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Cover: Square-lipped rhinoceros (*Ceratotherium simum*), Moremi, Botswana. 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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Meetings

In addition to attending the 13th Meeting of the Conference of the Parties to CITES in October, where African elephant issues still topped the agenda, the past six months have been action packed. At the request of African Elephant Specialist Group (AfESG) member Dr Marion Garaï, and after a year of careful planning, I was able to attend the annual general meeting of South Africa's Elephant Management and Owners Association, delivering a keynote address to a full house at Pilanesberg National Park. This meeting was followed by a second national-level elephant debate hosted by South African National Parks in Kruger National Park.

These were fascinating meetings with an excellent array of talks by students, researchers and managers covering the gamut of challenges facing elephants across the country, some controversial management approaches, and some impressive contemporary conservation initiatives. Of particular interest were the unique ethical and ecological issues raised by the country's practice of private ownership of African elephants. These elephants, some held on surprisingly small properties and increasing through both natural growth and additional translocations, are rapidly outgrowing their limited habitats. Advances in the use of immunocontraception for such populations and AfESG's policy on the sourcing of elephants from the wild for captive purposes were particularly topical, as more elephants than ever before are being captured in South Africa for the growing elephant-back safari business. Our new translocation guidelines were warmly received in the light

Réunions

Les six derniers mois ont été très extrêmement actifs même sans compter la 13ème Réunion de la Conférence des Parties à la CITES, en octobre, quand les questions relatives aux éléphants ont occupé une fois de plus une grande partie de l'agenda. A la demande du Dr Marion Garaï, qui est membre du Groupe des Spécialistes des Eléphants d'Afrique (GSEAf), et après une année de planification attentive, j'ai pu assister au Parc National de Pilanesberg à la réunion générale annuelle de la S*outh Africa's Elephant Management and Owners Association* et y faire une communication-programme devant une salle pleine. Cette réunion fut suivie d'un second débat de niveau national sur les éléphants, accueilli par les Parcs Nationaux Sud-africains au Parc National Kruger.

Ce furent des réunions fascinantes, avec une excellente suite de communications d'étudiants, de chercheurs et de gestionnaires couvrant toute la gamme de challenges touchant les éléphants dans tout le pays, certaines approches de gestions contestables, ainsi que certaines initiatives contemporaines impressionnantes en matière de conservation. Particulièrement intéressantes furent les questions éthiques et écologiques uniques que soulève la pratique nationale de la possession d'éléphants africains par des personnes privées. Ces éléphants, dont certains vivent dans des propriétés étonnamment petites et dont le nombre augmente aussi bien du fait de la croissance naturelle que par l'adjonction de nouveaux individus, dépassent rapidement les capacités de leurs habitats

of many planned movements. Gaining new insights and meeting new people provided me an excellent opportunity to update myself on the situation in this dynamic range state.

The African Elephant Database

With the African Elephant Status Report 2002 out of the way, African Elephant Database (AED) manager Julian Blanc has focused his efforts on documenting the AED and further developing it into a more consistent, self-contained resource. Many improvements have been implemented to ensure that the AED update cycle can continue smoothly and to ensure that even if AED activities have to be temporarily suspended due to lack of funds, the programme can be reinitiated easily as soon as the opportunity arises.

Activities in this period have also included the planning and preparation of a meeting of the Data Review Working Group to discuss these and other AED matters. In November 2004 Julian accompanies me to the IUCN World Conservation Congress in Bangkok, where we have been offered a unique opportunity to showcase the achievements and share lessons learned from the AED as one of the flagship products of the IUCN SSC. Work also continues on preparing a scientific paper analysing changes in comparable elephant populations between the 1998 AED and the 2002 status report, which we plan to publish in a future issue of *Pachyderm.*

Preparations for the next edition of the African Elephant Status Report are also under way with the collection of an ever-growing pile of survey reports, range information and other relevant data. A considerable number of new surveys have been conducted recently in southern, central and West Africa, and I am pleased to report that an increasing proportion of these originate from coordinated surveys across national boundaries.

Update on elephant conservation and management strategies

During this period, there have been a number of encouraging developments in the field of strategic planning. In July, Leo Niskanen and Julian Blanc joined me and representatives from the wildlife management authorities of most Southern African Development Community (SADC) countries to attend the African Wildlife Consultative Forum meeting in Sun City,

restreints. Les avances dans l'utilisation de l'immunocontraception dans ces populations et la politique du GSEAf en matière de traçage des éléphants prélevés dans la nature pour être mis en captivité étaient particulièrement d'actualité du fait que de plus en plus d'éléphants sont capturés en Afrique du Sud pour servir à l'industrie du safari à dos d'éléphant. Nos nouvelles directives sur les translocations ont reçu un accueil chaleureux étant donné les nombreux déplacements prévus. Grâce à de nouveaux éclaircissements et à des rencontres avec de nouvelles personnes, j'ai eu une bonne occasion de remettre à jour mes connaissances sur la situation dans ce si dynamique état de l'aire de répartition.

La Base de Données sur l'Eléphant Africain

Le Rapport 2002 sur le Statut de l'Eléphant Africain étant terminé, le responsable de la Base de Données sur l'Eléphant Africain (BDEA), Julian Blanc, a concentré ses efforts sur le rassemblement de documents pour la BDEA et sur le développement de celle-ci en une ressource plus cohérente et plus indépendante. Il y a eu de nombreuses améliorations pour s'assurer que le cycle de mise à jour de la BDEA se passe en douceur et que, même si les activités de la BDEA devaient être suspendues temporairement par manque de fonds, le programme puisse être relancé facilement dès que l'occasion se présente.

Dans les activités de cette période, il faut aussi compter le planning et la préparation d'une réunion du Groupe de Travail chargé de la Révision des Données pour discuter de celles-ci et aussi d'autres matières les concernant. En novembre 2004, Julian m'accompagne au Congrès Mondial de la Conservation de l'UICN, qui se tient à Bangkok, où nous avons une occasion unique de présenter les réalisations et de partager les leçons tirées de la BDEA, qui est un des produits phares de la CSE/UICN. L'on continue aussi à préparer un article scientifique qui analyse les changements qui ont touché des populations d'éléphants comparables entre la BDEA de 1998 et le rapport sur le statut de 2002, rapport que nous prévoyons de publier dans un des prochains numéros de *Pachyderm*.

Les préparatifs de la prochaine édition du Rapport sur le Statut de l'Eléphant Africain sont engagés, avec la collecte d'une pile toujours plus haute de rapports d'études, d'informations locales et de toutes

South Africa. At the meeting the range states unanimously endorsed a plan to develop a subregional elephant conservation strategy for southern Africa and requested AfESG and the IUCN/SSC Southern African Sustainable Use Specialist Group to provide technical input to the strategy while the IUCN regional office for southern Africa was invited to play an overall coordination and facilitation role. The process is now in the hands of Zimbabwe's Department of Wildlife and National Parks, which heads the task force mandated to secure formal SADC buy-in to the strategy. As soon as this approval has been granted, a meeting of the directors of wildlife will be organized to hammer out a detailed work plan and to begin fleshing out the strategic framework.

In West Africa useful comments have been received from the range states and incorporated into an updated West African Elephant Conservation Strategy (WAECS), which forms the central operational component of a draft intergovernmental memorandum of understanding among West African states on conserving elephants in the subregion. The memorandum, which is being developed under the aegis of the Convention on Migratory Species of Wild Animals (Bonn Convention), will be presented for signature at the ministerial level and is expected to provide an added boost to implementing the activities outlined in the WAECS.

During the period from April to August, Lamine Sebogo, the AfESG programme officer for West Africa, visited Guinea Bissau, Liberia and Sierra Leone to promote the adoption and implementation of the WAECS. All three range states gave their wholehearted support to the strategy and affirmed their commitment to helping implement it. The three range states also expressed a desire to develop national elephant conservation strategies and management plans for their respective elephant populations. However, owing to prolonged civil strife in these countries the status of elephant populations remains unclear. Therefore, when hostilities cease, an immediate priority for all three countries will be to seek funding to conduct comprehensive elephant censuses to get a better understanding of current numbers and distribution. AfESG will support these efforts by providing technical assistance on proposal development to assist the range state management authorities in their approach to donor agencies. During Lamine's visits, requests were also made to help provide training in HEC mitigation and other elephant conservation and management.

autres données intéressantes. On a réalisé récemment un nombre considérable de nouvelles études en Afrique australe, centrale et occidentale, et j'ai le plaisir de signaler qu'une proportion toujours plus grande de celles-ci sont des études faites en coordination transfrontalière.

Mise à jour des stratégies en matière de conservation et de gestion des éléphants

Pendant cette période, nous avons observé un certain nombre de développements encourageants dans le domaine de la planification stratégique. En juillet, Léo Niskanen et Julian Blanc se sont joints à moi et à des représentants des autorités de gestion de la faune sauvage de la plupart des pays de la *Southern African Development Community* (SADC) pour assister à la réunion du Forum Consultatif de la Faune sauvage Africaine à Sun City, en Afrique du Sud. Lors de cette réunion, les Etats de l'aire de répartition ont accepté unanimement un plan pour développer en Afrique australe une stratégie sous-régionale de conservation des éléphants et ils ont demandé au GSEAf et au Groupe sud-africain des Spécialistes de l'Utilisation Durable de la CSE/UICN de leur fournir un input technique pour cette stratégie, tandis que le Bureau régional de l'UICN pour l'Afrique australe était invité à jouer un rôle de coordination générale et de facilitation. Le processus est maintenant dans les mains du Département de la Faune sauvage et des Parcs nationaux du Zimbabwe, qui dirige l'équipe chargée d'assurer l'adhésion de la SADC à la stratégie. Dès que cette approbation sera acquise, une réunion des directeurs de la faune sauvage sera organisée pour élaborer un plan de travail détaillé et pour commencer à matérialiser le cadre stratégique.

Nous avons reçu des commentaires très utiles des Etats ouest-africains de l'aire de répartition et nous les avons intégrés dans une nouvelle Stratégie de Conservation des Eléphants Ouest-africains (SCEOA) qui constitue la composante centrale d'un projet de protocole d'accord entre les pays ouest-africains sur la conservation des éléphants dans la sous-région. Le protocole, qui est mis au point sous l'égide de la Convention sur les Espèces migratrices appartenant à la faune sauvage (Convention de Bonn), sera présenté pour signature au niveau ministériel et on s'attend à ce qu'il donne un élan supplémentaire aux activités soulignées dans la SCEOA.

ment activities. While every effort will be made to respond to these requests, such activities will have to take place within the limits set by our current funding constraints and the already heavy demand on our network of voluntary experts.

Kenya has recently joined the growing list of countries forging ahead with national elephant strategies and management plans. In August, a funding proposal for developing a National Elephant Conservation Strategy for Kenya was finalized with technical guidance from AfESG. Kenya Wildlife Service is currently approaching various donors for support to develop this strategy.

Other countries that have made significant headway with a national elephant strategy include Niger, which held a successful stakeholder planning workshop in July, and Benin and Guinea Conakry, which are scheduled to hold their national planning exercises before the end of 2004. Mali and Nigeria are busy raising funds to support their work in developing a national strategy.

Human–elephant conflict

Update on AfESG's site-based HEC project

In 2002 WWF International's African Elephant Programme (AEP) awarded AfESG a grant to establish human–elephant conflict monitoring activities at selected sites in Africa. The long-term objective was to improve our understanding of HEC, to design more effective mitigation strategies, and to build local management capability. Some of these achievements to date are exciting.

In the Selous in Tanzania, 12 months of HEC data have now been collected. These data will be analysed and the results presented in a paper to be published in a future issue of *Pachyderm*. It is hoped that more funding can be made available to continue data collection at this site, which is necessary to make management recommendations.

Since 2003, when AfESG conducted a HEC training workshop in South Luangwa, Zambia, some 200 HEC incidents have been documented. It is expected that within three conflict seasons, sufficient data will be available to help guide management action at this site. Plans to test chilli-based deterrent methods in South Luangwa are also being discussed.

In Tarangire in Tanzania, an elephant-enumerator training workshop was carried out in late 2002. Since

Pendant cette période, d'avril à août, Lamine Sebogo, le responsable du programme du GSEAf en Afrique de l'Ouest, a visité la Guinée Bissau, le Liberia et la Sierra Leone pour promouvoir l'adoption et la réalisation de la SCEOA. Ces trois Etats de l'aire de répartition ont donné leur support enthousiaste à la stratégie et ont affirmé leur engagement à aider à sa réalisation. Les trois Etats ont aussi exprimé le souhait de développer des stratégies nationales de conservation et des plans de gestion des éléphants pour leurs populations respectives. Cependant, en raison des luttes civiles prolongées dans ces pays, le statut des populations d'éléphants y reste incertain. C'est pourquoi, dès que les hostilités cesseront, ces pays devront en priorité demander un financement pour faire des recensements complets, afin d'avoir une idée plus correcte du nombre réel et de la distribution des éléphants. Le GSEAf soutiendra ces efforts en fournissant une assistance technique pour le développement de la proposition, afin d'aider les autorités de gestion des Etats de l'aire de répartition dans leur approche des organismes donateurs. Pendant les visites de Lamine, il y eut aussi des demandes d'aide pour une formation en mitigation des CHE et dans d'autres activités de conservation et de gestion des éléphants. Nous ferons certes tout ce qui est possible pour répondre à ces demandes, mais ces activités devront s'inscrire dans les limites imposées par nos propres contraintes financières et par la demande déjà forte sur notre réseau d'experts bénévoles.

Le Kenya a récemment rejoint la liste déjà longue des pays qui prennent l'avance dans les stratégies nationales pour les éléphants et pour les plans de gestion. En août, une proposition de financement pour le dévelop-pement d'une Stratégie Nationale de Conservation des Eléphants pour le Kenya a été finalisée avec l'aide technique du GSEAf. Le *Kenya Wildlife Service* est occupé à contacter divers donateurs pour obtenir un soutien pour le développement de cette stratégie.

D'autres pays ont déjà fait des progrès significatifs dans leur stratégie nationale pour les éléphants, dont le Niger qui a tenu un atelier de planification très réussi en juillet, et le Bénin et la Guinée Conakry, qui prévoient de faire leurs exercices nationaux de planification avant la fin de 2004. Le Mali et le Nigeria sont occupés à récolter des fonds pour supporter le développement d'une stratégie nationale.

then a conflict resolution committee has been established, responsible for making decisions on issues relating to HEC in the area and with representation from the local communities and the wildlife authority. Subsequently, local people have been hired to patrol the fields at night, using firecrackers to scare away elephants. Local enumerators have conducted 258 interviews with local villagers to understand their perceptions of the extent of elephant damage and what they thought should be done to tackle it. These data on perceptions should provide a useful comparison with actual figures of elephant damage later measured by the enumerators. Four experimental and four control plots have also been established to test the effectiveness of a variety of deterrent techniques including string fences, cowbells and chilli-dung briquettes.

However, progress has been slow in other sites, primarily because of workforce limitations and resources for carrying out the required monitoring activities on site. These problems were discussed at a meeting of the AfESG's Human–Elephant Conflict Working Group (HECWG), which took place in Nairobi in June 2004. At this meeting it was decided that it was necessary to modify the original project to better deliver the project's HEC mitigation objectives. New planned activities include developing an AfESG-certified HEC training curriculum and training modules, which will be made available in both English and French, and closer collaboration with the CITES MIKE programme on collecting HEC data at MIKE sites. These activities will be designed to complement the ongoing successful monitoring in the Selous, Tarangire and South Luangwa sites, and they are expected to make an important contribution to building capacity for HEC management. A new proposal outlining these activities and their budgetary implications is under preparation.

Developing models for HEC management

In addition to useful refocusing of the site-based project, the June meeting also provided an opportunity for HECWG to reflect on AfESG's future work on HEC. One of the key lessons learned from work that HECWG has carried out in the last seven years is that for site-based HEC mitigation efforts to be effective they need to be supported by appropriate national policies and legislative measures.

To date, efforts to tackle HEC have focused mainly

Conflits hommes–éléphants

Mise à jour du projet CHE du GSEAf sur site

En 2002, le Programme international du WWF pour l'Eléphant Africain (PEA) a attribué au GSEAf une subvention pour réaliser des activités de surveillance continue des conflits hommes–éléphants (CHE) à certains endroits sélectionnés d'Afrique. L'objectif à long terme était d'améliorer notre appréhension des CHE, de concevoir des stratégies de mitigation plus efficaces et de construire des capacités de gestion locales. Certaines de ces réalisations sont excitantes.

Dans le Selous, en Tanzanie, on a maintenant récolté 12 mois de données sur les CHE. Elles seront analysées et les résultats seront présentés dans un article qui sera publié dans un prochain numéro de *Pachyderm*. On espère que de nouveaux fonds seront disponibles pour poursuivre la récolte de données à cet endroit, car elles seront nécessaires pour faire des recommandations pour la gestion.

Depuis 2003, quand le GSEAf a dirigé un atelier de formation sur les CHE au Luangwa Sud, en Zambie, on a enregistré quelque 200 incidents CHE. On s'attend à ce qu'en trois saisons de conflits, suffisamment de données soient disponibles pour aider à orienter les activités de gestion à cet endroit. On discute aussi des programmes destinés à tester à Luangwa sud les méthodes de dissuasion à base de piment.

A Tarangire, en Tanzanie, a eu lieu fin 2002 un atelier de formation au dénombrement des éléphants. Depuis lors, un comité de résolution des conflits a été créé ; il est chargé de prendre des décisions dans les questions relatives aux CHE dans la région, avec des représentations des communautés locales et des autorités de la faune sauvage. Suite à cela, des gens ont été engagés sur place pour patrouiller dans les champs pendant la nuit, en se servant de pétards pour disperser les éléphants. Les personnes chargées des dénombrements ont réalisé 258 interviews de villageois afin de comprendre comment les villageois percevaient l'étendue des dommages dus aux éléphants et ce qu'ils pensaient qu'il fallait faire pour y faire face. Ces données sur la perception des dommages devraient permettre une comparaison très utile avec les chiffres réels des dégâts qui ont ensuite été mesurés par les personnes chargées des dénombrements. Quatre plots expérimentaux et quatre plots de contrôle ont été créés pour tester l'efficacité de toute une variété de techniques de dissuasion, y compris

on short-term, field-based mitigation measures. Despite a few successes at individual sites, these efforts have not always been applied as an integrated package and therefore have not been able to provide a lasting solution to this widespread problem. This is because, while deterrent methods to reduce elephant damage are an important component of an overall HEC management strategy, they deal only with the immediate symptoms of the problem and not the root causes such as incompatible land-use practices, rural poverty, lack of land tenure, and lack of ownership rights to wildlife.

Addressing such underlying causes is not only necessary to reduce the damage caused by HEC in the long term, but it also offers great potential for developing strategies that maximize benefits and minimize costs of elephants to local communities. Effective long-term management of HEC therefore needs to take a more holistic approach that involves a much more diverse set of participants at all levels—from the affected community up to the relevant policymakers at local, district and national government levels. Appropriate action at each of these levels is necessary and must be coordinated to ameliorate HEC.

Against this background HECWG decided that the group's long-term goal should be to develop national HEC management systems that would address the numerous technical, institutional, sociopolitical and economic issues that must be tackled at all levels from the site up to the national level and back again. Such systems would first be tested and developed in a few pilot countries and the lessons learned documented in a manual of best practices for HEC management. This could then serve as a basis for developing successful HEC management models throughout the range of the African elephant. Furthermore, such model approaches could have wider application. The models could serve in different geographic regions, especially in the Asian elephant range states where HEC poses a serious threat to the long-term survival of elephants. And the models could be used by groups who are grappling with human–wildlife conflict issues with other species.

Subsequent to the HECWG meeting, the idea of developing HEC management models was discussed with potential donors including the United Nations Development Programme Global Environmental Facility, who invited AfESG to submit a concept note for their consideration. This has since been submitted.

des barrières de corde, des cloches de vaches et des briquettes composées d'excréments et de piment.

Cependant, les progrès ont été lents à d'autres endroits, d'abord en raison du manque de personnel et de ressources pour mener à bien les activités de surveillance sur place. Ces problèmes ont été discutés lors d'une réunion du Groupe de Travail sur les Conflits Hommes–Eléphants (GTCHE) du GSEAf, qui a eu lieu à Nairobi en juin 2004. Lors de cette réunion, il a été jugé nécessaire de modifier le projet original pour mieux atteindre les objectifs du projet en matière de mitigation des CHE. Les nouvelles activités planifiées comprennent le développement d'un programme de cours et de modules de formation aux CHE certifiés par le GSEAf, qui seront disponibles en anglais et en français, et une plus étroite collaboration avec le programme MIKE de la CITES, pour récolter des données sur les CHE sur les sites MIKE. Ces activités seront conçues de façon à compléter la surveillance continue qui rencontre beaucoup de succès dans le Selous, à Tarangire et à Luangwa Sud et elles devraient constituer une contribution importante à l'élaboration des capacités pour la gestion des CHE. Une nouvelle proposition soulignant ces activités et leurs implications au plan financier est en préparation.

Développer des modèles pour la gestion des CHE

Après avoir utilement recentré le projet au niveau du site, la réunion de juin a aussi fourni au GTCHE l'occasion de réfléchir au travail futur du GSEAf sur les CHE. Une des leçons clés apprises grâce au travail que le GTCHE a réalisé pendant les sept dernières années est que, pour que les efforts de mitigation des CHE sur site soient efficaces, il faut qu'ils soient soutenus par des politiques nationales et des mesures juridiques appropriées.

A ce jour, les efforts pour résoudre les CHE se sont principalement concentrés sur des mesures de mitigation à court terme, au niveau des sites. Malgré certains succès à certains endroits, ces efforts n'ont pas toujours été appliqués comme un « package » intégré et c'est pourquoi ils n'ont pas réussi à apporter une solution durable à ce problème très répandu. En effet, même si les méthodes dissuasives pour réduire les dommages causés par les éléphants sont une composante importante d'une stratégie globale de gestion des CHE, elles ne font que traiter des symptômes immédiats du problème et ne s'attaquent

Update on the CITES MIKE programme

The 13th Conference of the Parties to CITES provided an opportunity to take stock of MIKE and where the programme has reached. By the 12th Conference of the Parties to CITES (CoP 12) in Santiago in November, the MIKE programme was up and running in Africa and starting in Asia, with progress made primarily in its operational aspects. There was as yet no ability to report on illegal killing data, let alone trends at that time.

Today MIKE implementation is progressing smoothly in all the six subregions and the programme is beginning to flag emerging patterns in illegal killing. With the help of a recently developed operational computer database linked to GIS capability and adapted for Asia and Africa, a preliminary analysis of the mortality data gathered to date has been carried out. These data indicate active poaching in central Africa, which may to a great extent be fuelled by the unregulated domestic ivory markets in Africa and Asia as corroborated by MIKE's sister programme, the Elephant Trade Information System (ETIS), and other related work.

New additions to the AfESG Web site

The Portuguese versions of AfESG's Decision Support System for Managing Human–Elephant Conflict Situations in Africa, the Human–Elephant Conflict Data Collection and Analysis Protocol, and the Training Package for Enumerators of Elephant Damage have been added to the growing list of useful resources hosted on the AfESG Web site: http://iucn.org/afesg. Hard copies of all three documents will be distributed to relevant practitioners in Portuguese-speaking range states by the end of this year. Also added are the digital version of *Pachyderm* 36, an overview of lessons learned to date from the work of AfESG's Human–Elephant Conflict Working Group, and a link to the comprehensive new glossary of elephant terms, recently compiled by Philip Kahl and Charles Santiapillai.

Small Grants Fund

The last round of applications submitted for consideration for funding from the European Commission-financed Small Grants Fund, which expired on 30

pas aux racines telles que des pratiques incompatibles d'utilisation des terres, la pauvreté rurale, le manque de contrats de propriété terrienne et le manque de droits de propriété de la faune sauvage.

S'attaquer à ces causes sous-jacentes n'est pas seulement nécessaire mais offre de grandes possibilités de développer des stratégies qui maximisent les avantages et minimisent le coût des éléphants pour les communautés locales. C'est pourquoi une gestion effective, à long terme, des CHE doit adopter une approche plus globale, qui implique un ensemble plus divers de participants à tous les niveaux—de la communauté touchée aux décideurs politiques concernés au niveau du gouvernement local, celui du district et le national. Des actions appropriées sont nécessaires à chacun de ces niveaux et elles doivent être coordonnées pour améliorer la gestion des CHE.

C'est la raison pour laquelle le GTCHE a décidé que l'objectif du groupe à long terme devrait être de développer des systèmes nationaux de gestion des CHE qui traiteraient les nombreuses questions techniques, institutionnelles, socio-politiques et économiques, qui devraient être abordées à tous les niveaux, du site jusqu'au national et inversement. De tels systèmes devraient d'abord être testés et mis au point dans quelques pays pilotes, et les leçons apprises seraient reprises dans un manuel des meilleures pratiques pour la gestion des CHE. Elles pourraient ainsi servir de base pour développer de bons modèles de gestion des CHE dans toute l'aire de répartition des éléphants africains. De telles approches modèles pourraient encore avoir des applications plus larges. Elles pourraient servir dans différentes régions géographiques, spécialement dans les Etats de l'aire de répartition de l'éléphant d'Asie où les CHE posent de sérieuses menaces sur la survie à long terme des éléphants. Ils pourraient encore servir aux groupes qui sont confrontés à des conflits hommes–faune sauvage qui impliquent d'autres espèces.

Suite à la réunion du GTCHE, l'idée de développer des modèles de gestion des CHE a été discutée avec des donateurs potentiels, y compris le Fonds Mondial pour l'Environnement du Programme des Nations Unies pour le Développement, qui a invité le GSEAf à soumettre une note à leur attention. Ce qui fut fait.

Mise à jour du programme MIKE de la CITES

La 13ème Conférence des Parties à la CITES a donné l'occasion de faire le point sur MIKE et de voir où en

November 2004, has led to four new projects: a study of elephants in the Mt Kilimanjaro ecosystem in Tanzania, an elephant census and habitat study in Gorongosa National Park in Mozambique, a study on using bees as a deterrent against crop raiding, and translation of the MIKE aerial survey standards from English into French and Portuguese. Reports on the outcomes of these studies and other Small Grant projects still pending completion will appear in future issues of *Pachyderm*. In total, 22 projects in 13 range states were funded from the AfESG's Small Grants Fund in the 2000–2004 period.

Evaluation of AfESG's activities since 2000

Since 2000 AfESG has been supported by a substantial core grant from the European Commission. One of the conditions of this grant, which expired on 30 November 2004, is that the project be independently evaluated to determine the extent to which it has achieved its objectives. Following official EC guidelines, detailed terms of reference for the evaluation were drafted by the AfESG Secretariat with valuable guidance from Nancy MacPherson, coordinator for monitoring and evaluation at IUCN headquarters. In April the EC approved these terms of reference and selected a two-man team comprising Dr Stephen Turner and Dr Jean Pierre d'Huart to carry out the evaluation.

In early September, Dr Turner visited the AfESG Secretariat in Nairobi to interview staff. A number of AfESG members, relevant staff in IUCN regional offices and the species programme in Gland as well as donors and key partner organizations in all four subregions were also contacted by email or phone to give their impressions on AfESG performance during 2000 to 2004. The team also circulated a questionnaire to help gather further information.

The conclusions and recommendations from this evaluation were very positive. In particular, AfESG's work in synthesizing, improving and disseminating information on the conservation and status of African elephants, providing cutting-edge technical advice, and catalysing conservation action were highlighted as some areas of major achievement in the last four years. The EC and other donors were encouraged to provide further support for the core costs of the group and its activities.

est le programme. Lors de la 12ème Conférence des Parties (CoP 12) à Santiago en novembre 2002, le programme MIKE avait démarré en Afrique et il commençait en Asie, les progrès s'observant d'abord dans ses aspects opérationnels. Il n'était pas encore possible de faire rapport de massacres illégaux, sans penser même à des tendances à ce moment-là.

Aujourd'hui, la réalisation de MIKE progresse en douceur dans les six sous-régions, et le programme commence à dégager les schémas émergents des massacres illégaux. Grâce à une base de données informatique opérationnelle, développée récemment, en lien avec un dispositif GIS et adapté pour l'Asie et l'Afrique, on a pu réaliser une analyse préliminaire des données récentes sur la mortalité. Ces données indiquent un braconnage intense en Afrique centrale, qui pourrait bien être en grande partie attisé par les marchés intérieurs d'ivoire, en Afrique et en Asie, comme le confirment le programme-frère de MIKE, le Système d'information sur le commerce des éléphants (ETIS) ainsi que d'autres travaux.

