numbers increased from about 95 in the late 1960s to 612 in 2000, almost all in and around Royal Chitwan and Bardia National Parks. From mid-2000 to mid-2003, however, at least 91 rhinos were poached for their horns and nails, the largest number anywhere during this time. The main reason was Maoist insurgents, who are breaking down law and order in most of Nepal. The part of the Royal Nepalese Army based inside the two parks, fearing attacks from the Maoists, withdrew from 30 guard posts to reinforce their remaining 14. Adding to this problem, Chitwan's communication repeater station broke, intelligence funding for the Chitwan area was cut, and patrolling needed updating with the extra pressure on the parks. Thus, poachers could more easily enter the parks and kill rhinos. In 2003 the Parks Department started to implement new anti-poaching strategies that were more effective. Strategies included more funds for intelligence; improved cooperation regarding rhino protection among the parks, Army and NGO staff; a new patrol system for Chitwan; improved telecommunications; more help from neighbouring communities to identify potential poachers; and of greatest importance, better leadership. Rhino poaching was nearly stopped with only one rhino known to be killed between July and December 2003.

Résumé

La conservation des rhinos au Népal est une des plus réussies au monde. Leur nombre a augmenté en passant d'environ 95 à la fin des années '60 jusqu à 612 en 2000, presque tous dans et autour des Parcs Nationaux et Royaux de Chitwan et de Bardia. Entre la moitié de l'année 2000 et celle de 2003, cependant, au moins 91 rhinos ont été braconnés pour leur corne et leurs ongles, le plus grand nombre atteint où que ce soit dans le monde. La cause principale, ce sont les insurgés maoîstes qui ne respectent ni loi ni ordre dans une grande partie du Népal. La partie de l'Armée Royale Népalaise qui est basée à l'intérieur des deux parcs, craignant des attaques de la part des maoîstes, s'est retirée de 30 postes de gardes pour renforcer les 14 autres. Pour aggraver le problème, ajoutons que le relais radio de Chitwan est tombé en panne, que les fonds alloués aux renseignements dans la région de Chitwan ont été coupés et que les patrouilles auraient eu besoin de renfort en raison de l'augmentation des pressions sur le parc. Les braconniers ont donc pu plus facilement pénétrer dans le parc et tuer des rhinos. En 2003, le Département des Parcs a commencé à mettre en action de nouvelles stratégies anti-braconnage qui furent plus efficaces. Celles-ci comprenaient plus de fonds pour le renseignement, une meilleure coopération entre les parcs, l'Armée et le personnel des ONG pour la protection des rhinos, un nouveau système de patrouilles pour Chitwan, de meilleures télécommunications, plus d'aide de la part des communautés voisines pour identifier les braconniers potentiels, et, très important, une meilleure direction. Le braconnage des rhinos fut pratiquement stoppé et il n'y a plus eu qu'un rhino tué entre juillet et décembre 2003.

Introduction

Insurgencies in Africa and to a lesser extent in Asia cause rising levels of rhino poaching. Occasionally, such rebel activities have enabled poachers to move into wildlife protected areas and eliminate rhinos due to breakdown in law and order. Recent examples in Africa have been in Chad, Democratic Republic of Congo (DRC), Mozambique, Rwanda, Sudan, Uganda and Zimbabwe. Burma, India, Indonesia and Nepal have also witnessed insurgency groups, including Marxists, Maoists and other rebels, fighting against their central governments, to the demise of the rhino. Internal conflicts occurring today that are causing rhinos to be

poached in Africa are in DRC's Garamba National Park, southern Sudan and Zimbabwe's wildlife conservancies. In Asia, the target areas are in Assam in north-east India, Aceh Province in Indonesia and around Royal Chitwan and Bardia National Parks in southern Nepal. In some countries, the insurgents themselves are poaching rhinos such as the Sudanese rebels in Garamba and the so-called war veterans in Zimbabwe. Elsewhere, such as in Nepal, neighbouring villagers rather than rebels are taking advantage of the weakened control and are poaching rhinos.

This paper examines the difficulties that Nepal has faced since 2000 due to rebel activities and how the Nepalese authorities have fought back to protect their rhinos. From mid-2000 to mid-2003, Nepal's rhino poaching had been the worst since the national parks were founded and the worst in the world during that time. However, from July 2003, the Parks Department has made a remarkable recovery despite having to continue to battle with insurgency problems. Perhaps other wildlife departments in Africa and Asia should learn from Nepal on how to reduce rhino poaching during a major insurgency.

Methods

I carried out fieldwork in Nepal for three weeks in December 2003 with visits to Kathmandu, Royal Chitwan National Park and Royal Bardia National Park (fig 1). These national parks and their surrounding areas are home to all Nepal's greater one-horned rhinos except for six in the Royal Suklaphanta Wildlife Reserve. I interviewed personnel from conservation organizations, the Department of National Parks and Wildlife Conservation (DNPWC), the Royal Forest Department, the Royal Nepalese Army, academics, and other knowledgeable individuals. I read reports, both published and unpublished, on rhino conservation, especially those dealing with anti-poaching strategies.

Results and discussion

Political developments in Nepal

With the overthrow of the *panchayat* regime, parliamentary elections were held in 1991, and Maoists were able to win some seats. In 1995 the Police launched a broad sweep against these left-wing activists in the western part of the country. Following this, the leaders of the Maoists publicly announced a doctrine of violence. In 1996 the Maoists launched their first incursions. Since then they have attacked the Army, Police, Forest Department buildings, bridges, clinics, dams and electricity generating stations. The Maoists have also tortured and executed government teachers and local political leaders. On

Figure 1. Map of Nepal showing location of parks and reserves where rhinos are found.

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Grass cutters are allowed into Chitwan Park for three days a year to obtain thatch for their houses. They cross the Rhapti River to enter the park, as do the poachers.

26 November 2001 a state of emergency was declared in Nepal. From 1996 to December 2003 at least 8,500 people have been killed in the conflict on both sides (International Crisis Group 2003; Sahni 2003).

The Maoists have been demanding an interim government in which they would have major influence. They wish—at the least—to reduce the power of the royal family, eliminate rich landlords, redistribute land to the poor, lower interest rates of moneylenders, reduce government corruption and remove the caste name 'untouchable'. Maoists are not against the tourists who come to Nepal; they support a clean environment but have not been specific about wildlife.

The effect of the Maoist uprising on the economy and society of Nepal has been devastating. During the 1980s Nepal's average gross domestic product increased by 4 to 5% a year (Rana 1999). However, from 1999/2000 to 2002/03 the per capita income actually fell to USD 249 a year, one of the lowest in Asia (His Majesty's Government 2003a). Fighting and bombings in Nepal have scared away new foreign investment and many townspeople and productive farmers are leaving for India, the Gulf States and Malaysia. In 1999 there were estimated to be 90,000 Nepalese in the Gulf and 34,000 in eastern Asia (Rana 1999). By 2002 numbers were up to 170,000 in the Gulf and at least 64,000 in Malaysia alone (Swiss Development Corporation 2003). In Nepal, farmland has become fallow, overall agricultural production has fallen, and working hours have declined due to curfews and fear of attacks (Chazee 2003). Imposed Maoist taxes in the countryside have resulted in 120,000 to 200,000 internally displaced people who have found refuge mostly in towns since 2002.[1] The number of foreign tourists to Nepal fell from 491,504 in 1999 to 361,237 in 2001 (His Majesty's Government 2003a), which has diminished the revenue of the national parks and buffer zones. One night in November 2003, bandits, probably Maoists, attacked a tourist lodge in Royal Chitwan National Park, the Gaida Wildlife Camp, burned down part of it and stole money from the manager, which alarmed the tour-

[1] Laurent Chazee, agricultural and rural development specialist, Asian Development Bank, pers. comm. 2004.

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Police checks on the roads entering Kathmandu catch illegal wildlife products and hand them over to the Forest Department. These confiscated rhino horns are wooden fakes.

ists. There have also been numerous incidents of extortion from hotels, lodges and tourism businesses since 1996.

Recent rhino poaching in the Chitwan Valley

Royal Chitwan National Park was gazetted a park in 1973 and from then until 1998, about 66 rhinos were known to have been poached in the Chitwan Valley, which covers the park and surrounding areas. Thus an average of 2.6 a year were poached (Martin and Vigne 1995; Martin 1998). In 1998 and 1999, 20 rhinos were illegally killed, on average 10 a year, and in 2000, 15 were poached (Martin 2001). Rhino poaching continued to surge up to mid-2003. Several sets of figures are given for those three years for Chitwan Valley. The Nepalese calendar-year figures given for April 2001/02 were 34 and 30 for the following year.[2]

For the western calendar, the Nepal 'Annual Report of CITES Unit' gives 13 poached rhinos for 2000, 18 for 2001 and 37 for 2002 (Dhakal 2003). Tika Ram Adhikari, the former team leader of the anti-poaching units in the Chitwan Valley, also gives the calendar-year figures of 18 for 2001 and 37 for 2002 (Adhikari 2002). However, Chapagain and Dhakal (2003) state that rhinos poached numbered 12 in 2000, 17 in 2001 and 35 in 2002. I have chosen for this article the figures published in the DNPWC annual reports, which are for the Nepalese financial year. This is because they give the most details on where the rhinos were poached, by what method, and what body parts were removed. These figures show that 12 rhinos were poached during the financial year July 2000/01, 38 rhinos during July 2001/02, and 28 during July 2002/03 (see table 1). All sets of figures show that 2002 was the worst year for rhino poaching in Nepal. This spate of poaching would have considerably reduced the growth potential of 544 rhinos, the 2000 census for Chitwan Valley, which was the latest.

DNPWC's poaching figures show that 65% of the poaching of rhinos in Chitwan Valley occurred in the

[2] According to Kamal Jung Kunwar, assistant warden in charge of anti-poaching, Chitwan Park, letter to the manager, Tiger Tops Lodge, 17 September 2003.

Table 1. Minimum number of rhinos poached in Nepal, July 2000 to December 2003

Year	Chitwan Valley	In and around Bardia Park	Total
2000/01	12	2	14
2001/02	38	3	41
2002/03	28	8	36
2003 (Jul–Dec)	1	0	1
Total	79	13	92

Sources: Subba 2001–2003; Kunwar, pers. comm. 2003

park: 5 were taken in 2000/01, 24 in 2001/02, and 22 in 2002/03. All except for one were killed using modern .303 rifles or home-made guns; that one was found dead from poison just inside the park in 2001/02. In the rest of the valley, most were shot, but 6 were electrocuted, either from electric fences or from electric wires hanging down from power cables. The data are precise from July 2001 to July 2003 for the 66 rhinos killed in the Chitwan Valley. There were 46 poached in the park, 16 outside and 4 from unknown areas. Horns were removed from 48 of the animals, 36 inside the park, 9 from outside and 3 from unknown areas. Data are available about the nails on 53 of the rhinos; 9 had had their nails removed, at least 6 inside the park (Subba 2002, 2003).

The poachers are mostly local people who know the valley well, especially from the Brahman, Chepang, Chhetri, Magar, Tamang and Tharu ethnic groups**.** Outsiders would be spotted by the villagers surrounding the park and thus usually do not come. The Maoists do not poach as they have neither the experience nor the interest. A poaching gang consists of two to five men with one or several guns. Those entering the park cross the northern boundary where many rhinos live. They swim across the Rapti River or use a tyre tube. Sometimes to be less conspicuous a gang member will go ahead with the guns to hide them in the park, before returning for the others. They bring dry foods (biscuits, rice and tea) as they often need to spend several days in the park, sleeping in trees or in caves, before finding their rhino.

For a gang of five, the shooter receives Nepalese rupees (NPR) 50,000 to 100,000 or USD 676 to 1,351 while the others may each receive NPR 25,000 to 40,000 or USD 338 to 513 for one horn averaging 722 grams.[3] Thus the gang can earn from USD 2,027 to 3,514 for one horn, or USD 2,807 to 4,867 per kilogram. In 2000, according to arrested poachers, the maximum payment for a gang was then the equivalent of USD 5,894 per kilogram.[4] This slight fall is partly due to the devaluation of the Nepalese rupee.

Often a poaching gang will obtain assistance, financial or otherwise, from a middleman who lives in a nearby village or town such as Narayanghat**.** He pays the gang for the whole horn, not per kilogram. He then takes the horn to Kathmandu or sells it to another middleman who takes it to Kathmandu. The trader who buys it there for export pays the equivalent of USD 9,460 to 10,135 a kilogram.[5] Very occasionally fake rhino horns, most often made of wood, are brought to Kathmandu for sale (see table 2).

Table 2. Seizures of wildlife products by the Nepalese government in Kathmandu, 2000/01 to 2002/03

Year and item	Pieces or weight
2000/01	
Elephant ivory	1.3 kg
Leopard skin	1
Musk deer pod	1
Otter skins	36
Python skin	1
Rhino horn, fake	1
2001/02	
Bear gall	1
Bear galls, fake	6
Beetles	271
Leopard bone	2 kg
Leopard nails	342
Musk deer pod	1
2002/03	
Beetles	240
Leopard skins	109
Otter skins	14
Rhino horns, fake	3

Source: Krishna Raj Basukala, district forest officer, Kathmandu, pers. comm. 2003

[3] Kunwar, pers. comm. 2003.

[4] Adhikari, pers. comm. 2001.

[5] Kunwar, pers. comm. 2003.

Reasons for increased rhino poaching in the Chitwan Valley

- The main reason for the upsurge of rhino poaching from 2001/02 to 2002/03 was due to the Royal Nepalese Army changing the positions of its soldiers within Chitwan Park to prevent Maoist attacks on them. Until December 2001, one battalion of about 800 men was widely dispersed in the park at 32 guard posts. Then following the declared state of emergency and with increasing threats of Maoist attack, the Army decided to withdraw from 24 of the posts to concentrate their soldiers at the remaining 8 guard posts. The Army believed that the Maoists could too easily overrun a remote guard post occupied by only a handful of soldiers. From a military point of view this was a rational decision, but for rhino conservation it was a disaster. Although some media claimed incorrectly that the number of soldiers in the park was reduced, soldiers did abandon large areas of it, a fact quickly noticed by the poachers.[6] In October 2003 the Maoists burned down one guard post in the east where some park staff were temporarily based, and they stole walkie talkies and a motorbike.[7]
- The Army stopped patrolling adequately as they feared they would be attacked by Maoists if they moved too far from their posts.
- The breakdown in law and order made it easier for the poachers and traders to operate in and around Chitwan Park.
- There was a reduction in payments for the park's former anti-poaching unit (APU) staff; for example, some incentive allowances stopped. Staff morale thus fell and motivation declined for the eight APUs stationed in the park, consisting of a

[6] Major Gunga Khadka, Deputy Battalion Commander, Royal Nepalese Army, Chitwan Park, pers. comm. 2003.

[7] Kamal Gairhe, veterinary officer, Chitwan Park, pers. comm. 2003.

Helen van Houten

As well as the Park Department's domesticated elephants, several lodges have elephants for their tourists, as the best way to find rhinos and tigers is on elephant back.

Esmond Martin

Tigers in Chitwan Park killed at least 6 rhino calves from mid-2000 to mid-2003, but this one was saved by the park's staff.

ranger, senior game scout, about two game scouts and a local informer.[8]

- Some of the more experienced anti-poaching staff were transferred, and APU activities slackened with limited patrolling (His Majesty's Government 2003b).
- Coordination among those involved in anti-poaching declined (His Majesty's Government 2003b).[9] Those involved are the parks department, the Army, local informers, buffer zone committees, the Forest Department, the Police, donor agencies and NGOs. The main reason for weakened coordination was that park wardens were frequently transferred, making continuity difficult.
- The informant network became poorly managed and coordinated. Therefore, the chief park warden was catching poachers only after a rhino had been killed, unlike before; poachers' confidence grew.[10]
- For many years the International Trust for Nature Conservation (ITNC), a British NGO, provided park staff with more money for them to give to their informants as wages and as reward money than any other organization in the Chitwan Valley. From April 2001 to April 2002, ITNC paid NPR 24,000 a month for informers (about USD 3,600 for that year). The ITNC staff based in Nepal, however, became disillusioned with the anti-poaching efforts in the park and wanted a new plan. They therefore cut off all funding of monthly payments for informers (but continued paying reward money) from July 2002 to April 2003.[11]

[8] Kunwar, pers. comm. 2003.

[9] Narayan Poudel, deputy director, DNPWC, pers. comm. 2003; Gairhe, pers. comm. 2003; Kunwar, pers. comm. 2003.

[10] Poudel, pers. comm. 2003.

[11] Dinesh Thapa, manager, ITNC funds, Nepal, and manager, Tiger Tops Lodge, Chitwan Park, pers. comm. 2003.

- In mid-2002 heavy monsoon rains broke the communication repeater station and the solar power station in the park (WWF Nepal Program 2003). Park staff had very few mobiles and walkie talkies so communication among staff almost collapsed making coordination with anti-poaching patrollers difficult.

Policy changes implemented in 2003 to stop poaching in the Chitwan Valley

Senior staff of the DNPWC realized by late 2002 that their anti-poaching strategy was not working well. The national press published stories on all the rhino problems. The parks department therefore wrote background papers and held workshops to produce a new plan to protect the rhinos in Chitwan (WWF Nepal Program 2003). This new strategy started in early 2003. By mid-2003, with the arrival of a new chief park warden with excellent leadership ability, the anti-poaching plan started to work. He motivated his men and improved cooperation among groups involved in anti-poaching. From July onward, all strategies were implemented together and only one rhino was known to have been poached in the valley in the following six months (although carcasses may be found later). The factors involved were as follows.

- The main policy change that also brought most improvement concerned a change in the anti-poaching patrol strategy. Before, the APUs were based in specific parts of the park and just outside, and they patrolled within their limited area. The new strategy for Chitwan Park, adopted from Bardia Park, is called a 'sweeping operation'. It puts together a large group of men from the park and Army to patrol intensively when a problem is perceived. The patrollers use some of the park's domesticated elephants (which total 55), motor vehicles, motor boats and bicycles. The men may stay out for a week, camping in 'hot spots' where rhino poaching is common.[12]
- Incentives for patrollers such as better food were improved, greatly boosting morale.
- Coordination between the Army and park staff was improved, with more meetings between senior personnel and better communication. Meetings were started among senior park staff in Kathmandu to assess and update the effectiveness of this new anti-poaching strategy.
- A flying squad of 9 park staff and 12 Army personnel was established to be able to reach the scene of an incident quickly.
- Army and park staff were increasingly allowed to go outside the park boundary to arrest poachers and traders, no longer having to rely solely on the Forest Department and Police for this, as was the case before 2002.
- Park staff took over and reinforced some of the abandoned Army guard posts and patrolled with domesticated elephants.
- ITNC recommenced its funding in early April 2003; thus informers were paid for their March work and this has continued. The funds were increased from NPR 20,000 to 25,000 (about USD 255 to 338) per month and are now given to the chief park warden to distribute. Of the NPR 25,000, most of it (NPR 20,000) goes to 10 regular informers while NPR 2000 is available as reward money and NPR 2500 goes towards the sweeping operations.[13] These funds, combined since July 2003 with monthly sums of NPR 16,000 from the WWF Nepal Program and NPR 20,000 from the King Mahendra Trust for Nature Conservation (KMTNC), total NPR 61,000 (USD 824) a month. This intelligence money is vital for the success of the anti-poaching operations.[14]
- The Parks Department received from the WWF Nepal Program a motor boat and a new communications network to replace the faulty one.
- A new, more skilled and motivated Army commander took control of the battalion in May 2003. The Army then became more active and effective in patrolling.
- The Parks Department further educated the people surrounding the park on the importance of rhino conservation and its benefit to them. Buffer zone inhabitants receive half the park revenue annually. This is a huge incentive for these 300,000 or so people living in the buffer zone to conserve the rhinos and other animals. At the end of 2003, the buffer zone council had NPR 76 million (USD 1 million) in the bank accumulated from around three years of revenue from the park.[15]

[12] Kunwar, pers. comm. 2003.

[13] Thapa, pers. comm. 2003.

[14] Kunwar, pers. comm. 2003.

[15] Meghanath Kafla, assistant warden in charge of buffer zone activities, Chitwan Park, pers. comm. 2003.

- Around mid-2003, park staff helped officers in the buffer zone (who are elected from the villages to manage the zone) to initiate a volunteer campaign for the youth of Nawalparasi District to reduce rhino poaching. There are eight buffer zone user committees in this district and they all helped set up the youth groups and gave them financial assistance. Young people started to seek out potential poachers in the district, particularly among those working on the Nayarani River such as transport boatmen and fishermen. This valuable information was given to park staff, which helped to eliminate rhino poaching in the district.[16]

Recent anti-poaching operations in the Chitwan Valley

From early July to late November 2003, 52 poachers were arrested in the Chitwan Valley: 17 for rhinos, 2 for tigers, 5 for 'less important' animals, 19 for timber and 9 for other small offences (see table 3).[17] In August, following a tip-off from an informer, a poacher was arrested who claimed, probably correctly, to have killed 17 rhinos over the past seven years and earned NPR 875,000 for the horns. He came from Chitwan District and claimed to have killed all the rhinos with his home-made muzzle loader

Table 3. Number of rhino poachers and traders arrested in and around Chitwan and Bardia Parks, July 2000 to November 2003

Year	In and around Chitwan Park	In and around Bardia Park
2000/01	39	5
2001/02	28	9
2002/03	26	9
2003 (Jul–Nov)	17	?
Total	120	23+

Sources: Subba 2001–2003; Poudel, pers. comm. 2003

[16] Tirtha Maskey, director general, DNPWC; Shyam Bajimaya, ecologist, DNPWC; Poudel; Ram Prit Yadav, community development consultant, KMTNC; Kafla, pers. comm. 2003.

[17] Poudel, pers. comm. 2003.

Esmond Martin

This rhino and her calf inhabit the Karnali River floodplain, essentially the only place accessible for tourist rhino-viewing in Bardia Park.

Esmond Martin

In Bardia Park, the Army was looking after this orphaned rhino in late 2003.

(DNPWC 2003). He had been a poor man looking after domestic animals for another person. He was then attracted into poaching rhinos by a middleman who offered to buy any horns he could get. He shot 15 of the rhinos on the western bank of the Narayani River around Dibyapuri just to the north-west of the park. The poacher's main source of information on where the rhinos were in the area came from a community guard of the Forest Department. On one occasion he wounded a rhino with a bullet and then went up to it with an axe and cut off a leg to immobilize it!

From 2000/01 to 2001/02 the Army killed one rhino poacher, but in 2002/03 they killed six as anti-poaching was stepped up (Subba 2001, 2002, 2003). Thereafter, potential poachers feared to enter the park.[18]

Recent rhino poaching in and around Bardia National Park

To establish a second rhino population in the country, in 1986 the parks department translocated their first group of 13 rhinos from Chitwan Park to Bardia Park in western Nepal. Since then there have been eight more translocations from Chitwan to Bardia with a total of 87 rhinos brought to the park by 2003. The most recent census in April 2000 showed 67 rhinos in the park; from then until November 2003 Bardia received 35 more rhinos (Subba 2003).

From 1986 to 1999 at least 10 rhinos were poached in and around Bardia Park, averaging less than one a year. More rhinos,13, were poached from mid-2000 to mid-2003 in and around Bardia than in the previous 13 years combined; 12 were poached inside the park and each (but 2 that were unrecorded) had its horn removed. Records were kept on the nails of 9 animals; 4 had them taken, 5 did not. One more rhino was poached outside, but its horn and nails remained intact. Most poaching occurred in the Babai Valley in the south-east portion of the park where, along with the Karnali River floodplain, many rhinos are concentrated. It is a remote area with no proper roads and difficult terrain for the anti-poaching staff to patrol. Poaching gangs killed most of the rhinos with guns, usually home-made rifles.

[18] Poudel, pers. comm. 2003.

Bardia has far fewer rhinos than Chitwan and they have only recently been translocated to the region, so contacts between poachers and middlemen are weaker. Almost all the horns are transported from Bardia to Kathmandu for export.

Reasons for increased rhino poaching in Bardia

Rhino poaching escalated in Bardia from 2000 up to mid-2003.

- Two Army companies were stationed in the park (with 250 men each), but due to the threat of Maoist attacks, they halved their 12 guard posts to double up the remaining 6, leaving large areas with no protection.
- In early 2002 Maoists put a bomb on a road 15 km from the park near the Indian border to ambush the Army; seven soldiers were killed including a major commanding one of the companies in Bardia.[19] They also harassed nearby villagers in 2002. With insecurities in the countryside, it was easier for poachers to enter the park.
- Maoists extorted money from managers of tourist camps and lodges and scared away the tourists from Bardia. From a peak of 12,388 in 2001, numbers fell to 2,895 in 2002/03 (Subba 2002 and 2003). Of the 19 tourist lodges and camps around Bardia, 4 were closed in December 2003 and compared with 300 staff in 2000, only 97 remained for the 290 beds available. The main road from Kathmandu to Bardia is now closed every night and there are about 12 Police and Army checkpoints, each one of which takes a bus about half an hour to get through. From late 2002 to late 2003 the government cut off all phones in the area to hinder the Maoists, but tourist facilities suffered too. Employees of these tourist facilities (12 of which are owned by local people) are in fear of losing their jobs. Bardia's buffer zone of 328 km^2 is no longer receiving the large tourist economic benefits as in the past (half the park revenue), due to Maoist activities, so the 100,000 local villagers are also now struggling. Thus, they have less desire to help protect rhinos, especially considering that they damage crops and livestock—and injure people. Between 1998/99 and mid-2003, 21 people have been killed by rhinos in Nepal, including 2 by Bardia rhinos (Subba 1999–2003).

Policy improvements in and around Bardia in 2003

Nevertheless, from July to December 2003 no rhinos are known to have been poached. There are several reasons for this huge improvement, as compared with eight rhino deaths in the previous 12 months.

- Coordination between the Army and the Parks Department improved, resulting in better sweeping operations, faster mobile patrols and regular patrols from the Army guard posts.
- The park staff had taken over four of the six empty guard posts by late 2003.[20]
- More anti-poaching patrols took place in the Babai Valley, including sweeping operations that lasted for many days, using 10 elephants, 20 elephant men, 20 game scouts, 2 or 3 senior game scouts, 2 rangers and some Army personnel.
- Starting in 2002, but improving by 2003, the park and Army staff were legally allowed to arrest poachers and traders outside the park as well as in.
- Overall relations between the Parks Department, Army, and buffer zone villagers improved with better cooperation, leading to the villagers providing more information on poacher suspects.[21]
- NGOs improved their education programmes in the buffer zone to make the residents more sympathetic to helping rhinos.
- NGOs put more resources into the buffer zone, financing the local people to build watch towers, trenches and construct electric fences to prevent wildlife from destroying crops and injuring people.
- The chief park warden started to hold monthly meetings to keep Bardia's anti-poaching strategies up to date and effective.[22]

Conclusion

It is vital that the most competent personnel be posted to the national parks, from the chief park warden

[19] Major Sudeep K.C., company commander, Thakurdwara, Bardia Park, pers. comm. 2003.

[20] Puran Shrestha, chief park warden, Bardia Park, pers. comm. 2003.

[21] Shant Raj Jnawali, project director, KMTNC, Bardia Conservation Programme; Babur Ram Yadav, assistant warden, Bardia Park, pers. comm. 2003.

[22] Shrestha, pers. comm. 2003.

downwards, especially during political insurgencies when law and order in a region break down, be it in Nepal or elsewhere. To select the best team is a tough job as it involves lobbying and creating the political and administrative will to get the best people in the responsible positions for as long as they are effective. NGOs should help ensure that the right government people are in service in the protected areas (Thapar 2003). No amount of vehicles and community development projects can significantly help without good park leadership. Thus, the key to the success of rhino conservation is getting the most capable park staff, keeping them in position for as long as is feasible, and supporting an effective anti-poaching strategy. Such a strategy consists of an adequate budget, sufficient personnel for patrolling, an efficient intelligence-gathering network, and ongoing appraisal and implementation of the strategy.

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POLICY

Ecological basis of the new elephant management policy for Kruger National Park and expected outcomes

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Abstract

In 1995, a moratorium was placed on culling elephants in Kruger National Park (KNP) while its elephant management policy was being reviewed. This review resulted in a completely new policy in which maintaining KNP's indigenous biodiversity is the primary objective. Managing for maximum biodiversity will be achieved through principles outlined in the 'intermediate disturbance hypothesis' and by inducing elephant population fluctuations, which it is believed will also play an important role. For these purposes KNP was divided into six zones: two will be botanical reserves in which medium densities of elephants will be maintained, two will be low-elephant-impact zones where elephant densities will be actively reduced through management, while the final two will be high-elephant-impact zones where no elephant management will be conducted and densities will be allowed to increase. Management options for the low-elephant-impact zones and the high-elephant-impact zones will be reversed, once biodiversity monitoring programmes indicate that acceptable thresholds of change have been reached or exceeded. KNP zoning was based on results of research on elephant clan movements. It is believed that zoning along natural clan boundaries will limit movements of elephants between zones once the policy is implemented.

Additional key words: biodiversity, contraception, culling, intermediate disturbance hypothesis, translocation

Résumé

En 1995, on a mis un moratoire sur l'abattage d'éléphants au Parc National Kruger (PNK) tandis qu'on révisait sa politique de gestion des éléphants. Cette révision a abouti à une politique complètement neuve dans laquelle le maintien de la biodiversité indigène du PNK est l'objectif premier. Une gestion qui vise un maximum de biodiversité sera possible grâce aux principes mis en évidence dans l'« hypothèse de perturbation moyenne » et en provoquant des fluctuations de population d'éléphants qui, on le croit, joueront aussi un rôle important. Dans cet objectif, le PNK a été divisé en six zones : deux seront des réserves botaniques dans lesquelles on maintiendra des densités moyennes d'éléphants, deux seront des zones où l'impact des éléphants sera maintenu faible en réduisant activement la densité des éléphants, et les deux dernières seront des zones avec un fort impact des éléphants, où l'on ne pratiquera aucune gestion des éléphants et où leur densité pourra augmenter librement. Les options en matière de gestion dans les zones de faible impact et celles d'impact important seront inversées, une fois que les programmes de contrôle de la biodiversité indiqueront que des

seuils acceptables de changement ont été atteints ou dépassés. Le zonage du PNK s'est basé sur les résultats de recherches sur les déplacements des clans d'éléphants. On pense que cette façon de faire limitera les déplacements des éléphants entre les différentes zones une fois que la politique sera mise en place.

Mots clés supplémentaires : biodiversité, contraception, abattage, hypothèse de perturbation moyenne, translocation

Introduction

Between 1967 and 1994, the policy for managing elephants in Kruger National Park (KNP) was to maintain the population at around 7000, allowing it to fluctuate between 6000 and 8500 (Joubert 1986). In late 1994 the reasons for culling and the ethical morality of killing elephants were questioned by an animal rights group, which resulted in a public debate in May 1995. This debate culminated in South African National Parks undertaking to review its policy and to place a moratorium on culling until the review was completed. Meetings and workshops were held to reconsider the policy and recommend appropriate management practices for the future. The review resulted in a completely new policy (see Whyte et al. 1999; Whyte 2001a) in which the primary objective is to maintain KNP's indigenous biodiversity. It is the product of many hours of consultative debate between South African National Parks and a wide diversity of interested and affected people and organizations. While this new policy was published earlier (Whyte et al. 1999), KNP has since been rezoned and that version is now outdated. There was also no attempt to model the expected population trends after the policy was implemented or to determine the number of elephants that may need to be removed from the population. This paper provides an updated version of this policy and examines implications subsequent to its implementation.

Theoretical basis of the new policy

The previous policy (Joubert 1986) was committed to a fairly vague definition of the 'maintenance of biodiversity' through holding KNP's elephant population at a stable level of around 7000 (Joubert 1986), but it did not entirely fulfil this objective. Even at this relatively low density, directional changes were detected that showed that certain plant species were declining (Whyte et al. 2003).

In the new policy, however, KNP now subscribes to the Noss (1990) definition of biodiversity. It therefore emphasizes biodiversity in the widest sense (that is, structure, function and composition across scales from genetic to landscape and even subcontinental) and makes specific mention of fluxes. The theoretical basis of quantifying and managing for biodiversity and flux has its origin in the emergent paradigm relating to heterogeneity (for example, Christensen 1997; Fiedler et al. 1997).

Critical variables in savannahs include nutrients, moisture, fire and herbivory (for example, Wiens 1997). Elephant herbivory is considered particularly significant, as in some studies elephants at high densities have been shown to affect biodiversity negatively (Western and Gichohi 1989; Cumming et al. 1997). If these variables change, an ever-changing mosaic should be the outcome, and the patches that result should be organized in a hierarchy of scales (Wiens 1997). If, for example, many levels of herbivory are naturally superimposed on a fire mosaic, then at certain scales the outcome should be even greater diversity.

The intermediate disturbance hypothesis (Connell 1978; Huston 1979) claims that the greatest species richness (and perhaps overall biodiversity) at any one point is likely to result from intermediate levels of disturbance. At extreme levels of either low or high disturbance, there might indeed be fewer species, but certain species that are not favoured or are absent at intermediate levels would likely prosper. Thus, if the ecosystem can pass through various stages of disturbance in different places and at different times, the patchwork created might support the greatest overall diversity desirable in a natural system, although spatial variation can in many ways substitute for temporal variation and vice versa.

Equally important is the rate of change, as influenced by the pattern and intensity of disturbance—a regime of rapidly increasing disturbance may affect the ecology differently from a slowly increasing one, even if the final intensity is the same.

In recent years there has been increasing belief that most of the important changes in savannahs are caused by events. They may occur only occasionally, when a certain co-occurrence of events brings about a particular shift from one state to another (perhaps an invasion of bush into grassland). Different ecological pressures then prevail, which may stabilize the system in a new state for years or even decades. Current ecosystem theory takes cognizance of the likelihood of the existence of multiple stable states (Dublin 1995) as well as other models from the homogeneity and stability paradigms through to disequilibrium theory (Behnke et al. 1993). Holling (1995) and others suggest that keeping an ecosystem static for too long will invariably lead to catastrophic change if an extreme event occurs, usually because of lack of resilience.

Elephants are one such agent of ecological disturbance. The positive effects that elephants may have are that they open up woodlands, creating habitats for plains or grassland-favouring species; they create microhabitats for organisms requiring shelter under fallen trees and logs; they provide browse by pushing over trees and breaking branches; they distribute the seeds that they pass in their dung; and they can provide water for other species by digging for it in sandy riverbeds. Elephants, as animals with large body size, home range and mobility, and with a propensity for rapid population growth, can affect the environment on a landscape scale. At lower density, they may create a mosaic of medium-scale effects. At the fine scale, elephants feeding on some parts of an individual tree and not others might lead to increased habitat diversity for small vertebrates and invertebrates. Time scales are equally important: longer- and shorter-term fluctuations contribute to the natural flux.