Nouveaux ajouts au site Web du GSEAf

On a ajouté les versions portugaises du Système du GSEAf de Support des Décisions pour la Gestion des situations de Conflit Hommes–Eléphants en Afrique, du Protocole de Récolte et d'Analyse des Données sur les Conflits Hommes–Eléphants, et du « Package » de formation au Dénombrement des Dommages dus aux Eléphants, à la liste toujours croissante des ressources utiles accessibles sur le site du GSEAf : http://iucn.org/afesg. Des versions papier des trois documents seront distribuées à la fin de cette année à toutes les personnes concernées dans les Etats lusophones de l'aire de répartition. On y trouve aussi la version digitalisée de *Pachyderm* 36, un aperçu des leçons apprises à ce jour du travail du Groupe de Travail sur les Conflits Hommes–Eléphants du GSEAf, et un lien vers le nouveau glossaire complet des termes concernant les éléphants, compilé récemment par Philippe Kahl et Charles Santiapillai.

Fonds de petites subventions (Small Grants Fund)

Le dernier groupe de demandes soumises pour l'obtention d'un financement de la part du Fonds de

Updates from the office of the Secretariat

Thanks to a new grant from the US Fish and Wildlife Service and continuing support from the UK Department for Food Environment and Rural Affairs, the funding situation for the AfESG has improved since my last report. However, these new funds, as much as we appreciate them, will support AfESG's core activities only until about mid-2005, and so the pressure is still on to try to secure long-term funding to help put AfESG on a more secure financial footing. As I write this, the European Commission's Programme on Environment still has under consideration our application submitted last March for a five-year project to support AfESG's core activities. Should it be approved, it will go a long way in providing the badly needed financial stability required to reduce the administrative burden of proposal writing and enable us to devote all our energies to our primary *raison d'être*—helping conserve African elephants throughout their range.

In July, after serving almost three years as the AfESG programme officer for central Africa, Eli Hakizumwami, left AfESG to join the WWF Central Africa Regional Programme as regional forest officer. Undoubtedly Elie's skills and the experience he gained during his tenure at AfESG will be an asset to his new employer. We will miss Elie's enthusiasm and the initiative he showed in helping to drive development of a subregional strategy for central African elephants. The service rendered to our membership in central Africa will be sorely missed. Not to lose momentum on the progress we have made in central Africa over the last few years, we intend to recruit a replacement for Elie as soon as possible, provided of course that the necessary funds can be raised for this purpose.

Future developments

As many of you already know, I am slated in the new year to become the new Chair of the Species Survival Commission for the coming quadrennium. Although many challenges lie ahead for me personally, I shall not desert the African Elephant Specialist Group. In fact, I hope to avoid any disruption in the fabulous work and wonderful collegiality that have been built since I took office in 1992 and shall battle on to ensure that it continues on a healthy and productive course into the future.

petites subventions financé par la Commission Européenne, qui expirait le 30 novembre 2004, a conduit à quatre nouveaux projets : une étude sur les éléphants de l'écosystème du Kilimandjaro, en Tanzanie, un recensement des éléphants et une étude de leur habitat dans le Parc National de Gorongosa, au Mozambique, une étude de l'utilisation des abeilles comme moyen de dissuasion contre le saccage des récoltes et la traduction des standards de MIKE en matière de surveillance de l'anglais en français et en portugais. Des rapports sur le résultat de ces études et d'autres projets *Small Grants* qui sont encore en cours seront publiés dans les prochains numéros de *Pachyderm*. Au total, ce sont 22 projets qui furent financés dans 13 Etats de l'aire de répartition au moyen du Fonds de petites subventions du GSEAf pendant la période 2000–2004.

Evaluation des activités du GSEAf depuis 2000

Depuis 2000, le GSEAf a été soutenu par une subvention principale substantielle de la Commission Européenne. Une des conditions liées à cette subvention, qui expirait le 30 novembre 2004, était que le projet soit évalué de manière indépendante pour déterminer dans quelle mesure il avait atteint ses objectifs. Comme le demandent les directives de la CE, des termes de référence détaillés pour l'évaluation ont été rédigés par le Secrétariat du GSEAf, avec l'assistance appréciée de Nancy MacPherson, coordinatrice pour la surveillance continue et l'évaluation au quartier général de l'UICN. En avril, la CE a approuvé ces termes de référence et sélectionné une équipe de deux personnes, le Dr Stephen Turner et le Dr Jean-Pierre d'Huart pour faire l'évaluation.

Début septembre, le Dr Turner a visité le Secrétariat du GSEAf à Nairobi pour y interviewer le personnel. Un certain nombre de membres du GSEAf, le personnel concerné des bureaux régionaux de l'UICN et le programme des espèces à Gland ainsi que des donateurs et les organisations partenaires principales des quatre sous-régions furent aussi contactés par email ou par téléphone pour qu'ils donnent leurs impressions sur les performances du GSEAf entre 2000 et 2004. L'équipe a aussi fait circuler un questionnaire pour aider à rassembler plus d'informations.

(Continue en page 10)

Les conclusions et les recommandations de l'évaluation sont très positives. Elle a particulièrement mis en lumière le travail du GSEAf pour synthétiser, améliorer et diffuser les informations sur la conservation et le statut des éléphants africains, pour fournir des conseils techniques précis et pour catalyser les activités de conservation, comme étant certains domaines où les réalisations ont été importantes ces quatre dernières années. La CE et d'autres donateurs ont été encouragés à accorder un nouveau soutien pour financer les frais de base du groupe et de ses activités.

Dernières nouvelles du bureau du Secrétariat

Grâce à une nouvelle subvention du *Fish and Wildlife Service* américain, et du soutien continu du *Department for Food, Environment and Rural Affairs* britannique, la situation financière du GSEAF s'est améliorée depuis mon dernier rapport. Cependant, même si nous apprécions ces fonds à leur juste valeur, ils ne permettront de supporter les activités de base du GSEAf que jusqu'à environ la moitié de 2005, ce qui fait que nous sommes encore sous pression pour tenter d'assurer le financement à long terme, afin de placer le GSEAf sur une base financière plus sûre. Au moment où j'écris ces lignes, le Programme de la Commission Européenne pour l'Environnement étudie encore la demande que nous avons soumise en mars dernier pour un projet d'une durée de cinq ans destiné à soutenir les activités de base du GSEAf. S'il est approuvé, il sera très important pour assurer la stabilité financière dont nous avons tellement besoin pour réduire la charge administrative que représente la rédaction de propositions, et il nous permettra de consacrer toute notre énergie à notre première raison d'être—aider la conservation des éléphants africains dans toute leur aire de répartition.

En juillet, après avoir été pendant près de trois ans le responsable du programme du GSEAf en Afrique centrale, Elie Hakizumwami a quitté le Groupe pour rejoindre le Programme Régional du WWF en Afrique centrale en tant Responsable régional des forêts. Il ne fait aucun doute que les compétences et l'expérience qu'Elie a acquises par ses activités dans le GSEAf seront un atout pour son nouvel employeur. Son enthousiasme nous manquera, ainsi que l'esprit d'initiative dont il a fait preuve en aidant au développement d'une stratégie sous-régionale pour les éléphants d'Afrique centrale. Nous regretterons beaucoup les services rendus à nos membres en Afrique centrale. Pour ne pas perdre l'élan qui a été donné à nos activités en Afrique centrale, nous avons l'intention d'engager dès que possible quelqu'un pour remplacer Elie, pour autant que nous trouvions les fonds nécessaires.

Développements futurs

Comme beaucoup d'entre vous le savent déjà, je suis candidate au poste de Présidente de la Commission de Sauvegarde des Espèces pour une durée de quatre ans à partir de l'année prochaine. Bien que de nombreux défis personnels se présentent à moi, je ne quitterai pas le Groupe des Spécialistes des Eléphants d'Afrique. Au contraire, j'espère éviter toute interruption du fabuleux travail et de la collégialité merveilleuse que nous avons construite depuis que j'ai pris mon poste en 1992, et je me battrai pour que cela continue de façon saine et productive à l'avenir.

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

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Seventh AfRSG meeting

From 6 to 11 June 2004, AfRSG held its seventh meeting at Kilaguni Lodge, Tsavo West National Park, in Kenya. The meeting was officially opened by the Hon. Dr Newton Kulundu, Kenya's Minister of Environment, Natural Resources and Wildlife. He was supported by a Kenyan delegation, including the permanent secretary, Mrs Rachel Arungah, the director of Kenya Wildlife Service, Mr Evans Mukolwe, the Protected Areas head, Mr John Muhanga, the head of Security, Josiah Achoki, and the Rhino Programme coordinator, Mr Martin Mulama.

The goals of the meeting, which strongly mirror AfRSG's objectives, were to compile and synthesize information on the status and management of rhinos; provide improved technical information and advice; promote and catalyse rhino conservation activities; and build capacity through exchanging ideas, information and expertise.

As usual, the meeting started with country reports being presented that summarized each country's management programme; the status of its rhino conservation plans, rhino population numbers and trends; the extent of poaching and illegal trade; and details of their horn stockpiles. Information from Botswana, Cameroon, Democratic Republic of Congo, Ethiopia, Kenya, Malawi, Mozambique, Namibia, Rwanda, South Africa, Swaziland, Tanzania, Zambia and Zimbabwe was compiled and summarized to produce updated continental statistics, which are presented in a short note by the AfRSG Scientific Officer in this issue. This note provides rhino numbers and trends by subspecies and country, the number of rhinos under different ownership and management models, and the number of *Key* and *Important* populations. To avoid duplication I shall only mention here that the positive trend in black rhino numbers continues with numbers up to 3600. On the negative side, the reported number of rhinos poached has increased. The north-

Septième Réunion du GSRAf

Le GSRAf a tenu sa septième réunion au Kilaguni Lodge, dans le Parc National de Tsavo Ouest, au Kenya, du 6 au 11 juin 2004. La réunion a été officiellement inaugurée par l'Hon. Dr Newton Kulundu, Ministre kenyan de l'Environnement, des Ressources naturelles et de la Faune sauvage. Il était entouré d'une délégation kenyane comprenant le Secrétaire permanent, Mme Rachel Arungah, le Directeur du Kenya Wildlife Service, M Evans Mukolwe, le Chef des Aires Protégées, M John Muhanga, le Chef de la Sécurité, Josiah Achoki et le Coordinateur du Programme Rhino, M Martin Mulama.

Les objectifs de la réunion, qui reflètent beaucoup ceux du GSRAf, étaient de compiler et de synthétiser les informations sur le statut et la gestion des rhinos ; d'apporter de meilleures informations et de meilleurs conseils techniques ; de promouvoir et de catalyser les activités de conservation des rhinos et de développer des capacités grâce à un échange d'idées, d'informations et d'expertise.

Comme d'habitude, la réunion a commencé par la présentation des rapports nationaux qui résumaient le programme de gestion de chaque pays, le statut de chaque programme de conservation des rhinos, les effectifs et les tendances de chaque population de rhinos, l'étendue du braconnage et du commerce illégal, et les détails sur les stocks de corne. Les informations en provenance d'Afrique du Sud, du Botswana, du Cameroun, de la République Démocratique du Congo, de l'Ethiopie, du Kenya, du Malawi, du Mozambique, de Namibie, du Rwanda, du Swaziland, de Tanzanie, de Zambie et du Zimbabwe ont été compilées et résumées pour donner les nouvelles stati-stiques à l'échelle du continent, qui sont présentées dans une courte note dans ce numéro, par le Responsable scientifique du GSRAf. Cette note donne le nombre de rhinos et les tendances par sous-espèce et par pays, le nombre de rhinos qui appartiennent à divers

ern white rhino is currently threatened with extinction in the wild following a major poaching onslaught by Arabic horsemen from northern Sudan, which has halved rhino numbers. Recent surveys indicate only 15 northern white rhinos may remain. The status of the rare western black rhino in Cameroon is also unknown.

A presentation on the status of the three Asian species of rhinos and their conservation was followed by an update on the current status and performance of rhinos in captivity worldwide.

One session provided delegates with information on the activities of a number of rhino support programmes: the Italian-funded SADC Regional Programme for Rhino Conservation, the Rhino and Elephant Security Group, WWF/Ezemvelo-KZN-Wildlife's Black Rhino Range Expansion Project, the UK-funded Kenyan Darwin Initiative Project, the US Fish and Wildlife's Rhino and Tiger Fund, WWF's African Rhino Programme, the Frankfurt Zoological Society, the International Rhino Foundation and the African Wildlife Foundation.

Biological management presentations followed on black rhinos in Kunene; Ngorongoro Crater black rhinos and ecosystem dynamics; and issues emanating from the 1999–2001 SADC Rhino Management Group's black rhino status report for Namibia and South Africa.

Delegates were given an update on software developments, including a presentation on the performance characteristics of the revised RHINO 2 software for estimating population; a brief description of the new law enforcement and transponder databases; an update on progress with the WILDb database system and the WILDxl and analysis spreadsheet; and an update on Kifaru, the Kenyan database system.

The meeting then focused on re-establishment, with presentations on the recent black rhino re-establishment in North Luangwa, Zambia, and black and white rhino re-establishment in Mombo, Botswana. The planned programme for re-establishing rhinos in Uganda was outlined.

Delegates were informed of a cheaper way of temporarily fencing rhino areas using existing trees as fence posts, and of a new mobile boma system that has just been built in Namibia.

A report on block counting of black rhinos in Etosha, Namibia, was followed by a brief presentation on revisions of the AfRSG training course on rhino monitoring and the instructors' training and ac-

propriétaires et qui sont soumis à différents modèles de gestion, et les chiffres pour les populations *Clés* et *Importantes*. Pour éviter des redites, je mentionnerai simplement ici que la tendance positive se confirme pour les rhinos noirs, avec un nombre qui dépasse 3600. Par contre, le nombre de rhinos braconnés est en augmentation. Le rhino blanc du Nord est actuellement menacé d'extinction dans la nature suite à une vague majeure de braconnage par des cavaliers arabes venus du nord du Soudan, qui a réduit de moitié le nombre de ces rhinos. Des études récentes indiquent qu'il ne resterait que 15 rhinos blancs du Nord. Le statut du rare rhino noir de l'Ouest au Cameroun est aussi inconnu.

Une présentation sur le statut des trois espèces de rhinos d'Asie et de leur conservation a été suivie par une mise à jour du statut et des performances actuels des rhinos captifs dans le monde entier.

Au cours de l'une des sessions, les délégués ont reçu des informations sur les activités d'un certain nombre de programmes de support des rhinos : le Programme Régional pour la Conservation des Rhinos de la SADC financé par l'Italie, le *Rhino and Elephant Security Group*, le *WWF/Ezemvelo-KZN-Wildlife's Black Rhino Range Expansion Project*, le *Kenyan Darwin Initiative Project* financé par la Grande-Bretagne, le Fonds Tigres et Rhinos du *Fish and Wildlife Service* américain, le Programme pour les rhinos d'Afrique du WWF, la Société Zoologique de Frankfort, l'*International Rhino Foundation* et l'*African Wildlife Foundation*.

Ont suivi des présentations sur la gestion biologique des rhinos noirs à Kunene ; sur les rhinos noirs du cratère du Ngorongoro et la dynamique de l'écosystème ; et sur des questions suscitées par le rapport de 1999–2001 du Groupe de gestion des rhinos de la SADC sur le statut du rhino noir, en Namibie et en Afrique du Sud.

Les délégués ont été informés des derniers développements en matière de logiciels, y compris les caractéristiques de la nouvelle version du RHINO 2 pour l'estimation des populations ; ils ont reçu une brève description des nouvelles bases de données sur l'application des lois et les transpondeurs ; on leur a fait part des progrès réalisés avec le système de base de données WILDb et avec les tableurs WILDxl et d'analyse, et donné une mise à jour de Kifaru, le système kenyan de base de données.

La réunion s'est alors concentrée sur le rétablissement des populations, avec des présentations sur le

creditation courses that have been held in Pilanesberg, South Africa, and Nakuru, Kenya.

The TRAFFIC member gave a presentation on managing rhino horn stockpiles, including how to use the facilitating database that TRAFFIC has developed, and the dynamics of illegal horn trade in Africa.

The session on rhino management and strategies discussed conserving rhinos in war situations, veterinary advances, and disease screening both for zoo rhinos translocated into Africa and for wild rhinos translocated within Africa.

An interactive plenary discussion and workshop was held on reporting requirements for rhino range states in terms of CITES Res. Conf. 9(14) revised, a resolution that encourages implementation of effective conservation programmes and rhino range states to report on these to CITES. The aim was to get the group's reaction to the CITES Secretariat's proposal to either scrap or amend this resolution. Namibia and South Africa gave a brief explanation of their proposed hunting quotas for black rhinos, and Swaziland's proposed downloading of its southern white rhino population from Appendix I to II, which would allow international trade. These proposals were discussed.

Before the workshops and other SADC-related meetings began, participants went on a field visit to the Ngulia Rhino Sanctuary in Tsavo West National Park.

A meeting of the SADC Regional Programme for Rhino Conservation Range States was held, followed by a SADC Rhino Recovery Group meeting. Workshops were also held on disease screening protocols for rhinos, community-based rhino conservation, and metapopulation planning for *Diceros bicornis michaeli*.

The meeting closed with a meeting of members in which AfRSG priorities for the next triennium were discussed.

AfRSG is extremely grateful to the SADC Regional Programme for Rhino Conservation and WWF for jointly funding the meeting. In addition the Serena Hotel group is thanked for providing an excellent venue at a substantially discounted cost. Kenya Wildlife Service is also thanked for providing transport for delegates to and from Kilaguni, as well as for the field visit.

Confidential and detailed proceedings of the meeting have been written up and distribution has begun.

récent rétablissement du rhino noir dans le Luangwa Nord, en Zambie et celui des rhinos noirs et blancs à Mombo, au Botswana. On a aussi présenté le programme de rétablissement des rhinos en Ouganda.

Les délégués ont appris une façon plus économique de clôturer temporairement des zones où sont enfermés des rhinos, en utilisant les arbres et les poteaux existants, et ils ont pris connaissance d'un nouveau système de boma mobile qui vient d'être construit en Namibie.

Un rapport sur le comptage en bloc des rhinos noirs à Etosha, en Namibie, a été suivi par une brève présentation sur la révision des cours GSRAf de formation à la surveillance continue des rhinos et de formation et d'accréditation d'instructeurs, qui ont eu lieu à Pilanesberg, en Afrique du Sud, et à Nakuru, au Kenya.

Le membre de TRAFFIC a fait une présentation sur la gestion des stocks de cornes de rhino, y compris sur la façon d'utiliser la base de données de facilitation que TRAFFIC a mise au point, et sur la dynamique du commerce de cornes de rhinos en Afrique.

Pendant la session sur la gestion et les stratégies des rhinos, il y eut des discussions sur la question de la conservation des rhinos en situation de guerre, sur les progrès vétérinaires et sur la détection des maladies chez les rhinos transférés des zoos vers l'Afrique et d'un point à l'autre, en Afrique.

Il y eut aussi une discussion plénière interactive et un atelier sur les exigences en matière de rapports pour les Etats de l'aire de répartition au vu de la Rés. Conf. 9(14) de la CITES révisée, une résolution qui encourage la réalisation de programmes de conservation effectifs, et qui demande aux Etats de l'aire de répartition de faire rapport à ce sujet auprès de la CITES. Le but était d'obtenir la réaction du groupe à la proposition du Secrétariat de la CITES d'abandonner ou d'amender cette résolution. La Namibie et l'Afrique du Sud ont brièvement expliqué les quotas de chasse qu'ils proposaient d'adopter pour les rhinos noirs et le déclassement de l'Annexe I à l'Annexe II que le Swaziland propose pour sa population de rhinos blancs du Sud, ce qui lui permettrait un commerce international. On a discuté de ces propositions.

Avant que les ateliers et les autres réunions liées à la SADC ne commencent, les participants ont visité le Sanctuaire des Rhinos de Ngulia, dans le Parc National de Tsavo Ouest.

Il y a eu une réunion des Etats de l'aire de répartition des rhinos de la SADC participant au Programme Régional pour la Conservation des Rhinos,

Appreciation

Once again, AfRSG would like to acknowledge the support of WWF for its partial support of the Scientific Officer up to June 2004 as well as some support for the Chair's operating expenses.

suivie par une réunion du *SADC Rhino Recovery Group*. Il y eut aussi des ateliers sur les protocoles de détection des maladies des rhinos, sur la conservation communautaire des rhinos et sur la planification en métapopulation de *Diceros bicornis michaeli.*

Enfin, il y eut pour terminer une réunion des membres qui ont discuté des priorités du GSRAf pour les trois prochaines années.

Le GSRAf remercie chaleureusement le Programme régional de la SADC pour la Conservation des Rhinos et le WWF qui ont financé cette réunion. Il remercie aussi le Groupe des Hôtels Serena qui a mis à sa disposition des locaux impeccables à un prix préférentiel. Merci au *Kenya Wildlife Service* qui a prêté un bus pour le transport des délégués de et vers Kilaguni et pour la visite de terrain.

Des rapports confidentiels et détaillés sur la réunion sont rédigés et leur distribution a commencé.

Remerciements

Une fois de plus, le GSRAf tient à reconnaître le soutien du WWF dans sa prise en charge partielle du Responsable scientifique jusqu'en juin 2004, ainsi que des frais de fonctionnement du Président.

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/et Nico van Strien, Programme Officers/Responsables de Programme

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Captive propagation programme for the Sumatran rhino

On 30 July 2004, the second Sumatran rhino calf **(***Dicerorhinus sumatrensis***)**, a female, was born to the reproducing pair (female Emi and male Ipuh) at the Cincinnati Zoo. The first calf, a male, had been born 13 September 2001. This female calf, whose name is Suci (pronounced 'Suchi', an Indonesian word for 'sacred'), was born after a gestation period of 477 days and weighed 34 kg at parturition. The gestation period for Suci's brother, Andalas, was 475 days and he weighed 33 kg at birth.

Programme de propagation en captivité pour le rhino de Sumatra

Un second rhino de Sumatra (*Dicerorhinus sumatrensis)*, une femelle, est né en captivité le 30 juillet 2004, au zoo de Cincinnati, de la femelle Emi et du mâle Ipuh. Le premier petit, un mâle, est né le 13 septembre 2001. Cette petite femelle, nommée Suci (prononcer Suchi, un mot indonésien qui signifie « sacré »), est née après une période de gestation qui a duré 477 jours, et elle pesait 34 kg à la naissance. La durée de la gestation pour son frère, Andalas, avait été de 475 jours, et son poids était de 33kg.

David Jenike, Cincinnati Zoo and Botanical Garden

Suci, the second Sumatran rhino born in captivity at the Cincinnati Zoo, with her mother, Emi.

The 2001 birth was an epochal event for Sumatran rhino conservation. This birth of a second calf is equally significant since it provides encouragement that the art and science of reliably reproducing this most endangered of rhino species has hopefully been mastered.

This encouragement is reinforced by the fact that this second pregnancy was carried to term without the supplementation of exogenous hormone (progesterone) that was required for the first birth. This supplementation was used because Emi had lost five previous pregnancies. Dr Terri Roth of the Center for Conservation and Research of Endangered Wildlife (CREW) at the Cincinnati Zoo reports that there appears to be no difference in Emi's endogenous progesterone levels from levels in the first pregnancy. The first pregnancy is described in detail in Roth et al. (2004).

According to Dr Roth, the reasons for the failure of the first five pregnancies may never be known. One hypothesis was that Ipuh might be Emi's father since capture locations (in the Kerinci Seblat area of Sumatra), and relative ages were suggestive of such a relationship. The lost pregnancies were therefore thought possibly to have been the result of some inbreeding depression. However, molecular genetics work conducted under the leadership of Dr Peter J. van Coeverden de Groot (Department of Biology, Queens University, Kingston, Ontario, Canada) and colleagues (at the Center for Environmental Research and Conservation at Columbia University, New York City) has rather convincingly disproven this hypothesis. Their results were presented in a poster session at the 2004 Society for Conservation Biology meeting in New York. A full paper describing these studies is in preparation.

A detailed behavioural study of this second calf is being conducted, as it was for the first. Among other data, the study is collecting moulds of footprints in various types of substrate (dry soil, mud, etc.) and in correlation with precisely known ages and weights to provide a database for studies of this species in the wild. The footprint data are already being provided to the rhino protection units operating for the Sumatran rhino in both Indonesia and Malaysia.

Andalas, the first calf born at the Cincinnati Zoo, is now at the Los Angeles Zoo, where he is doing well except for eye problems, which have also occurred in captive Sumatran rhinos at Cincinnati and in Indonesia. These problems are believed to derive

La naissance de 2001 avait été un événement marquant pour la conservation des rhinos de Sumatra. La naissance d'un second petit est aussi très significative dans la mesure où elle signifie que l'art et la science qui permettent de reproduire de façon fiable cette espèce particulièrement menacée de rhino sont désormais maîtrisés.

Cet optimisme est renforcé par le fait que cette seconde gestation a été menée à terme sans que l'on administre le supplément hormonal (progestérone) qui avait été nécessaire la première fois. Ce supplément avait été administré parce qu'Emi n'avait pas pu mener à terme cinq premières gestations. Le Dr Terry Roth, du Centre pour la Conservation et la Recherche de la Faune sauvage en danger (CREW) au zoo de Cincinnati, signale qu'il ne semble pas y avoir de différence du niveau de progestérone endogène avec celui de la première gestation. Celle-ci est décrite en détail dans Roth et al. (2004).

D'après le Dr Roth, les raisons de l'échec des cinq premières gestations pourraient ne jamais être connues. Une des hypothèses était qu'Ipuh pourrait peut-être être le père d'Emi puisque le lieu des captures (dans la région de Kerinci Seblat, à Sumatra) et l'âge des deux animaux permettaient une telle relation. On a pensé que les gestations perdues pouvaient être le résultat de quelque dépression due à l'inbreeding. Mais le travail de génétique moléculaire réalisé sous la direction du Dr Peter J. van Coeverden de Groot (Département de Biologie, Université de Queens, Kingston, Ontario, Canada) et de ses collègues (au centre de Recherche et de Conservation Environnementales de l'Université de Columbia, New York) a démenti cette hypothèse de façon assez convaincante. Leurs résultats ont été présentés lors d'une session de posters lors de la réunion de 2004 de la Société pour la Biologie de la Conservation à New York. Un article complet décrivant ces études est en préparation.

Une étude comportementale détaillée de ce deuxième jeune sera réalisée, comme ce fut le cas pour le premier. Parmi d'autres données, l'étude récoltera des moules d'empreintes des pattes dans différents types de substrats (sol sec, boue, etc.) correspondant exactement à un âge et à un poids connus, pour les mettre sur la base de données destinée aux études de cette espèce dans la nature. Les données sur les empreintes sont déjà fournies aux unités de protection des rhinos qui travaillent sur les rhinos de Sumatra en Indonésie et en Malaisie.

David Jenike, Cincinnati Zoo and Botanical Garden

Bonding time for Suci and Emi.

from the higher levels of sunlight, especially UVb radiation, that occur in captivity compared with the dense forest habitat of this species. The Cincinnati Zoo has recently completed an elaborate shade structure that is reducing light to tropical forest levels, which Dr Roth has measured in field tests in both Malaysia and Indonesia.

During the next year, there will be a concerted effort to transfer the methodology successful at the Cincinnati Zoo to the pair of Sumatran rhinos at the managed reproduction centre in Way Kambas National Park in Sumatra. Moreover, there will be an attempt to establish a more formal and active Global Management and Propagation Board for the captive programme for this species. This board will comprise representatives from all range states and facilities that have the species as well as organizations (including AsRSG) and institutions involved with the programme. The first meeting is proposed for Way Kambas in late March 2005, after a period of about three months during which more of the Cincinnati methods will be tried at the Way Kambas reproduction centre.