We are now entering an era in which many believe that heterogeneity needs to be not only understood but also encouraged through management in some practical way. The belief is that this management strategy will enhance biodiversity, and at the same time it will provide an opportunity to learn by managing—a crucial element of adaptive management. Although much use will be made of the outcomes to learn more about future elephant management, it should not be seen primarily as an experiment—the options chosen are intended to meet KNP's primary objective of biodiversity rather than constitute any contrived or forceful experiment. 'Thresholds of potential concern' or TPCs (see below) provide an attempt to outline the 'envelopes' of acceptability to management. They are meant to delineate thresholds beyond which, it is believed, the system will have exceeded its inherent elasticity, and from which it may not have the ability to return to a healthy state. These TPCs will be continuously refined as knowledge, experience and hopefully wisdom grow.

The new policy for managing KNP's elephant population

Principles

This new elephant management policy rests on three fundamental principles:

- In accordance with KNP's new vision statement, it is accepted that flux in ecosystems is natural and desirable as this contributes to biodiversity, and that this will probably also hold true for the elephant population.
- It is accepted that elephants are important agents of disturbance and as such create heterogeneity and thus can contribute to biodiversity in accordance with the principles defined in the intermediate disturbance hypothesis (Connell 1978; Huston 1979). This has been demonstrated in Amboseli National Park (Western and Gichohi 1989). In the absence or very low densities of elephants, biodiversity will be negatively affected as no disturbance occurs. Excessive disturbances at high densities will also affect biodiversity negatively. These high and low end-points may also be considered desirable, as it is believed that certain species will benefit from the conditions thus created, provided that these conditions do not occur over a large area for too long.
- It is also accepted that elephant populations that are confined but not managed will increase in number to a level where negative effects on the system's biodiversity will result.

In recognizing the above three principles, the following corollaries have also been considered and accepted:

- To maintain an elephant population at a high level will require culling or translocating more animals than when maintaining the population at a lower level. This has moral or ethical implications.
- Reducing an elephant population from a high level to a lower level will also require culling or translocating more animals than when maintaining the population at a lower level. This has the same moral or ethical implications.

Elephant management options

Options for controlling elephant numbers include two that are non-lethal—contraception (Whyte and Grobler 1998; Fayrer-Hosken et al. 2001) and translocation (Dublin and Niskanen 2003), and the lethal option of culling. These various options were logistically evaluated by van Aarde et al. (1999) and Whyte et al. (1998), and ethically by Whyte (2001b) and Whyte and Fayrer-Hosken (in press).

The new policy states that wherever possible, the elephant population will be managed by non-lethal means, but that where these methods prove inadequate, unfeasible or inappropriate, culling will remain an option. When culling is necessary, the most humane method available will be used.

At the time of writing, the demand for live elephants was limited and the expectation is that annually South African National Parks will be able to dispose of only about 30 animals from breeding herds and 30 bulls through live transfer. As contraception is not yet available as a tool for managing large elephant populations (van Aarde et al. 1999), culling will have to be the method used to dispose of most of the quota. While this limits opportunities for managing the KNP elephant population by non-lethal means at present, this situation will in all likelihood change once the fence between KNP and the new Limpopo National Park in Mozambique has been removed, as proposed. This will offer considerable opportunity for natural recolonization, and it is conceivable that it will relieve some of the necessity for reducing populations in KNP. It must be remembered, however, that Limpopo National Park will offer only a temporary solution, as the number of elephants that it will be able to accommodate also has limits.

Thresholds of potential concern

The new elephant management policy will differ from the old one in that the elephant population will be managed according to measured effects on biodiversity rather than on absolute numbers of elephants. Different management options will be practised in different zones and various aspects pertaining to biodiversity will be monitored. This management option will continue until there is clear evidence that the prevailing density (either too high or too low) of elephants is having a negative impact on some aspect of biodiversity that warrants concern. This point will be known as a 'threshold of potential concern' or 'TPC'. A TPC can be defined as the upper or lower level along a continuum of change in a selected environmental indicator that when reached or exceeded prompts an assessment of the causes that led to the extent of such change. It results in either management action to moderate such cause(s), or recalibration of the threshold to a more realistic or meaningful level.

Such TPCs are initially established at somewhat arbitrary levels, based on the best available knowledge and experience. It is absolutely necessary when deciding to use such TPCs that they be accompanied by monitoring at appropriate intervals, and that there be considerable understanding of the factors causing change in the parameter being monitored.

TPCs have the advantage that management has definite proactive objectives or parameters within which to manage a system, in contrast to previous practices, which reactively managed events or processes to minimize or avoid crises. Nevertheless, TPCs should be constantly challenged as to their appropriateness or validity, and adaptively modified as knowledge and experience increase.

The appropriate TPCs for managing the KNP elephant population (Whyte et al. 1999) have been set widely, which will allow considerable fluctuation in the populations of the various management zones.

Zoning KNP for managing elephant impact

KNP has been divided into six zones, which will receive different treatments in terms of managing their respective elephant populations (fig. 1):

- Two high-elephant-impact zones (HEIs)
- Two low-elephant-impact zones (LEIs)
- Two botanical reserves (BRs)

In the HEIs elephant populations will be allowed to increase (no culling, contraception or live removals) until indications are that one or more of the TPCs have been reached or exceeded. It is expected that the elephant population of these zones will increase at ±7% per year.

In the LEIs elephant populations will be decreased (through culling or live removals) until there are indications that low densities of elephants have induced change to a point that one or more of the TPCs have been reached or exceeded. This decrease will be achieved by reducing the populations in these zones by 7% per year. (It is important to note that contraception is not an option in LEIs as this technique can

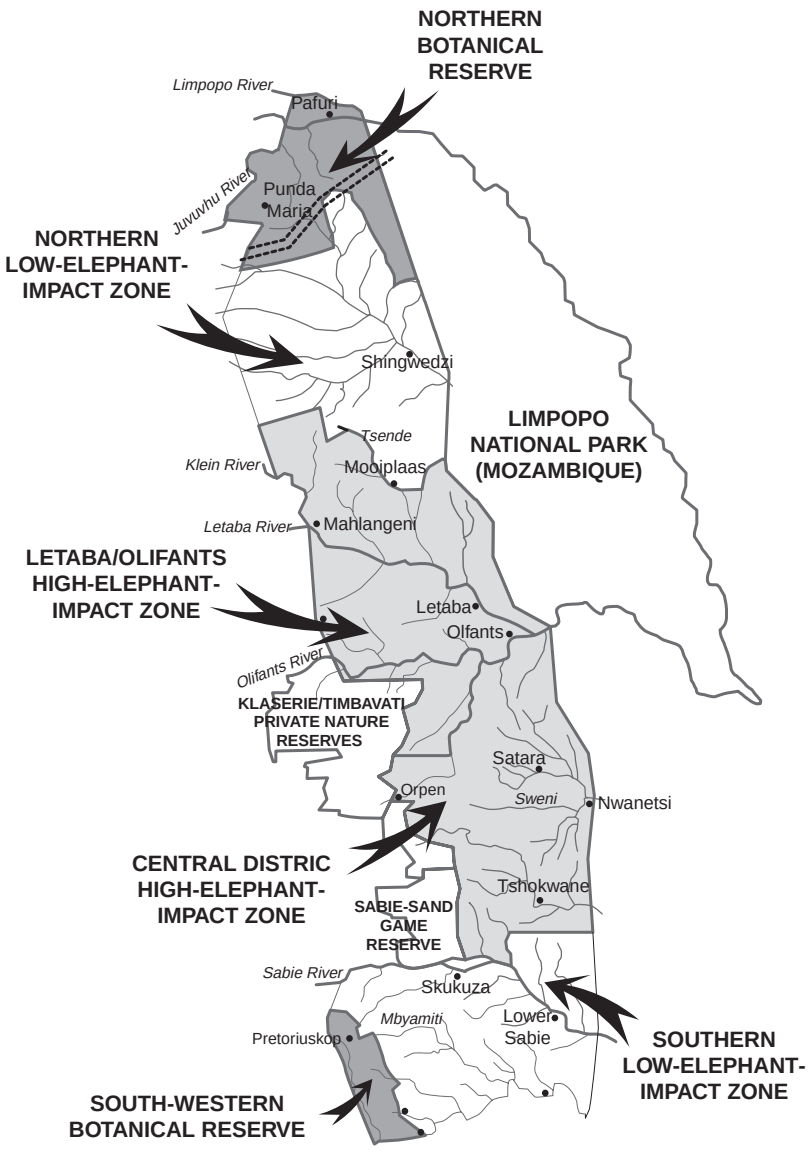

Figure 1. Zonation of Kruger National Park for elephant management as proposed in the new elephant management policy (Whyte et al. 1999).

only stabilize a population, not reduce it.) It is expected that the populations in these LEIs will also be increasing at around 7% per year, so to achieve a 7% decline, 14% of the total recorded in the zone must be removed annually.

The BRs are to maintain medium densities. 'Medium density' is here considered the density prescribed in the previous master plan (Joubert 1986), which was one elephant per 2.85 km^2 (7000 elephants in 20,000 km^2). Populations will be reduced to this density by either culling or translocation, and the density maintained by culling, translocation or contraception. Management of the BRs will be regulated by special TPCs yet to be formulated for these areas. Should one or more of these proposed TPCs be reached or exceeded, elephant numbers will be adjusted (reduced or increased) to bring this into line.

Ultimately, once a TPC has been reached or exceeded in any of the HEIs or LEIs, the management actions applied in these zones will be alternated, and the alternate action will be applied. HEIs will then be treated as LEIs and their populations systematically reduced while the elephant populations of the LEIs will be allowed to increase.

The boundaries of the respective elephant management zones (fig. 2) were defined to conform to the known boundaries of elephant clans. This allows meaningful elephant management without disrupting the home ranges of these clans. Boundaries have also been defined so as to ensure that the four major zones (excluding the botanical reserves) are similar in size.

The two high-impact zones have been placed adjacent to one another in the centre of KNP to establish a large core area of non-management. The two low-impact zones then lie between the high-impact zones and the botanical reserves to obviate the problems of a hard edge between high densities of elephants and the botanical reserves. Once TPCs have been exceeded and the management actions in the respective high- and low-impact zones have been reversed, it is accepted that management problems will have to be addressed.

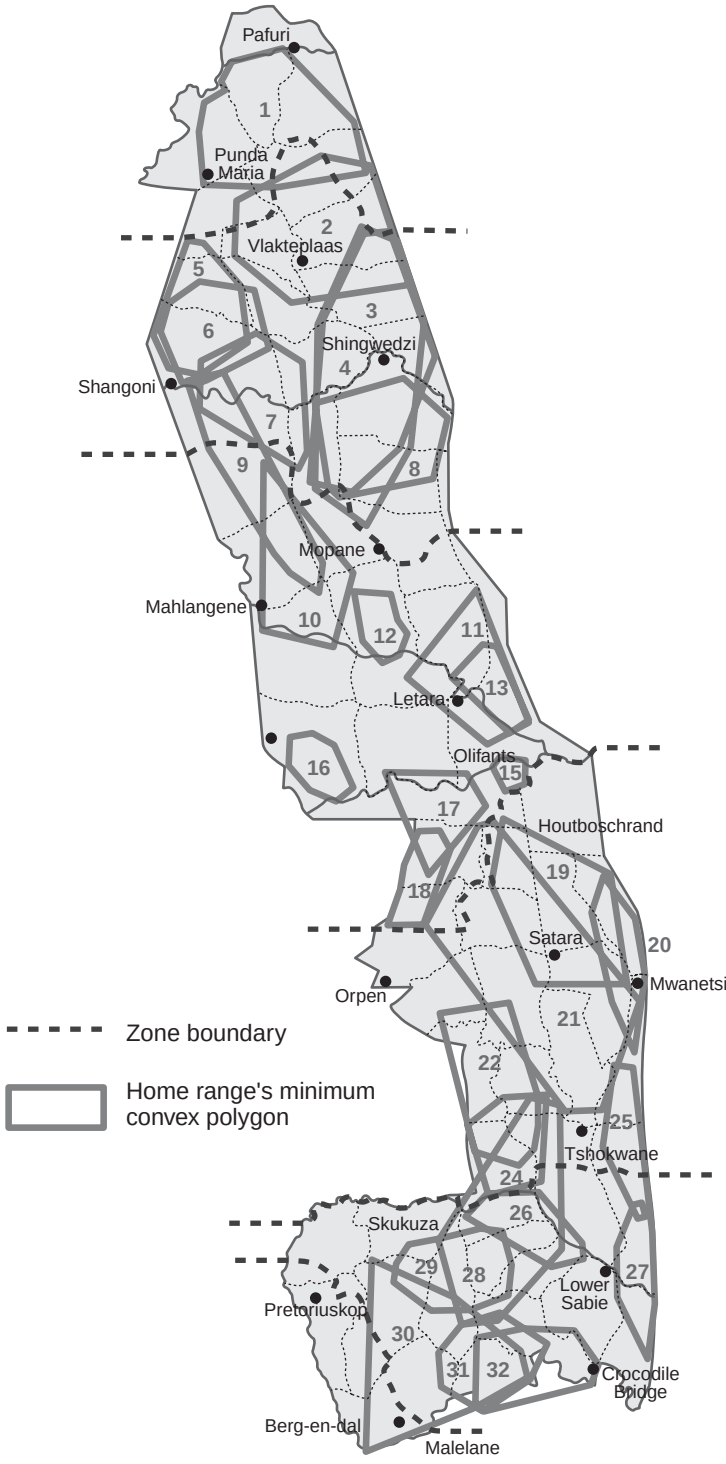

Figure 2. Ninety per cent minimum convex polygons of the home ranges of 29 radio-collared elephant cows in Kruger National Park (Whyte 2001a). Note the boundaries of the elephant-management zones were defined on the boundaries of these home ranges.

It might be expected that by reducing numbers in the two LEIs, the total number of elephants in KNP will not be greatly influenced by increases in the other two zones, keeping the total population at a stable level. However, modelling of the responses of these zones has shown that this will not be the case, and the total KNP population will probably increase dramatically (see section 'Implications of implementing the new elephant management policy' on the next page).

Will the policy work?

One of the crucial questions pertaining to this policy is whether elephants will remain in the designated management zones. Some have suggested that elephants will move from LEIs to HEIs as a result of traumas induced by management. Others suggest that movements will be from HEIs to LEIs as food resources will become increasingly limited when elephant numbers increase. There are two reasons to believe that they will do neither. The first comes from information from home range studies (Whyte 1993). These showed that cow–calf groups in KNP had maintained their home ranges since the start of studies in 1989 and that these groups were unaffected by either culling or change in feeding conditions as a result of patchy rainfall. Ongoing studies on the same animals (Whyte 2001a) confirmed that these home ranges had still not changed after 12 years. The second reason is that the private nature reserves on KNP's western boundary (fig. 1) had very different elephant densities before fences separating these conservation areas were removed in 1993. The Klaserie/Timbavati complex, known as associated private nature reserves or APNRs, had elephant densities similar to those in KNP, while in the Sabie-Sand Game Reserve

Table 1. Population trends in numbers and densities (km² per elephant) of elephants between 1993 and 2003 in Kruger National Park and the private nature reserves on its western boundaries

Year	KNP (19,624 km²)		Sabie-Sand (572 km²)		APNRs (1266 km²)	
	Count	Density	Count	Density	Count	Density
1993	7,834	2.50	60	9.53	424	2.99
1994	7,806	2.51	116	4.93	511	2.48
1995	8,064	2.43	202	2.83	526	2.41
1996	8,320	2.36	202	2.83	355	3.57
1997	8,371	2.34	311	1.84	759	1.67
1998	8,869	2.21	429	1.33	617	2.05
1999	9,152	2.14	497	1.15	636	1.99
2000	8,356	2.35	531	1.08	726	1.74
2001	9,276	2.12	601	0.95	824	1.54
2002	10,459	1.88	757	0.76	927	1.37
2003	11,672	1.68	689	0.83	1092	1.16

(SSGR) densities were low (table 1). By mutual agreement, the fence between these reserves and KNP was removed, and the subsequent growth rates in the populations differed markedly. The intrinsic growth rates ($\bar{r}$) between 1993 and 2003 were 0.034 for KNP, 0.088 for APNRs and 0.231 for SSGR. SSGR has experienced a massive population growth, which can only be as a result of an influx from KNP, while that of the APNRs was not far from the 0.66% recorded for KNP during the years that it was fenced entirely (Whyte 2001a). On the other hand, KNP's rather reduced rate over the period would have been the result of the negative influences of culls (n = 552), translocations (n = 657) and emigration into SSGR.

Moss (1988) described that elephant families belonging to a particular home range will defend them from intrusion by other families. The significance of this from the policy's point of view is that where elephants are already established in home ranges, overlap between neighbours is limited. At the time the fence was removed, the APNRs already had established residents while SSGR did not. Movement of elephants from KNP into the APNRs did not occur; a large influx occurred into SSGR, which had 'vacant' home ranges.

There is thus confidence that the elephants will maintain these home ranges in spite of changing densities. If this proves not to be the case and the elephants move from LEIs to HEIs, this will facilitate the policy as the number of elephants to be removed will be reduced, and the desired low and high densities will be achieved with limited management. If, however, the movement goes from HEIs to LEIs, the policy will not work, as all that will have happened is that a source sink will have been created and excess elephants from the source area will have to be removed from the sink. This would then require formulating a new policy.

Implications of implementing the new elephant management policy

To assess the implications of implementing the new management policy on elephant population, a spreadsheet model was developed to simulate trends in the zones and in KNP as a whole. The simple model (Whyte 2001a) calculates the number of elephants to be removed from each zone based on the management strategies listed for each of the six strategies described. The starting point (year 1) was the data derived from the aerial census of 1999. In the model, populations in the botanical zones were reduced to the prescribed density and held there, those in the low-impact zones were reduced by 7% per year, and those in the high-impact (unmanaged) zones were increased by 7% per year. The projections were based on three assumptions:

- that the elephants recorded in the respective management zones will remain where they are and will not move into adjacent zones
- that population growth rates will remain a constant 7% per year
- that to achieve a 7% reduction in a population that is growing at 7% per year, 14% of the animals recorded in that zone will have to be removed each year

The number of elephants to be removed from the populations of each zone is given in table 2. Since the prescribed limits for the two botanical zones are ex-

Table 2. Hypothetical population reduction quotas for the elephant management zones of Kruger National Park as defined in the new elephant management policy, based on the 1999 census data

Management zone	Counted in 1999	Limit	To be removed		
			Total	Bulls	Breeding herds
Northern Botanical Reserve	901	550[a]	351	53	298
Northern Low Impact	1720		241	36	205
Northern High Impact	2665		0	0	0
Central High Impact	1524		0	0	0
Southern Low Impact	2001		280	42	238
Southern Botanical Reserve	341	250[a]	91	14	77
Total	9152		963	144	819

Census totals are from 1999. Quotas are 15% for bulls and 85% for breeding herds, as these are the ratios at which they occur naturally.

[a] The limits for the botanical reserves are specified in the management policy.

ceeded by far, a large number of animals must be removed. It is assumed that all the excess elephants in the botanical reserves are removed in the first year while in the low-impact zones a 7% reduction is made. This gives a total of around 950 elephants to be removed in the first year. This large number results in a small total population decline after the first year, but once the excess in the botanical zones has been removed, the quotas for removal decline rapidly and the KNP population begins to increase.

If the assumptions given above hold true, population trends and trends in the number of elephants to be removed can be projected into the future (fig. 3). Once the excess elephants have been removed from the botanical zones, the number to remove drops significantly in the second year (from 963 to 540). In

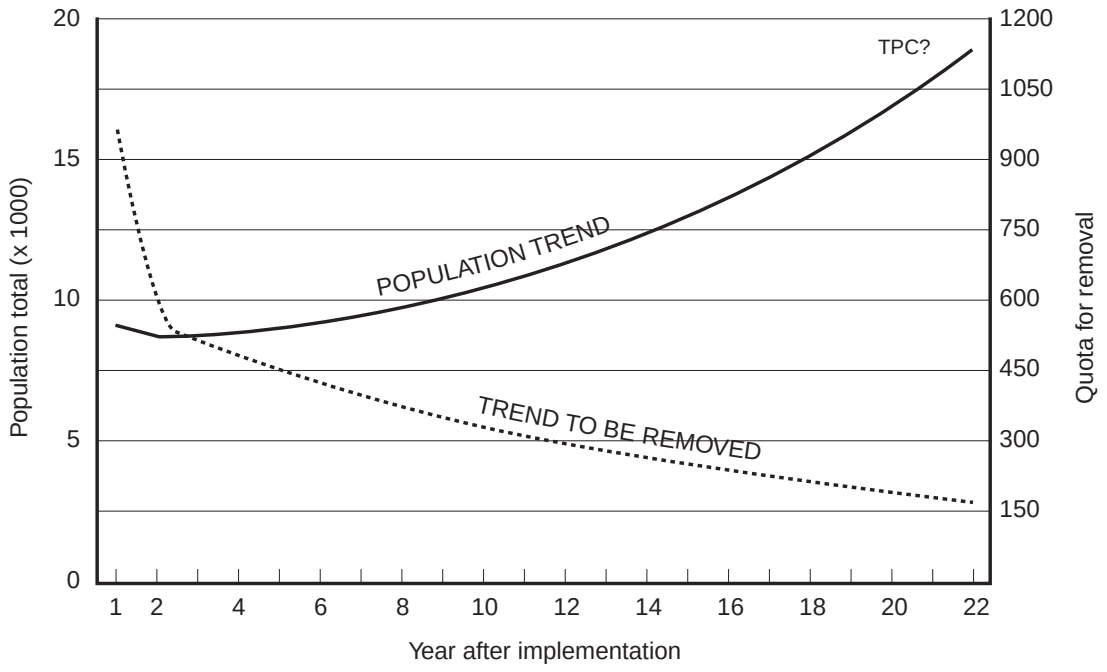

Figure 3. Expected elephant population trends and numbers to be removed from the population after implementation of the new management policy until a TPC (threshold of potential concern) is reached after a hypothetical period of 22 years.

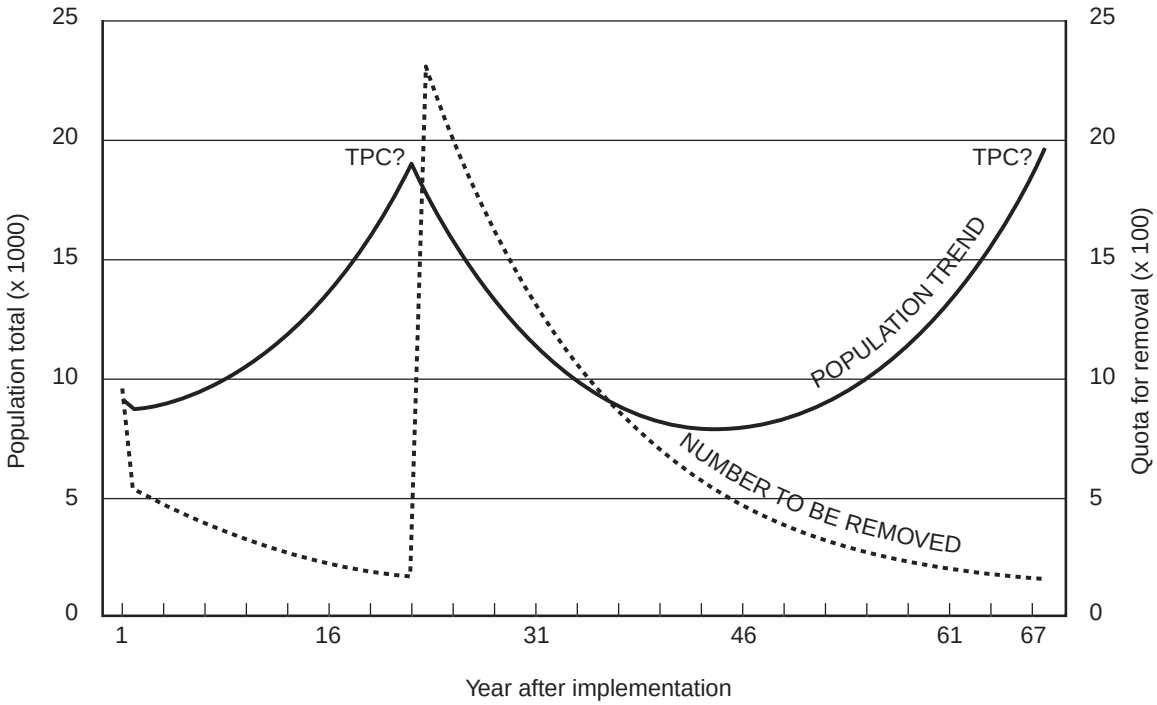

Figure 4. Expected elephant population trends and number to be removed from the population before and subsequent to reaching a TPC (threshold of potential concern), at which time the management option for the zones would be switched (see text).

subsequent years the management option for each zone is maintained until a hypothetical TPC is reached in year 22. The number to be removed decreases as the population declines. After 22 years the number to be removed has decreased to just 170, while the KNP population as a whole has increased to around 19,000.

Once a TPC has been reached and management options for high- and low-impact zones are reversed, the number of elephants to be removed once again increases dramatically due to the high number of elephants in the high-impact zones, which now need to be reduced (fig. 4). This also results in a decline in the overall population, which persists for about 20 years. At this time, the number of elephants in the newly designated high-impact zones has built up to a level where the 7% increase exceeds the number to be removed from the new low-impact zones—and the population begins another growth cycle. This will continue until another TPC is reached sometime in the future.

This management will induce significant population fluctuations, not only in individual HEIs and LEIs, but in KNP as a whole. It is believed that such fluctuations will significantly contribute to the overall biodiversity of KNP.

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FIELD NOTES

Black rhinoceros mortality in Matusadona National Park, Zimbabwe: 1992–2003

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Introduction

In 1987 Zimbabwe had the largest population (c. 1775) of black rhinoceros, *Diceros bicornis,* L. in Africa. Over the next five years it lost over 80% of its population as a result of poaching activities (Alibhai et al. 1999). In 1992 the government of Zimbabwe, through the Department of National Parks and Wildlife Management, established intensive protection zones (IPZs) on state land and conservancies on private land as part of a comprehensive strategy to save the rhino. In the Zimbabwe context, an IPZ is a designated area where resources are concentrated for the purpose of conserving particular species. Matusadona National Park was one of four IPZs that were formed in 1993 to conserve rhinos.

Rhinos that remained in unprotected areas or in areas where protection was inadequate were relocated to these new conservation areas. Relocation meant immobilizing and transporting the animals. Matusadona National Park received about 25 wild rhinos from other areas between 1991 and 1995. In addition, the park received 12 hand-raised rhinos either for final release or for further hand-raising and rehabilitation before final release between 1994 and 2001. New animals were kept in a *boma* (kraal) to acclimatize them to the new environment or to hand-raise them for some time. Before their release, some rhinos were radio-collared for tracking purposes and ear-notched for identification, and some were dehorned to discourage poaching. After their release some were periodically recaptured for recollaring.

The study area

Matusadona National Park stretches from 28°23' to 28°51'E and from 16°41' to 17°13'S (fig. 1). The park is 1407 km^2 in area. It is divided by an escarpment into two major geomorphologic landscapes: the semi-arid eutrophic valley floor lying at an altitude of between 485 and 600 m, and the wet, dystrophic, rugged highland section lying between 600 and 1200 m. The lowland area is dominated by semi-arid vegetation, mainly *Colophospermum mopane* woodland, while the highland area supports *Brachystegia–Julbernadia* woodlands.

Observations

As noted in file records and field observations, 18 rhinos died in Matusadona National Park between 1992 and 31 December 2003 (table 1). Deaths took place mostly among rhinos that originated from within the park (44.4%) and from Chizarira National Park (27.8%). Mortality was recorded in all age groups—adults, subadults and calves—with the highest number of deaths (44.4%) recorded in each of the adult and subadult segments. The highest number (5) of deaths in a single year took place in 1994 (fig. 2).

Between 1992 and 1995, 42 rhinos were darted an average of 2.64 times each (range 1–6 times); 11 of the animals darted died during that period. Deaths of animals that were relocated from other areas took place at an average of 4.47 months (range 1 month 3 days to 12 months 7 days) after release from holding

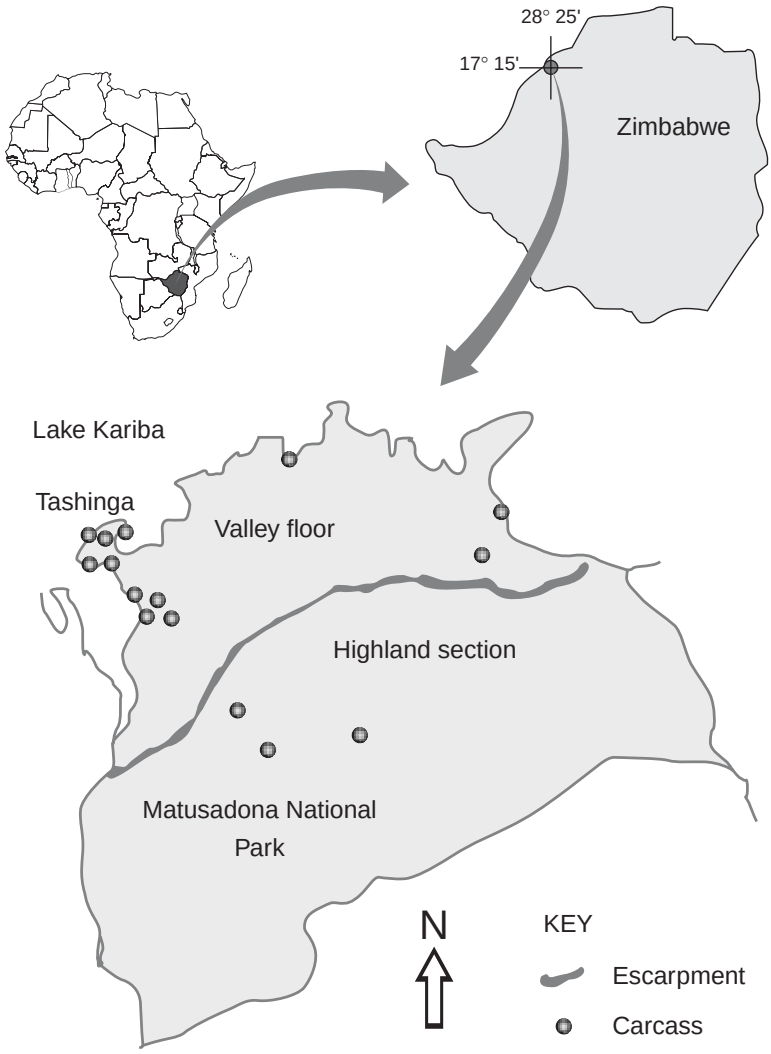

Figure 1. Location of Matusadona National Park in Zimbabwe and location of 15 of the 18 rhino carcasses found in the park; location of the other 3 is not known.

pens, and at an average of 5 months and 12.5 days (range 1 month 10.8 days to 8 months 14 days) after the last darting.

File records show that there were logistical problems during capture operations. Once, rhinos destined for Matusadona National Park were rerouted to Sinamatella because heavy rains prevented transport into the park. During boma holding, some animals did not feed for at least 24 hours on the browse placed in pens after they were offloaded, possibly due to stress and or to loss of appetite caused by long-acting tranquillizing drugs administered at capture. The stress on some animals might have been great enough that during post-capture and release they died. Deaths of adult and subadult animals may have been due to the effects of darting for relocation, dehorning or collaring. No intraspecific rhino fights with fatal results were observed. However, the high number of adult and subadult deaths was consistent with reports of post-release fatal intraspecific fights (Brett 1998).

An abortion**,** not included in table 1, occurred on 23 August 1994 from a cow that had been darted twice, in June and in August 1994. Abortion took place five days after the cow was darted the second time, when she was 29 weeks pregnant. Alibhai et al. (1999) observed that chemical immobilization can compromise the fertility of female rhinos and result in abortion if the animal is darted in the first five months of pregnancy. In this instance the cow was over five months pregnant. Darting an animal that was under stress and confined in a boma twice within three months might have brought on the abortion.

Lions and leopards were responsible for the loss of two emaciated and diarrhoea-ridden calves, aged between four and seven months. The mothers of the calves were also in poor body condition: one cow had diarrhoea and struggled to stand, and the other died five weeks after losing her calf. Postnatal calf mortality in black rhinos is known to occur under natural conditions through predation on calves under the age of three months, which are the most vulnerable (Alibhai et al. 1999). In Ngorongoro Crater, Tanzania, lions preyed upon a rhino calf, and the mother died four months later (Maige 2001). In the Hwange National Park, Zimbabwe, hyenas preyed upon emaciated newborn elephants whose mothers were apparently also thin in the late dry season (Salnicki et

Table 1. Black rhino mortality in Matusadona National Park, 1992–2003

Entry no.	ID no. or name	Sex	Date of birth	Date of death	Source	Cause of mortality
1	1	male	adult	09 Feb 93	Matusadona NP	poached
2	4	female	1983, adult	24 Nov 95	Matusadona NP	natural, pregnant, near full term
3	5	male	subadult	13 Oct 92	Matusadona NP	natural. broken jaw
4	6	male	subadult	06 Nov 92	Matusadona NP	poached
5	10	female	subadult	01 Jan 93	Matusadona NP	natural
6	31	female	adult	26 Jun 94	Chizarira NP	stuck in mud
7	32	male	1989, subadult	13 Mar 94	Chizarira NP	natural
8	34	male	adult	17 Nov 94	Chirisa SA	natural
9	35	male	1984, subadult	27 Sep 94	Chizarira NP	unknown, close to spring
10	39	female	1990, subadult	08 Oct 94	Chizarira NP	natural
11	36	female	subadult	07 Oct 95	Chizarira NP	natural, supernumerary tooth in nose
12	?	?	adult	c.1996	?	unknown, carcass in dry pan
13	?	?	10 Apr 98, calf	08 Nov 98	Matusadona NP	lion predation
14	?	?	04 Jun 00, calf	30 Sep 00	Matusadona NP	leopard predation
15	15	female	1963, adult	06 Nov 01	Partridge Islands	natural
16	?	?	adult	May 2002	?	poached
17	Chibage	male	24 Aug 99, subadult	28 Mar 02	Imire	poached in bomas
18	50	male	adult	12 Feb 03	?	poached

? – information unknown; NP – national park; SA – safari area

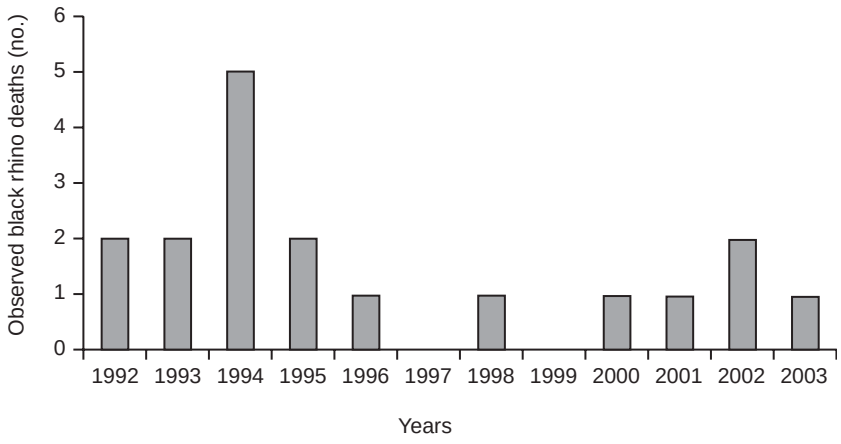

Figure 2. Number of rhino carcasses recovered in Matusadona National Park, 1992–2003.

al. 2001). Rhino and elephant mothers in poor body condition seemed unfit to provide their calves with adequate protection, and similarly calves in poor health appeared to be poorly provided with adequate parental security. This occurrence of cows and calves in a poor state of health implies that there might have been a transmittable disease affecting mother and calf.