Andalas, le premier jeune rhino né au zoo de Cincinnati, se trouve maintenant au zoo de Los Angeles. Il se porte bien, à part le problème aux yeux qui a aussi touché les rhinos de Sumatra captifs à Cincinnati et en Indonésie. On croit que ces problèmes résultent d'un niveau de lumière solaire, et spécialement des rayons UVB, plus élevé en captivité que dans l'habitat de forêt dense que fréquente cette espèce. Le Zoo de Cincinnati a érigé une structure élaborée d'écrans qui permettent de réduire la lumière au niveau existant en forêt tropicale et que le Dr Roth a mesuré lors de tests de terrain en Malaisie et en Indonésie.

L'année prochaine, il y aura un effort concerté pour appliquer la méthodologie qui a réussi au zoo de Cincinnati au couple de rhinos de Sumatra qui se trouvent au Centre de reproduction assistée du Parc National de Way Kambas, à Sumatra. On va aussi tenter de créer un Conseil Global de Gestion et de Propagation plus officiel et plus actif pour le programme de cette espèce en captivité. Ce conseil comprendra des représentants de tous les Etats de l'aire de répartition et des institutions qui possèdent

The successful reproduction programme for this species has been developed by Dr Terri Roth and her CREW team at the Cincinnati Zoo. Dr Roth recently received a Chevron-Texaco Conservation Award for this achievement.

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Roth, T.L., Bateman, H.L., Kroll, J.L., Steinetz, B.G., and Reinhart, P.R. 2004. Endocrine and ultrasonic characterization of a successful pregnancy in a Sumatran rhinoceros (*Dicerorhinus sumatrensis*) supplemented with a synthetic progestin. *Zoo Biology* 23:219–238.

de ces rhinos ainsi que des organisations (y compris le GSRAs) et des institutions impliquées dans le programme. On propose d'organiser la première réunion à Way Kambas fin mars 2005, trois mois environ après que la plupart des méthodes de Cincinnati auront été testées au Centre de reproduction de Way Kambas.

Le programme réussi de reproduction de cette espèce a été mis au point par le Dr Terry Roth et son équipe CREW au zoo de Cincinnati. Le Dr Roth a reçu récemment un Prix de Conservation Chevron-Texaco pour cette réalisation.

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RESEARCH

Population model for the greater one-horned rhinoceros (*Rhinoceros unicornis*) in Royal Chitwan National Park, Nepal

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Abstract

One of the largest wild populations of the highly endangered Indian rhinoceros (*Rhinoceros unicornis*) resides in and around Royal Chitwan National Park (RCNP) in Nepal. Unfortunately, rhino poaching in the park has increased dramatically since 1998. This paper presents a demographic model of the Royal Chitwan rhino population to describe the effect of poaching on the population, explore the validity of a decreasing carrying capacity in the park, and provide input to an overarching bioeconomic model. We used a simple, logistic-style model to describe the rhino population. Starting with values available from the literature, three sets of best-fit parameter values were chosen. We then used these three model variations to indicate the size the RCNP rhino population would have been had the extensive poaching between 1998 and 2003 not occurred. All three model variations suggested that the current rhino population was below the park's capacity and revealed the strong negative impact of poaching. These results supported the vital importance of continued anti-poaching efforts in Royal Chitwan.

Résumé

Une des plus grandes populations sauvages du très menacé rhinocéros d'Inde (*Rhinoceros unicornis*) réside dans le Parc National et Royal de Chitwan (RCNP) et dans ses environs, au Népal. Malheureusement, le braconnage des rhinos a terriblement augmenté dans le parc depuis 1998. Cet article présente un modèle démographique de la population de rhinos du Royal Chitwan pour décrire les effets du braconnage sur la population, étudier la validité d'une capacité de charge en diminution dans le parc et fournir un modèle bioéconomique général. Nous avons utilisé un modèle simple, style logistique, pour décrire la population de rhinos. En partant des valeurs disponibles dans la littérature, trois sets de paramètres les mieux adaptés ont été choisis. Nous avons alors utilisé ces trois modèles de variation pour indiquer quelle aurait été la taille de la population de rhinos du RCNP si le braconnage intense n'avait pas existé entre 1998 et 2003. Les trois variations modèles ont suggéré que la population actuelle de rhinos était en dessous de la capacité du parc et révélé le grave impact négatif du braconnage. Ces résultats insistent sur l'importance vitale de la poursuite des efforts antibraconnage à Royal Chitwan.

Introduction

One of the largest wild populations of the highly endangered (Zschokke et al. 2003) Indian rhinoceros (*Rhinoceros unicornis*) resides in and around the 932-km^2 Royal Chitwan National Park (RCNP) in Nepal. RCNP was established in 1973 and is Nepal's oldest national park. The park was designated a World Heritage Site in 1984 by the United Nations Educational, Scientific, and Cultural Organization (UNESCO) because of its rich flora and fauna and because it is one of the last refuges of both the greater one-horned rhinoceros and the Bengal tiger (*Panthera tigris*).

The greater one-horned rhinoceros is considered a flagship species of Nepal (Dhakal 2002) and conserving these animals is a major priority for the country. Unfortunately, rhino poaching in the park has increased dramatically (Martin 2004) since 1998 (fig. 1). Rhinos are poached for their nasal horn, which is highly valued in East Asia (Maskey 1998; Martin 2004). Approximate rhino population size estimates for RCNP are available for the years 1972, 1978, 1988, 1994 and 2000 (see Martin and Vigne 1996; Nepal 2000).

In 2003, an international and interdisciplinary team of researchers was formed to study the problem of rhino poaching in RCNP. The team is using surveys of local people, stakeholder analysis and modelling of the rhino population to yield a set of models that can be used to predict the outcome of various anti-poaching strategies. This research is a coordinated effort by personnel from Simon Fraser University, the Institute for Environmental Studies (Free University, Amsterdam), the Environmental Resource Institute (Forest Action, Nepal), the Ministry of Forests and Soil Conservation in Nepal, and several consultants.

In this paper, we present a demographic model of the RCNP rhino population. The purpose of this model is to 1) describe the effect that recent and future poaching has and could have on the population, 2) explore the validity of a decreasing carrying capacity in RCNP as a key influence on population change, and 3) provide annual population estimates between 1972 and 2003 (for years in which field counts are not available) as input to an overarching bioeconomic model. We used a simple, logistic-style model (Cromsigt et al. 2002) to describe the rhino population. Starting with values available from the literature, we chose three sets of best-fit parameter values by comparing the predicted population time trajectory according to

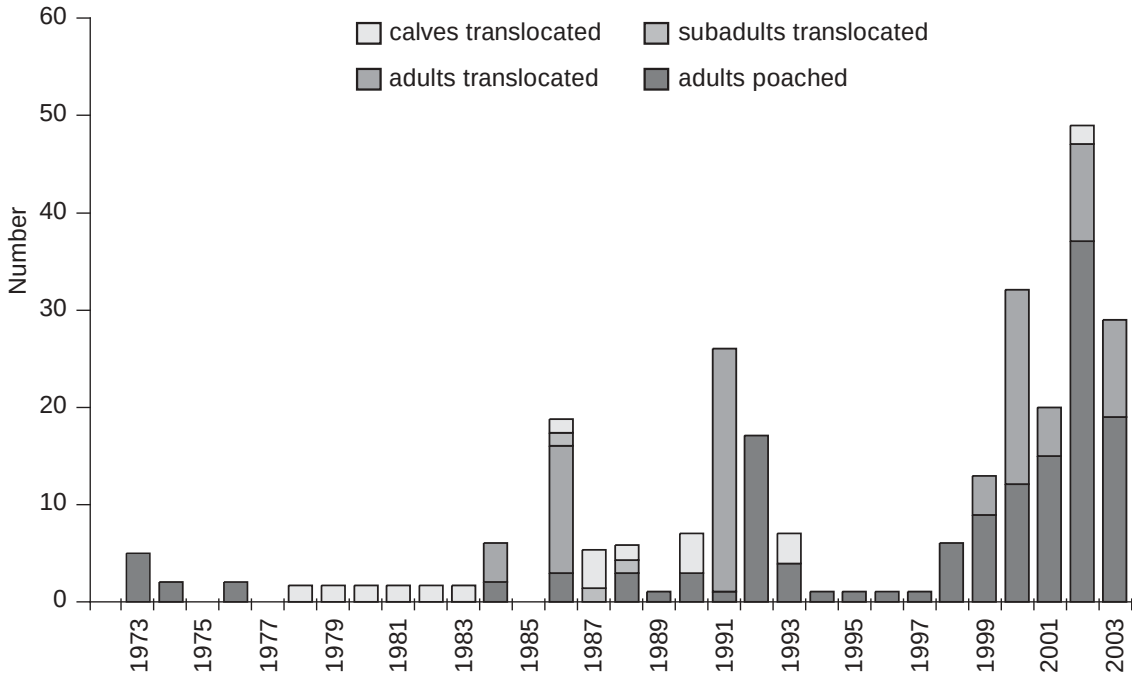

Figure 1. Rhinos translocated or poached from Royal Chitwan National Park, 1972–2003.

the model with actual field counts. We then used these three model variations to indicate what the size of the RCNP rhino population would have been had the extensive poaching between 1998 and 2003 not occurred.

Materials and methods

A discrete, stage-class population model with a one-year time step was used to represent the rhinos. The population was assumed to experience density-dependent regulation that can be described according to a logistic growth model. The animals were divided into three groups: 1) calves, including animals less than four years old, 2) subadults, which are between four and six years old, and 3) adults, which are seven years old or older. These distinctions are made because of the different mortality and reproductive rates experienced by rhinos in each group. Calves are highly vulnerable to tiger predation and do not reproduce. Subadults are relatively less vulnerable to tigers but are not yet reproductively active. Adults also are rarely subject to tiger predation and do reproduce. Adult males may die as a result of fights with other adult males (Dinerstein and Price 1991; Zschokke and Baur 2002). Adult males and females both have a nasal horn and may, therefore, be killed by poachers. Calves, subadults and adults have occasionally been translocated from their natal population (RCNP) to other national parks in Nepal for conservation purposes.

The specific model used can be described according to the following pseudocode:

$A_t = A_{t-1}$ + (maturing subadults – adult deaths – adults poached – adults translocated) * Δt

$SA_t = SA_{t-1}$ + (maturing calves – maturing subadults – subadult deaths – subadults translocated) * Δt

$C_t = C_{t-1}$ + (births – maturing calves – calf deaths – calves translocated) * Δt

adult deaths = $A_{t-1} * d_a$

subadult deaths = $SA_{t-1} * d_{sa}$

calf deaths = $C_{t-1} * d_c$

$T_{t-1} = A_{t-1} + SA_{t-1} + C_{t-1}$

births = $b * f * A_{t-1} * (1 - T_{t-1}/K)$

where A_t is the number of adults at time period t, SA_t is the number of subadults at time period t, C_t is the number of calves at time period t, d_a is the adult death rate, d_{sa} is the subadult death rate, d_c is the calf death rate, T_t is the total number of rhinos at time period t, b is the annual female reproductive rate, f is the percentage of adults in a population that are female, K is the equilibrium value of the RCNP rhino population where gains are exactly balanced by losses, and Δt is the time step (one year). Note that while K in our model refers only to RCNP rhinos, these animals may wander beyond the park boundaries so that the equilibrium value can be influenced by conditions both within and outside the park.

Three estimates of annual female reproductive rate b were tested in the model. The first two, 0.286 calves born per adult female per year (3.5-year intercalving interval) and 0.357 calves born per adult per female per year (2.8-year intercalving interval), are based on the overall birth rate per cow and the median intercalving interval, respectively, as reported by Laurie (1982). The third, 0.25 calves born per adult female per year (4-year intercalving interval), is based on figures reported by Dinerstein and Price (1991).

The first estimate of 57% for f, the percentage of adults in a population that are female, comes from the Dinerstein and Price (1991) description of the RCNP rhino population in 1988. The second, 59%, is based on 1994 survey data (Yonzon 1994). The third, 58%, is based on the 2000 survey (Nepal 2000). Laurie (1982) also reported adult male : female sex ratios but his definitions of the adult and subadult categories differ from those used in this analysis.

Three estimates are used for the equilibrium value K of the RCNP rhino population. The first, 800 rhinos, is the estimate of the 1950 Chitwan Valley population size reported by Martin and Vigne (1996) from Willan (1965) in Laurie (1978). The second, 1000 rhinos, is an estimate of RCNP population size in 1950 from Dinerstein and Price (1991). The third, 500 rhinos, is based on the loss of almost 60% of the original RCNP grassland areas favoured by rhinos (World Wildlife Fund pers. comm.).

Stage-specific annual natural mortality rates d_a, d_{sa}, and d_c come from the work by Dinerstein and Price (1991) on the Sauraha subpopulation of rhinos in RCNP: 2.8% for calves, 2.2% for subadults and 2.9% for adults. These rates include natural mortality events such as tiger predation, separation of calves from their mothers, floods, quicksand, or fights with conspecifics, they but do not include poaching.

Poaching data for kills made inside RCNP boundaries (fig. 1) are available for the years 1973 through 1993 where they are reported as ‘minimum number

poached' during a given year (Martin and Vigne 1996; Maskey 1998). Similar data were obtained for the years 1994 through 2000 from Dhakal (2002) and for the years 2001 through 2003 from the annual reports of the Department of National Parks and Wildlife Conservation (Nepal 2001–2003). Estimates of poaching from 1994 through 2000 are consistent with values from Martin (2001), who reports that the average number of rhinos killed in the entire Chitwan Valley (RCNP and surrounding areas) between 1994 and 1997 was under two a year and that 20 rhinos were illegally killed in 1998/1999 and 15 in 2000. It is assumed that all poached animals were adults.

Translocation data (fig. 1) are derived from the Department of National Parks and Wildlife Conservation annual reports (Nepal 1993–1994, 2001–2003), supplemented by values from Dinerstein and Price (1991) and Dhakal (2002). In several instances, the stage class from which animals were drawn or the exact year during which the translocation occurred is unknown. For these cases, total translocation numbers were evenly split between stage classes and over the time interval in question; hence some translocations are non-integer numbers.

The initial stage-class distribution for the starting population in 1972 was unknown and therefore set to the values observed by Dinerstein and Price (1991) in 1988. In that year, 21% of the rhinos were calves, 14% subadults, and 65% adults. This same age structure was observed by Laurie (1978) in 1975. The population in 1972 in RCNP (see Martin and Vigne 1996) was estimated, based on a helicopter survey, to consist of between 120 and 147 rhinos. However, the minimum estimated population size in 1978 was 270. This implies that at least 21 rhinos were added each year during this six-year interval, well above the 16.3 births per year recorded by Dinerstein and Price (1991) between 1984 and 1988 when the population was nearly three times as large. It is therefore likely that the 1972 survey underestimated the true number of rhinos. Instead, an initial 1972 population size of 216 animals was estimated by calculating the average net number of individuals (9 per year) added to the population between 1978 and 1988 (358 minus 270 divided by 10 years) and then back-calculating from 1978 to 1972 (six years).

The complete rhino population model was coded and run using the Stella 5.1.1 software package (High Performance Systems 1998). To begin the analysis, the model was used to predict 27 different population trajectories between 1972 and 2003 using all combinations of the three possible *f* (percentage of adult females), *b* (annual female reproductive rate), and *K* (equilibrium value) values. The validity of each parameter combination was assessed according to the differences between actual and predicted total rhino population size for the four years for which rhino count data are available.

Based on these 27 model runs, a smaller parameter space was explored to choose the three best parameter sets (combinations of *b*, *f*, and *K* that yielded a population trajectory that best fitted the field counts). The resultant best models were used to investigate the effect of recent poaching on the rhino population. For each model, the rhino population trajectory was first predicted including the poaching events between 1998 and 2003 and then a second time as if these poaching events had not occurred.

Results

None of the nine model runs for which the equilibrium value *K* was equal to 500 rhinos yielded population trajectories that were consistent with the field counts (fig. 2a). Instead, for these runs the model always underestimated the actual counts. This difference between predicted and actual rhino numbers became more exaggerated with time. For these nine runs, the only way that the model could be correct and the field data incorrect would be if there were continually increasing instances of double counting of rhinos during the field surveys, which is an unlikely scenario.

For the nine model runs where equilibrium value *K* was equal to 800 rhinos, the model always underestimated the 1994 and 2000 field counts (fig. 2b). For the three runs where the annual adult female reproductive rate *b* was equal to 0.250 the model always underestimated the actual counts. For the three runs where *b* was equal to 0.286 the model underestimated the actual counts in 1988, 1994 and 2000. For the three runs where *b* was equal to 0.357 the model overestimated the 1988 count but underestimated the counts in 1994 and 2000. The apparent 1988 overestimates could potentially be accurate (that is, the field count was an underestimate of the true population size) because the population estimate for this year came from a field study that focused on just one subpopulation of rhinos in RCNP (Dinerstein and Price 1991). However, the underestimates for all nine runs in 1994 and 2000 cast doubt on the validity of these parameter combinations because, as described

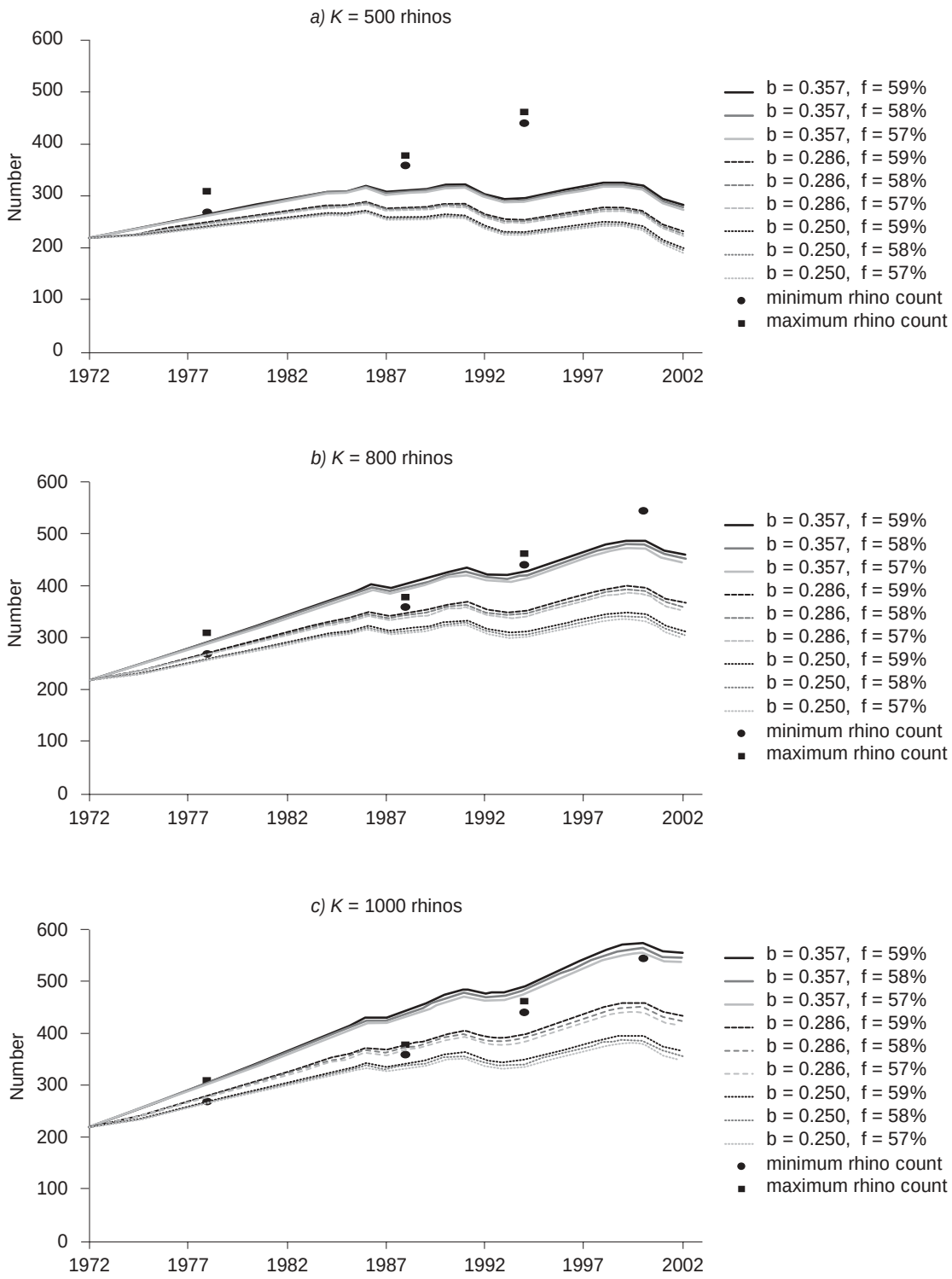

Figure 2. Population trajectories using three equilibrium values (*K*), in which *K* is *a)* 500, *b)* 800 and *c)* 1000 rhinos; *b* = annual female reproductive rate, *f* = percentage of adults in a population that are female.

above, they can be explained only by systematic double counting during the field surveys.

For the three model runs where equilibrium value *K* was equal to 1000 rhinos and the annual adult female reproductive rate *b* was equal to 0.250, the model always underestimated the actual counts (fig. 2c). For the three runs where *K* was equal to 1000 and *b* was equal to 0.286 the model underestimated the actual counts in 1994 and 2000. However, for the three runs where *K* was equal to 1000 and *b* was equal to 0.357 the model correctly predicted the number of rhinos within the range (between the minimum and the maximum) from the 1978 count, overestimated the 1998 count, but only slightly overestimated the 1994 and 2000 counts. For the run where the percentage of adults that were female *f* is equal to 57%, the overestimates were 14 rhinos in 1994 and 11 rhinos in 2000.

Based on these 27 runs, the parameter space was reduced and systematically explored. With *b* and *f* set to their maximum values, no model with *K* less than 840 predicted a population trajectory that passed between both the 1978 and the 1994 minimums and maximums so only *K* values between 840 and 1000 were considered. With *K* set to 1000 and *f* set to its maximum value, no model with *b* less than 0.320 predicted a population trajectory that passed between both the 1978 and the 1994 minimums and maximums so only *b* values between 0.320 and 0.357 were considered. Ultimately there was no single best model found because, while many parameter combinations yielded population trajectories that passed between both the 1978 and the 1994 minimums and maximums, parameter values that overestimated the 1988 population size (according to the field counts) underestimated the 2000 population size. Instead, three best models were chosen, where K = 1000. Model A, where b = 0.34 and f = 58%, minimized the underestimate of the 2000 count (fig. 3). Model B, where b = 0.34 and f = 57%, yielded a trade-off between overestimating the 1988 count and underestimating the 2000 count. Model C, where b = 0.32 and f = 59%, minimized the overestimate of the 1988 count.

The best models, A, B and C, all indicated that the RCNP rhino population is smaller now (in 2004) than

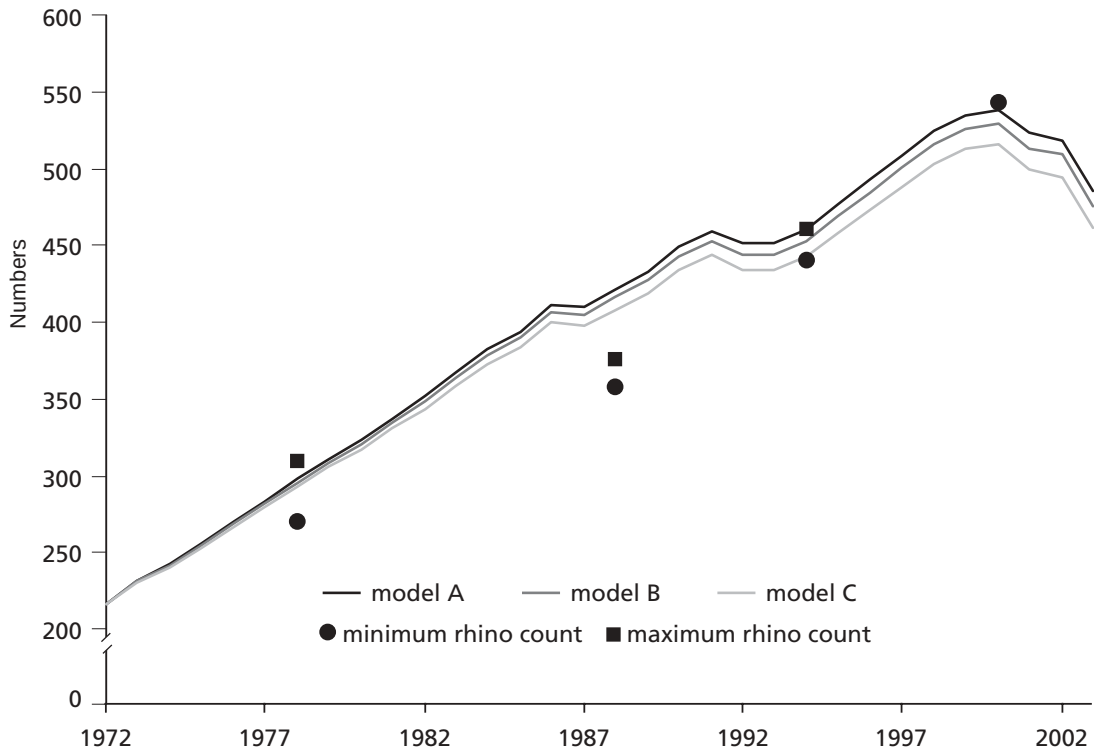

Figure 3. The three best models. In all three models equilibrium value K = 1000. In model A, *b,* the annual female reproductive rate = 0.34; *f,* the percentage of adults in a population that are female = 58%. In model B, again b = 0.34 but f = 57%. In model C, b = 0.32 and f = 59%.

it was in 2000 (fig. 3). All three models also showed that without the poaching losses between 1998 and 2003 the 2003 population would have been larger than the size estimated in 2003 (fig. 4). Models A and C indicate that in 2003 there were 79 rhinos fewer in the RCNP than there would have been had the poaching not occurred between 1998 and 2003. Model B indicates that in 2003 there were 78 fewer.

Discussion

Any of the three best-fit models may be used to provide annual RCNP rhino population estimates between 1972 and 2003 for years in which field counts are not available (objective 3). All three models yield estimates that fit the 1978 and 1994 counts. All three indicate a similar drop in the population size between 2000 and 2003. The major differences in these models are their overestimates of the 1988 count and underestimates of the 2000 count. Further information about these counts would be helpful in selecting a single best model. As described above, because the 1988 count was based on fieldwork focused on a single subpopulation within the park, it is plausible that individuals in the other subpopulations went unobserved and that this count is low. All parameter combinations that yielded a population trajectory fitting both the 1978 and the 1988 counts, as reported, underestimated the subsequent 1994 and 2000 counts. For example, even when K = 1000 and f = 59%, the model underestimated the 1994 count by 43 animals and the 2000 count by 86 animals (fig. 2c). However, without additional data it is difficult to estimate how low the 1988 count might have been. The 2000 rhino count, which recorded 544 animals, was conducted in the Chitwan Valley 'in and around the park' (Nepal 2004) and so is likely to be an overestimate of the number of rhinos in RCNP alone. Because this count is more recent, it may be possible to assemble extra information and approximate how many of these 544 rhinos were non-park animals.