Reports that deaths were due to 'natural' factors show how difficult it is to identify mortality factors in the field when carcasses have decomposed. Natural factors were believed to have caused deaths in cases where horns were recovered. Over 40% of all the deaths were attributed to natural causes and 27.7% to poaching from 1992 to 2003. Loss of

rhinos to poaching had been last recorded in 1993 until poaching recurred in 2002 and 2003; the poaching included a hand-raised subadult male that was being rehabilitated. Poaching caused the highest number of mortalities until the park was designated an IPZ in 1993. The current upswing in poaching activity is a worrisome development for rhino conservation.

The distribution of mortality in the park is shown in figure 1. Captured animals were kept in bomas at Tashinga Camp. Four deaths took place close to the bomas after release; four deaths were observed near water bodies or holes and the reason for their dying close to waterholes was not established. More deaths (83.3%) were observed in the valley floor than in the highland section of the park because a significant number of animals died within five months not far from Tashinga boma after release. Also, the spatial distribution of the observed mortality was biased because ground patrols have easier access to the valley floor than to the rugged highland section.

Conclusion

It is not easy to identify the mortality factor in natural populations, especially several days after death. Effects of capture operations should be monitored and studied for longer than five months after animals, including pregnant cows, are manipulated. Although death figures are generally low in a given year, for an endangered species they have significant impact on population growth. Poaching activities are on the upswing in the park. Past lessons show that a comprehensive multiple-pronged strategy for rhino conservation drastically reduces losses to poaching.

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Previously, ecologists M. Murphree and P. Wood collected valuable information retrieved from station files. Scouts from both Management and Research Units of the then Department of National Parks and Wildlife Management helped with data collection in the field. Finally, the director and directorate of the Parks and Wildlife Authority are thanked for supporting the publication of this article.

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Coprophagy and unusual thermoregulatory behaviour in desert-dwelling elephants of north-western Namibia

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Abstract

The incidence of coprophagy in wild African elephants has rarely been reported in the literature. This paper reports on two such observed incidents among elephants of north-western Namibia. Unusual thermoregulatory behaviour in desert-dwelling elephants is also reported.

Introduction

The distribution, ranges, habitat selection and effect on vegetation of the desert-dwelling elephants (*Loxodonta africana* Blumenbach, 1797) of north-western Namibia have been reported by Leggett et al. (2003), Lindeque and Lindeque (1991), Viljoen and Bothma (1990) and Viljoen (1987, 1988, 1989a, 1989b). However, there have been no publications on certain aspects of desert-dwelling elephant behaviour.

Although the incidence of coprophagy in captured elephants has been reported (Sikes 1971; Stoinski et al. 2000), it is generally regarded as 'abnormal behaviour' (Stoinski et al. 2000). It has only once been reported in wild African elephants (Guy 1977), where younger members of a herd (two subadult females, one subadult male and two juveniles whose sex was not determined) fed on the dung of the dominant female.

This paper also reports two different methods of thermoregulatory behaviour employed by desert-dwelling elephants to cool their bodies in high ambient temperatures (> 40°C): moistening the back of the ears and body using water extracted from the pharyngeal pouch and using sand wetted by the urine of an adult female.

Study area

The 12 ephemeral rivers flowing to the west of Namibia arise in relatively high and wet regions of central Namibia and flow into the Atlantic Ocean or end in the Namib Sand Sea. Many originate in commercial farmlands, flow through communal farming areas, and near their mouths, traverse a protected conservation area. The Hoanib and Hoarusib River catchments occupy an area of 32,000 km^2, 2% of which lies in private farmlands, 92% in communal farmlands and 6% protected as Etosha National Park and Skeleton Coast Park (Jacobson et al. 1995). Leggett et al. (2003) provide a detailed description of the research area. The observations reported in this paper were made from January 1998 until March 2003 in the Hoanib and Hoarusib catchment areas. An additional incident of elephant coprophagy was observed at Okaukuejo Rest Camp in Etosha National Park.

Methods

These observations were ad hoc in nature, obtained while researchers were occupied with other observational research. Temperature readings were taken using a hand-held thermometer under the shade of the nearest large tree to the observation. The thermometer was held in the shade at arm's length away from the car for 2 minutes before readings were recorded.

Results

Coprophagy

On 25 August 2002, an adult dominant female was observed to excrete dung loose in texture. A three-month-old female calf (born 29 May 2002) was observed to scrape the dung together with her foot, then she lowered herself onto her front knees and ate some

of the dung. She twice repeated this behaviour before moving off with the herd.

On 24 August 2003, similar behaviour was observed of three adult males. One older male (approx. 45 years) excreted dung of loose texture, which was immediately consumed by a young adult male (approx. 20 years). After 4 minutes, a third male (approx. 40 years) approached the young male, and he also took small amounts of the dung and ingested it.

Thermoregulatory behaviour

On seven separate occasions adult elephants (both male and female) were observed to place their trunk into their mouth and extract water from the pharyngeal pouch (Shoshani 1997), withdraw water and squirt it over their back and behind their ears. These observations were made only on hot days (> 40°C). Young animals were not observed to exhibit this behaviour.

On 7 September 1999 and 1 February 2002 adult female elephants were observed to urinate on sand. Juvenile and subadult elephants then scooped up the wet sand with their trunks and threw it over their backs and behind their ears. These observations occurred with two separate family units; the young elephants varied in age from 3 to 8 years. On both occasions, the temperature was > 40°C with no wind evident.

Discussion

The observations of coprophagy in the juvenile elephant are similar to those reported by Guy (1977) from Sengwa Research Station in Zimbabwe. In both cases it was dominant adult female that excreted and juvenile animals that ate the dung. In neither case did any other adult animal eat the dung. While coprophagy has been observed more often in captive elephants, it is regarded as 'abnormal behaviour' and termed 'faeces manipulation' (Stoinski et al. 2000). It is possible that in the wild it is an attempt by young elephants to obtain necessary gut enzymes to facilitate digestion. In very young elephants like the animal observed, the behaviour could also be 'play', through which the young elephants are simply learning about their environment by sampling anything in their surroundings. The reason for the ingestion of dung by adult elephants is unknown; however, both observed incidents occurred during the time of year when vegetation was limited in the veld. It was probably some form of dietary supplementation or an attempt to supplement gut enzymes.

Extracting water out of the pharyngeal pouch by placing the trunk into the mouth and sucking water as a thermoregulatory mechanism is well recorded from other areas of Africa (Sykes 1971; Moss 1988). Elephants generally used it as a way of cooling themselves after they have been subjected to some form of stress. In the case reported by Moss (1988), elephants were scared by Maasai tribesmen and fled in panic. When they had calmed down, they extracted water from their pharyngeal pouches to cool themselves. The desert-dwelling elephants appear to use this thermoregulatory mechanism routinely when under no apparent stress other than that from ambient temperature. While scooping and throwing sand is not commonly done to regulate body temperature, young elephants of two different desert-dwelling family units used urine-soaked sand in this way to cool themselves in hot temperatures (> 40°C).

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WORKING PAPER

Determining the number of elephants required to supply current unregulated ivory markets in Africa and Asia

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Abstract

The relationship between unregulated ivory markets and illicit trade in ivory in Africa and Asia has been highlighted in a recent series of reports. What is not clearly indicated is the number of elephants that are required annually to service these markets, and the geographical regions from which these elephants are being taken. With the use of various published studies of ivory markets in Africa and Asia, it has been possible to estimate the number of carvers. This is only the first step to knowing the volume of ivory they require annually. This paper therefore attempts to estimate this volume. Although the data are highly variable in availability and precision, a comparative scoring method has been developed to apply and extrapolate these data to derive minimum and maximum estimations of ivory consumption in 25 key countries around the world. This makes it possible to estimate minimum and maximum values for the number of elephants required to support these ivory-carving industries. A surprising result is that unregulated ivory markets in Africa appear to consume a higher volume of ivory than those in Asia. The study also suggests that 4000 elephants or more are required each year to meet the estimated demand from both continents. Determining the source of this ivory is necessary to determine which elephant populations are under pressure. Drawing on preliminary information from other sources, the study raises a concern that the supply of ivory for the unregulated markets in both continents is coming from elephants in central Africa. The analysis undertaken here is presented as work in progress, and suggestions for improving it are welcome as a basis for building MIKE and ETIS links.

Résumé

La relation entre le marché de l'ivoire non réglementé et le commerce illégal de l'ivoire en Afrique et en Asie a été mise en lumière dans une série de récents rapports. Ce qui n'est pas clairement indiqué, cependant, c'est le nombre d'éléphants nécessaires, sur une base annuelle, pour alimenter ce marché, et les régions géographiques où ces éléphants sont prélevés. En reprenant diverses études sur les marchés de l'ivoire en Afrique et en Asie, il a été possible d'estimer le nombre de sculpteurs d'ivoire. Ce n'est que la première étape avant de savoir le volume d'ivoire dont ils ont besoin chaque année. Cet article essaie dès lors de faire une estimation de ce volume. Bien que les données ne soient pas toujours disponibles ni exactes, une méthode de classification comparative a été mise au point pour utiliser ces données ou les extrapoler afin d'en déduire les estimations

maximale et minimale de la consommation d'ivoire dans 25 pays clés du monde entier. Ceci permet d'estimer les valeurs maximale et minimale du nombre d'éléphants requis pour satisfaire ces industries du travail de l'ivoire. Nous avons été surpris de constater que les marchés non réglementés de l'ivoire en Afrique semblent consommer un volume d'ivoire plus élevé que ceux d'Asie. Notre étude tend aussi à montrer que 4000 éléphants, voire plus, sont nécessaires chaque année pour répondre à cette demande sur les deux continents. En se basant sur des sources d'information antérieures, l'étude signale que l'ivoire qui se retrouve sur les marchés non réglementés des deux continents provient d'éléphants d'Afrique centrale. L'analyse entreprise ici est présentée comme un travail en cours, mais on la considère une base de départ pour construire les liens entre le contrôle des massacres illégaux d'éléphants (Monitoring the Illegal Killing of Elephants—MIKE) et le Système d'informations sur le commerce des éléphants (Elephant Trade Information System—ETIS) et toutes les suggestions qui pourraient l'améliorer sont les bienvenues.

Introduction

The Elephant Trade Information System (ETIS) analysis presented to the 12th meeting of the Conference of the Parties to CITES (CoP12) clearly demonstrated a highly significant statistical correlation between the illicit trade in ivory and the presence of unregulated domestic ivory markets in Africa and Asia (Milliken et al. 2002a,b,c). Ongoing serial studies of these ivory markets by Martin and Stiles and more recent TRAFFIC research in India and West Africa have provided 'snapshot' documentation of the number of carvers and other ivory trade dynamics found in various locations around the world at specific times (Martin and Stiles 2000, 2002, 2003; Courouble et al. 2003; anon. 2003).

A prime objective of the site-based CITES Monitoring the Illegal Killing of Elephants (MIKE) programme is to provide information on the amount of illegal killing of elephants presently occurring in elephant range states in Africa and Asia. To meet this objective, the MIKE programme needs to have some sense of the magnitude of the ongoing trade in terms of how many elephants are potentially being killed to service the ivory requirements of the carvers supplying the unregulated markets identified in the reports mentioned above. The first purpose of this paper, therefore, is to present available data in an attempt to determine the number of carvers and the annual rate of turnover of raw ivory they use in their production. This will then form the basis for assessing how many elephants are required to support such a supply.

The second purpose is to link the demand for such elephants with possible sources of ivory supply and patterns of illegal killing, on the basis that most of the ivory supplied to these domestic markets is illegally obtained. Thus, using different sources of information, this paper will also assess whether any evidence exists to suggest where elephant poaching is currently most acute. As the CITES MIKE programme progresses, it should be possible to achieve this second objective with greater certainty and precision.

Developing and using early warning flags is seen as an important step in the evolution of MIKE and ETIS as effective monitoring programmes for elephants.

Methods

Through a review of recent published literature, the number of carvers identified at various locations is summarized in table 1. In addition, table 1 includes a number of African and Asian countries that traditionally had ivory-carving industries in the recent past but do not appear to have active industries today. In such instances, the number of carvers is designated '0'. However, there are certain gaps. In Africa, Angola, Benin, Congo (Brazzaville), Ghana, Malawi, Namibia, Togo and Zambia are countries that have had, or continue to have, minor ivory-carving industries but have not been surveyed in recent years. For this reason these countries are not included in this analysis but should be added in the future if information implicating them becomes available.

The method generally used in the reported surveys draws on interviews and questionnaires from which the estimated number of carvers is derived. It is extremely difficult either to visit all carvers in the course of a survey or to verify precisely all information on their existence. Thus some margin of error exists in the estimation, particularly where the estimate is significantly higher than the number actually observed or interviewed. Nevertheless, the estimated number of carvers provided by these reports has been

Table 1. Estimated number of ivory carvers in Africa and Asia

Subregion/ country	Location	Estimated no. carvers
AFRICA		
West Africa		
Cote d'Ivoire	Abidjan	88
Nigeria	Lagos	38
Senegal	Dakar	26
	Subtotal	152
Central Africa		
Cameroon	Douala	44
Cameroon	Yaounde	6
CAR	Bangui	22
DR Congo	Kinshasa	116
Gabon	Various	10
Tchad	Ndjamena	0
	Subtotal	198
North Africa		
Egypt	Cairo	110
	Subtotal	110
East Africa		
Djibouti	—	0
Ethiopia	Addis Ababa	15
Sudan	Khartoum/Omdurman	19
	Subtotal	34
Southern Africa		
Mozambique	Maputo	100
South Africa	Durban	2
Zimbabwe	Harare	30
	Subtotal	132
	Total in Africa	**626**
ASIA		
South Asia		
India	Various	525
Nepal	Kathmandu	4
Sri Lanka	Various	14
	Subtotal	543
East Asia		
China	Various	190
Hong Kong	—	5
South Korea	—	0
Taiwan	—	1
Japan	Various	107
	Subtotal	303
South-East Asia		
Cambodia	Phnom Penh	30
Laos PDR	Vientiane	5
Myanmar	Mandalay	45
Myanmar	Yangon	10
Singapore	—	0
Thailand	Phayuha Kiri	55
Thailand	Bangkok	20
Thailand	Chiang Mai	6
Vietnam	Hanoi	20
Vietnam	Ho Chi Min	2
	Subtotal	193
	Total in Asia	**1039**

used as the maximum figure for the countries in question. With more funds and more time, researchers conducting future surveys of the ivory markets in question could increase accuracy by increasing the level of direct observations.

There is also a need to better understand a variety of other related factors when deriving estimates of ivory carvers and their turnover. For example, the report on India estimates 525 carvers (anon. 2003). Given the size of India and its population, it may well be that the figure is reasonable. In a climate of active suppression, however, ivory carving in India today is undertaken in secret on a part-time commissioned basis with few, if any, observable workshops or retail or wholesale outlets. In other words, most craftsmen turn their hand to carving ivory when requested to do so, but they usually rely on other income-earning activities (S.S. Bist, director, Project Elephant, pers. comm. 2004). Compare this with the Democratic Republic of Congo (DR Congo), for example, where there are active full-time workshops and active retail markets in Kinshasa. Therefore in a situation like India, it should be noted that deriving an ivory turnover per carver may produce a reasonable average, but this may mask the reality that a few carvers have a relatively high turnover in any one year, whereas the majority may have none.

Having established an estimate of the number of operational carvers, we then attempt to determine the annual turnover of raw ivory for each carver, based on reported or observed information at the time various markets were surveyed. We emphasize that the method used here is based on determining the amount of ivory being carved each year, not the amount being sold through wholesale or retail outlets. Data concerning rates of retail and wholesale turnover are generally poor and assumptions with regard to stockpiling in the marketplace are complex, making estimation of turnover difficult. Wherever possible, however, retail data for comparison and verification have been considered.

The estimated rate of turnover for each carver is presented in kilograms in table 2 in columns 3 and 4. However, some explanation of our basic assumptions is necessary.

- As stated, the data concerning the number of carvers and their rate of turnover are variable. Some data are based on surveys conducted in 1997 and 1998, for example those for Omdurman and Khartoum, Sudan, and Cairo, Egypt, while the most

Table 2. Provisional estimate of the number of elephants required to supply ivory carvers in Africa and Asia

1	2	3	4	5	6	7	8	9	10
		Turnover							
	Estimated no.	(kg/carver per year)		Quantity of ivory (kg)		No. of elephants[a]		Main source	
Subregion/country	of carvers	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	of ivory	Source of data
AFRICA									
West Africa									
Cote d'Ivoire	88	48	121	4,224	10,648	612	1,543	Africa	4, 1
Nigeria	38	62	156	2,356	5,928	341	859	Africa	1
Senegal	26	44	111	1,144	2,886	166	418	Africa	4, 1
Subtotal	152			7,724	19,462	1,119	2,821		
Central Africa									
Cameroon	50	62	156	3,100	7,800	449	1,130	Africa	1
Central Afr. Rep.	22	48	121	1,056	2,662	153	386	Africa	1
DR Congo	116	66	166	7,656	19,256	1,110	2,791	Africa	1
Gabon	10	40	101	400	1,010	58	146	Africa	1
Subtotal	198			12,212	30,728	1,770	4,453		
North Africa									
Egypt	110	44	111	4,840	12,210	701	1,770	Africa	6
Subtotal	110			4,840	12,210	701	1,770		
East Africa									
Ethiopia	15	46	116	690	1,740	100	252	Africa	1
Sudan	20	40	101	800	2,020	116	293	Africa	5
Subtotal	35			1,490	3,760	216	545		
Southern Africa									
Mozambique	100	46	116	4,600	11,600	667	1,681	Africa	1
South Africa	2	32	81	64	162	9	23	Africa	1
Zimbabwe	30	38	96	1,140	2,880	165	417	Africa	1
Subtotal	132			5,804	14,642	841	2,122		
Africa	627			32,070	80,802	4,648	11,710		
Minus Zimbabwe	597			30,930	77,922	4,483	11,293		
Minus southern Africa	495			26,266	66,160	3,807	9,588		

Table 2. (continued)

1	2	3	4	5	6	7	8	9	10
		Turnover							
	Estimated no.	(kg/carver per year)		Quantity of ivory (kg)		No. of elephants[a]		Main source	
Subregion/country	of carvers	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	of ivory	Source of data
ASIA									
South Asia									
India[b]	525	1	3	525	1,575	66	197	Asia	8
Nepal	4	1	3	4	12	1	2	Asia	2
Sri Lanka	14	1	3	14	42	2	5	Asia	2
Subtotal	543			543	1,629	68	204		
South-East Asia									
Cambodia	30	2	5	60	150	8	19	Asia	2
Laos PDR	5	2	5	10	25	1	3	Asia	2
Myanmar	55	6	16	330	880	41	110	Asia	2
Thailand	76	9	22	684	1,672	99	242	Africa	2
Vietnam	22	2	5	44	110	6	14	Asia	2
Subtotal Africa[c]	76			684	1,672	99	242		
Subtotal Asia[c]	112			444	1,165	56	146		
S/SE Asia from African elephants[c]	76			684	1,672	99	242		
S/SE Asia from Asian elephants[c]	55			987	2,794	123	349		
East Asia									
China	190	34	86	6,460	16,340	936	2,368	Africa	3, 7
Hong Kong	5	24	59	120	295	17	43	Africa	3
Japan	107	47	117	5,029	12,519	729	1,814	Africa	3
Taiwan	1	21	53	21	53	3	8	Africa	3
Subtotal	303			11,630	29,207	1,686	4,233		
Asia from Asian elephants[c]	655			987	2,794	123	349		
Asia from African elephants[c]	379			12,314	30,879	1,785	4,475		
Asia from African elephants minus Japan[c]	272			7,285	18,360	1,056	2,661		

Table 2. (continued)

1	2	3	4	5	6	7	8	9	10
		Turnover							
	Estimated no.	(kg/carver per year)		Quantity of ivory (kg)		No. of elephants[a]		Main source	
Subregion/country	of carvers	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	of ivory	Source of data
Summary									
All elephants									
Africa				32,070	80,802	4,648	11,710		
Africa minus Japan, South Africa and Zimbabwe				25,837	65,241	3,744	9,455		
Asia				13,301	33,673	1,908	4,824		
Asia minus Japan				7,285	18,360	1,056	2,661		
Asian elephants									
Asian demand for Asian elephants				987	2,794	123	349		
African elephants									
Asian demand for African elephants				12,314	30,879	1,785	4,475		
Asian demand for African elephants minus Japan				7,285	18,360	1,056	2,661		
African demand for African elephants				32,070	80,802	4,648	11,710		
African demand for African elephants minus Zimbabwe				30,930	77,922	4,483	11,293		
Total demand for African elephants				44,384	111,681	6,432	16,186		
Total demand for African elephants minus Zimbabwe and Japan				38,215	96,282	5,538	13,954		
Total demand for African elephants minus southern Africa and Japan				33,551	84,520	4,862	12,249		

Source notes: 1. Martin and Stiles 2000; 2. Martin and Stiles 2002; 3. Martin and Stiles 2003; 4. Courouble et al. 2003; 5. Martin 1998; 6. Martin 2000; 7. Daniel Stiles, pers. comm. 2004; 8. anon. 2003

[a] average 6.9 kg per African elephant and 8 kg per Asian elephant

[b] see text in paragraph 3 of Methods section (page 2)

[c] the reference to Africa and Asia distinguishes the markets using African and Asian ivory

recent observations of West African and East Asian countries were in 2002. Although acknowledging that the literature on various ivory markets at particular times characteristically illustrates wide fluctuation in the number of ivory carvers over relatively short periods, we use a static model for this analysis. In other words, we assume that all data are indicative of the current situation regardless of the year from which they derive.

- Another issue with using carvers as the basis for estimating consumption volumes is that this methodology probably fails to some extent to pick up the existence of 'closed', secretive and highly illegal carving operations that are based on the export of worked and semi-worked products into foreign markets. The presence of African-based, Asian-run ivory-processing operations has been established for some time (Dublin et al. 1995). To illustrate, countries such as Kenya have no domestic ivory market whatsoever, and consequently no identifiable ivory carvers, but seizure records in ETIS indicate that successful law enforcement against Korean-run processing operations in 1993 led to the seizure in Nairobi of nearly 350 kg of worked ivory products. Similarly in 2002, a single illegal consignment of ivory from Malawi contained over 41,000 processed ivory pieces, weighing over 1500 kg. Such large-scale, export-oriented operations become apparent only when exposed through law-enforcement action, and their effect is not necessarily captured when the basis of analysis relies on an evaluation of ivory carvers in more transparent markets. Indeed, neither Kenya nor Malawi features in this analysis.
- There are no empirical assessments of rates of consumption by the carving industry, only reported information. The best data for Africa stem from the Martin and Stiles (2000) report where, for example, an estimate of 166 kg of ivory per carver per annum was given for operations in Kinshasa, DR Congo, in 1999. This estimate is used as the starting point for assessing other markets in Africa. Reasonable data on the rate of consumption are also found for Japan and Thailand, and they are used as a baseline for assessing Asian countries that predominantly use African elephant ivory in their carving operations. The data for Cambodia, Laos, Myanmar, Nepal, Singapore, Sri Lanka and Vietnam in South and South-East Asia are also believed to be quite accurate, as multiple surveys have been carried out in these countries. Their data are used as the baseline for estimating the rate of consumption of Asian elephant ivory in other Asian countries. The data for China are poor, however, due to the huge size of the country, its large human population, and the increasingly informal nature of the trade and processing industry. Carving operations in Hong Kong and Taiwan have also changed dramatically in recent years, and what remains is small and secretive. However, as these industries generally rely upon African ivory for their limited production needs, it is possible to estimate a rate of consumption using the data from Japan and Thailand.
- Where data on the rate of ivory consumption in key locations are not at hand, it has been necessary to estimate the likely turnover. To do so, characteristics of the ivory markets have been compared so that those with similar characteristics are ascribed a similar rate of consumption as a maximum turnover value. The characteristics examined are as follows:
    1. trend concerning the number of ivory carvers as mentioned in the survey reports used for each country
    2. method of carving, for example whether predominantly by hand or by machine
    3. degree to which carvers, directly or through a wholesaler, engage in the export of the items they carve
    4. degree to which carvers engage in the production of products fashioned from alternative substances, for example wood or bone
    5. extent to which ivory stockpiles are believed to exist in the custody of carvers
    6. degree of access to illicit sources of ivory
    7. degree to which the market is expanding or contracting, with some reference to the time period since the date of the relevant report (for example, Kinshasa is currently seeing an increase in potential buyers, due to the peace process in DR Congo)
    8. legality of the supply of ivory
    9. degree of internal regulation

We developed a scoring system for each of the above criteria (see table 3) and ranked each of the baseline countries accordingly. However, it is important to state that in using the scoring approach, we made no attempt to weight the above criteria. We recognize that a weighting mechanism should be considered for the future, but probably only after the scoring system has been further

Table 3. Criteria used to score domestic ivory markets around the world

Criteria	Score	Definitions
1. Trend for number of carvers	High base increase – 5	Increasing from a base of more than 50 in number
	Low base increase – 4	Increasing from a base of less than 50 in number
	Stable – 3	Stable: less than 10% variation
	High base decrease – 2	Decreasing from a base of more than 50 in number
	Low base decrease – 1	Decreasing from a base of less than 50 in number
2. Method of carving	Highest value machine use – 5	Almost all carvers use machines
	Moderate value machine use – 4	Most carvers use machines
	Mixed (machine and hand) – 3	Mixed; about half and half
	Moderate value by hand – 2	Most carvers work by hand
	Highest value by hand – 1	Almost all carvers work by hand
3. Degree of commercial wholesale export of worked ivory products	Very high – 5	Almost all carved ivory is exported
	High – 4	Most carved ivory is exported
	Medium – 3	Mixed; about half and half
	Low – 2	Most carved ivory is sold through local retail market
	Very low – 1	Almost all carved ivory is sold on local retail market
	Insignificant – 0	
4. Use of alternatives	Very low – 5	Almost all carvers work with ivory most of the time
	Low – 4	Most carvers use ivory most of the time
	Medium – 3	Mixed; about half and half
	High – 2	Most carvers use alternatives most of the time
	Very high – 1	Almost all carvers work with alternatives most of the time
5. Extent of stockpiling	Very high – 5	Over a 2-year supply of ivory generally at hand
	High – 4	Over a 1-year supply of ivory generally at hand
	Medium – 3	A 4-month to 1-year supply of ivory generally at hand
	Low – 2	A 1- to 3-month supply of ivory generally at hand
	Very low – 1	Less that a 1-month supply of ivory generally at hand
6. Access to illicit sources	Very high – 5	Excellent; in-country proximity to large supply; well-developed trade routes; no effective law enforcement
	High – 4	Good; close proximity to some supply; well-developed trade routes; poor law enforcement
	Medium – 3	Fair; moderate proximity to fair supply; developing but not established trade routes; moderate law enforcement
	Fair – 2	Poor; moderate or poor proximity to uncertain supply; uncertain trade routes; good law enforcement
	Low – 1	Bad; distant proximity to uncertain supply; poorly developed trade routes; effective law enforcement
7. Market trend	Booming – 5	Market trend rapidly increasing
	Increasing – 4	Market trend generally increasing
	Stable – 3	Market trend shows little change
	Decreasing – 2	Market trend generally decreasing
	Depressed – 1	Market trend rapidly decreasing
8. Legality of ivory supply	Predominantly illegal – 5	Virtually all ivory is obtained through illicit channels
	Mixed – 3	Some stocks illicit, some from longstanding legal stockpiles
	Predominantly legal – 1	Virtually all ivory obtained through legal sources
9. Degree of internal regulation	Very low – 5	Virtually no regulation at all
	Low – 4	Modest but ineffective attempt at regulation
	Moderate – 3	Some success in attempt to regulate
	High – 2	High regulation with large measure of success
	Very high – 1	Active suppression of ivory market

examined and validated with better data.

By adding the score and dividing it by the number of countries contributing to the baseline data, we derive a single baseline market score for each ivory type (that is, African elephant or Asian elephant) and regional grouping (Africa and Asia). By adding the baseline data on maximum rate of turnover and dividing by the number of countries, we obtain a single baseline value for the volume of ivory consumed. By scoring the other countries individually and dividing the baseline value for volume by the baseline market score, we derive a per unit baseline value. Finally, we multiply the per unit baseline value by the scores for each country to which the baseline unit value is relevant, thus calculating a maximum rate of turnover.

To illustrate, DR Congo is the baseline for African elephants in Africa. Scoring the characteristics of the DR Congo market results in a score of 33. Dividing the baseline value for the rate of turnover, which is 166 kg, by 33 gives a per unit baseline value of 5.0303. This figure is used to score other African countries for which the rate of consumption is unknown. For example, Senegal's market score is 22, so by multiplying 22 by 5.0303 we establish a maximum rate of turnover of 111 kg for Senegal.

As stated, determining the maximum rate of turnover is dependent on extrapolating from data that contain several real weaknesses. The difficulty of obtaining accurate estimates of the number of carvers and rates of ivory consumption has already been mentioned. While the scoring system addresses to some extent these concerns, we acknowledge that some of the criteria used in scoring either have little actual data or the data for a given market are highly variable (such as degree of commercial export, extent of stockpiling, use of alternatives, market trend). Thus it is important to reduce the assumed rate of consumption to a level where the influence of the uncertain variables is minimized. To ensure a conservative estimate we have used a 60% reduction of the maximum rate of turnover to determine the minimum rate of consumption. The choice of 60% was based on the one check that was possible against Indian mortality figures (see section below).

Table 4 therefore provides a score for each of the nine criteria used for comparatively assessing the domestic ivory markets in the 25 countries under consideration. These features are described in the source reports or are known to the authors of the reports from personal visits and knowledge. In some cases objective information, such as distance from elephant range (for instance, Egypt compared with Mozambique) or ETIS data on semi-worked and worked ivory seizures, has been taken into account. As described, the resulting scores together with the data on ivory carvers in table 1 have been used to allocate a minimum and maximum estimate of kilograms of ivory each carver uses per year. We emphasize that estimates of the rate of turnover remain the weakest point in the data available. Thus as mentioned, we have taken a cautious approach to reduce the risk of exaggeration.

Based on the above approach, columns 5 and 6 of table 2 estimate the possible range in the volume of ivory that is required for domestic ivory production in each country. To assess the effect of current poaching, countries such as South Africa, Zimbabwe and Japan, where the greater part of their carving industry comes from government-owned or -regulated legal stocks, have been removed from the totals where appropriate.

Results

How many elephants are potentially poached per annum?

When we compare the estimated volume of ivory for Africa with that for Asia, it comes as a surprise that Africa appears to require more ivory to sustain its domestic ivory markets than Asia; 13 countries in Africa need 32–81 tonnes of raw ivory per annum compared with 12 countries in Asia requiring 13–34 tonnes. To focus on the possible impact of unregulated markets, the ivory requirements of South Africa, Zimbabwe and Japan can be excluded. Africa still requires some 26–65 tonnes of raw ivory compared with only 7–18 tonnes for Asia. In sum, African countries require between 2 and possibly up to 11 times as much raw ivory to support domestic ivory carvers as is the case for Asia—a finding contrary to conventional notions about contemporary ivory trade dynamics.

This raises the question of who is purchasing this worked ivory from Africa. Martin and Stiles (2000), Stiles and Martin (2001) and Courouble et al. (2003) all report that buyers include European and Asian diplomats, French military, Asian businessmen, United Nations staff, West African traders, expatriates, and tourists from Europe, America and Asia. These reports indicate that such trade is not just individual demand for personal effects but that significant quantities of carved ivory are being purchased for selling commercially else-

Table 4. Scoring of 25 domestic markets, based on a scale of 1–5

Market	1. Trend in no. carvers	2. Method of carving	3. Degree of export	4. Use of alternatives	5. Extent of stockpiling	6. Access to illicit sources	7. Market trend	8. Legality of ivory supply	9. Degree of regulation	Total
African baseline										
DR Congo	2	3	4	4	1	5	4	5	5	33
West Africa										
Cote d'Ivoire	2	3	1	2	2	4	1	5	4	24
Nigeria	3	3	1	3	3	5	3	5	5	31
Senegal	1	3	0	2	1	3	2	5	5	22
Central Africa										
Cameroon	1	3	4	3	2	5	3	5	5	31
Central Afr. Rep.	1	3	2	2	1	4	1	5	5	24
Gabon	1	3	1	1	2	4	1	5	2	20
North Africa										
Egypt	2	3	0	2	2	3	2	5	3	22
Eastern Africa										
Ethiopia	1	3	0	2	2	4	2	5	4	23
Sudan	1	3	0	2	1	3	2	5	3	20
Southern Africa										
Mozambique	2	1	0	2	2	4	2	5	5	23
South Africa	1	5	1	2	2	1	1	1	2	16
Zimbabwe	1	4	0	5	2	3	1	1	2	19
Asian baseline for Asian elephant ivory										
Cambodia	1	1	0	2	1	3	1	5	3	17
Lao PDR	1	1	0	2	1	2	1	5	3	16
Myanmar	3	1	0	4	2	3	3	3	4	23
Nepal	1	1	0	2	1	2	1	5	3	16
Sri Lanka	1	1	0	1	1	2	1	5	2	14
Vietnam	1	2	0	2	1	1	1	5	3	16
South Asia										
India	2	1	1	1	2	3	1	3	1	15
Asian baseline for African elephant ivory										
Japan	2	4	0	4	5	1	2	1	2	21
Thailand	3	3	0	4	2	3	3	5	3	26
East Asia										
China	2	4	3	3	3	3	3	5	3	29
Hong Kong	2	2	2	1	5	1	1	3	2	19
Taiwan	1	4	1	1	1	2	1	5	2	18

where in the world. Evidence of commercial trade has been documented, with worked and semi-worked products being shipped to markets in Asia and Europe from West Africa (Courouble et al. 2003). There is also evidence that ivory is being sold by dealers through markets in Europe, particularly in London, Brussels and Paris, and through Internet auction sites such as eBay under the pretext that it is antique or pre-1989 ivory (IFAW 2004). The role of these markets and the number of buyers of worked ivory in Europe and North America need more attention, an issue also raised by Martin and Stiles (D. Stiles, pers. comm. 2004).