A visual comparison of the predicted population trajectories (fig. 3) and the poaching data (fig. 1) suggests the strong negative impact poaching can have

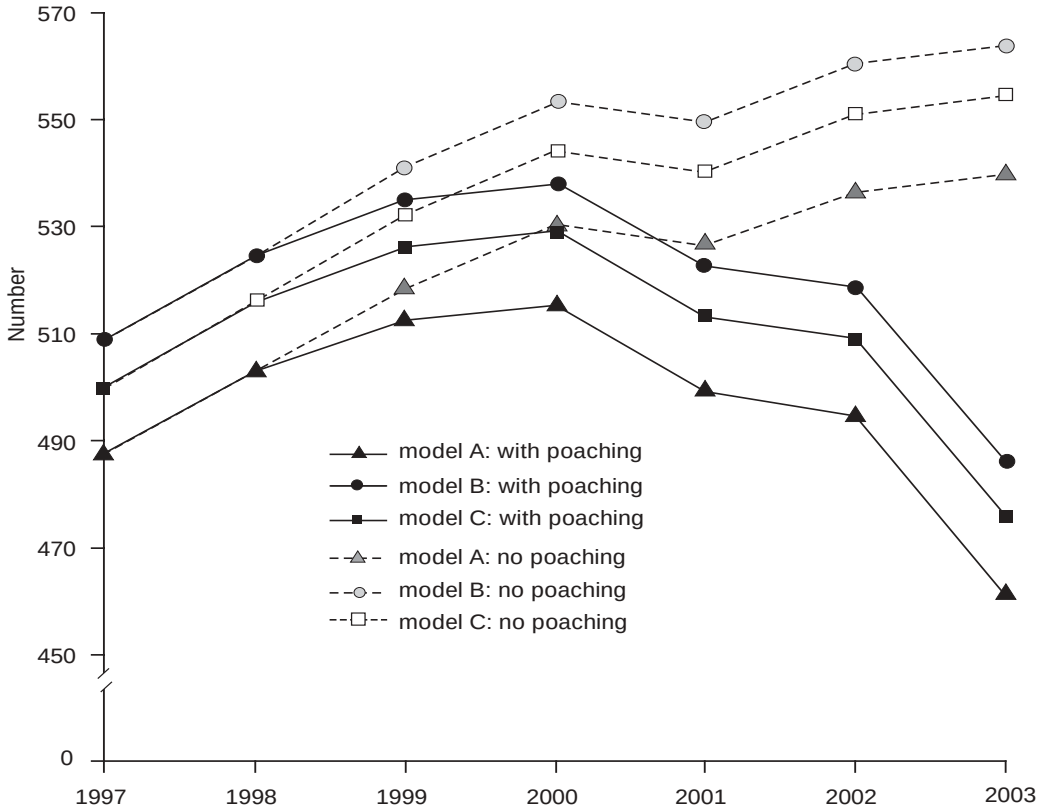

Figure 4. Modelled projections of what rhino populations are and what they would have been had the poaching in 2000–2003 not occurred.

on rhinos (objective 2). For example, the 17 poaching events in 1992 correspond to the predicted downturn in the rhino population size between 1991 and 1993. Similarly, the heavy poaching between 1998 and 2003 corresponds to a predicted drop in rhino numbers between 2000 and 2003. All three best-fit models indicate that if there had been no poaching between 1998 and 2003, the rhino population would have continued to rise (fig. 4).

Anti-poaching efforts such as those described by Martin and Vigne (1996) and promoted by the 2000 Anti-poaching Workshop conducted by the Department of National Parks and Wildlife Conservation and the World Wildlife Fund Nepal Program are critical to the recovery and persistence of rhino populations in RCNP and elsewhere (Martin 1998, 2001). In particular, actions that build support within local communities for conservation and create alternative income opportunities complement direct anti-poaching interventions. This process works by reducing social acceptability and the financial attractiveness of poaching (Milner-Gulland and Leader-Williams 1992). Much of the poaching in Nepal is thought to involve poor and marginal social groups who have few alternatives, and their activities may be tolerated by other groups who view rhinos negatively because of the damage caused to crop fields near the national park.

The significant loss of rhino habitat in and around RCNP and the increase in proximal human settlement (Martin and Vigne 1996) may have resulted in a reduction in the carrying capacity of the park (the density of rhinos sustainable over time; Dhondt 1988). Indeed if, as models A, B and C indicate, the current rhino count finds fewer rhinos now than in 2000, part of the cause may be a decrease in carrying capacity that has triggered density-dependent regulation via increased mortality rates, decreased birth rates, and increased emigration. However, it is important to note that models A, B and C indicate that a population decline will occur as a result of past poaching losses even if there has been no decrease in the equilibrium value *K* of RCNP. As described above, no model with *K* less than 840 showed a population trajectory that fit both the 1978 and the 1994 rhino counts. All three of the best-fit models use *K* equal to 1000. The model results suggest that the current rhino population is still considerably below an equilibrium value, and therefore natural (non-poaching) losses might equal or outpace gains and poaching cannot be viewed as a form of compensatory mortality. While it is logical that habitat loss and human settlement have had a negative effect on RCNP rhino population to some degree, this modelling exercise provides strong evidence that poaching has a major negative effect on rhino numbers (objective 1) and that the RCNP population size would be higher in the absence of poaching. This result again supports the importance of continued anti-poaching efforts.

As described above, the rhino population trajectory generated from demographic models described here is being used as input to an overarching bioeconomic model for natural, social and management systems for RCNP. One component of this larger modelling effort that makes direct use of the population trajectory is a retrospective econometric analysis of factors that may have influenced historical levels of rhino poaching. This analysis will indicate the effectiveness of current interventions and simulate the outcome of alternative policy options.

Acknowledgements

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Elephant reintroductions to small fenced reserves in South Africa

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Abstract

The Elephant Management and Owners Association has been collecting information on translocated elephants in South Africa for nearly 10 years. In 2001 a database was initiated and detailed information collected by means of a questionnaire. This paper deals with the question of whether the translocation of elephants can be termed successful according to the short-term indicators of natural reproduction, mortality rate and population growth. Between 1979 and 2001, over 800 African elephants, *Loxodonta africana,* were reintroduced to over 58 reserves in South Africa. The mean founder population size was 26.4 (minimum = 2 and maximum = 227). Thirty-eight reserves (68% of 56 reserves) have shown an increase of greater than 10% of the initial population. An average of 56% of the adult females that were translocated gave birth within 2 years, that is, were pregnant at the time of capture. When young orphans were translocated on their own, mortality was relatively high (18% of 226 animals), but mortality decreased when complete family groups were moved. This analysis confirms the short-term success of translocating elephants in small fenced reserves. However, there have been a range of behavioural problems, mainly linked to disrupted social structure, and these need to be studied further and managed.

Résumé

La *Elephant Management and Owners Association* (Association de Gestion et des Propriétaires d'Eléphants) récolte des informations sur les éléphants déplacés en Afrique du Sud depuis près de dix ans. En 2001, une base de données a vu le jour et des informations détaillées ont été récoltées au moyen d'un questionnaire. Cet article parle de la question de savoir si le déplacement d'éléphants peut-être qualifié de réussi d'après les indicateurs à court terme que sont la reproduction naturelle, le taux de mortalité et la croissance de la population. Entre 1979 et 2001, plus de 800 éléphants d'Afrique (*Loxodonta africana*) ont été réintroduits dans plus de 58 réserves en Afrique du Sud. La taille moyenne de la population fondatrice était de 26,4 (minimum 2 et maximum 227). Trente-huit réserves (68 % des 56 réserves) présentent une augmentation de plus de 10 % de la population initiale. En moyenne, 56 % des femelles adultes qui ont été déplacées ont mis bas dans les deux ans, cela signifie qu'elles étaient gravides au moment de la capture. Lorsque de jeunes orphelins étaient déplacés seuls, la mortalité était assez élevée (18 % sur 226 animaux), mais la mortalité diminuait lorsque des groupes familiaux étaient déplacés au complet. Cette analyse confirme le succès de la translocation d'éléphants dans de petites réserves clôturées. Cependant, on a observé toute une série de problèmes comportementaux, liés principalement à la rupture de la structure sociale, et ceux-ci doivent être étudiés et traités davantage.

Introduction

Over the last 20 years, translocation of African elephants *Loxodonta africana* to private or to other smaller state reserves has become a welcome option to removing surplus elephants in South Africa. Previously within the country only Kruger National Park (KNP), Tembe Elephant Park and Addo Elephant National Park had elephants. Translocation was initiated in KNP in the late 1970s but became popular with private landowners

only in the early 1990s. Acquisition of surplus elephants from KNP seemed an ideal option for many game reserves to enhance their tourism potential and at the same time to create populations outside the KNP complex. The Elephant Management and Owners Association (EMOA) has been collecting information on translocated elephants in South Africa for nearly 10 years. In 2001 a database was initiated and detailed information was collected by means of a questionnaire. To date 58 reserves within the country have elephants outside the KNP complex (see Results).

The aim of this paper is to document the history of these introductions and to assess their success in the short term. Defining success is extremely difficult, as it depends on the management objectives of a particular reserve. In the long term, a successful introduction would result in a viable population of elephants. However, as most introductions have been in place for only 10–15 years, it is impossible to assess long-term population viability. In addition, the size of the reserves to which elephants have been introduced, and the fact that these reserves are fenced and thus prohibit gene flow, means that each individual population could never be genetically viable. We therefore define success as a short-term measure, depending on whether the elephants have settled in the reserve and whether the population is reproducing. In this paper we aim specifically to 1) document the history of reintroductions to fenced reserves in South Africa, and 2) assess the short-term success of these translocations through studying elephant reproduction, mortality and population growth. Further, we discuss some problems with translocation into small, confined areas.

Methods

EMOA has been collecting information on translocated elephants for the past 10 years. In 2001 a comprehensive survey was conducted of all elephant populations outside the KNP complex. This complex includes KNP as well as all adjacent private and state reserves that are not fenced separately from KNP and therefore share common wildlife. The survey consisted of a written questionnaire that was completed by either the owner or the reserve manager, with additional information obtained in some instances from the relevant conservation authority. Where uncertainty existed a site visit was conducted. To ensure confidentiality to the private owners, only state reserves will be named. All private reserves are identified by a two-letter code.

The analyses include only wild, free-ranging elephant populations. All populations with the exception of Addo Elephant National Park and Tembe Elephant Reserve are introduced elephants. With minor exceptions all elephants originated from KNP. All reserves are fenced, and elephant populations are therefore isolated from each other.

In addition to the survey, EMOA collated qualitative information on introductions, particularly on incidents that occurred on reserves. We have included such information as we have available.

In the following the term ‘founder population’ is used solely for the purpose of first introduction and does not imply any biological or demographic factors.

History of elephant translocation

The elephant population in KNP had increased from an estimated 25 in 1908 to 6586 in 1967 (Whyte 2001), the year in which the first aerial census was conducted and management was initiated to keep the elephant population at a level of around 7000 (Whyte 2001). Changing land-use practices in South Africa have resulted in ranch land reverting to wildlife areas, and these have afforded the opportunity of reintroducing elephants to areas where they previously occurred. However, in the late 1970s translocation equipment allowed moving elephants only smaller than 2 m at shoulder height. This meant that until 1994 only juveniles could be captured and translocated during the massive culling operations; at that time, new techniques were acquired and entire family groups could be moved. Adult bulls over 20 years of age could be moved only from 1998, when appropriate equipment was developed.

A consignment of 26 juveniles was sent to zoos in the USA in 1966, but it was only in 1978 that translocation to wild areas was initiated. The very first 27 young elephants not destined for captivity went to Namibia in 1978, followed by another 61 young elephants during the next si years (KNP database 1996).

Other South African conservation agencies considered reintroducing elephants into reserves from which they had been extirpated, and the first eight elephants were moved to Pilanesberg Game Reserve from Addo Elephant National Park in 1979. Following this initial unsuccessful introduction (only one survived), in 1981, a further 18 young animals from

KNP were introduced, and in 1983 another 24 young animals followed. In 1982, two 19-year-old females were introduced from the USA, and two young animals from Namibia. A further 25 young animals were introduced in 1992, another 32 in 1993, and 6 large bulls were introduced in 1998, bringing the total to 117 introduced elephants (see Slotow and van Dyk 2001 for details).

Between 1981 and 1993, 172 elephants were introduced to Hluhluwe-Umfolozi Park (1981 = 8; 1983 = 8; 1984 = 10; 1985 = 30; 1986 = 6; 1987 = 18; 1988 = 35; 1989 = 35; 1990 to 1993 = 22) (data supplied by Natal Parks Board). During or shortly after the introduction process, 23 of the young orphans died.

Although the above introductions were successful, in that elephants remained within the reserves and reproduced (first young born in Pilanesberg Game Reserve in 1989, Slotow and van Dyk 2001), no further movements occurred until 1990 (fig. 1). Private landowners perceived translocation as an ideal way of establishing new populations and of enhancing the tourism potential of their game reserves. In 1990 the first seven private game reserves started purchasing juvenile elephants (fig. 1); since then, about four new reserves per year have purchased elephants.

In 1994 culling was temporarily put on hold at KNP, and this ended the supply of cull orphans available for translocation to new areas. In 1993 Clem Coetzee in Zimbabwe pioneered the technique of moving entire family groups. That same year the first large cross-border translocation of 200 female elephants and their offspring took place from Gonarezhou National Park in Zimbabwe to Madikwe Game Reserve in North West Province of South Africa. Simultaneously a translocation of 470 elephants within Zimbabwe (from Gonarezhou National Park mainly to the SAVE Conservancy) took place (JG du Toit pers. comm.). This began a new era of translocating elephants and since 1994 only entire cow-and-calf groups have been moved to new locations.

By 1997 KNP had developed specific transport trucks to transport large bulls, and between 1998 and 2002 about 118 adult bulls were translocated within South Africa—93 from KNP, the others were migrants, mainly from across the border, or animals who had broken out of a reserve.

By 2002, over 800 elephants had been translocated out of KNP. Most state reserves suitable for elephant introduction had acquired elephants by 1996, with only one state reserve having obtained elephants since then.

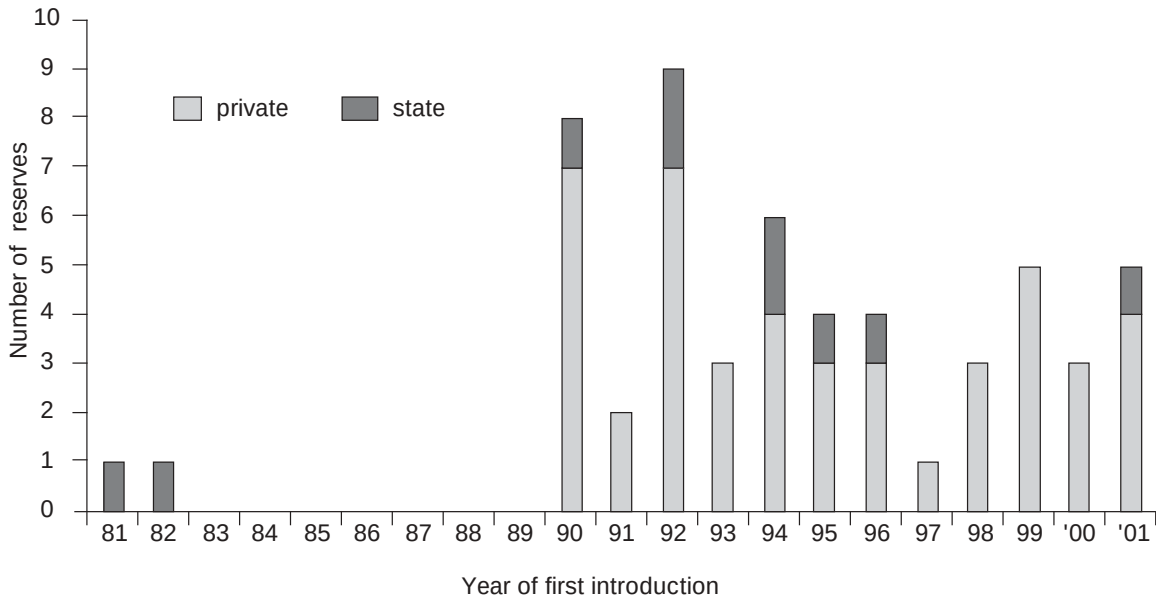

Figure 1. Year of first introduction of elephants to the reserves. Where multiple introductions to a single reserve occurred, only the year of first introduction is shown. The first successful introduction of animals from KNP to Pilanesberg occurred in 1981. The translocation of animals from KNP to Hluhluwe-Umfolozi Park started in 1982. Note that there were a series of introductions to the first two parks in the period from 1983 to 1989, but only the date of the first introduction to each reserve is shown.

At the time of the survey 58 reserves in South Africa had free-ranging elephant—12 state owned and 46 privately owned. Limpopo (Province) contains 50% (2 state, 27 private) of the reserves; it and KwaZulu-Natal (5 state, 12 private) make up 79% of the reserves with elephants in South Africa (fig. 2).

Distribution of elephants outside the KNP complex

Elephants were reintroduced into four major regions: Zululand in KwaZulu-Natal, the Waterberg and Hoedspruit areas in Limpopo, and a few in Eastern Cape (fig. 2). These patterns reflect the change in land use in those areas to game farming. Additional introductions have since taken place in the Eastern Cape and also a single introduction in 2003 to the Western Cape. Most of the elephant introductions have been to the savannah biome, with a few to the thicket biome, particularly in the Eastern Cape (fig. 2).

Number of elephants introduced

The minimum founder population size was 2 and the maximum was 227 with a mean founder population size of 26.4 (standard error 4.6) in the 57 reserves included in the analysis. Almost half of the reserves received 10 or fewer elephants (fig. 3). Above that level there is an even spread of introduction number. There was a significant increase in founder population size with increasing area (fig. 3). This is not surprising. However, there was a wide range away from the regression line. This indicates that there was little standardization in the initial density. Tenty-one reserves stocked above this predicted line, with some reserves stocking as much as 60% above the norm for that area, given the patterns of introduction across all reserves.

Thirty-nine reserves initially stocked at a density of < 0.2 elephants/km^2 (fig. 3). Several reserves initially stocked at levels much higher, and in fact at or above what may be considered an ecologically sensible stocking rate.

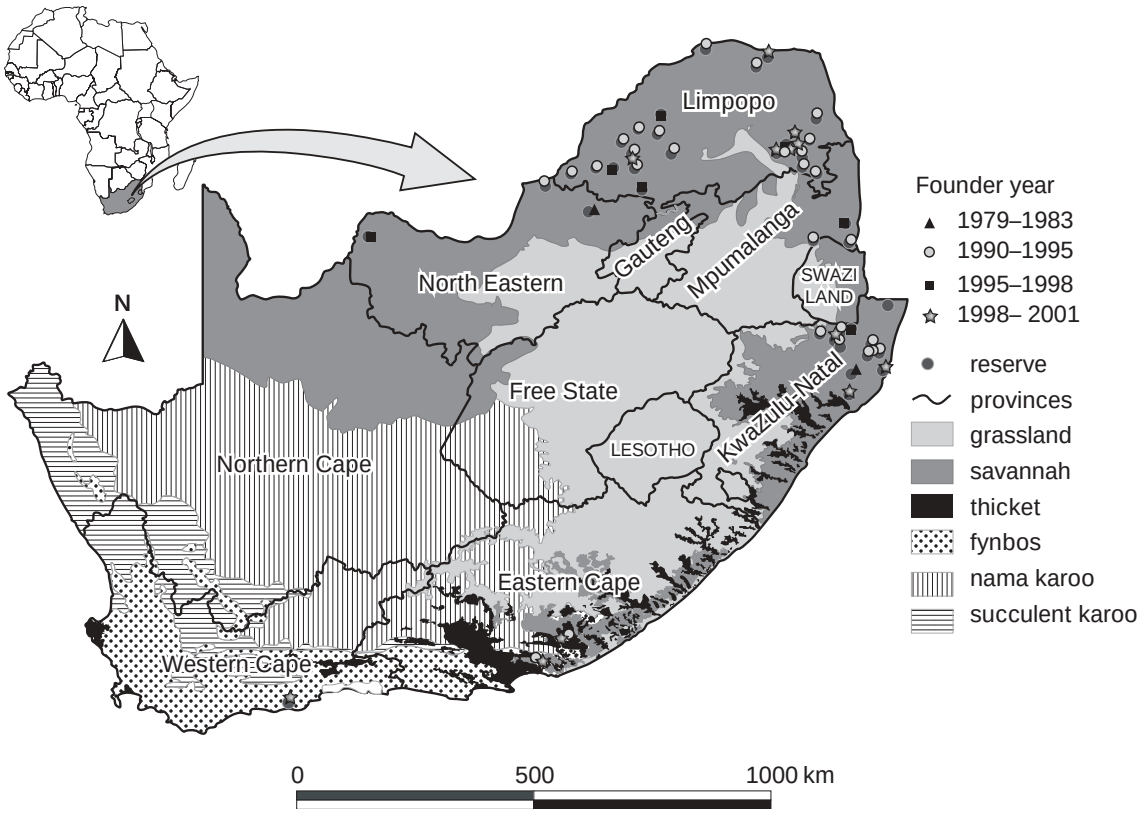

Figure 2. Distribution of reserves to which elephants had been introduced up to 2001 (Low and Robelo 1996).

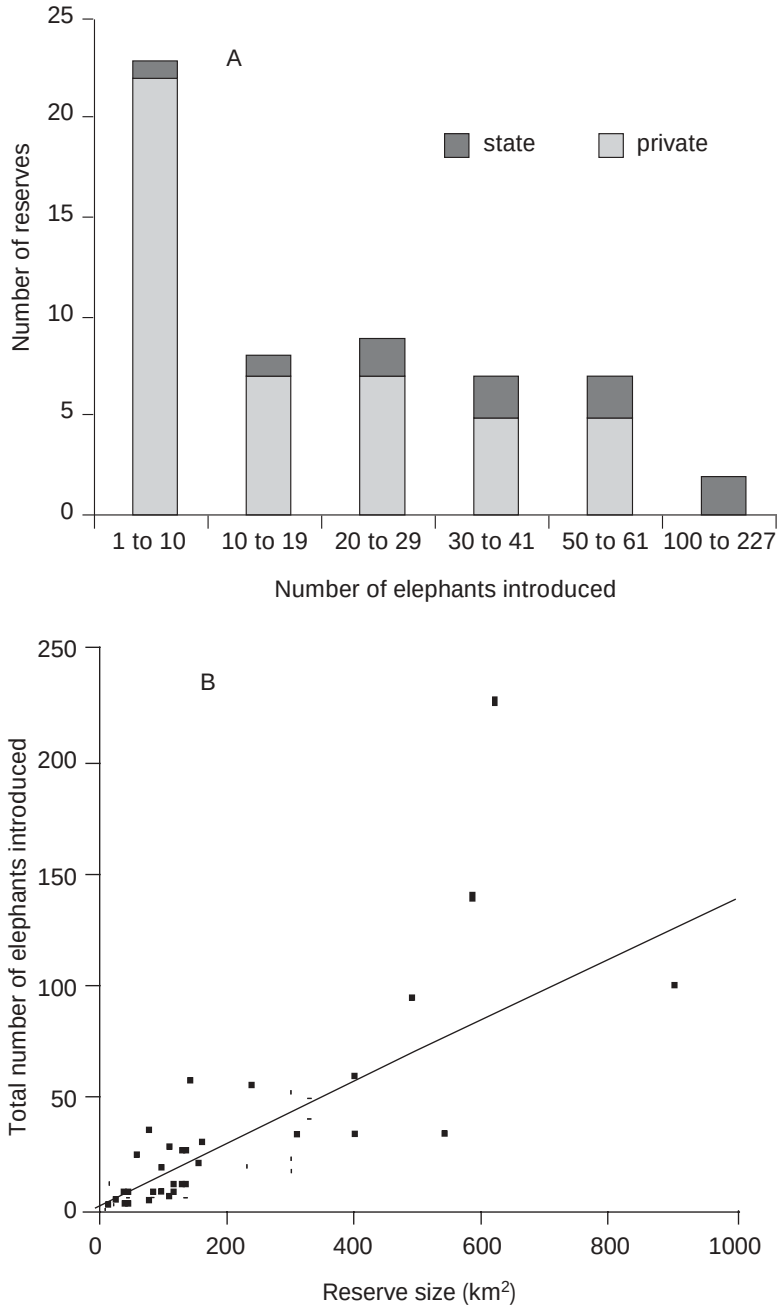

Figure 3. Number of elephants introduced to reserves in South Africa (founder population size). A. Frequency distribution of introduction totals. B. Introduction total relative to reserve size. Note that for multiple introductions values are the sum of all introductions to a reserve.

Population change

Thirty-eight reserves (68% of 56 reserves) have shown an increase of greater than 10% of the initial population (fig. 4). Of the reserves that showed no change, less than three years had elapsed since introduction in 5, and 10 had founder populations < 10 (< 5 adult females). The two reserves that showed a decline had 5 and 12 founders—all young orphans in the latter. Some reserves showed an alarmingly high population increase of up to 16% per annum (average population increase of 7.4% p.a.) (Slotow et al. in prep.).

Movement of pregnant females

For those reserves for which we have details of births per year since introduction we assessed how soon elephants were breeding. At 21 of the 23 reserves elephants had given birth within two years of introduction (table 1). We counted the number of adult females introduced and divided the number of births by that figure to get the percentage of females that gave birth over that period. An average of 56% of the adult females that were translocated gave birth within two years (standard error 8%). This means that those elephants were pregnant at the time of capture. In two additional reserves no adult females were translocated, but three of the subadult females gave birth within two years.

The important point to note here is that the effective founder population was actually much larger than originally thought because many of the females being introduced were pregnant.

Mortalities

Until 1994 only young animals were moved, and mortality was 17.5% (table 2), mainly due to the ig-

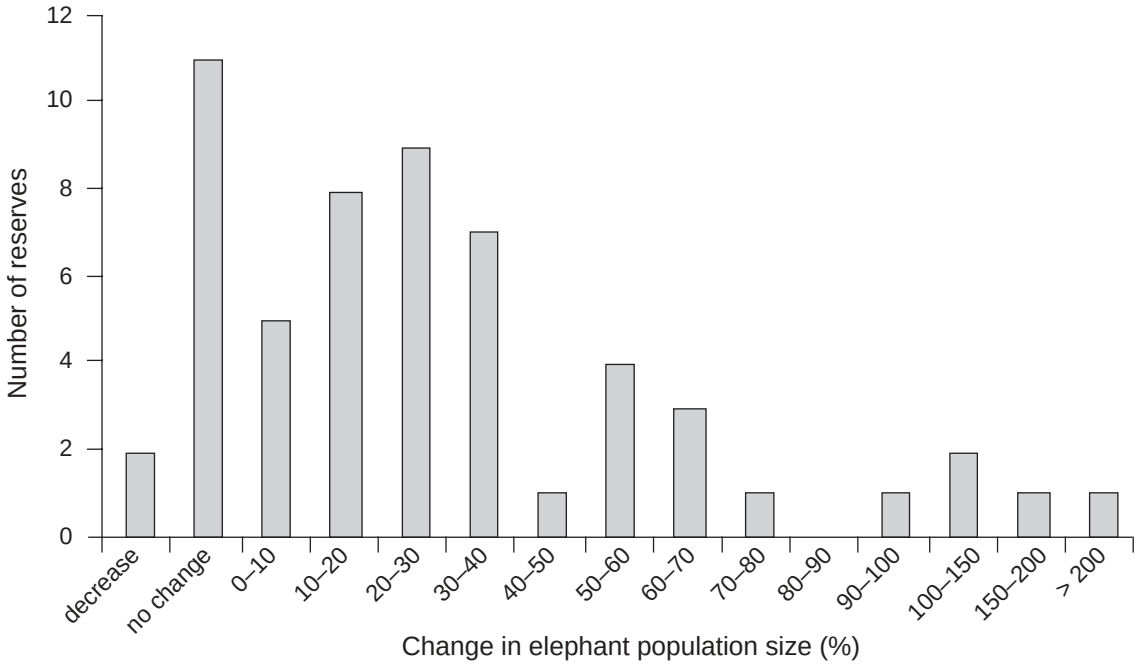

Figure 4. Change in elephant population size since introduction. Note that the number of years since introduction is not considered.

norance of most owners on how to raise very young elephants. Most deaths occurred shortly after introduction, and mainly very young calves were affected.

During 1994 the first family units were translocated; a few deaths occurred, mainly of young calves, probably due to stress. Some problem animals, including matriarchs, had to be shot after they broke out of a reserve. Thanks to better management and boma technology these incidents do not occur any more. Few deaths, other than through problem animal control or hunting, have been experienced to date after the elephants settled down in their respective reserves. Interestingly more males than females died between 1995 and 2002. Of the deaths not due to management intervention by culling or hunting, 46 were males and 22 females. Of the males, 12 were adults, 2 subadults, 12 juveniles and 8 calves, and 12 had no details given. Of the female mortalities, 2 were adults, 2 subadults, 5 juveniles (> 3 years), 2 calves and 11 had no details given.

Discussion

Since the initiation of translocation at KNP in 1978 over 800 elephants have been moved, including about 118 adult bulls. In the earlier days only juveniles were captured and moved during the yearly culling operations. After 1994, when culling was put on hold, entire family groups were moved.

To date 58 reserves have free-ranging elephant populations distributed over four main regions in South Africa. The minimum founder population size was 26.4 (range 2–227); 38 reserves have shown an increase greater than 10% of the initial population. All populations with over 15 founding individuals are growing at present, some of them more rapidly than the owners might wish. In 21 out of 23 reserves females gave birth within two years of introduction, indicating that they were pregnant at the time of capture, a fact totally ignored by decision-makers. One would expect a decrease in this growth figure over the next few years, especially on those reserves with few adult or subadult males.