Given this estimate of annual ivory turnover, the question remains of how many elephants must be poached to supply these unregulated markets. A basic assumption is the belief that almost all of the ivory used in the carving industries of West and central Africa comes from elephants that have been illegally killed. Tusks from natural mortality are rarely found in forest habitats (R. Barnes, pers. comm. 2004). They are more easily found in savannahs, so it is possible that small quantities of ivory from natural mortality are reaching these markets. Nonetheless, such ivory is still illegal if it has moved across international borders without CITES permits. Likewise, some supply of ivory is believed to 'leak' from various government-owned stockpiles in Africa, and a portion of these stocks certainly find their way into carving markets in Africa. Finally, elephants are killed for a variety of reasons, especially for meat for human consumption or in defence of human life or property. In such cases, killing for ivory is not the primary motive, but the ivory is often taken and subsequently goes into trade as an important by-product.

As derived from conversion variables used in the TRAFFIC analysis of more than 7800 ivory seizure records, average tusk weight is 3.68 kg (Milliken et al. 2000c). Assuming that each elephant yields 1.88 tusks (Parker and Martin 1982), we establish an estimate of 6.9 kg of ivory per African elephant. For Asian elephants, where only males have tusks, we assume an estimate of 8 kg per animal (this figure is based on measurements taken by E. Martin from tusks in storage in southern India and is used in the absence of any reliable published figure). Using these conversion figures, we estimate that the ivory from between 4862 to 12,249 African elephants and between 123 to 349 Asian elephants is required annually (see columns 7 and 8 in table 2) for the unregulated markets examined in this report.

For India, we can compare the number of elephants derived in table 2 and the Indian mortality database (currently of the countries listed in table 2, only India and Sri Lanka have such a database). According to data from 1991 to 2003, the annual number of Indian tuskers poached for ivory ranges between 40 and 80. Because reporting dead elephants is widely acted on and is very much part of Indian culture and tradition, it is believed that few dead elephants are missed. Indeed, the encounter rate of carcasses could be as high as, or better than, 90% (S.S. Bist, pers. comm. 2004). It is reassuring to note that the minimum figure for the number of elephants required for India's ivory trade in table 2 is consistent with the numbers reported in India's mortality data. The difference at the maximum level is probably due to two factors: 1) some portion of India's ivory-carving industry derives from ivory sources that have been stockpiled in the country for over a decade, and 2) the data and extrapolation methods used in this analysis have certain inherent weaknesses. Regardless, the Indian data serve to support the conservative approach in applying a 60% reduction to the maximum consumption value.

Where are the poached elephants coming from?

As stated in the introduction, evidence on where elephants are being poached will continue to improve, with programmes such as MIKE being put in place. But currently, Courouble et al. (2003), as did Martin and Stiles (2000), state that their investigations reveal that the ivory supplying West African carvers is coming from central Africa. Preliminary evidence from MIKE supports the view that West African elephants are not a major source of ivory, probably because most populations in the region are already small and fragmented, thus providing an inadequate supply and making any offtake relatively uneconomical.

Similarly, preliminary MIKE evidence suggests that while elephant poaching certainly exists in eastern and southern Africa, levels of illegal killing appear to be comparatively low and stable. For southern Africa, it is assumed that what is required by Mozambican ivory carvers is largely derived from elephants poached in Mozambique or stolen from existing stockpiles within the southern African region. Ivory poached in eastern Africa probably contributes to the Ethiopian market and to a lesser extent to the Sudanese and Egyptian markets. Even if we take these

assumptions into consideration, an estimated annual supply of 26–65 tonnes of ivory, representing between 3700 and 9500 elephants, remains unaccounted for. If the Asian demand for African elephant ivory is included, the number of elephants unaccounted for rises to between 4800 and 12,250 per year.

This places the spotlight on central Africa. Information provided to the IUCN/SSC African Elephant Specialist Group meeting in December 2003 by the Institut Congolaise pour la Conservation de Nature (ICCN) in collaboration with the Wildlife Conservation Society highlighted the significant state of recent elephant poaching in eastern DR Congo, a region consumed by civil strife. This information is supported by carcass data from that area provided to MIKE for 2003.

Further evidence suggests that this is not the only part of the Congo Basin forest that is under worrying levels of poaching pressure. Elephant research work is signalling disappearance of elephants from an area under survey in one park located in the tri-national area of south-eastern Cameroon, south-western Central African Republic and northern Congo (Brazzaville) (A. Turkalo, pers. comm. 2004). The MIKE programme is currently undertaking a number of forest elephant surveys in that region, and although a careful and objective analysis of the data is still pending, there are worrying signs that carcass encounter rates are higher than what would normally be expected in some of the sites. There is also concern that encounter rates of elephant dung are low in those same sites. This raises the spectre that elephant poaching may have been going on relatively unknown to outsiders for some time.

Discussion and conclusion

The supposition that central African forest elephants are under real poaching pressure is not yet backed by hard scientific evidence, but the body of circumstantial evidence is certainly growing. The principal purpose of this article is to fly an early warning flag and raise serious concerns that central African elephants are facing poaching pressures that are stronger than any of the current signals coming from the other three African subregions or Asia. The likelihood of central Africa being the main source of poached ivory, when linked to the elephant population data for that region provided by the *African elephant status report 2002* (Blanc et al. 2003) suggests that the illegal killing for ivory carving examined in this study may be occurring at the rate of between 2.5% and 6.3% of the elephant population per annum of that region (see table 5). In making this observation, it is important to keep in mind that central Africa's elephant population estimates rely largely on the *Possible* and *Speculative* categories as defined by Blanc et al. (2003). Still, if the percentage of illegal off-take for ivory to service African and Asian carvers proves true, it is certainly worrying, keeping in mind that no consideration whatsoever has been made in this study regarding other forms of mortality—illegal, legal and natural. Such occurrences clearly push elephant mortality up further. If the assumption is valid that elephant killing is concentrated in the forest areas of central Africa, the sustainability of current rates of off-take becomes even more precarious.

While the analysis represented in table 2 is not

Table 5. Estimated annual offtake of elephants, based on a central Africa scenario as the main source of ivory required for unregulated markets

	Elephant numbers (Blanc et al. 2003)			
	West Africa	Central Africa	Southern Africa	Eastern Africa
Definite (*w*)	5,458	16,450	246,592	117,716
Probable (*x*)	1,188	32,263	23,722	17,702
Possible (*y*)	3,039	64,477	26,098	22,511
Speculative (*z*)	3,498	82,563	7,508	5,738
w + *x* + *y* + *z*	13,183	195,753	303,920	163,667

Scenario 1. Ivory for West, central, eastern, northern Africa, China and Thailand coming from central Africa

	Estimated no. of elephants poached	Annual % of central African elephants
Minimum	4,862	2.5
Maximum	12,249	6.3

based on precise data, it nonetheless does not preclude concluding that the unregulated ivory markets in Africa, let alone Asia, are a significant drain on African elephant populations, especially those in central Africa. This supports the conclusions of the ETIS analysis at CoP12 and the subsequent conclusion by the CITES Parties that the illicit trade in ivory is most directly linked to the existence of unregulated domestic ivory markets around the world. The CITES Parties agreed to subject selected ivory markets that had been highlighted in the ETIS analysis to an intersessional oversight process to ensure that such markets comply with CITES requirements for internal trade control or risk punitive sanctions. More recently, the CITES Standing Committee has broadened the scope of this initiative to include all unregulated ivory markets in Africa. Decisions at the 50th meeting of the CITES Standing Committee have put a timetable and a process in motion for shutting down these markets, if they are not properly regulated.

Even though table 2 is not based on precise data, we recommend that future work on analysing ivory markets use it as a template for getting better data. This paper should be regarded as a work in progress; suggestions for improving the methods and data are most welcome as a basis for building MIKE and ETIS links.

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Special thanks are due to Holly Dublin and Daniel Stiles, who were generous with their time in reading drafts and providing valuable comments and suggestions. The article is much better for their inputs and contributions, but responsibility for the methods used and results obtained belong entirely to the three authors. Ken Burnham provided a useful critique of the final draft and we are grateful to him for his help. Jim Armstrong of the CITES Secretariat also deserves thanks for encouraging us to publish this article as another step forward in developing MIKE and ETIS.

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READER RESPONSE

Clarifying MIKE and ETIS

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Introduction

The opinion piece by Reeve et al. (2003) essentially provides the authors' assessment of how the CITES Standing Committee should improve or interpret conditions related to the sale of ivory, which they believe to be flawed. These conditions were determined by the 12th CITES Conference of Parties (CoP) in regard to the one-off sale of ivory that has been agreed for Botswana, Namibia and South Africa, as long as a series of conditions are met. The purpose of this article is not to quarrel with the authors' right to express any opinions they want in regard to the conditions, although targeting the Standing Committee appears to overlook the fact that it has no power to alter Conference of Parties decisions. However, some of their recommendations and conclusions are based on incorrect or misunderstood information in regard to MIKE and ETIS. Our purpose here is to provide better information on which to forge any opinion.

MIKE—Monitoring Illegal Killing of Elephants

The issue of causality

The decision to develop a monitoring system to track the illegal killing of elephants in the field was initiated by the African elephant range states and agreed by CITES Parties at CoP 10 in Resolution Conf. 10.10. The text for this resolution was drafted by a working group of CITES Parties set up for that purpose during the course of the meeting in Harare. It is this text that used the words 'determine whether there is a causal relationship between changes in illegal killing, for example, and CITES decisions'. It was not wording that was introduced by those persons who were then mandated to help with the MIKE design after CoP 10. Indeed, it was they who first requested the wording to be changed to what was agreed at CoP 11, by substituting the above with 'assessing whether observed trends are related to CITES decisions in regard to ivory trade and populations listings'. However, it is a wrong conclusion or a misinterpretation that this change was a tacit admission that MIKE could therefore no longer achieve what the parties wanted it to do in regard to CITES decisions. What in fact the change in wording recognized was that the reality of proving 'causality' through a scientific approach was unlikely but this did not mean that no relationship could be determined.

The best way to explain this is through the analogy of lung cancer and smoking. It is very unlikely that any doctor doing a post-mortem on someone who has died from lung cancer would be able to prove that that person died from smoking. But the use of a statistical approach has convinced today's world that there is a strong relationship between smoking and getting lung cancer. MIKE will therefore use a similar statistical approach to look at the relationship between the illegal killing of elephants and various possible explanatory factors.

The issue of site selection and coverage

To criticize MIKE in terms of site selection because the designated sites include low poaching areas, do not cover ecosystems, and so on, misses another fundamental point. The essence of MIKE is to look at the factors influencing elephant trends. It would increase the bias if MIKE did not have sites with different characteristics; otherwise, how would MIKE be able to do site comparisons and determine why poaching may be less in one site as compared with another, in direct response to its objective to assist with decision-making. The preliminary bias in the subregion of central Africa in regard to protected-area coverage has been fully recognized and is being addressed. For example, because a site is defined as a protected area does not preclude the extension of the monitoring effort into adjacent areas, which are not afforded the same degree of protection. Likewise, some areas may carry a protected status but in essence be mere paper parks with little or no patrolling or enforcement. Southern Africa, on the other hand, has very little bias in terms of site selection with a good cover of protected and non-protected areas, and in this context the reference to Chobe is misleading.

The issue of MIKE methodology

There is implied criticism of the distance sampling dung count approach to estimating elephants in forest sites. These criticisms include that such surveys need to be undertaken to a minimum standard, they are comparable only with aerial sample surveys, they use secondary indicators, and results can vary according to choice of software. It is already a MIKE principle that any survey should meet a minimum required standard. Dung sample surveys are a perfectly acceptable and scientifically acknowledged approach, and if anyone can suggest how a total direct count can be successfully done in a forest situation, then please get in touch. The same applies to the use of software. The MIKE TAG already guides which software to use in a consistent and systematic manner and which not to use. A possible unforeseen benefit of the distance sampling approach is that it may be an appropriate method for measuring carcass encounter rates, which is something random patrolling is unlikely to measure with any degree of accuracy or precision.

The second methodology issue deals with law-enforcement monitoring (LEM). The main contention is that MIKE is not using LEM as a management tool but only as a measure of effort linked to carcass discoveries. It is in fact a MIKE objective to help management make decisions at the site. This explains why site computers have been provided and a GIS link made to the database. Monitoring where law enforcement officers go, how long they take and what they find is common to both aspects of LEM and is the basis of the patrol form format. Surely this is an artificial split that cannot be attributed to MIKE. Nor is MIKE guilty of having imposed a top-down or oversophisticated approach. The forms that MIKE uses were developed as a result of site-based work in savannah and forest situations. A process of harmonizing these forms was undertaken at the request of the range states, and a process of ensuring harmonization at site level, where LEM is already practised, is also adhered to. It is equally a false argument to suggest that the main task of guards is to protect and that monitoring where they go and what they do and find will detract from their main task. It is illogical to argue that LEM is a management tool and then argue that it detracts from the task of protecting ecosystems. Good feedback can and will guide where best to deploy often scarce protection resources.

The third methodology issue is that of measuring effort. If the patrolling information is properly and consistently provided, then measuring effort is not an over-ambitious objective for patrols, particularly as it is a post hoc measure and places no constraint on patrolling activities. It is not therefore the measuring of this sort of effort that is a problem per se. The correct issue is that MIKE, as it evolves, is looking to see how best to get carcass information, recognizing that patrols will not be the only relevant method. Obviously how best to measure effort expended in these alternative methods still needs to be determined. But the more methods MIKE can use, the stronger MIKE becomes.

The issue of site logistics

It is suggested that data analysis will be a problem because of the lack of scientifically trained field staff and because desktop computers cannot be run by solar power. Surely it is now widely accepted that computer skills and usage do not require a high degree of scientific or academic training. It is presumably suggested that desktops are not suitable for solar because they use more power than laptops. The reason that

flat-back monitors are being provided is because they use 40% less power than conventional monitors. Also, the use of modern storage batteries and invertors in today's solar power systems makes the use of desktops straightforward.

Some baseline issues

A requirement of the baseline is that each site must have a dossier capturing the information on any influencing factor relevant to that site. Thus, for example, the patterns of land use surrounding each site will have been identified. Confusion comes from suggesting that this baseline is not valid because it will not initially have been captured in a GIS. It is perfectly possible to establish a baseline and monitor changes in land use without a computer. It makes life easier to have it in a GIS, which is why that remains an objective of the database, but lack of GIS capability does not invalidate the use of hard-copy maps and reports.

The issue of MIKE needing more time appears to be premised on a concern that the recent Standing Committee 50 (March 2004) was going to decide whether a sale could take place. The fact remains that the Standing Committee cannot consider the sale until the conditions are met. In MIKE's case the condition requires the baseline to be in place and verified.

ETIS—Elephant Trade Information System

ETIS is a comprehensive information system to track illegal trade in ivory and other elephant products. It shares the same objectives as those set out for MIKE in Resolution Conf. 10.10 (Rev. CoP 12), with the difference that its aim is to record and analyse levels and trends in illegal trade, rather than the illegal killing of elephants. Thus as a monitoring mechanism for elephants under CITES, ETIS complements the focus of MIKE and holds a position equal to it.

Throughout their paper, the authors cite future operational and analytical links between MIKE and ETIS as an issue of considerable importance. If that is the case, then it is reasonable to question why the article contains no objective assessment of the status and results of ETIS to date. In fact, the achievements of ETIS are inexplicably and completely ignored in the article. The authors argue that more time is needed 'to collect baseline data on elephant populations, poaching and *illegal trade*'. But they fail to explain that ETIS has not only a baseline but also 14 years of time-series data in place. The two ETIS analyses submitted by TRAFFIC to the 12th meeting of the Conference of the Parties to CITES (CoP 12) were based on 7124 and 7817 elephant product seizure records spanning the period from 1989 to 2002 and involving data from 67 countries.

At CoP 12, analysis of the ETIS data identified the major countries involved in the illicit trade in ivory and clearly established the significance of large-scale unregulated ivory markets as the principal driver of illegal trade in ivory today. The same ETIS reports also produced a trends analysis, showing an increase in illicit trade in ivory since 1998. The analysis attributed the influence of China as a rapidly emerging ivory market as the sole reason for the increasing trend in illicit trade. While this result was somewhat controversial at the time, it has since been corroborated with the results of a recent study of East Asia's ivory trade by Esmond Martin and Daniel Stiles, who also concluded that China has emerged as East Asia's leading manufacturer of ivory products. The results of the ETIS analyses directly led to the adoption of Decision 12.39, which targeted 10 countries—Cameroon, China, Democratic Republic of the Congo, Djibouti, Ethiopia, Japan, Nigeria, Thailand, Uganda and the United States—for an assessment of their compliance with the provisions of Resolution Conf. 10.10 (Rev. CoP 12) concerning internal trade in ivory.

In sum, the ETIS reports to CoP 12 fulfilled all of the requirements of the CITES Parties outlined for the monitoring systems in Resolution Conf. 10.10 (Rev.). Further, the ETIS reports directly led to the adoption of a series of decisions that subject unregulated domestic ivory markets in Africa and Asia to an intercessional process under the direction of the CITES Standing Committee. ETIS is now fully and credibly established as the world's leading tool for monitoring illegal trade in elephant products, and the CITES Parties are proactively using the results of the ETIS analyses to engage problematic nations and to address illegal trade issues.

MIKE and ETIS links

The issue of links between ETIS and MIKE is important. The intention and commitment to link the two analyses has been expressed on numerous occasions, and there is nothing to suggest that this is not unfolding in an acceptable manner. Indeed, it has always been the

objective to achieve as much linkage as possible. The article by Hunter et al. in this issue of *Pachyderm* demonstrates some of the tangible ways that such links should and can evolve. But there are several levels through which this can occur, including data collection, the sharing of database components and data analysis. This can be illustrated with three examples.

In terms of data collection, if law-enforcement actions at a MIKE site leads to the seizure of ivory or other elephant products, this qualifies as a data point in both systems. A mechanism has been put in place to isolate ivory and elephant product seizures within the MIKE data collection process to ensure that all such records are reported to ETIS as well. It needs to be appreciated that such an occurrence is actually rather rare, but a cross-checking system is now in place to ensure that MIKE records become part of ETIS as appropriate.

As a comprehensive information system, MIKE will use key components of ETIS as appropriate. For example, subsidiary databases that hold background economic variables and information on domestic ivory markets are a jointly shared resource.

Finally, the issue of data analysis looms large as a future area of direct collaboration. At CoP 12, while ETIS produced a full analysis, MIKE had not developed to the extent that it could issue an analytical report. In the future, however, both systems will be producing analytical results and an integrated analysis will be attempted. At present, MIKE needs time to acquire sufficient data to be able to conduct such an analysis.

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NOTE FROM THE AFRICAN RHINO SPECIALIST GROUP

Update on the Black Rhino Range Expansion Project

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Much of the focus this year of the Black Rhino Range Expansion Project of the World Wide Fund for Nature and Ezemvelo KwaZulu-Natal Wildlife has been negotiating the legal and administrative requirements involved in transferring state assets—black rhinos—onto non-state property. The aim of the project is to increase land available for black rhino conservation, thus reducing pressure on existing reserves and providing new areas in which black rhino numbers can rapidly increase. This will be done by forming strategic partnerships with private and communal landowners on whose land founder populations of up to 20 black rhinos will be released. As the arrangements will be custodial, with Ezemvelo KwaZulu-Natal Wildlife retaining ownership of the founder population and half of the progeny, National Treasury has an interest in ensuring that these state assets are being dealt with in a responsible manner.

The project initially applied for exemption from National Treasury through the public–private partnership (PPP) process, but this was not granted. Thus we are now going through the full PPP process, which involves appointing a legal team to submit the application to National Treasury. We are working closely with National Treasury and should have the final stamp of approval for transferring black rhinos to the first project site within a few months. That means that the project will still be on track to release the first founder population this year.

The final selection of Site One has been delayed until the PPP process is completed, but potential candidates have been identified and assessed according to a number of criteria, the most important of which are the ecological carrying capacity for black rhinos and security prospects. The land must also be free of barriers to black rhino movement. To meet these requirements fences between neighbouring landholders will have to be dropped. Already potential site partners have done a great deal of work, and although the project has not yet committed itself to any specific site, it is good to see that many landholders in the province are prepared to consolidate their pieces of land into larger, more ecologically viable blocks.

BOOK REVIEW

The return of the unicorns: the natural history and conservation of the greater one-horned rhinoceros

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Columbia University Press, New York
ISBN 0 231 08450 1

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Dinerstein first went to Nepal in 1975 for a short study of tigers and their habitat and returned in 1984 to start four years of fieldwork on the rhinoceros in Royal Chitwan National Park. The data gathered during that period about the natural history and ecology of these fascinating animals constitute the main part of this book. The author returned annually to Nepal, working on large mammal conservation, and therefore has been able to supplement and update his original findings. This is a serious book full of essential information, and one that has but few rivals. Although the Indian rhinoceros (*Rhinoceros unicornis*), or the greater one-horned rhinoceros, as Dinerstein calls it to avoid the geographic epithet, has been studied in the field, both in Chitwan and in Kaziranga National Park in Assam, the results have often only been summarized. An earlier comprehensive field study of the rhinoceros in Nepal was undertaken by Andrew Laurie in the 1970s, and while his results are available in summary form, the main data are still found only in his unpublished dissertation (Laurie 1978, 1982). If only for that reason, Dinerstein's book should be consulted regularly.

At first glance, the book looks very attractive, with a colourful cover after a painting by Stuart Gentling and Nancy Ferguson. It has a foreword by George Schaller of the Wildlife Conservation Society, and all essential supplementary matter like a list of references and a comprehensive index. When I first continued to leaf through the book, without reading any of the text, I felt that Dinerstein has been poorly served by his publisher. The print quality of many photographs (all in black-and-white) is inadequate with essential subject matter hidden in the shadows. In many maps (like those on pages 248 and 250) the shades of grey are almost impossible to make out, perhaps because they were originally produced in colour, thereby obstructing a proper understanding.

The book is divided into three parts. The first part, on 'vanishing mammals, vanishing landscapes' is an overview of the world's rhino populations and the threats to their existence. Although it has all the necessary components and information, it shows that the book was ready for publication many years ago. For instance, Dinerstein (p. 16) gives the number of African rhinos in the wild in 1994, which could so easily have been actualized by reference to the status survey by Emslie and Brooks (1999). In case of the Asian rhinos, the author refers to the action plan of 1997 (Foose and Van Strien 1997), but in his table 1.1 (p. 24) with estimated numbers of *Rhinoceros unicornis*

in India, Nepal and Pakistan, the latest figures are for 1995.

The second part, which comprises 40% of the book (120 out of 316 pages), is the core of the book, the reason why it was written and the reason why many of us would want to buy it. Here we find the findings of Dinerstein's fieldwork, properly put in the right context and with discussion of their validity and significance. There is a chapter on the measurements and sexual dimorphism of the animals in the Chitwan population, with appropriate tables (and all methods are carefully explained in the appendices). This is followed by data on the characteristics of the population, including age structure, fecundity, mortality and genetic diversity. Another chapter tells us about the behaviour of the rhinoceros in its habitat with details on home range, movements, diet, activity patterns and thermoregulation.

During his field work, Dinerstein developed and tested the 'incisor-size hypothesis' which says that the size and condition of the tusks (upper incisors) in breeding-age male rhinos help to determine dominance, access to oestrous females and reproductive success. He also studied the effects of the rhinoceros on the ecosystem and the landscape in which they live by eating and dispersing certain fruits. These are complex issues, important to ecologists and conservationists alike, and they are treated with admirable clarity. Dinerstein guides us with ease through the various theories and data systems, and one does not need to be a professional scientist to follow his arguments.

Dinerstein really finds himself in the third part of the book, where he discusses how different projects and scenarios contribute to the long-term conservation of a large mammal like the Indian rhinoceros. It is obvious that he has immersed himself in the subject during the more recent years, and his explanations and summaries are clear and to the point. He discusses conservation strategies like relocation to industrialized nations, dehorning, rhinoceros farming and captive breeding, and dismisses these as viable options. He does give an alternative, a comprehensive strategy for the long-term viability of rhinoceros and other large mammals, which includes elements of conservation of large core areas, economic incentives, legislation and public awareness, anti-poaching information networks, identification of leaders and translocation of animals from one reserve to another. Not everybody will agree with him, debate will continue, and not all strategies are necessarily equally effective in every situation. Dinerstein presents us with the situation in Nepal, where his strategy has been effective to protect the rhinoceros in the wild where it properly belongs.

Dinerstein's book is a welcome contribution to the areas indicated in his subtitle: the natural history and conservation of the rhinoceros in Nepal. It is not too technical, concepts are clearly explained, and the data are presented neatly and comprehensively. The book should not be bought for the illustrations, but the text is well worth the price.

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NOTES FROM THE AFRICAN ELEPHANT SPECIALIST GROUP

Report: Sixth meeting of the African Elephant Specialist Group

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AfESG held its sixth meeting for members from 4 to 8 December 2003 in Mokuti Lodge, next to the world-famous Etosha National Park in Namibia. In addition to participation of most of the AfESG members, the meeting was attended by Mr Martin Brasher, director of the Global Division of UK-Department for Environment Food and Rural Affairs, and Dr Malan Lindeque, the permanent secretary for Namibia's Ministry of Environment and Tourism and former AfESG member, both of whom actively participated throughout.

The tightly packed agenda consisted of technical presentations and work sessions on a variety of issues relating to African elephant conservation and management. The main themes are summarized here.

Multiple species of African elephant

The growing evidence that there might be more than one species of African elephant and the possible conservation and management implications of such a finding had been exhaustively discussed at the 2002 AfESG members meeting in Shaba, Kenya (see *Pachyderm* issue 32, January–June 2002, p. 74–77). As a result of these discussions, the group issued a statement in February 2002 cautioning against prematurely allocating Africa's elephants to two or more species, which could result in significant populations being left in taxonomic limbo because of the uncertain status of elephants in West Africa, and because some populations of high conservation value might consist wholly or partly of interspecific hybrids under a multiple-species scenario.

This issue was revisited at the December 2003 meeting, where members were presented with results of the most recent genetic and morphological studies on the taxonomic status of African elephants. After much discussion, the group agreed that more studies were still needed before AfESG could formally accept the taxonomic division of the African elephant into multiple species. However, the importance of morphological as well as genetic evidence was noted and the list of sites recommended for further sampling was expanded to include Dzanga-Sangha (Central African Republic), Noubalé-Ndoki (Congo Brazzaville), Minkébé (Gabon) and Gourma (Mali). The 2002 statement on multiple species was revised accordingly and is now available on the AfESG website: http://iucn.org/afesg.

Listing of the African elephant by IUCN Red List criteria

At its 2002 meeting, AfESG agreed to become the IUCN Red List listing authority on the African elephant and to carry out the global assessment for the listing of *Loxodonta africana*. The 2003 members meeting provided an ideal opportunity to move this initiative forward with the help of experts from various parts of the continent. After a brief discussion of the listing process, a temporary task force was established under the leadership of David Balfour to carry out a rough-and-ready assessment using the revised IUCN Red List criteria, version 3.1. This task force,

which included representation from all four subregions, worked in the evenings after the close of the official meeting sessions. The findings they presented to the plenary on the last day of the meeting are as follows.

The Red-Listing process requires that the population change be estimated within a 'moving window' of three generations or 10 years, whichever is longer. A generation time of 25 years was chosen for the African elephant. This figure, which represents the average age of breeding females, is based on data from Kruger National Park in South Africa. The moving window approach permits projecting likely population changes into the future, but it was felt that such a projection would be too speculative in the present circumstances. Instead, the alternative of going three generations (75 years) back in time was settled on. However, as figures for the late 1920s are unavailable, and since elephant populations in southern and eastern Africa, which today harbour the largest known populations in the continent, are believed to have been lower in the early 20th century than in the 1970s, it was deemed more precautionary to assume the continental population of three generations ago to have been equal to that of one generation ago. Thus figures from the *African ele-phant status report 2002* (Blanc et al. 2003) and the *African elephant action plan* (Douglas-Hamilton 1979) were used for national, regional and continental comparisons. This produced a *Vulnerable* listing for the species. It was agreed that after checking through the data used in this assessment the AfESG Secretariat would submit the official listing to the IUCN Red List Committee for review and consideration together with relevant supporting documentation.

Furthermore, it was agreed that AfESG would continue, through its internal processes, to work on subregional listings to bring them into the strategic planning processes under way in the subregions.

Wild sourcing of African elephants for captivity

Recently there has been an increase in the number of captures of African elephants from the wild for a wide variety of purposes including zoos and elephant-back safaris. While in many countries it is considered perfectly legal to export and import African elephants (even from Appendix I populations) to captive facilities, it is much less clear whether an argument can be made that such moves truly contribute to the conservation of the species overall. Faced with increasing transfers of elephants from the wild into captivity (some supposedly justify-

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Participants attending the African Elephant Specialist Group meeting at Mokuti Lodge in Namibia, December 2003.

ing the transfer as contributing to efforts to conserve the species), it was deemed essential that AfESG make its position on captive use clear. This was considered particularly important in light of the fact that the group's 1998 statement on the role of captive facilities had focused exclusively on zoos and zoological parks.

After hearing presentations on recent case studies of elephant captures, the group concluded that captive use presented no direct benefit to in situ conservation and that AfESG could not endorse removing African elephants from the wild for any captive use. A statement to this effect was drafted and has now been placed on the AfESG website.

Strategic thinking to conserve Africa's elephants: a scenario-planning approach

At the fifth members meeting in 2002, it was suggested that AfESG consider developing a continental strategy for conserving and managing Africa's elephants. Subsequently, the AfESG Chair consulted widely about the best way to take this initiative forward. Ideally, a continental elephant strategy would take into account not only current threats and opportunities for the continent's elephants but also consider future developments that might affect them. As a result of these consultations, an innovative planning approach known as scenario planning was identified as a promising way forward. Scenario planning is a tool for strategizing in a world of uncertainty with perhaps increasing but unknown risks along the way. It has been used for almost three decades by multinational companies such as Shell International. Taking advantage of the opportunity provided by the meeting in Namibia, members decided to devote the fourth day to applying this approach to African elephants.

Developing scenarios for African elephants involves identifying the forces that will influence their future. These include economic issues (for example, changing prices and availability of fossil fuels; the effect of corruption), social dynamics (including demographic issues and the spread of HIV/AIDS), political issues (how is the status of African elephants likely to respond to a greater degree of local democracy? or greater centralization? more civil instability?), technological issues (including transport and communications), and environmental issues (climate change, habitat loss and fragmentation, changes in fire regimes). By enabling African elephant managers to consider different forces and how they might shape future developments on the continent, new threats, risks and opportunities become apparent, leading to better strategies for decision-making. Such scenarios can also help managers determine priorities for research and monitoring, including identifying gaps in our current knowledge and information needs for the future.

To start the scenario-planning process, meeting participants were divided into subregional groupings and each group was given the task of developing a historical time line for its subregion, highlighting events of the past that have had a direct bearing (positive or negative) on the status of Africa's elephants. Each group was also asked to identify, describe and prioritize the critical issues and forces that are likely to shape the future of African elephants and to outline the characteristics of pessimistic and optimistic future scenarios for elephants in its subregion. The results of these group sessions were presented to the plenary.

This exercise proved highly stimulating and provided a fascinating picture of the past and future for elephants in the different subregions. It also identified some of the key players from different walks of life that were likely to have an effect on African elephants in the future. As a next step in this process, information from the group exercise will be used to develop a fund-raising proposal to organize a series of workshops in the various subregions involving all relevant parties, including the private sector, that are likely to have a stake in the future of Africa's elephants or to affect their future conservation and management. The final subregional scenarios will be combined to form a strategy for the future.

The Local Overpopulation Task Force

Although several options exist for managing local overpopulation of elephants, the practical application and comparative costs and benefits of each are not widely known or understood by many management authorities because active elephant management has not taken place in most range states for a decade or more. As a result, poor management decisions are often undertaken that end up both harming biodiversity conservation objectives and reducing the potential for generating local benefits.

In response to calls by individual AfESG members that more needed to be done to address this issue, the group agreed that a special task force be established to produce a technical document on best practices, outlining the pros and cons of various management options. This task force will compile and synthesize existing information into a concise document for wide dissemination to relevant practitioners and decision-makers. The task force planned to begin its work by the end of May 2004.

In addition to the main themes of the meeting, latest results of cutting-edge research into a wide variety of topics were presented including human–elephant conflict, illegal killing and trade, and elephant survey techniques. Several of the presenters have submitted papers to *Pachyderm*, some of which appear in this issue.

Overall, the meeting was highly productive, and in spite of the few unavoidable logistical hiccups, it was conducted relatively free of glitches—a considerable feat given that most members had to spend several days in transit to and from their home bases. As always, the timing and venue of the next members meeting will depend on availability of funds but likely will not be held before the end of 2005, following re-appointment of the membership for the next IUCN quadrennium.

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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 dissemination of information concerning the activities of the African Elephant, the African Rhino, and the Asian Rhino Specialist Groups of the IUCN Species Survival Commission (SSC).

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Papers may be reports of original biology research or they may focus more on the socio-economic aspects of conservation, including market surveys.

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Journal conventions

Nomenclature

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

Use an 's' for the plural form for animals: rhinos, elephants.

Spelling

Use British spelling, following the latest (10th) edition of the *Concise Oxford Dictionary*, using 'z' instead of 's' in words like 'recognize', 'organization', 'immobilized'; but 'analyse', 'paralyse'.

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Use SI units for measurement (m, km, g, ha, h) with a space between the numeral and the unit of measurement. Give measurements in figures, for example 12 mm, 1 km, 3 ha, except at the beginning of a sentence.

Spell out numbers under 10 if not a unit of measurement unless the number is part of a series containing numbers 10 or over, for example: 14 adult males, 23 adult females and 3 juveniles.

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

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

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

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Government reports, reports to wildlife departments, MSc theses, PhD theses, etc. are to be noted as unpublished.

Not accepted as references are papers in preparation or submitted but not yet accepted.

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