Technology, equipment, and experience with capture, movement and introduction of elephants has increased over time. Although initially a large number of mortalities were associated with translocating orphaned juveniles, mortality resulting from the translocation process is now a rare event.

The results emphasize the broad short-term success of reintroducing elephants to small reserves in

Table 1. Effect of pregnancy at time of translocation

Reserve	Total	Total adult and subadult females	Births in 2 years	Births in 4 years	Adult and subadult females breeding in 2 years (%)
Madikwe	227	148	25	62	17
Az	56	19	5	6	26
Wd	50	25	30	30	120
Vt	41	9	4	0	44
Nz	36	12	2	0	17
St Lucia Park	34	13	1	0	8
Pg	30	7	5	7	71
Kz	28	15	2	0	13
Mk	27	15	6	8	40
Sd	26	8	4	0	50
Kw	21	7	1	0	14
As	20	10	4	9	40
Mg	20	8	2	2	25
Lp	12	6	1	0	17
By	10	3	1	0	33
Sh	9	6	3	0	50
CR	9	4	1	0	25
Kg	9	4	3	0	75
Mw	8	2	2	0	100
Wk	8	6	2	0	33
Mm	8	2	0	0	0
TT	8	3	3	0	100
Sb	7	3	1	0	33
Eb	5	2	0	0	0
Tk	3	1	1	0	100

South Africa, based on the criteria that the populations have not only persisted, but that they are reproducing at a rapid rate.

We now have the capacity to successfully create elephant populations. However, a number of intrinsic problems have not been dealt with. We have very little understanding of the long-term consequences of translocation on elephant society and behaviour. Movement of young animals without adults has led to problems with both males and females becoming aggressive to people (resulting in some deaths), vehicles, or other species such as rhino (Slotow et al. 2000; Slotow and van Dyk 2001; Slotow et al. 2001) or buffalo. Disruption of the social structure of a group of elephants leads to abnormal behaviour (Garaï 1997). Possibly this has also been the cause of some matriarchs becoming aggressive and some bulls and adult cows attempting to break out (Garaï and Carr 2001). Managers will have to deal with the legacy of past mistakes long into the future.

Recently suggestions of removing individual elephants out of the herds could have serious consequences on behaviour, and studies in this respect are needed. Already in some instances where the matriarch was either left behind (Gonarezhou National Park to Madikwe) or shot (due to break out and aggressive behaviour), the rest of the family was left without the knowledge carrier and security provider (Moss 1988; McComb et al. 2001; Kurt and Garaï in press). How this will affect future learning possibilities of the rest of the group and the general and individual behaviour patterns remains to be seen and studied. Overpopulation and high density are always referred to in an ecological sense. Little thought has been given to social density. In view of the high densities seen on some reserves, this topic needs investigation.

The challenges that lie ahead are great. Eventually elephant populations on small reserves will be faced with problems of genetic drift and bottleneck effects. Managers will be faced with serious challenges and will require alternatives to regulate their populations. Habitats have to be protected from being overused to the point of extinction, or their biodiversity from being seriously affected. At the same time the social, behavioural and other requirements of the elephants must not be compromised. Clearly we need to think fast before the whole well-intended translocation process turns into a disaster to the animals themselves. Owners and officials need to come up with plans to connect populations and provide possibilities for elephants to exchange genes, use larger areas and meet with social partners in order to live out their behavioural requirements according to their genetic make-up.

Although additional populations will no doubt be founded in the future, the number of elephants being translocated out of KNP is decreasing rapidly. A number of factors are driving this trend:

1. The permitting system for introducing elephants

Table 2. Mortalities of juvenile elephants in the early days of translocation for the years 1992–1994 (during this period only animals < 10 years old were moved)

Size class	Elephants introduced (no.)	Deaths (no.)	Cause of death
2, 3	43	2	mothers stressed, calves died
2, 3, 4	31	5	4 unknown, 1 killed by other elephants
1, 2, 3	30	2	1 male unknown, 1 male resold, died after long trip
2, 3	26	4	1 pneumonia, 2 accident, 1 stress, cold and constipation
2, 3	17	1	stress, was alone
1	12	8	stress, malnutrition
3	12	1	overdose of M99
3, 1	10	1	smallest died of stress
3	8	2	1 bullied, 1 killed by rhino
1	8	1	killed by lightning
2	6	1	snakebite?
1	6	3	sand colic, stress, sold, malnutrition?
2	4	1	killed by lion
1	4	1	would not eat branches
1	3	3	stress, malnutrition?
1	3	3	salmonella
3	3	1	pneumonia and stress
Overall	226	40	17.7%

Size classes: 1 = 1.20–1.34 m shoulder height; 2 = 1.35–1.48 m; 3 = 1.49–1.80 m; 4 = 1.8–2.1 m

is becoming more rigorous. The reasons are that problems and consequences of overpopulation experienced on many small reserves have suddenly become an issue and options available to the owners are limited. Official regulatory bodies therefore are taking a cautious approach.

2. Problems with managing elephant populations (that is, dealing with overpopulation) have led to owners and managers being more cautious with introducing elephants onto smaller reserves, partly due to habitat destruction and partly due to limited future management options. The only tools left to managers to deal with overpopulation are culling, immunocontraception and translocation. The first two are expensive, and translocation possibilities are limited, as certain factors need to be taken into account, such as natural separation into subgroups of animals before they are moved.
3. The number of large reserves able to hold family groups and bulls is limited.
4. Many of the reserves have already reached overpopulation and these elephants are now also available as a source for translocation (for example, Madikwe Game Reserve). The consequence is that KNP cannot rely on translocation within South Africa to alleviate the problem of growth in elephant populations. Now even small reserves are facing a dwindling market for their surplus elephants.

Translocations raise issues in two senses: ethical and social (that is, how we affect elephants), and practical (how the elephants affect us).

Ethical issues such as stress through high human densities have been and are currently being investigated (Burke et al. 2002; Pretorius and Slotow 2002). Management effects of immunocontraception are currently being studied at Makalali Game Reserve and a few other private reserves. The effects of other management interventions such as splitting groups, hunting and culling still need more study.

Practical issues include habitat use by elephants and how this affects management decisions and biodiversity. Decisions that are taken now have consequences long into the future. Landowners who introduce elephants have a responsibility to manage them in a sound, ethical manner into the future.

It is vital that we continue to study and understand the effects of past, present and future management interventions on elephant behaviour. In that way we can try to avoid making or repeating the errors of the past.

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The concept of home range in relation to elephants in Africa

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Abstract

The concept of home range has been a source of debate among ecologists, especially regarding animals such as elephants. Methods for determining home range that are widely reported in elephant literature are outdated and inaccurate. This paper outlines the concept of home range; it compares different methods that have been used to determine ranges and discusses their relevance to elephant ecology. Rainfall is used as a variable across elephant habitats to explain range variation.

Additional key words: *Loxodonta africana*, core areas, habitat destruction

Résumé

Le concept de domaine vital est une source de débats entre les écologistes, spécialement quand cela concerne des animaux tels que les éléphants. Les méthodes qui servent à déterminer le domaine vital et qui sont largement reprises dans la littérature sur les éléphants sont dépassées et inexactes. Cet article décrit le concept de domaine vital, il compare les différentes méthodes qui ont servi à déterminer les domaines et discute de leur adéquation avec l'écologie de l'éléphant. Les chutes de pluie servent de variables dans les habitats des éléphants pour expliquer les variations du domaine.

Mots clés supplémentaires : *Loxodonta africana*, aires centrales, destruction de l'habitat

Introduction

'One may wonder whether it is worthwhile to attempt to measure anything as indefinite and variable as home range' (Stickel 1954).

Elephants require large areas in which to roam. But the areas available to them are decreasing rapidly as humans clear and settle more of the elephants' habitat. The many organizations involved in wildlife conservation use the term 'home range' widely with reference to elephants. This review of the home range concept is made to illustrate the complexity of the concept when it is applied to the biological requirements of elephants, because of their unique ability to move vast distances and their long lifespan.

The definition of home range most often encountered in the literature was given by Burt (1943): it states that home range is 'the area traversed by the individual in its normal activities of food gathering, mating and caring for young'. The problem with this definition is the idea of 'normal'. He also notes that dispersal and 'occasional sallies outside the area, perhaps exploratory in nature, should not be considered as part of the home range'. White and Garrott (1990) state that home range is not the entire area over which an animal moves but the area over which it *normally* moves. Again, the problem is that mammals exhibit widely diverse movement patterns that are influenced by the resources available, social behaviour, predator avoidance and human disturbance. Some animals may regularly shift their range in response to environmental conditions.

The idea of home range is of interest because the properties of an animal's range should have adaptive significance and be a predictable aspect of its feeding strategy (Schoener 1981). Jewell (1966) states that 'home range is an area with a certain productivity that meets the energy requirements of the individual that occupies it'. McNab (1963) found that home range size could be expressed as a function of body

weight that was directly comparable with the function relating basal metabolic rate to body weight. The range of an animal is also affected by behavioural constraints, such as predator avoidance, territoriality and interspecific competition. It is important to remember Sanderson's (1966) caveat that the size and shape of an animal's home range has little significance in itself; rather, it is essential to concentrate on the ecological factors that affect it.

To help clarify the concept, Jewell (1966) suggested the term *lifetime range*, meaning the 'total area with which an animal has become familiar, including seasonal home ranges, excursions for mating and routes of movement'. It then follows from this baseline definition that the range assessments attained for relatively long-lived and highly mobile animals are 'snapshots' and do not represent all the places they have traversed in their lifetime. This is particularly important with regard to elephants, as they are both long-lived and extremely mobile. It is not unreasonable, therefore, to state that no accurate assessment of the lifetime range of a free-ranging elephant has been made.

The boundaries of a home range may shift and vary as use patterns change. Stickel (1954) notes that the edges of range should be seen as diffuse and as estimations rather than as being sharply defined. This attitude continues to frustrate efforts to make range estimation precise, as many of the decisions regarding key definitions are still surprisingly arbitrary. In their extensive review of radio telemetry and home range analysis, Harris et al. (1990) note that most authors do not state why they chose one method of analysing home range over another. The criterion on which they based their home range size estimation, the number of fixes, autocorrelation or determination of cores was also not consistently reported. However, it is generally believed that determining home range can be useful for a variety of reasons if the objectives are clearly defined and the techniques used are stated.

Core areas

Hayne (1949) observed that mammals do not use their entire home range with equal intensity but occupy certain areas with greater frequency than others do. Generally, researchers have been interested in the areas where animals spend *most* of their time. By definition, methods to estimate core areas identify areas of high animal activity and exclude occasional sallies.

For example, crop-raiding behaviour generally falls into the category of 'occasional sallies' and is therefore not easily incorporated into the present efforts to define home range structure. The sallies may be more important biologically than core areas. The core area may be over-represented as it will tend to be the location where an elephant is merely resting. In her study of home ranges of small mammals Stickel (1954) states that the 'extreme sallies of young animals may represent wandering or the dispersal of animals without an established range'. Some adults, however, make long trips that may be important for their orientation in their environment. Stickel (1954) also notes that males have 'a natural tendency for exploration that is important in the invasion of depopulated areas and in the extension of a species range'. Dispersal of young animals can be related either to behaviour such as competition for mates, or to finding new areas in response to lack of resources in an area. Dispersal in elephants is usually used in the context of wet-season movements. Young bull elephants leave family units and wander (Lee and Moss 1986), eventually associating with bull groups. The 'pioneering' phenomenon of bull elephants may be a more accurate description of this behaviour in certain cases. Bulls have been recorded preceding female herds into areas of traditional elephant range depleted of elephants. In areas where elephant habitat increased abruptly due to civil unrest (such as in Mozambique, Namibia), bull elephants often 'colonized' new areas from which people had moved before females came into them (Lindeque 1995). These factors are particularly important in connection with conflict with people.

Assessing home range

Kenward (1990) noted that there are at least six fundamentally different approaches for representing an animal's home range. A review of the literature on range analysis indicates that there is little agreement among authors about which technique is generally the most appropriate. Decision on which to use depends heavily on the questions being asked and the type of data being collected. Methods for calculating home range can be separated into those based on a statistical distribution of activity loci (Dixon and Chapman 1980) and non-statistical methods. Techniques for assessing range non-statistically involve either drawing polygons (convex, concave or re-

stricted) around the outer fixes or overlaying grid cells (White and Garrott 1990). Probabilistic methods include drawing probabilistic circles or ellipses around all the fixes (Jennrich and Turner 1969) or using mathematical equations to draw contour lines around percentages of fixes (Dixon and Chapman 1980).

The simplest way to estimate the size of a home range is to draw a polygon that encloses all the points then estimate the area in the polygon. The *minimum convex polygon* (MCP) (Mohr 1947) is simple to calculate and is the most widely published estimate of range size. However, it is an unsatisfactory estimate because it has been shown that the range estimate continues to increase as more fixes are added (Jennrich and Turner 1969) or that the range estimate is a function of the number of locations used to generate the range (White and Garrott 1990). MCPs are also heavily influenced by 'outliers' and sample size (Schoener 1981). It is a common procedure to eliminate the outer 5% of fixes in the range. This technique has also been criticized because when two fixes are closely spaced but far from the majority of locations, the area contributed to the polygon by each of the outliers is small (Kenward 1987). Removing one fix may reduce the area of the polygon only slightly. The other limitation of this technique is that MCPs estimate the total area and give no indication of areas of intensive use.

Structure of core areas

It is not only the size and shape of a home range that is of interest, but also its *structure.* To determine the structure, one first determines the 'centre of activity' by using either the arithmetic mean (the mean of *x* and *y* coordinates) or a harmonic mean (inverse reciprocal mean of distances) for a set of fixes (Kenward and Holder 1995). One common approach to determining a 'core', is to draw an MCP around 50% or 60% of fixes farthest away from the 'centre of activity' (fig.1a). However, this technique encounters the same problems listed earlier for the MCP method (Clutton-Brock et al. 1982). Increasingly, non-parametric approaches are being used because no assumptions are made about the shape of the area used.

The variability seen when examining the use of an area by an animal is generally referred to as *utilization distribution* (Worton 1989). A common method to measure home range was the arithmetic mean centre or the geographic centre of all points. However, this 'centre of activity' may not have any biological significance and certain home-range configurations may cause this point to lie outside an animal's actual home range (for example, a boomerang-shaped range) (Harris et al. 1990).

The *harmonic mean* (HM) has been widely used as a measure of animal activity centres (Dixon and Chapman 1980) (fig. 1b). The HM technique first calculates the harmonic centre of the fixes, which is the location where the inverse reciprocal mean distance to all other fixes is minimal (Spencer and Barrett 1984). Then isolines (contours) are drawn to predetermined percentages of fixes. The mathematics of contouring aims 'to define the fix density distribution and provide an ideal approach for identifying an activity centre' (Kenward 1990). However, the HM method has some drawbacks in that the contours that include all fixes tend to 'balloon' into areas never visited by an animal (Kenward and Holder 1995).

An approach that is effective at separating core from outlying fixes is the *cluster* method (fig. 1c). This technique identifies the densest cluster of fixes and then either adds fixes to it or starts a new cluster depending on distances of neighbouring fixes (Kenward 1987). This system is particularly useful for identifying patches of usage (Kenward 1990).

The *kernel* method proposed by Worton (1989) is similar to the HM method but uses the 'kernel fix estimator' instead of the HM centre and tends to give a more accurate representation of range. This method generates a grid using raw fixes and calculates the estimated probability of finding a location at any point in the study area (fig. 1d). The kernel method is preferable to the HM method because the output is the actual probability values. The HM method gives, for any given point on a map, a number that is the distance of that point from an 'activity centre' (R. Charif pers. comm.). Both methods, however, depend on contouring, which in turn depends on density estimation at intersections of an arbitrary grid imposed on the fixes. The kernel analysis described in Worton (1989) does minimize grid dependence by avoiding inverse reciprocal functions. Kenward (1990) states the 'density estimation is a smoothing process, so that even core isolines do not always conform well to the fixes'.

Figure 1 illustrates the differences between the four commonly used methods for home range estimation, using the same set of fixes. Table 1 shows the area enclosed by the different contours for the four methods. While the MCP is considered a poor estimate of home

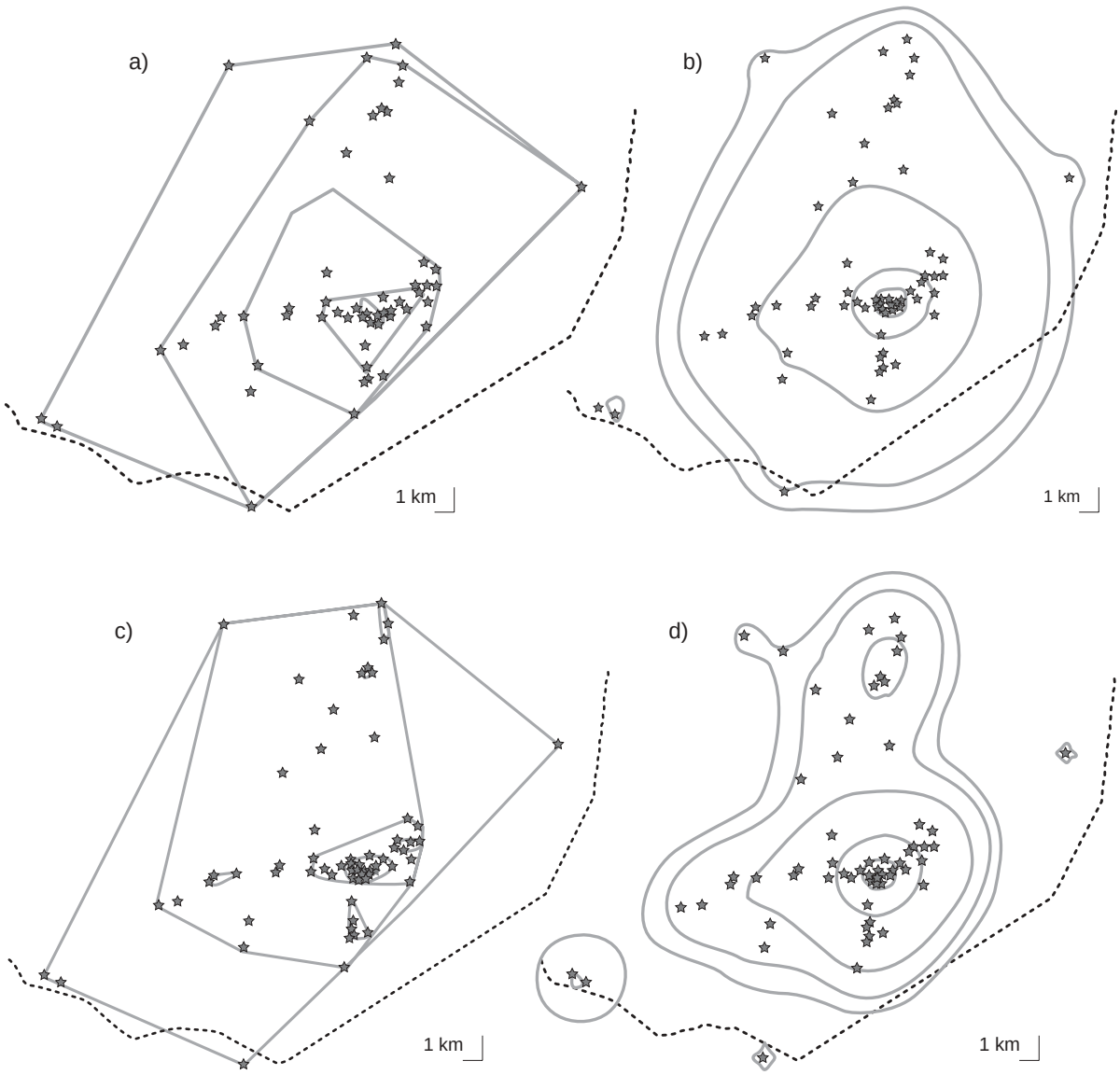

Figure 1. Four commonly used methods for estimating home range, using the same set of fixes: *a)* minimum convex polygon or MCP; *b)* harmonic mean; *c)* cluster; *d)* kernel.

range, it is still widely used. The kernel method, which appears to give the most accurate representation of the structure of an animal's range, is used for more precise estimates of total range and core area sizes.

Variation in range sizes

Comparing range size between elephant populations in different habitats is fraught with difficulty because the most widely used estimation of range is the MCP. As noted, MCPs are heavily influenced by outlying fixes although some trends are noticeable. Thouless (1996), in a review of the literature, points out that some elephant populations are 'sedentary' (for example, in Lake Manyara National Park, Douglas-Hamilton 1972) while others are nomadic or disperse in the wet season (Leuthold 1977; Viljoen 1989; Lindeque and Lindeque 1991). He demonstrates that home range sizes for el-

Table 1. Area included in different percentages of fixes by the four methods used in figure 1

	Percentage of fix and coverage in km²				
Type of analysis	25%	50%	75%	95%	100%
MCP	0.39	3.95	24.73	79.91	121.34
Harmonic mean	0.79	4.26	34.94	125.17	162.19
Cluster	0.20	1.18	5.45	67.22	121.00
Kernel	0.77	5.10	29.64	71.43	101.39

ephants in Laikipia District in Kenya are inversely correlated with rainfall. Data obtained from the literature suggests that more factors may be influencing range size than just rainfall and primary productivity. These factors include the distribution of surface water, the topography of the landscape, and the diversity and quality of the soil and vegetation. There does, however, seem to be a relationship between rainfall and elephant range size. Using 100% MCPs, table 2 shows home range sizes for cows and bulls.

Figure 2 compares the mean annual rainfall and the ranges for the elephant populations listed in table 2. The relationship between rainfall and home range size does exist, but the trend is weak. It is not clear whether this is because home range was estimated inaccurately due to previously noted problems with

Table 2. Published home range sizes of male and female elephants based on 100% minimum convex polygon and the relationship to rainfall in different habitats

Location [a]	Home range size (km²)	No. [b]	Annual rainfall (mm)	Reference
Female elephants				
Tsavo East NP	2380	8	300	Leuthold 1977
Namibia	5800–8700	7	315	Lindeque and Lindeque 1991
Amboseli NP	2756	6	350	Western and Lindsay 1984
Laikipia	600–800	14	400	Thouless 1996
Kruger NP	129–1255	21	550	Whyte 1993
Tsavo West NP	408	2	550	Leuthold 1977
Transvaal	115–465	11	600	De Villiers and Kok 1997
Hwange NP	1038–2544	11	632	Conybeare 1991
Waza NP	2484–3066	2	700	Tchamba et al. 1995
Laikipia	450–500	4	750	Thouless 1996
Zambezi Valley	156	11	800	Dunham 1986
Queen Elizabeth NP	363	6	900	Abe 1994
South India [c]	105–115	2	900	Sukumar 1989
Lake Manyara NP	10–57	2	1000	Douglas-Hamilton 1972
Male elephants				
Tsavo East NP	1035–1209	2	300	Leuthold and Sale 1973
Tsavo West NP	294–337	2	550	Leuthold and Sale 1973
Transvaal	157–342	21	600	De Villiers and Kok 1997
Hwange NP	1300–2981	7	632	Conybeare 1991
Sengwa	322	9	668	Osborn 1998
Queen Elizabeth NP	500	6	900	Abe 1994
South India [c]	170–320	2	900	Sukumar 1989
Malaysia [c]	32–60	4	2500	Olivier 1978

[a] Listed in ascending order of rainfall
[b] Number of elephants used in the analysis
[c] Asian elephants included for comparison
NP – national park

the MCP method or if other factors are influencing these results. Elephants in the Communal Lands of north-eastern Zimbabwe appear to have much larger ranges than those that are always in protected areas (Taylor 1983). The rainfall in the protected areas and in the Communal Lands in this part of Zimbabwe is similar. What is causing the variation in range? Perhaps it is caused by human settlement.

Human impact on elephant ranging patterns

Numerous authors indicate that human settlement patterns and illegal hunting have had a profound effect on ranging patterns of elephants. Rapidly expanding human populations maintained by a subsistence economy are changing land-use patterns in a way that constricts the habitat available to elephants. Human encroachment into elephant habitat cuts off the channels through which elephant populations responded to environmental fluctuations, such as emigration and dispersal (Watson and Bell 1969). For example, seasonal migration is affected by human pressures, primarily poaching, in the elephant wet-season range in Amboseli (Western and Lindsay 1984). Lewis (1986) noted a shift in elephant feeding patterns once the disturbance of poaching was relieved in the Luangwa Valley in Zambia. Human interference and harassment influences movement patterns of elephants in the forests of Central Africa (Ruggiero 1992; Barnes et al. 1992; Tchamba et al. 1995). Kangwana (1995) found that elephant movements are strongly affected by competition with pastoralists over livestock forage and access to water and by direct, targeted killing by warriors in Amboseli National Park.

In dry areas, the general trend for elephants is to move large distances in search of food and water. In wet areas, elephants tend to have smaller home ranges because both food and water are more available. However, this trend is not always seen in the rainforest. Merz (1986) reports that forest elephants (*Loxodonta africana cyclotis*) can move considerable distances in the wet season. The home range of forest elephants in Cameroon varies between 224 and 315 km^2 (Powell 1997). I suggest that rainfall may once have had a strong impact on the size of elephant home range, but now the major influence in many areas is the size of the area in which elephants are allowed to move

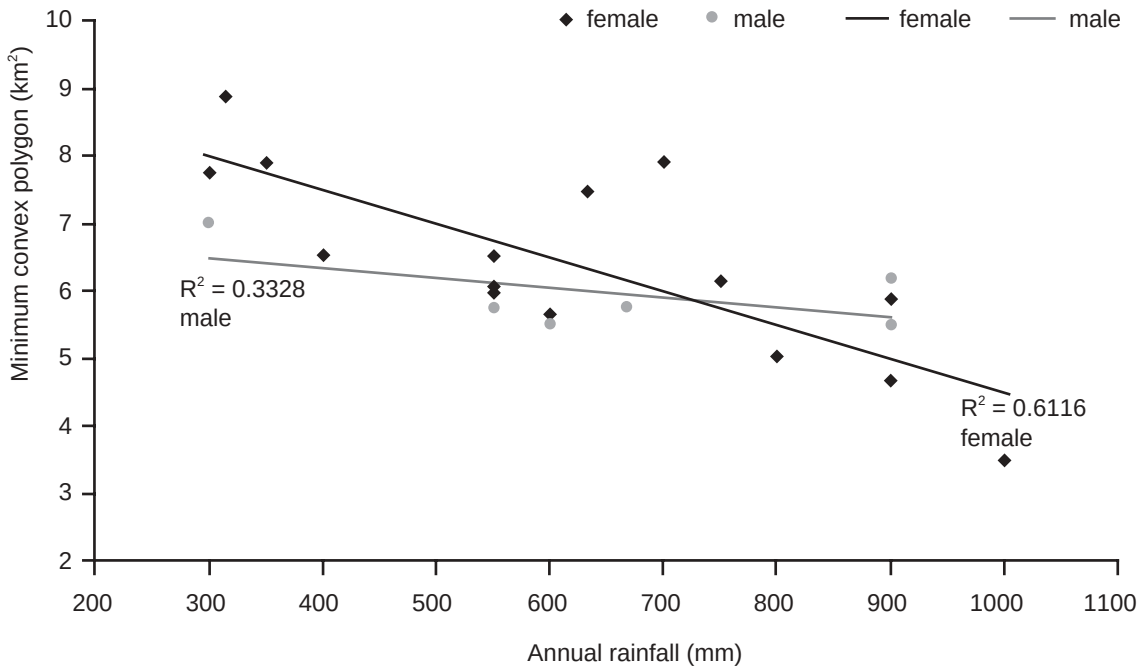

Figure 2. Home range size (100% minimum convex polygon (MCP)) for male and female elephants from across Africa and Asia, compared with the mean annual rainfall. See table 2 for sources of information on other populations.

unimpeded. From the data in table 2, it appears that the estimated ranges relate more closely to the size of the area in which the elephants are free to roam, unharassed, than to rainfall patterns. In dry areas, there tends to be little agriculture, thus elephants are able to range over much larger distances. In wet areas, agriculture is far more intensive and the elephant home range is correspondingly restricted. For example, the range that Douglas-Hamilton (1972) found for the Lake Manyara National Park elephants is almost exactly the size of the protected area available to them. In Namibia, at the other extreme, there are almost no restrictions to the east–west movement of elephants and they use the available habitat fully (Lindeque and Lindeque 1991).

Conclusion

This review outlines the concept of home range with regard to elephants and different commonly used techniques to measure it. The importance of understanding core areas and linking their relevance to elephant conservation is noted. The influences that dictate range size are related to rainfall, but human influences may now play a larger role in determining where elephants can roam.

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The elephants (*Loxodonta africana*) of Zoba Gash Barka, Eritrea: Part 3. Ecological and other data from tusks, teeth and carcasses

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Abstract

There are approximately 100 elephants in Eritrea; they survive in unprotected areas and migrate into Eritrea from Ethiopia during the dry season and return to Ethiopia during the wet season. These elephants are isolated. Their habitat consists of doum palm, ziziphus and acacias. Between 2002 and 2004, 11 elephants were found dead. Four had fallen into water wells dug by humans, two were killed by farmers; the other five died of unknown causes, although some exhibited pathological bones and teeth. There are no known cases of elephant poaching. Data obtained on tusks since 1993, although meagre, are the most comprehensive compiled thus far for Eritrea. Based on measurements of 31 tusks, average total length was 103.2 cm, average weight was 8.7 kg, and the average age at death was ~15.1 years. These and other averages can be used as bases for future comparisons with other elephant populations and to assess differences in age groups and between sexes. Weight appeared to be above the average for elephant populations in Africa but lower than the eastern Africa average. Our observations confirmed that a healthy elephant population inhabits parts of Eritrea; this population suffered a loss of approximately 5% per annum over the period of our study. Measures must be taken to prevent young elephants from falling into artificial water wells. A detailed study of the remains of dead elephants should be conducted to learn of possible causes of death and urgent steps should be taken to protect this beleaguered elephant population.

Additional key words: accidental death, ecology, elephant pathology, tusks

Résumé

Il y a approximativement 100 éléphants en Erythrée ; ils survivent dans des zones non protégées, migrent d'Ethiopie en Erythrée pendant la saison sèche et font le trajet inverse pendant la saison des pluies. Ces éléphants sont isolés. Leur habitat consiste en palmiers doum, en ziziphus et en acacia. On a trouvé onze éléphants morts entre 2002 et 2004. Quatre sont tombés dans des puits creusés par des hommes, deux ont été tués par des fermiers et les cinq autres sont morts de cause inconnue, même si certains présentaient des dents et des os pathologiquement atteints. Il n'existe pas de cas connu de braconnage d'éléphant. Les données obtenues depuis 1993 sur les défenses, quoique maigres, sont les premières pour l'Erythrée. D'après les mesures de 31 défenses, la longueur totale moyenne était de 103,2 cm, le poids moyen était de 8,7 kg et l'âge moyen au moment de la mort était d'environ 15,1 années. On peut se servir de ces moyennes, et d'autres, comme bases pour de futures comparaisons avec d'autres populations d'éléphants et pour évaluer les différences entre les groupes d'âge et entre les sexes. Le poids semblait se situer au-dessus de la moyenne générale des populations africaines mais en dessous de la moyenne d'Afrique orientale. Nos observations ont confirmé qu'une population saine d'éléphants habite certaines parties de l'Erythrée ; cette population subit une perte d'environ 5 % pendant la période de notre étude. Il faut prendre des mesures pour empêcher les jeunes éléphants de tomber dans les puits artificiels. Une étude détaillée des carcasses d'éléphants morts devrait être réalisée pour en connaître les causes possibles et il faut prendre des mesures urgentes pour protéger cette population coupée des autres.

Mots clés supplémentaires : mort accidentelle, écologie, pathologie des éléphants, défenses

Introduction

In historical times (from the 3rd century BC to the 19th century) elephants in Eritrea were observed in many parts of the country where there are no elephants today, but also in Zoba Gash Barka where they are now found. During the 20th century they were confined to Zoba Gash Barka. Approximately 100 elephants live in south-west Eritrea; they subsist in unprotected habitats consisting mostly of doum palm, ziziphus and acacia in various locations within the watersheds of the Gash and Setit Rivers. This population is fecund and appears in good physical condition.

In part 1 of our findings (Hagos et al. 2003) we focused on documenting historical records of elephants in Eritrea; in part 2 (Shoshani et al. 2004) our findings centred on elephant census and distribution, and aspects of elephant ecology and ecosystem. In this third part of our findings, we summarize nine years of ecological data retrieved from tusks and three years of data from dead elephants, and what lessons can be learned.

Habitat of current elephant distribution in south-western Eritrea

Eritrea may be divided into three phytogeographic zones: Sudanian, western lowland; Afromontane, highland; and Somalia-Masai, eastern lowland (White 1983). Further subdivisions into western lowland, western escarpment, central highland, eastern escarpment, and coastal lowland have been employed by Zinner et al. (2000). Elephants in Eritrea inhabit a portion of the Sudanian phytogeographic region. There are two rainy seasons in Eritrea, the short season, from about March to April, and the long season from about June to September. Elephant habitat in Eritrea is xeric (dry) to semi-desert with an average of up to 600 mm of rainfall per year during May and September. Zoba Gash Barka includes the only permanent river in Eritrea, the Setit (Tekezze) River, that marks the boundary between Ethiopia and Eritrea in the south-west (fig. 1). Based on previous observations (Hagos et al. 2003; Shoshani et al. 2004) elephants in Eritrea are physically and possibly genetically isolated, yet they migrate between Eritrea and Ethiopia—during the dry season from Ethiopia into Eritrea and in the reverse direction during the wet season. Elephant poaching has not been reported in Eritrea; killings by farmers were to protect farmlands.

Materials and methods

Materials

Tusks were collected from dead elephants by staff of the Ministry of Agriculture (MoA) or were brought by farmers and villagers to local authorities as from 1993. Local people were interviewed to learn about the habits and behaviour of the elephants before they died. Tusks are kept at government storehouses in Barentu, Haicota and Asmara. Bones and teeth are stored at the National Museum of Eritrea (NME), or at the University of Asmara (UoA), both in Asmara. The pathological data in this paper were drawn from field observations from elephants that died recently, and from collections at NME and UoA.

Methods

The preferred method of investigation was direct observation of dead elephants. Information from villagers and farmers was also obtained. Every datum possible was collected from carcasses (cf. Whyte 1996), including external observations, forefoot diameter and length of hind foot to calculate shoulder height and estimate age. Calculation of the shoulder height from the forefoot diameter was done by multiplying the circumference by 2.03 (following Sukumar et al. 1988). Hind foot lengths were employed to estimate ages of elephants using the formula of Western et al. (1983) and data from Lee and Moss (1995). Data on tusks were collected after Laws (1966, 1969), Pilgrim and Western (1983, 1986), Moss (1996) and Ngure (1996) (fig. 2). These measurements include tusk weight (n = 28), total length (n = 29), length at lipline (n = 24), circumference or girth at lipline (n = 24), circumference at base (n = 31), and pulp length (n = 29). Dental characters for age estimation were collected after Laws (1966) and Sikes (1971). Elephant skull measurements, as given by Groves and Grubb (1986), were also collected. All observations were documented either in field notebook or by photograph (fig. 3), or both. Data on tusks reported here include those collected since 1993 and for dead elephants since February 2002. Tissue and dung samples were collected for DNA analysis.

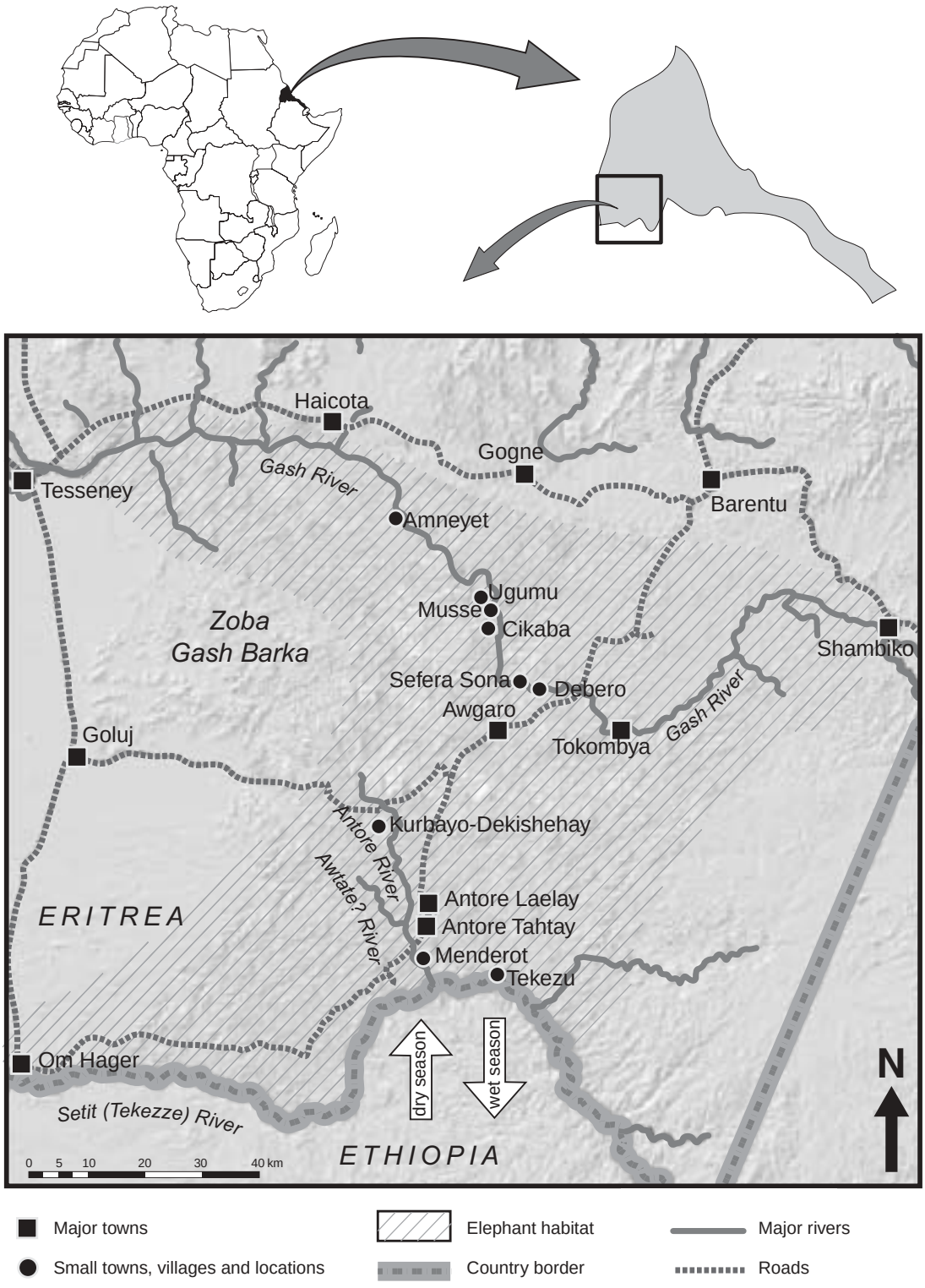

Figure 1. Distribution of elephants in Zoba Gash Barka, Eritrea, based on data presented in table 1 of Shoshani et al. (2004), and place names where elephant carcasses were found (technical and artwork by Maria Christine Hill and Philip Miyare).

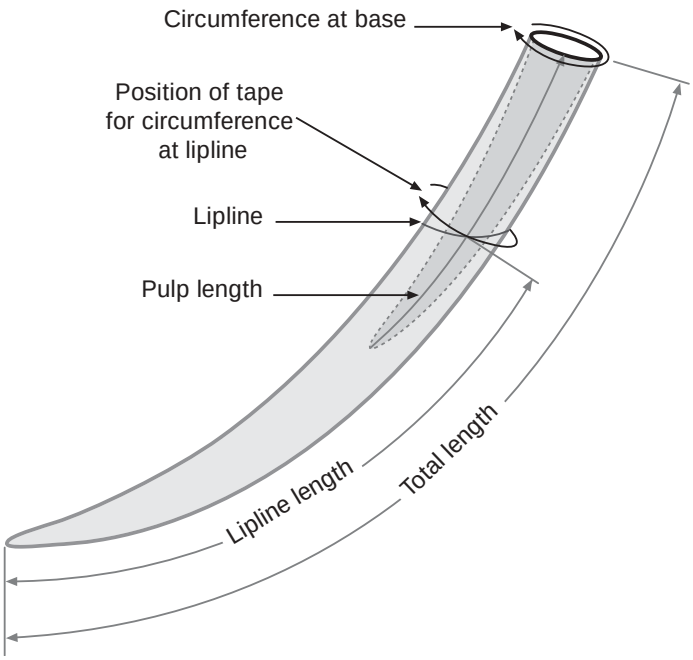

Figure 2. A simplified illustration depicting measurements given in table 2 (artwork by G.H. Marchant, modified after Ngure 1996).

Results

Reports on 11 elephants that died recently

A summary of known elephant mortality between 2 February 2002 and 20 May 2004 is given in table 1. Additional details including information on possible causes of death are provided below. Listing is chronological by date of death.

Elephant No. 1, died on 2 February 2002, near Tekezu village close to the Setit (Tekezze) River. In June 2002, we travelled to this site to collect the remains of the carcass. Before dismembering it, we noticed that its tusks were absent. We collected a short piece of one tusk (tusk no. 9, table 2) but did not find the other. Epiphyses of some of the long bones were separated and chewing marks (probably of hyenas, other carnivores and rodents) were evident. Some bones, large and small, were found at a radius of about 30 m from the carcass. There were no bird droppings

J. Shoshani

Figure 3. Five average-sized tusks (two pairs and one odd) at Ministry of Agriculture storage, Barentu.

Table 1. Summary of information on elephant carcasses in Eritrea, February–May 2004

No.[a]	Date of death	Location	Cause of death[b]	Age(yr)/ sex[c]	Notes[d]
1	2 Feb 2002	near Tekezu village; GPS: N 14°27.30', E 37°17.17'	unknown, possibly from cholelithiasis	~ 25/M	no. 9 in table 2; tusk fragment housed at MoA, Asmara; pathological bones
2	14 Mar 2002	near Debero village; GPS: N 14°49.92', E 37°20.47'	unknown	~ 10/M	nos. 10, 11 in table 2; tusks housed at MoA, Asmara
3	13 June 2002	Cikaba near Ugumu village; GPS: N 14°54.22', E 37°17.58'	fell into a water well by the Gash River	juvenile/?	nos. 12, 13 in table 2; tusks housed at MoA, Barentu
4	8 Nov 2002	Tekezu area; GPS: N 14°26.11', E 37°19.11'	unknown	20–30/M	nos. 14, 15 in table 2; tusks housed at MoA, Barentu; pathological bones and abnormal dentition
5	22 Nov 2002	Awtate River; GPS: N 14°32.46', E 37°10.88'	unknown	~ 15/M	no. 16 in table 2; right tusk at MoA, Barentu
6	21 Apr 2003	Sefera Sona; GPS: N 14°50.47', E 37°18.55'	fell into a water well by the Gash River	~ 7/?	collected skin samples for DNA analysis
7	7 May 2003	Musse site; GPS: N 14°52.89', E 37°17.94'	fell into a water well by the Gash River	~ 2/?	collected skin and hair samples for analysis
8	26 Oct 2003	Kurbayo-Dekishehay; GPS: ~N 14°32.23', ~E 37°09.62'	killed by farmers	~ 5/?	no samples or tusks collected
9	Nov 2003	near Amnayet; GPS: N 15°04.03'', E 37°09.88''	shot by farmers	10–15/?	nos. 17, 18 in table 2, right tusk at MoA, Haicota; tissue samples collected
10	4 Feb 2004	Menderot R; GPS: N 14°27.73', E 37°11.86'	unknown	subadult/?	nos. 19, 20 in table 2; tusks
11	20 May 2004	Debri Mussa, near Ugumu; GPS: N 14°35.30', E 37°17.10'	fell into a water well along the Gash River	juvenile/?	no samples or tusks collected

[a] Listed chronologically by date of death.
[b] Additional details on possible causes of death are given in the text.
[c] M = male; ? = sex unknown
[d] Data on tusks are given in table 2 and in the text.

on the skin, although in eastern Africa droppings are often observed, as large birds (raptors and marabou storks) scavenge on the remains. A relatively large shrew, possibly a white-toothed shrew, *Crocidura ?olivieri* (Lesson, 1827) (Insectivora, Soricidae), was seen escaping from the carcass. We searched but did not find any bullets or bullet holes in the skin.

Between 21 and 22 June we removed all bones (including the hyoid apparatus), cleaned and transported them to NME in Asmara, some 400 km away. While removing putrid and decomposing flesh from the lumbar region, we noticed a large round to oval-shaped object that measured 22 x 14 cm in cross section and weighed approximately 4 kg. The internal content of this object was fine, clay-like, orange-yellow particles. Samples were sent for analysis to the USA; results on cholelithiasis are reported below. We think this elephant was a male (based on large tusk diameter, round mandibular condyle, and protruding tip of mandibular symphysis). Other unusual anatomi-

Table 2. Data on tusks and dentition of elephants from Eritrea

Tusk no.[a]	Weight (kg)[b]	Total length (cm)[c]	Length at lipline (cm)[d]	Circumference at lipline (cm)[d]	Circumference at base (cm)[e]	Pulp length (cm)[f]	Estimated or (extrapol.) age (yr)[g]
1-L	13.0	120.0	66.5	39.0	43.0	64.5[a]	(~ 20)
2-R	12.0	112.5	63.5	37.3	41.0	49.5[a]	(~ 20)
3-L	8.0	114.5	64.0	30.5	37.5	62.5[a]	(~ 12)
4-R	7.0	104.0	51.0	30.0	36.5	59.0[a]	(~ 12)
5	10.5	106.7	64.0	37.0	42.5	47.0[h]	(~ 20)
6	~ 5.0	90.0	—	—	26.5	29.0[i]	(~ 11)
7-L	~ 12.0	104.0	—	—	42.5	—[j]	(~ 20)
8-R	11.5	114.5	—	—	40.5	70.5[j]	(~ 20)
9	—	—	—	—	43.5	—[k]	~ 25
10-L	3.0	77.0	45.0	23.5	27.0	55.5[l]	~ 10
11-R	2.8	79.0	41.5	24.5	26.5	58.0[l]	~ 10
12-L	800.0[g]	49.5	21.5	15.0	17.0	23.0[m]	2–4
13-R	800.0[g]	50.5	22.5	14.5	16.5	31.3[m]	2–4
14-L	13.0	99.5	39.0	37.0	38.5	57.5[n]	20–30
15-R	10.0	106.0	39.0	32.0	36.5	65.5[n]	20–30
16	11.0	110.0	53.0	32.0	34.0	39.0[o]	~ 15
17-L	1.6	[43.0]	—	—	28.0	43.0[p]	10–15
18-R	3.0	87.5	42.0	23.0	28.0	45.0[p]	10–15
19-L	7.0	81.0	34.0	28.0	24.5	23.5[q]	(~ 12)
20-R	7.5	89.0	41.5	28.0	26.0	27.5[q]	(~ 12)
21-L	1.4	67.5	30.5	17.5	21.0	36.5[r,s]	(~ 5)
22-R	1.4	64.0	27.0	17.5	20.0	37.0[r,s]	(~ 5)
23-L	4.0	70.0	29.5	26.0	23.5	27.0[t,s]	(~ 8)
24-R	3.0	64.5	24.5	24.0	23.0	26.5[t,s]	(~ 8)
25	7.0	94.0	49.5	30.0	27.2	29.5[u,s]	(~ 12)
26-L	—	186.0	—	—	58.2	95.0[v,s]	(~ 30)
27-R	—	173.3	—	—	60.0	97.0[v,s]	(~ 30)
28-L	37.0	179.0	116.0	51.5	49.5	89.0[w]	(~ 30)
29-R	31.0	165.0	106.0	50.0	49.0	88.0[w]	(~ 30)
30-L	9.2	108.5	45.0	36.0	42.0	84.5[x]	(~ 15)
31-R	9.8	125.0	62.5	35.0	40.0	86.5[x]	(~ 15)
n =	28	29	24	24	31	29	31
Average	8.7	103.2	49.1	29.5	34.5	53.4	(~ 15.1)

Table updates data presented in Shoshani et al. (2000, p. 16)

[a]Tusks no. 1 through 4 were collected in the vicinity of Haicota in Zoba Gash Barka, as recently as December 1996. Tip of tusk no. 2 is broken (missing), data include estimation for the missing piece. Initial data for tusks no. 1–8 were collected 26 June 1997 by J. Shoshani and Y. Yacob with the help of Solomon Tewelde and others. Data for tusks no. 9–21 were collected in 2003, and for tusks no. 22 and 23 in 2001. L = left, R = right of a pair of tusks.

[b] Weights were taken with a hand-held spring scale with 200-g increments; thus the weight estimation is to the nearest 200 g. Tusks lose weight as they dry out (based on four data points, range of 5 to 15%, depending on size and storage of tusks), and since most measurements were taken in 2003, we have used these most recent weights.

[c] The longest length, measured along the outer curvature (fig. 2). Comparing data collected in previous years on weights, lengths and circumferences to those re-collected on the same tusks in 2003, we found differences, usually due to loss of moisture and to shrinkage.

[d] The length at the lipline is the exposed portion of the tusk (fig. 2)—that is, the length from the lip to the tip. Lipline on tusks removed from the cranium is identified by stained markers on the tusks (due to chemicals in the food).

[e] Measured as close to the proximal end as possible (fig. 2).

[f] Measured by inserting a stiff wire into the pulp until it stopped (fig. 2).

[g] Estimated ages (no parentheses) are based on dental data (after Laws 1966 and Sikes 1971) and epiphyseal degree of fusion (Roth 1984). Extrapolated ages (within parentheses) are based on various parameters collected from individuals whose ages are estimated.
[h] Tusk no. 5 was collected in 1996 near Hasta Sahel Province, 200 km north of Haicota, far beyond the current elephant zone in Eritrea. A small piece is missing at the tip. Circumference is estimated because base is broken. This also affected the measurement for the pulp length. Length of pulp cavity is 38.5 cm, and the estimated length is 47.0 cm.
[i] Tusk no. 6 was displayed at the Expo/Festival, Asmara, Eritrea, 6 September 1998.
[j] Data on these tusks (no. 7 and 8) were taken at the Jolly Gift Shop, Asmara, Eritrea (26 November 1999); tusks are said to have been collected in the Gash Barka area, Eritrea.
[k] Fragment of tusk no. 9 belongs to elephant no. 1 in text (Tekezu village). This fragment, measuring 30 cm long, was found near the carcass; the other tusk was not found.
[l] Tusks no. 10 and 11 belong to elephant no. 2 in text (Debero village).
[m] Tusks no. 12 and 13 belong to elephant no. 3 in text (Cikaba, near Ugumu). Tusk no. 13 (right side) has a groove at the tip.
[n] Tusks no. 14 and 15 belong to elephant no. 4 in text (Tekezu area, near Setit River). Tusks are housed at MoA in Barentu; data collected 29 December 2003.
[o] Tusk no. 16 belongs to elephant no. 5 in text (Awtate River). Only the right tusk was found; it has a longitudinal ridge. It is housed at MoA in Barentu; data collected 29 December 2003.
[p] Tusks no. 17 and 18 belong to elephant no. 9 in text (close to Amnayet). Tusks are housed at MoA in Haicota. Distal end of tusk no. 17 (left) is missing.
[q] Tusk nos. 19 and 20 belong to elephant no. 10, which died on 4 February 2004 at Menderot River, close to Antore. Tusks are housed at MoA in Barentu. Data collected 29 December 2003.
[r] Tusks no. 21 and 22 have notes on masking tape that reads: 'brought by Pawlos Estifanos'.
[s] Tusks were collected in 2002 or before.
[t] Tusks no. 23 and 24 are said to come 'from the court' (perhaps confiscated).
[u] Tusk no. 25 is a left tusk. Portion of tusk was cut with a sharp object at the alveolus above the lipline.
[v] Data on tusks no. 26 and 27 were collected by Emun Kebrom on 10 October 2001; the left tusk is the longest measured thus far. This pair of tusks is housed at the local government storage in Barentu. According to Yohannes Yacob, these tusks belong to an elephant that died about 1998 close to Alebu, Zoba Gash Barka.
[w] Tusks no. 28 and 29 are said to have been collected at about 1993. This is the heaviest pair measured thus far (data collected 29 December 2003). Tusks are housed at MoA in Haicota.
[x] Tusks no. 30 and 31 are said to have been collected during the Haile Selassie regime (about 1950s or 1960s). Data collected 14 July 2004. Tusks are in government storage in Barentu.

cal conditions are given under 'Information obtained from elephant carcasses'. The dental characters of this individual (Laws 1966; Sikes 1971), indicate that it was about 25 years old at time of death. Tests for anthrax, using the polychrome methylin glue technique, by the veterinary laboratories in Vilajo, near Asmara, were negative; cause of death is unknown (fig. 4).

Elephant no. 2 died in March; we visited the carcass on 21 April 2002 (table 1 gives details of all 11 elephant carcasses). We noted that its state of decomposition was more advanced than that of elephant no. 1, possibly because it was a younger animal, only about 10 years old. (See data from tusks no. 10 and 11 in table 2.) Separation of the epiphyses of the long bones was more extensive than in elephant no. 1, and more chewing marks of carnivores were evident on many of the bones. Bird droppings on the skin were absent. A mandibular portion of this elephant is currently being cleaned in UoA. Villagers reported that this elephant was ill before death with reddish fluid oozing from the ears, nose, mouth and anus. No signs of gunshot or spearing were found. Tests for anthrax were negative; cause of death is unknown.

Elephant no. 3 died in June 2002 near Ugumu village along the Gash River. Both tusks were collected from the carcass soon after it died (no. 12 and 13, table 2). When we visited this site on 11 January 2003, we found only a fragment of an ulna, now housed at NME. Cause of death: slipping and falling into a dug water well.

Elephant no. 4 died on November 2002 in the Tekezu area close to the Setit (Tekezze) River. Residents suspect that it had died from a contagious disease, and thus local herdsmen fenced off the carcass with thorny acacia and ziziphus to prevent domestic animals approaching it. We visited this site in January 2003 and collected the mandible (currently housed at NME), the distal portion of the left thyrohyoideum, the basihyoid, and a skin sample from the chin area. The mandible exhibits abnormal tooth eruption; therefore the age estimation (between 20 and 30 years at the time of death) is based on epiphyseal fusion on some long bones (after Roth 1984). It is noted, how-

Figure 4. Team members examine the carcass of elephant no. 1 and take samples to test for anthrax.

ever, that in addition to the abnormal dentition, some osteossed (abnormal) bones, for example, the third trochanter of the femur, was greatly ruggosed and swollen with abnormal bone and bony spikes, as observed in elephant no. 1. Cause of death is unknown.

Elephant no. 5 died in November 2002 along the Awtate River, a tributary of the Antore River. We visited this subadult to adult elephant carcass (approximately 15 years old) on 10 January 2003 and collected the mandible, currently housed at NME. Also collected were both stylohyoidea and elephant dung. Cause of death is unknown.

Elephant no. 6 died on April 2003 in the Awgaro area at Sefera Sona. It was approximately 7 years old. It fell and died in a water well dug by local people on the east side of the Gash River where the depth of water was about 100 cm below the riverbed. We visited this site on 9 May 2003 and collected skin samples from the leg area for DNA analysis. Also collected were three dung samples (large, medium and small) taken for seed analysis. Cause of death: slipping and falling into a dug water well.

Elephant no. 7 died on May 2003 in the Ugumu area near Awgaro. A calf approximately 2 years old, it fell and died in a water well along the Gash River where the depth of water was about 100 cm below the riverbed. We visited this site in May 2003 and for DNA analysis we collected skin samples from the ear and hair from the tail. Cause of death: slipping and falling into a dug water well.

Elephant no. 8 died in October 2003 near the town of Kurbayo-Dekishehay, south of Awgaro. Its death was reported in the Tigrigna newespaper Haddas Eritra on 6 November 2003. According to its report, over 40 elephants had destroyed millet crops and during that time a farmer shot and killed a five-year-old elephant (accounts of this incident were also shown on Eritrean television).

Elephant no. 9 is said to have died in early November 2003 near Amnayet, close to Haicota. We visited this site on 26 December 2003, took measurements on foot circumferences and teeth, and collected the mandible (currently housed at UoA), a complete set of hyoid bones with cartilages, and skin samples for DNA studies. This elephant was said to have been sick and was shot by a farmer. Tusks were collected on 15 November by MoA in Haicota (tusks 17 and 18, table 2). Using the dental characters described by Laws (1966) and Sikes (1971), we judged that this individual was between 10 and 15 years old.

Elephant no. 10, a subadult, died on February 2004 near the Menderot River near Antore and Tekezze Rivers. The fresh carcass was visited as part of the MIKE programme. Both tusks were collected and are housed at MoA in Barentu (tusks 19 and 20, table 2). Habitat at the site was a dense riverine forest, which included

Hyphaene thebaica and *Ziziphus spina-christi*. The cause of death is unknown, but the elephant may have been sick since an eyewitness reported seeing it isolated from other members of the herd for a few days.

Elephant no. 11 died in May 2004 near Ugumu village. This juvenile fell and died in a water well along the Gash River. It fell with its head inside the well, so it was not possible to reach the tusks. The carcass was fresh, sex unknown. Cause of death: slipping and falling into a dug water well.

Information obtained from tusks

Data on eight tusks presented by Shoshani et al. (2000, p. 16) provide some insight on the natural history of elephants in Zoba Gash Barka. Data for 31 tusks are provided in table 2. Although the data are meagre, they are the only information available and the most comprehensive compiled thus far for Eritrea. The combined average of the estimated and extrapolated age of the 31 elephants is ~15.1 years. Tusk length ranged from 49.5 to 186 cm and averaged 103.2 cm (n = 29) (tusks 12 and 26 in table 2 and fig 5). Weight ranged between 0.8 and 37 kg with an average weight of 8.7 kg (n = 28). A pair of tusks from elephant no. 2 weighed 3 kg each in April 2003; in March 2002 the same tusks had weighed 3.5 kg each—a loss of 0.5 kg per tusk in about one year. For future investigators, it would help to state when the elephant died and when the tusks were weighed. This small size is possibly due to the young age (about 10 years) of the elephant.

Other statistics calculated from the available tusks included average pulp length (n = 29), which is about 53.4 cm, and average ratio of pulp length to total length (n = 28), which is 0.5. The average tusk length inside the cranium (the unexposed, n = 24) is close to 50 cm (49.1 cm), and the ratio of exposed to unexposed tusk is about 0.5 (a 1:1 ratio).

Discussion

Tusk size and age implications

Among the elephants in Eritrea, most of the tusks measured at the lipline and those observed on live

Eritrea MoA staff

Figure 5. Apparently the heaviest tusks recorded from Eritrea, and a pair of small tusks, photographed with students, teacher (J. Shoshani, with hat), and Kabede Awole, MoA staff in Haicota, standing on left (cf. tusks no. 28 and 29, the heaviest, and tusks no. 17 and 18, the smaller tusks, in table 2).

elephants appeared to be small, about 50 cm in length from the lipline. From data given in table 2 we calculated an average of 103.2 cm in length and 8.7 kg in weight. One possible explanation for their almost uniform tusk size and weight for an age category is the homogeneous genetic make-up of the population. Observations on tusk size date to the 19th century when Baker (1871, p. 219) noted that most Abyssinian elephants have very short yet fairly thick tusks. With caution, it is possible to surmise that there is little or no variation in tusk size for a particular age class. This hypothesis may be related to isolation and inbreeding. Other information gathered from tusk and teeth include estimated and extrapolated age for 31 elephants. The average age of approximately 15.1 years, as determined by our preliminary findings, provides an indication that the age at which elephants died in Eritrea during the past five years (1998–2003) is less than half of the normal life expectancy of eastern African elephants (Moss 1996; Eltringham 2000).

The average tusk weight for elephants in Eritrea (8.7 kg, table 2) seems to be higher than average for African elephants, according to Hunter et al. (2004) who estimated an average of 6.9 kg per tusk. This average is based on data from Milliken et al. (2002), who reported an average tusk weight of 3.68 kg calculated from 7800 ivory seizure records, and Parker and Martin (1982), who reported that each elephant yields 1.88 tusks (3.68 kg x 1.88 = 6.9 kg). For comparison, the average tusk weight of African elephants in 1986 and 1988 was close to 4.5 kg (cf. Morell 1990).

Specific data on tusk weights from eastern Africa are about 14 years old (Buss 1990) or older (Laws 1966). Average tusk weight for 46 tusks from western Uganda was 5.9 kg (Laws 1966, p. 23). Using tusk data also from western Uganda, Buss (1990, p. 70) found an average tusk weight for males (n = 39) to be 5.8 kg, and for females (n = 42) 4.5 kg. Data from Laws (1966) and from Buss (1990) have similar average tusk weights, and both are lower than the current average tusk weight for elephants in Eritrea. Tusks from eastern Africa are known to be large. Shoshani et al. (1987, p. 29) provided data for four elephants from eastern Africa with large tusks with an average of 81 kg (converted from 178.6 lb) the heaviest, from near Kilimanjaro, weighed 103 kg. Laws (1970, p. 254) noted that the record tusk weight for a male elephant is 106 kg and for a female 25 kg; Moss (1996, p. 61) gave similar records: for a male 100.8 kg and for a female 29.7 kg.

Buss (1990, p. 72) pooled his data on tusk weights in relation to age, charted them with data obtained from Laws (1966), both from western Uganda, and summarized his comparisons: 'the data show clear distinction between the sexes. Both display a tusk weight to age relationship that appears to be a linear function although males seem to increase their tusk weight more rapidly than do females.'

Tusk length measurements for eastern Africa were collected by Laws (1969), Pilgrim and Western (1983, 1986), Buss (1990), and in this study. The shortest tusk measured by Buss (1990) for males (n = 39) was 98 cm, and for females (n = 41) 97.8 cm; the longest tusk for males was 101.3 cm, and for females 102.9 cm (average for males was 99.5 cm and for females 100 cm). Our data for tusk length are given in table 2. Although the averages from these data are given in the table and summarized above, they are not sufficient to draw conclusions on gender differences.

Tusk circumference at the lipline, pulp depth and volume

Data on circumference at the lipline (CALL) were collected by Laws (1969) from Tsavo National Park, Kenya; Pilgrim and Western (1983, 1986) and Buss (1990) from western Uganda; and in this study from Eritrea. All four papers cited conclude that there is a clear distinction between males and females based on their tusk CALL; those of males have higher values. Buss (1990, p. 70), measuring 39 males and 42 females, gave an average of 26.6 cm of CALL for males and 21.15 cm for females. Buss (1990) also found that pulp depth and especially pulp volume provide differences between the genders. His average pulp depth for males was 52.73 cm, and for females 33.68 cm; average pulp volume for males was 1390.7 cc, and for females 438.4 cc. We also collected data on pulp depth but not on volume (this can be estimated assuming the pulp is in the shape of a cone). It appears that it would be valuable to continue to collect these data for future comparisons.

From these studies, it emerges that certain data (for example, tusk length, weight, circumference at the lipline, pulp depth and volume) can be useful to identify whether tusks originate from male or female individuals. This conclusion was reached by Laws (1966, 1969), Pilgrim and Western (1983, 1986), and Buss (1990). Haynes (1991, p 43–45) also provides data on girth of tusks of male African elephants from Zimba-

bwe. Because our tusk data on elephants from Eritrea are meagre, it would be premature to apply the CALL and pulp volume data presented on tusks by other investigators to assign gender to elephants whose sex is unknown. However, for elephants with known sex (no. 2 and 4 in table 1) the data appear to match our measurements.

As noted by Laws (1969), Pilgrim and Western (1986), Moss (1996), and Ngure (1996), valuable data can be retrieved from elephant tusks, including estimation of age and sex, identification of individuals and populations, ecology, DNA and isotopic sampling, assessment of population trends, and possible cause of mortality. For the available tusks from Eritrea, we also calculated averages of pulp length, ratio of pulp length to total length, exposed tusk length, and the ratio of exposed to unexposed tusk length (see under 'Results'). These data can be employed as a basis for future comparison of data in other elephant populations and for assessing differences in age groups and differences between sexes. These data can also be employed for assessing more accurately the age and gender structure of this population based on observations of live elephants related to the data being collected in situ and thus contribute to improved monitoring of this particular group of elephants. In addition, tusks include a wealth of information on the life history of elephants, including timing of death, nutritional stress and possible calving periods (Fisher 1996). We have not yet maximized the potential of data retrieval from tusks in Eritrea (see however, under 'Future investigation').

Information obtained from elephant carcasses

Eritrea has been trying to conserve wildlife, in spite of economic hardship, so it is a setback to lose 11 elephants in a period of 27 months (from February 2002 to May 2004), a loss of about 5% per annum. Unfortunately it was not possible to ascertain the cause of death of all the elephants, but in addition to some basic data on tusks, it was possible to collect information on age and sex. General and skull measurements might be useful in future pathologic (based on abnormal bones and teeth) and taxonomic studies. On elephants no. 1 and 4 we found evidence of abnormal or pathological features. Data collected (after Groves and Grubb 1986) from elephants no. 1, 2, 4 and 5 are available from J. Shoshani.

An unusual anatomical condition was observed on the bones of elephant no. 1. In addition to the pathological observations noted above, we noted that the right femur was shorter by 10 cm and wider than the left, and the third trochanter as well as the distal end were osteossed and swollen with abnormal growth. It was also observed that the left tibia was shorter by 3.5 cm than the right tibia. It would seem that the body attempted to compensate for the shorter right femur by lengthening the right tibia. There was another unusual finding in this elephant: it had a large, approximately 4-kg cholelith—a concretion composed of bile alcohols, bacteria, and traces of cobalt and sulphur found in the bile duct (Agnew et al. in press). The presence of bacteria within the cholelith strongly suggests a bacterial infection of the bile duct. Such a large cholelith itself could have caused the death of the elephant from cholelithiasis.

Easily recognized sexual dimorphic osteological characters include shape of the mandibular condyle and protrusion of the mandibular symphysis. Mandibular condyles (those that articulate with the cranium) are close to round in males; in females they appear elongated or oval when the long axis is directed from side to side (latero-medially). The protrusion of the mandibular symphysis in males is distinct and longer than in females. Tusks in males are longer and have a wider base than those of females of corresponding age (Pilgrim and Western 1986; Buss 1990).

Based on the above features, it appears that four of the five elephants that died in 2002 were males. Initially a suspicion arose that the four elephants were poached for their ivory. This hypothesis was negated on at least one occasion (elephant no. 4), as soldiers watched the carcass until the authorities visited the site. The skin of elephant no. 1 was searched for any bullet holes, but none were found. The tusks that were removed by people other than staff of the MoA were probably done in opportunistic post-mortem acts.

The phenomenon of a calf or juvenile elephant dying by slipping and falling into a sandy water well dug along the Gash River has repeated itself four times in two years (elephants no. 3, 6, 7, 11; cf. table 1 and text above). Sadly, this has become a common occurrence during the hottest months, from about March to mid-June. Urgent measures need to be taken to reduce or prevent such occurrences (see under 'Recommendations').

Estimated population growth and birth rate

An important factor that contributes to population size is the available area and competition with other mammals, humans included. Zoba Gash Barka is the bread basket of Eritrea, and conflict between human and elephants for accessible land is increasing (Hagos et al. 2000; Shoshani et al. 2004). At about 4200 km^2, elephant distribution and home range in Eritrea cover less than half the size of Gash Barka. Part of this range includes passageways or narrow corridors for movement between the southern part of the range (near the Setit River) and the northern part of the range (in the Gash River between Awgaro and Haicota, fig. 1).

Various factors contribute to population growth, including birth rate, death rate, immigration and emigration (Douglas-Hamilton 1972; Smith and Smith 1998). Immigration and emigration are not known to be relevant to the elephants in Eritrea, since they are an isolated population. There are, however, few data on elephant death rate in Eritrea (and almost no data for birth rate) available for conducting a thorough analysis of population growth. As noted above, 4 of the 11 deaths during 2000–2004 were calves, a normal level among young elephants (Lee and Moss 1986). Eleven elephant deaths spread over 27 months (from February 2002 to May 2004) gives a rate of 4.9% deaths per year. This is higher than the rate of 2–3% given by Laws (1969) and Corfield (1973) based on jaws found. With poaching, however, the death rate can range from 5% to 38% (Dublin and Douglas-Hamilton 1987; Moss 1990). Estimated population growth for other populations in Africa is between 5% and 7% per annum (Hall-Martin 1992; Carbone 2003). Data on the structure of elephant population for Eritrea are beginning to emerge, although they are insufficient for estimating population growth. The fact that this transboundary elephant population migrates between Ethiopia and Eritrea makes it difficult to monitor the death rate and subsequently to estimate the population growth.

Future investigation

We will continue to collect and analyse specimens from dead elephants. Analysis will include gathering basic data, finding possible causes of death and analysing DNA to shed light on herd genetic composition compared with other populations in Africa. We will continue to search for methods to prevent young elephants from falling into artificial water wells. In addition, we plan to conduct detailed macro- and microscopic examination of tusks as described by Fisher (1996) to better understand their life history. Results from DNA extracted from tissue samples collected from dead elephants and dung samples as compared with DNA from other elephant populations will be published elsewhere (A.L. Roca, in prep.). Other aspects to be considered for future investigation include elephant density, birth rate, death rate, and population growth.

Recommendations

One of the recommendations suggested by Shoshani et al. (2004) was to install a few artificial watering sites along the path of elephant movement. Constructing these sites, we propose, should be done in a way that would allow young elephants easy access, and thereby prevent their death by slipping and falling into artificial sandy water wells. Another recommendation suggested by Shoshani et al. (2004) was, if possible, to expedite the establishment of protected areas. This becomes more imperative as this healthy elephant population is reproducing, and assuming a steady growth, soon may become a source of increasing conflict with the growing human population of the area.

Concluding remarks

Data collected during past years have added significantly to the existing pool of knowledge on elephants in Eritrea, yet much more needs to be learned. The approximately 100 elephants in Eritrea constitute a healthy, fecund and viable population, yet they are physically and possibly genetically isolated.

The elephants we observed carried tusks on average about half a metre long. Other tusk statistics, although meagre, are the first assessments of such data for Eritrea. These can be employed as a basis for future comparison with data in other elephant populations and for differences among groups and between sexes. Average tusk weight of elephants from Eritrea is higher than that for Africa as a whole but lower than the average in eastern Africa.

Currently there are no reports of poaching in Eritrea; elephants are killed only to protect human life or stop crop raiding.

A detailed study of the remains of dead elephants should be conducted to learn of possible causes of

death. Reducing the possibility of juvenile elephants slipping and falling into artificial water wells is possible by constructing artificial water sites with gently sloping entrances.

Gaining more understanding of the ecology and natural history of elephants through examining their tusks and carcasses is an additional method that can augment our pool of knowledge on this keystone species. In Eritrea, the need to protect this beleaguered elephant population is urgent. We emphasize that because of their size, by saving elephants we will automatically save large areas that protect other wildlife in the same ecosystem.

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Chemical composition of mineral licks used by elephants in Aberdares National Park, Kenya

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Abstract

Physical and chemical properties of mineral licks and their use by the African elephant (*Loxodonta africana*) in a forest ecosystem in Aberdares National Park, Kenya, were investigated. Samples of lick earths and of control earths not ingested in the immediate vicinity were compared for nutrient composition and particle size. Mean concentrations of several macronutrients were greater in the lick earths than in the controls while there was no observable difference in the mean concentrations of micronutrients except iodine. Eaten earths differed from the uneaten earths primarily in their significantly higher sodium and iodine concentrations. The mineral lick samples had higher clay content than the control samples. This work therefore isolated sodium, iodine and clay content as the possible stimuli for geophagy among elephants in Aberdares National Park. Sodium preference could be attributed to palatability; clay has a possible medicinal function and also retards leaching of sodium and iodine. This study provides evidence that elephants supplement not only sodium but also the associated element iodine from inorganic sources.

Additional key words: geophagy, clay, sodium, iodine, nutrients, supplementation

Résumé

Les propriétés physiques et chimiques des *salt-licks* et leur utilisation par l'éléphant africain (*Loxodonta africana*) dans l'écosystème forestier du parc National des Aberdares, au Kenya, ont été étudiées. On a comparé la composition chimique et la taille des particules d'échantillons du sol qui est léché et du sol-contrôle voisin non consommé. Les concentrations moyennes des plusiers macro-éléments étaient plus fortes dans les sols léchés que dans les sols-contrôles, alors qu'il n'y avait pas de différence observable de la concentration moyenne des micro-éléments, excepté l'iode. Les sols léchés étaient différentes des sols non-léchés dans leur concentrations significativement supérieur en sodium et en iode. Les échantillons de minéraux léchés avaient un contenu en argile à celui des échantillons contrôles. Ce travail met en évidence le sodium, l'iode et le contenu en argile comme les stimuli possibles de la géophagie chez les éléphants du Parc National des Aberdares. La préférence pour le sodium pourrait peut-être être attribuée au goût ; l'argile a peut-être une fonction médicinale et retient peut-être le sodium et l'iode avec un effet retard. Cette étude apporte des preuves du fait que les éléphants ne suppléent pas seulement le sodium, mais aussi l'élément iode qui lui est associé, à partir de sources inorganiques.

Mots clés supplémentaires : géophagie, argile, sodium, iode

Introduction

Ingestion of earth (geophagy) has been observed in various animal species throughout the world. Elephants often seek out natural mineral licks, located where nutrients are concentrated for various reasons. Geophagy appears to be normal behaviour of all species of elephants in most of their habitats (Hanks 1979; Spinage 1994). The most spectacular evidence is the excavation of caves on the volcanic slopes of Mt Elgon in Kenya (Bowell et al. 1996). It is believed that lick earths may offer nutritional benefits or have medicinal properties (Henshaw and Ayeni 1971; Mahaney et al. 1996; Huffman 1997), as they do for humans.

Geophagy has important implications for conservation (Milewski 2000). Elephants are increasingly confined by human interests to mere fragments of their original range. Elephants were naturally nomadic over large distances, partly owing to movements to and from scattered mineral licks. This means that many conservation areas may not, in the long term, be viable for elephants unless appropriate provision is made for nutrient supplementation. In turn, many ecosystems may collapse without the pivotal role that elephants play.

This paper documents the location and chemical composition of mineral licks and their use by the African elephant (*Loxodonta africana*) in Aberdares National Park in central Kenya. The study area is part of the same montane forest ecosystem as Mt Elgon National Park but is located on the eastern side of the Rift Valley. Twelve nutrient elements were analysed: the macronutrients sodium, potassium, calcium, magnesium and phosphorus, and the micronutrients zinc, copper, manganese, iron, iodine, cobalt and chromium. Molybdenum, selenium and sulphur, although nutritionally important, were not analysed for practical reasons. Nutrient requirements vary with age, sex, season and reproductive status (Robbins 1993).

Study area

Aberdares National Park covers approximately 767 km^2 (fig. 1). The park lies between longitude 36º31′ and 36º57′ E and latitudes 0º08′ and 0º42′S within the Aberdare mountain range, which contains many valleys draining a series of peaks as high as 4000 m.

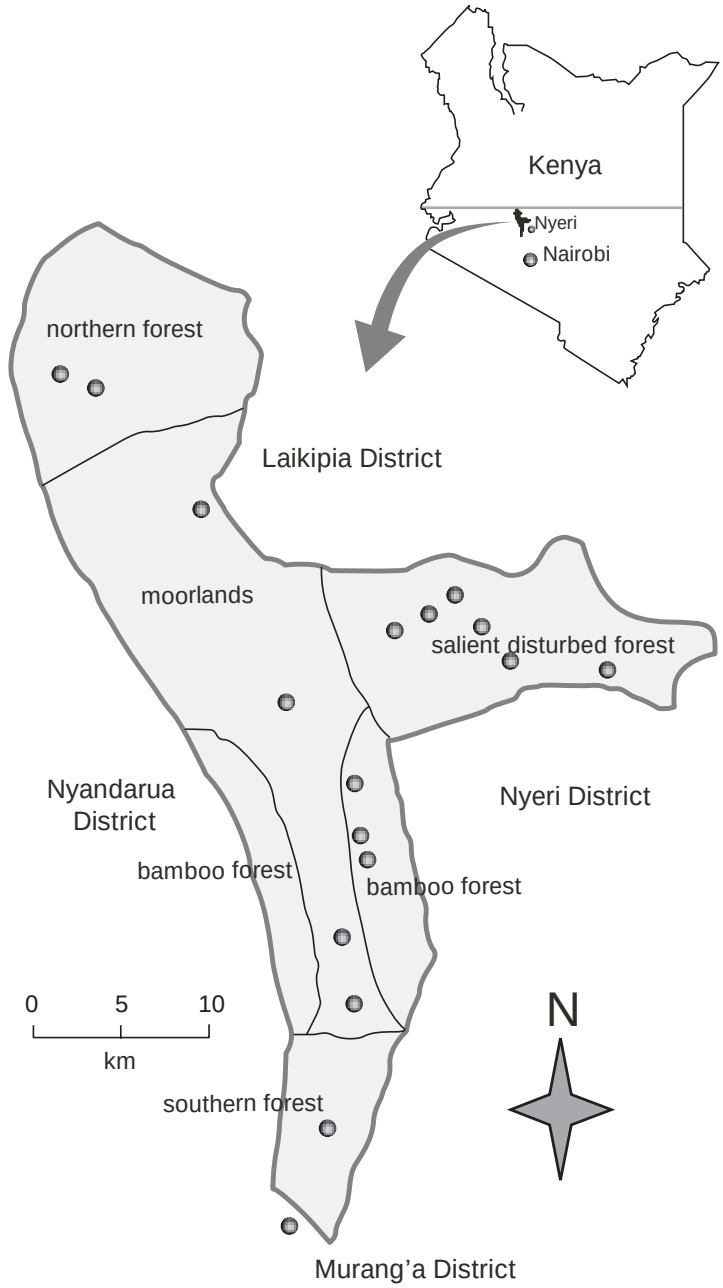

Figure 1. Aberdares National Park, showing the distribution of mineral licks (●).

The earth is mainly alkaline, derived from volcanic rocks such as basalts and rhyolites. Over much of the study area, deep clays predominate at lower altitudes, giving way to relatively coarse materials at higher altitudes. The earth desiccates and disintegrates in dry seasons, and become soggy and waterlogged during heavy rains.

Methods

Sampling approach

Active mineral licks were initially surveyed in July–August 2002, using the Gamins 12XL global positioning system (GPS). Fourteen licks were selected for chemical sampling based on altitude, habitat and status of use. Three of these had been artificially supplemented, occurring in open glades containing two tourist lodges (Treetops and The Ark) and one tented camp in Aberdares National Park. The lodges regularly replenished the salt at these three licks, which were far richer in sodium and calcium, and somewhat richer in magnesium and potassium than the natural licks. Because of this deliberate supplementation, these licks were omitted from statistical analysis.

At each lick site, earth samples were taken with a soil auger for subsequent analysis. The samples totalled 56 lick earths and 52 control earths. Lick earth samples were randomly collected in four replicates at a depth of 0.3–0.5 m. Control samples of uneaten earths were collected at a depth of 0.5 m, at a minimum distance of 200 m from the licks, in surrounding forest. All 108 earth samples were air dried in the field.

At the selected licks, dung, footprints, trampling and recent excavations were recorded to indicate how often elephants used the site for geophagy (table 1).

Laboratory analysis

Laboratory analysis was undertaken at the national agricultural research centre in Muguga, near Nairobi. Soil pH was measured on a 2.5:1 water to soil suspension using a pH meter. Exchangeable Na, K, Ca, Mg and P were extracted by leaching 10 g of earth with 100 ml of 1 M-ammonium acetate at pH 7. Cu, Mo, Zn, Co, Cr, Mn and I were extracted by leaching in 1% EDTA (ethylenediaminetetraacetic acid). EDTA is a chelating agent and 1% suspension with earth forms metal chelate ionic complexes (Okalebo et al. 2002). Flame photometry was used to determine concentrations of Na and K, and concentrations of Ca, Mg, P, Cu, Zn, Mn, Cr, Co, I and Fe were measured using an atomic absorption spectrophotometer (McKeague 1976). All nutrient concentrations were recorded in parts per million.

The hydrometer method (Bouyoucos 1962) was used to determine the particle sizes of composite samples from 10 lick earths and 10 control earths. A Calgon solution was used to disperse earth into its individual particles, categorized as sand, silt and clay, using standard procedures (Okalebo et al. 2002).

Frequency of lick use

The frequency with which elephants visited licks was observed at two of the artificial licks. Preliminary observations indicated that elephants do not visit licks

Table 1. Classification of mineral licks according to levels of use by elephants

Lick use status	Indicators
Heavy	Deep holes and cavities inside the lick with fresh tusk markings
	Presence of more than five fresh dung piles
	Visible footprints, trampling and tracks around the lick
Moderate	Relatively shallow holes and cavities inside the lick, with few tusk markings
	Presence of 2–5 fresh dung piles
	Moderate trampling around lick
Light	No holes and very few cavities inside the lick
	Few tusk marks
	One dung pile at most
	No trampling around the lick
Abandoned	Old holes and cavities with algal growth
	Decayed, scattered dung
	No recent sign of elephants

during the hours of bright daylight. Therefore, the number of individual elephants visiting the licks over a standard period was recorded, from 1500 to 0900 the following morning, for 15 days at each lick. Age and sex composition of the elephants was noted where possible. It was assumed that elephants visiting the artificial licks do visit the natural licks with similar frequency and similar group composition.

Statistical analysis

Lick earth was compared with uneaten (control) earths for differences in mineral concentration using one-way analysis of variance. The Kruskal-Wallis test was used to compare mineral concentration of three samples of each of the lick-use categories of heavily, moderately or lightly used. The Statistical Package for Social Scientists (SPSS) computer package was used for all the analyses.

Results

Chemical composition of the licks

Earths eaten at the natural licks (not replenished with salt) and uneaten control earths in the surrounding forest did not differ in pH (table 2). When the mean concentrations of elements in lick samples were compared with those in control samples, the results showed that the lick earths were relatively enriched in some macronutrients. Among the micronutrients, only iodine showed a trend of being more concentrated in lick than in control earths (table 2). One-way analysis of variance showed that sodium was highly significantly different ($p < 0.01$), and phosphorus and magnesium significantly different ($p < 0.05$) between lick earths and control earths. Zinc, manganese and iron were also significantly ($p < 0.05$) different, but more concentrated in control than in lick earths.

Earth texture

Student's *t*-test performed on the data displayed no significant differences ($p = 0.05$). However, eaten earths were overall richer in clay than the uneaten earths sampled in the surrounding forest. The lick samples contained 16–64% clay (mean 37.7%), whereas the control samples contained 3–37% (mean 23.4%) (table 3).

Nutrient preference

Kruskal-Wallis rank analysis showed that at licks of different levels of use (see table 1) sodium concentration was significantly different at $p < 0.05$ and iodine at $p < 0.01$ between heavily and lightly used licks (table 4).

Two of the five heavily used licks showed concentrations of sodium lower than those found in the moderately or lightly used licks. It was, however, noted that these heavily used licks were located on major elephant paths or near watering points, which may have been the reason that they were well frequented.

Age and sex of elephants using licks

The ages and sex of elephants visiting and using the artificial licks at Treetops and The Ark over a 15-day period are given in table 5.

All adults and subadults were distinguishable as female or male. At Treetops 65% of the elephants that visited the licks were females and 35% males. At The Ark 59% were females and 41% males.

Table 2. Chemical compositions of lick and control earth samples (means ±SE) and their mean differences in concentration (ppm) by ANOVA

Element	Lick earth (eaten)	Control earth (uneaten)	Mean difference (df = 1.87)
pH	4.96 ± 0.1	4.95 ± 0.1	0.0
P	39.3 ± 12.2	11.2 ± 2.6	26.9*
K	275 ± 53.4	291.7 ± 68.2	109.4
Na	464 ± 49.5	226.6 ± 29.4	272.3**
Ca	524.5 ± 101.3	585 ± 130.9	84.5
Mg	313.0 ± 68.2	206.0 ± 34.5	146.8*
Fe	170.2 ± 30.3	353.0 ± 49.2	–115.4*
Cu	2.0 ± 0.4	2.2 ± 0.5	–1.2
Zn	4.5 ± 0.4	13.7 ± 3.1	–5.74**
Mn	292.3 ± 69.8	851 ± 199.9	–235.81*
Co	0.11 ± 0.004	0.2 ± 0.004	–0.0052
Cr	9.7 ± 0.6	10.2 ± 0.5	0.02
I	89.0 ± 17.1	65.0 ± 9.1	20.5

*$p \leq 0.05$ – significant, **$p \leq 0.01$ – very significant

Discussion

Is sodium a proximate or an ultimate factor?

Scientists have long hypothesized that animals use 'salt' licks to supplement an insufficient dietary

Table 3. Particle size composition of lick and control earth samples (percentages)

Sample	Clay		Sand		Silt	
pair	Eaten	Uneaten	Eaten	Uneaten	Eaten	Uneaten
1	16	3	36	17	48	80
2	16	3	49	20	35	77
3	18	5	54	40	28	55
4	24	23	50	74	26	3
5	35	29	36	70	29	1
6	39	29	40	62	21	9
7	54	37	30	48	16	15
8	55	35	30	64	15	1
9	56	37	24	61	20	2
10	64	33	19	58	17	9
Mean	37.7	23.4	36.8	51.4	25.5	25.2

Table 4. Kruskal-Wallis analysis and significance testing for concentration difference between heavily, moderately and lightly used lick samples (*n* = 36)

Element	Mean conc.	Kruskal-Wallis mean rank			*P* value
	(ppm)	Heavy	Moderate	Light	df, 2
P	33.56	19.67	13.96	21.88	164.0
K	308.26	17.42	23.71	14.38	0.086
Na	470.36	24.33	18.17	13.00	0.03*
Ca	570.47	19.71	16.96	18.83	0.808
Mg	296.50	16.83	19.42	19.25	0.218
Fe	205.08	21.58	20.33	13.58	0.135
Cu	1.12	14.92	20.83	19.75	0.218
Zn	4.25	13.63	22.75	19.13	0.102
Mn	294.10	18.67	19.58	17.25	0.861
Co	0.12	20.71	19.75	15.04	0.356
Cr	9.56	24.23	15.67	15.58	0.068
I	81.13	24.92	24.08	6.5	0.001**

* significant at $p \leq 0.05$, ** significant at $p \leq 0.01$
n = 36 because tests involved only 9 natural licks—3 heavily used, 3 moderately used and 3 lightly used

Table 5. Artificial salt lick visitation by elephants for 15 days

Age and sex	Treetops lick visits		The Ark lick visits		Total visits	
	no.	%	no.	%	no.	%
Juveniles	20	15	29	15	49	15
Subadult males	16	12	18	9	34	11
Subadult females	18	14	19	10	37	11
Adult males	25	19	51	26	76	23
Adult females	53	40	79	40	132	40
Total	132	100	196	100	328	100

intake of sodium (Weir 1973; Fraser and Reardon 1980; Redmond 1982). Several authors have confirmed that sodium is the major macronutrient that elephants seek at mineral licks. Holds et al. (2002) in Hwange National Park in Zimbabwe observed that elephants with sodium-poor faeces ingested more earth than did individuals with relatively sodium-rich faeces, suggesting that geophagy was stimulated by sodium deficiency in the body of the herbivore.

The present study provides further evidence for the importance of sodium but suggests that other nutrients may also be important. All the lick earths that elephants in Aberdares National Park ate had significantly higher concentrations of sodium than found in adjacent earths that were not eaten. However, the elephants preferred licks with relatively great concentrations of not only sodium, but also iodine.

Sodium is unlike other macronutrients in that most woody plants do not concentrate this element in their tissues to the degree that herbivorous mammals do (Michell 1994). This would explain behaviour resulting in nutritional supplementation. Most of the sodium in earths is either in solution or weakly held as exchangeable ions on the surface of clay particles (Phillips and Chicy 1995). Sodium is thus more susceptible to leaching than are divalent cations. This explains the finding in the present study that sodium was more concentrated at depth than near the earth's surface, and at lower than at higher altitudes in Aberdares National Park.

Although there is consensus on the importance of sodium in geophagy by elephants, an appetite for salt does not prove a deficiency of this element (Phillips 1993). Studies of domestic herbivores have shown that ungulates consistently prefer sodium-rich foods over sodium-poor foods, implying that the animals may be indulging in luxury consumption (Reid and Horvath 1980; Michell 1994).

The nutritional wisdom of herbivores can apparently be overridden. Experimentally increasing the sodium content of food beyond requirements results in an increased intake (Phillips and Chicy 1995). Animals may choose a palatable but nutrient-poor diet over a nutritious but unpalatable diet (McDowell 1995). Excess sodium is readily excreted in urine and faeces. For these reasons, sodium deficiency in elephants will remain inconclusive until requirements have been quantified at a physiological level. The salt provided at artificial licks should be analysed for iodine.

Sodium and iodine have similar cycling properties and are linked in the geochemical cycle. Both elements are soluble, easily leached, and required in minimal amounts by plants, and this means that both are naturally concentrated only in certain situations. It is possible that elephants use a salty taste as an indicator of a likely concentration of iodine. Therefore, neglect of iodine in the many published analyses of mineral licks may help to explain the emphasis on sodium, and the otherwise generally inconsistent reported composition of mineral licks.

Earth is known to be a significant source of iodine. However, the analysis of iodine is often ignored because land plants have never been recorded as deficient in iodine, and analyses of this ultra-trace element are difficult and expensive. Iodine has the most categorical separation of any nutrient between animals and land plants. This is because it is required in animals for thyroid hormone synthesis at concentrations far greater than those required by land plants (Milewski 2000). Elephants are likely to be limited by the supply of iodine, inasmuch as their plant foods are deficient in this element relative to their hormonal requirements. The main supply of iodine in terrestrial ecosystems is atmospheric from marine sources, so that concentrations decrease with remoteness from the sea. Poverty of iodine can be expected not only at high altitudes far from a coast but also in areas subjected to glaciation in the Pleistocene (Underwood 1981), such as Aberdares National Park.

The present finding, that iodine is the only micronutrient with mean concentration higher in preferred than in less-preferred mineral licks, has implications for management. Inasmuch as cultivated crop species have higher iodine concentrations than wild plants, this might partly explain seasonal raiding of crops by elephants. Milewski (2000) has suggested variation of iodine concentration as a possible approach to elephant population control. The supply of iodine may particularly affect reproductive rate, since age of sexual maturation and frequency of oestrus depend on hormonal sufficiency, and the thyroid gland is an integral part of the endocrine system. Thyroxine is required in relatively large quantities for the rapid metabolism and growth of mammalian offspring, which depend on the mother for iodine until weaned. Milewski (2000) pointed out that in wild ungulates the mother takes priority in providing for her own thyroid, partly by delaying her reproductive attempts until she has sufficient iodine to support offspring. This implies that environmental poverty of iodine is likely to limit the reproductive rates of elephant populations.

Nutritional value of clay

Elephants are unable to lick earth surfaces directly. They differ from other ungulates in that they consume earths by gross excavation, usually by gouging clods with their tusks, and then transferring them to the mouth with their trunks. Even at artificial licks, where salt was placed on the surface, elephants did not merely consume surface deposits. While this may be partly owing to the relatively great appetite for mineral nutrients, it is also consistent with indirect benefits of inert mineral matter such as clays.

The present analyses showed that mineral licks were relatively rich in clay. This is consistent with previous studies of geophagy, in humans and other animals. Klaus et al. (1998) observed that natural mineral licks in the Hokou area of Dzanga National Park, Central African Republic, were located at dolerite intrusions that had weathered to clay-rich earths. Geophagy is also common at the mounds of termites, which are clay rich relative to their surrounds (Ayeni 1977; Davies and Baillie 1988; Ruggiero and Fay 1994; Mahaney et al. 1997, 1999). Termites transport clay particles from depth, enriching their mounds with nutrients as well as clay, even where topsoils are sandy.

Clay obtained from mineral licks is thought to aid in the neutralization of secondary plant compounds that animals ingest, such as tannins and alkaloids (Kreulin 1985; Knight et al. 1988). Clay components have been shown to bind and absorb plant toxins (Mahaney et al. 1999). The clay mineral metahalloysite is one of the principal ingredients in the pharmaceutical kaopectate, used to treat minor gastric ailments in humans (Vermeer and Ferrell 1985). Chimpanzees in Tanzania and colobus monkeys in Uganda, which eat mainly leaves, bark and pith, have been reported to consume clay-rich earth, believed to absorb secondary plant compounds (Oates 1978; Mahaney et al. 1999).

Elephants in Aberdares National Park probably eat several plant species that contain harmful substances because they rely on browse more than grass, and on the ripe and unripe fruits of various species (pers. obs.). The diet of large herbivores such as elephants is composed of many plant species, because it is more economical to include suboptimal species than to take the time to discriminate (Crawley 1983). Leaves, green fruits and seeds are generally heavily defended chemically, compared with grasses (Mattson 1980; Wink 1993). For example, condensed tannins have detrimental effects in many mammals by reducing protein digestibility (Mole and Waterman 1987). Although the foregut fermentation of ruminants neutralizes most of these substances, elephants rely on hindgut fermentation alone.

Management implications of lick location

Most of the natural mineral licks in Aberdares National Park are in road banks. Road construction has exposed nutrient- and clay-rich subsurface earth, on which elephants have capitalized for geophagy. It appears to be easier for elephants to excavate with their tusks on banks than to dig on a flat surface. At artificial licks, elephants were observed to dig by using their forelegs, sometimes kneeling on them to lower their tusks to ground level in an awkward posture. It was also observed that open glades are often flooded during the rainy season and their mineral licks were located at the edges of the glades, forming small banks. In Aberdares National Park, elephants appear to use mineral licks more in the wet than in the dry season. These patterns are possibly partly due to mineral licks in the open being exposed to volatilization and leaching (Underwood 1977).

Elephants appear to have degraded the artificial lick site at Treetops but not that at The Ark. Treetops is situated on what used to be a major migration route of elephants between the Aberdares and Mt Kenya, through Nyeri Forest. The vegetation around the lick at Treetops has only scattered trees left from the original woodland cover (pers. obs.).

Social patterns of geophagy

It has been shown in ungulates that geophagy is driven by nutritional requirements that tend to be greatest in females due to the demands of growing offspring (Holds et al. 2002). The present study provides inconclusive evidence for this pattern.

Although data on elephants visiting artificial licks at The Ark and Treetops indicate a preponderance of females, the population structure is unfortunately not known. It was observed that visits of males involved not only geophagy but also playing, wallowing and socializing. Adult females appeared to be purposeful, ingesting more mouthfuls of earth than did adult males. Male elephants visited the artificial licks alone or in groups of two to four, whereas females visited as part of family groups consisting of the matriarch,

several related daughters and their juveniles. The time spent by the family group at the lick appeared to be greatly influenced by the matriarch's appetite for salt, because of her role as leader.

Conclusions and recommendations

- Where the traditional range of elephants has been reduced, as in Aberdares National Park, the possibility must be borne in mind that elephants can no longer supplement their diet by visiting scattered, naturally enriched sites.
- Road banks appear to be attractive to elephants for geophagy, but it is unclear whether these are a sufficient substitute for resources lost by confinement to limited ranges. Further analyses should be done in other national parks.
- The reasons for geophagy by elephants remain inconclusive. Direct physiological work should be done to confirm deficiencies of sodium and iodine.
- Permission to provide salt to attract wildlife should not be given without considering its ecological effect. The sites for mineral supplementation should be judiciously selected and the chemical composition monitored and, if necessary, managed.
- The natural diet of elephants and supplements artificially provided to them should be analysed for iodine as well as sodium and other elements.
- Further comparative analyses of geophagy by elephants among different ecosystems in Africa and Asia should be carried out.

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OPINION

Long-term management of crop raiding by elephants around Kakum Conservation Area in southern Ghana

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Abstract

The Kakum Conservation Area appears to be Ghana's most successful national park, what with 60,000 visitors each year and its role in boosting the economy of Cape Coast, the regional capital. But to the local farming community, the park is not such a blessing. Marauding elephants damage their crops, making the local community hostile towards the park and towards the concept of biodiversity conservation. Short-term methods attempting to solve the problem have been used for a long time with short-term success. This paper outlines a strategic approach that addresses the underlying causes of crop raiding as opposed to a tactical approach that tackles the symptoms. It proposes a triple-pronged strategy of managing the landscape, detecting crop raiding, and repelling the elephants—thus reducing the risk of crop damage and building an appreciation of conservation in local people around the park area.

Résumé

L'Aire de Conservation de Kakum semble être le parc national qui réussit le mieux au Ghana, avec 60.000 visiteurs par an et un rôle évident dans la stimulation de l'économie de *Cape Coast*, la capitale de la région. Mais pour la communauté locale des fermiers, le parc n'est pas vraiment une bénédiction. Des éléphants en maraude dévastent les récoltes, ce qui suscite l'hostilité de la communauté envers le parc et envers le concept même de conservation communautaire. Depuis longtemps, on utilise des méthodes à court terme pour essayer de résoudre ce problème ; elles n'ont connu qu'un succès à court terme. Cet article présente une approche stratégique qui s'intéresse aux causes sous-jacentes des attaques des récoltes, par opposition à une approche tactique qui ne traite que les symptômes, et propose une stratégie à trois volets pour gérer le paysage, déceler les attaques des récoltes et repousser les éléphants—ce qui permet de réduire le risque de récoltes endommagées et de faire apparaître une appréciation positive de la conservation chez les populations locales qui vivent autour du parc.

Introduction

The Kakum Conservation Area in Ghana's forest zone (fig. 1) now attracts more than 60,000 visitors each year, most of whom are Ghanaians. To an outsider it appears to be Ghana's most successful national park and its development has helped to boost the economy around Cape Coast, the regional capital. However, many nearby farming communities are hostile towards the park and towards the concept of biodiversity conservation because of the crop damage that elephants cause.

In April 2000 park managers and the Elephant Biology and Management team of Conservation International held a workshop to discuss crop raiding around the conservation area. Until that point all discussion on the crop-raiding problem had centred on deterring marauding elephants, but at the workshop it was decided that the priority must be to address the *causes* of the problem because that was the only way to find a permanent solution.

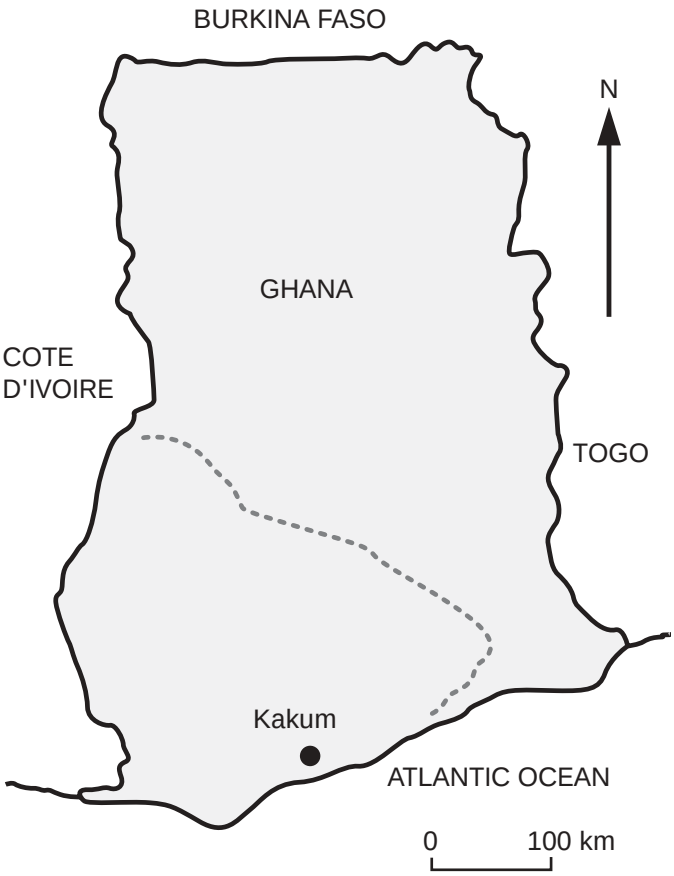

Figure 1. Map showing the location of Kakum Conservation Area in southern Ghana. The dotted line shows the boundary of the forest zone.

The crop-raiding problem at Kakum

The Kakum Conservation Area (KCA), consisting of Kakum National Park and the Assin Attandanso Resource Reserve, was created in 1992 and is managed as a national park. Covering 366 km^2, it is an isolated fragment of the Upper Guinea forests that once covered south-western Ghana. KCA is now a forest island in a landscape mosaic of cultivation, farm bush, secondary forest and swampland. The main cash crop is cocoa, and a few farmers also grow oil palm, coffee, citrus or coconut (Agyare 1995). The subsistence farming system is shifting cultivation (Agyare 1995). The staple food crops are cassava and maize; other crops include plantain, cocoyam, yam and vegetables such as okra, tomato, pepper, bean, eggplant and watermelon. The median farm size was 0.3 hectares in 2001 and 2002.

Elephants often leave the forest to feed in nearby farms, usually at night. Even before 1992 elephants were reported to be raiding farms (Dudley et al. 1992), but in the last decade the raids have become more frequent, and the number of complaints by farmers has increased particularly steeply during the last five years. One-third of the farms within 1 km of the park boundary were raided in both 2001 and 2002 (Barnes et al. 2003).

Causes of crop-raiding

Many farmers believe that the increasing frequency of raids is evidence of a growing elephant population. No data are available to confirm whether numbers have increased. There has been no immigration for many years because this elephant population is completely isolated. Vegetation changes caused by logging may have improved the food supply for elephants (Barnes et al. 1995), but elephant populations grow slowly, and reproduction alone could not explain the rapid increase

in the number of complaints in recent years. This sharp increase is more likely explained by a change in elephant behaviour.

Our analysis of the Kakum situation indicates that the increasing rate of crop raiding is a symptom of the changes in the landscape around Kakum over the last century (Barnes et al. 2003). Ghana's human population increased rapidly during the 20th century (United Nations 2000). In 1900 this part of Ghana was covered by lowland forest, but since then—and especially following the Second World War—roads, railways, villages and towns extended into the forest zone, and in addition many immigrant farmers moved into the south-western forests to grow cocoa (Barnes et al. 1995). The high forest was progressively replaced by farms and farm bush—a mosaic of newly abandoned farms, herbaceous tangle, thicket and young secondary forest (Ahn 1961). This type of vegetation is especially attractive to elephants (Nchanji 1994; Barnes 2002).

Small farming communities expanded rapidly, thus accelerating the landscape transformation during the last few years (Barnes et al. 2003). The shortage of land has caused more clearing close to the park boundary, where farms are at greater risk. We also found that elephants were attracted to farms with a variety of crop types. As a consequence of the expanding of food crop cultivation close to the park boundary, the landscape adjacent to the park has become increasingly attractive to elephants, and their crop-raiding behaviour is therefore a symptom of these changes. Similarly, Sitati et al. (2003) showed that the area under cultivation was the strongest predictor of crop raiding by both male and female elephants at their site in south-west Kenya.

Strategic versus tactical solutions

Methods for tackling crop-raiding problems can be divided into those that address the underlying causes of the problem (the strategic approach) and those that tackle the symptoms (the tactical approach). These are analogous, respectively, to tackling a brain tumour with surgery or giving aspirin to the patient (Barnes 2002). A headache today may be cured by aspirin, but it often returns the next day, and meanwhile the tumour continues to grow. In this case aspirin is a palliative or short-term solution. As time passes, one must give stronger and stronger aspirin, but the patient will eventually die.

Many of the methods used in the past for deterring elephants around KCA—firing shots in the air, shouting, banging drums, lighting fires—are examples of the aspirin approach (Barnes 2002). They do not address the underlying problem, but the temptation has always been to seek such deterrents because they are cheap and they give farmers the impression that their concerns are being addressed. Furthermore, they often appear to be a solution because elephants do not like novel features in the environment and will at first avoid a new deterrent tactic. But once they realize that this tactic or feature is harmless they ignore it. For example, in 1997 some farmers around Kakum built fences made with wire from car tyres. Elephants avoided those fields and the villagers assumed a cheap and simple deterrent had been found. But after a few months the elephants pushed the fences down and returned to the fields. They are now accustomed to the acetylene-and-bamboo bombs that are used locally to scare them from the fields. Similarly, many of the Kakum elephants now ignore the disturbance shooting (shots fired overhead) that has long been the Wildlife Division's main deterrent. We are dealing with intelligent animals that learn to adapt. Once elephants have learned that a particular tactic is harmless, that tactic can never again be used effectively against those elephants.

A risk of these aspirin tactics is that they may bring farmers and elephants into close contact, thus increasing the probability of human deaths. Also, tactics that annoy or inflict pain may make elephants aggressive.

Recommendations

Strategy to reduce crop-raiding

We propose a triple-pronged strategy of landscape management, crop-raiding detection, and elephant repulsion to reduce the risk of crop damage around KCA. If crop raiding is a symptom of landscape change, then the problem must be addressed by managing the landscape. However, there will always be some elephants that leave the park and those animals must be effectively detected and then effectively repulsed. One will never eliminate the problem, but one can at least reduce it to tolerable levels (Hoare 2001).

We recommend that a task force be created, consisting of officers from the Wildlife Division, the Ministry of Food and Agriculture, the Forest Research Institute of Ghana and the Forest Services Division.

The task force will work with farming communities, district assemblies, traditional chiefs and the local religious institutions to implement the strategy.

Landscape management

We propose a zoning system with two concentric bands around KCA, each 1 km wide. In the first zone, the land within 1 km of the park boundary, farmers should be discouraged from growing subsistence crops because it is the cultivation of such crops that creates the mosaic of farm and bush that attracts elephants. Instead, farmers should be encouraged to grow cash crops like pepper, ginger and teak. Encouraging the farmers to cooperate in community-level forestry and agroforestry would have the further effect of reversing the decline in tree canopy cover. They should also be encouraged to try other forms of generating income such as fish farming and snail farming. In this zone, therefore, the goal is to move away from the mosaic of constantly changing herbaceous and palatable plant types towards a landscape of unattractive perennial species.

In the second zone, lying between 1 km and 2 km from the park boundary, subsistence crops should be grown in a manner that does not render farms attractive to elephants: only two or three crops per farm, vegetables should be discouraged, maize should not be grown at all, and only modest amounts of cocoyam should be cultivated (Barnes et al. 2003).

A change in land management cannot be introduced overnight and may take up to a decade. In the meantime, it will be necessary to use deterrent tactics to keep elephants away from farmers' fields (Osborn and Parker 2002; Parker 2003).

Detection

Many farmers around the park do not protect their crops. Some are afraid of the nearby forest at night, some argue that the elephants belong to the government and therefore it is the Wildlife Division staff who should stand guard over their fields, while others say that they work hard all day and they lack the energy to stay out in the fields at night. Farmers should be encouraged to do more to protect their fields. Their options are discussed by Osborn and Parker (2002) and Parker (2003). Indeed, the mere presence of humans in fields is still a significant deterrent to marauding pachyderms. The risk of raiding varies with the phase of the moon (Dickinson 1998; Barnes et al. 2003), and so farmers must be alert especially during the critical new moon and waxing phases; they can afford to be less vigilant around the full moon.

Repulsion

Farmers must be trained in the most appropriate deterrent techniques for driving elephants away (Osborn and Parker 2002; Parker 2003). If landscape management is successful, then deterrent tactics will be needed only infrequently, and so elephants are less likely to become accustomed to them.

Discussion

Crop raiding by elephants is a major problem for wildlife managers in Ghana (Wildlife Division 2000) and elsewhere in the Upper Guinea forest zone (AfESG 1999). At each site in West Africa where we have seen crop raiding by elephants, park managers have been concerned only with addressing the symptoms of the problem, not the underlying causes. Radical changes in land use will be necessary to address crop-raiding problems at other sites in the Upper Guinea forest zone, in the same way that radical surgery may be necessary for a tumour. Overemphasis on aspirin may distract attention from the need for surgery. However, we emphasize that short-term deterrent tactics will be necessary to reduce farmers' suffering until resources can be mobilized to implement the land-use changes (e.g. Parker 2003).

To return to the medical analogy, one must keep the patient sedated while the preparations are made for the surgical operation that will remove the tumour. The point is to get the right balance between addressing the symptoms and the causes, between the aspirin and the surgery. Land-use management is the first line of defence in this proposed strategy. It will reduce the need for using deterrent methods to repulse the elephants, and using deterrents less frequently will lessen the risk of the elephants growing accustomed to them. Those tactics will therefore be more likely to remain effective in the long term.

The idea that protected areas can be managed as islands is now obsolete. KCA must be managed as a component of the regional landscape. Ideally, a large area around the park should be managed to reduce its attraction for elephants. To begin, we have proposed land-use changes of the area within only 2 km of the

park boundary (an area of about 250 km^2), recognizing that such changes in the lives of the populace will not be easy. Also, the risk of crop damage for a farm located 1 km from the park boundary is less than 10% of the risk adjacent to the park boundary (Barnes et al. 2003). Thus changes in land use and farming practices within 2 km of the park should result in a dramatic reduction in risk. Nevertheless, we recommend that a second phase, to expand the area covered by the land-use changes, be implemented later.

This problem is major and it can be tackled effectively only by large-scale changes.

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HISTORY

Fragments on the history of the rhinoceros in Nepal

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Abstract

The rhinoceros of Nepal was first mentioned in European literature by B.H. Hodgson in the 1830s. The animal was occasionally seen or hunted in the terai region between the Indian border and the Himalayas. Between 1846 and 1950, rhinos could be hunted only by permit and a few hunts of the late 19th century are quoted. The rhino was part of shoots organized for the British royal family in 1906, 1911 and 1921. Most Indian rhinos that were shown in Europe and America between 1905 and 1939 originated from Nepal.

Résumé

Le rhinocéros du Népal a été pour la première fois mentionné dans la littérature européenne dans les années 1830, par B.H. Hodgson. L'animal était occasionnellement vu ou chassé dans le Teraï, entre la frontière indienne et l'Himalaya. Entre 1846 et 1950, il fallait un permis pour avoir le droit de les chasser, et on rapporte quelques chasses à la fin du 19ème siècle. Le rhino était inscrit au programme des chasses organisées pour la famille royale britannique en 1906, 1911, et 1921. La plupart des rhinos indiens qui ont été montrés en Europe et en Amérique entre 1905 et 1939 venaient du Népal.

Introduction

Western literature on the biology and conservation of the Indian rhinoceros (*Rhinoceros unicornis*) in Nepal generally suggests that there are few early sources concerning its historical distribution and status (Laurie 1978; Dinerstein 2003). In his classic survey in 1959 of the rhinoceros areas of Nepal, Gee (1959) mentions no literature referring to the history of the region inhabited by rhinos prior to the books by E. Arthur Smythies (1942) and his wife, Olive Smythies (1953). While the literary record is certainly inadequate, I have endeavoured to bring together some of the relevant material to help our understanding of the rhino in Nepal. As many of these sources may not be easily accessible, I have quoted from their texts to help those interested in their contents. I have not been able to include possible references to the rhino in literature written in Nepalese languages or in reports kept in local archives, which could well contribute many more interesting facts if they were retrieved and recorded.

The rhino of the terai

Most authors agree that before 1950, due to the prevalence of malaria, there was very little human settlement in the areas at the foot of the Himalayas except for a few scattered villages of the indigenous Tharus tribes (Seidensticker 1976). Oliphant (1852:37) travelled from India to Kathmandu and described his impressions in these terms:

'A small stream divides the Company's from the Nepaulese dominions, and on crossing it the change of government is at once obvious. The villages looked more wretched, the people more dirty, the country was almost totally uncultivated, and nearly all traces of roads disappeared as we traversed the green sward of the Terai of Nepaul, scattered over which were large herds of cattle, grazing on the short grass, which extended in all directions over the vast expanse of flat country.'

The rhinoceros was found only in the terai region of Nepal, a narrow strip less than 40 km wide situated between the Himalaya Mountains in the north and the Siwalik Hills of India in the south. The 'historical distribution' of the rhinoceros, according to Gee (1959: map 1) and subsequent authors, once stretched from the far eastern border throughout the length of Nepal to the far western border (fig. 1). This runs parallel to the occurrence of the rhinoceros in the Ganges Valley, where the animal was recorded eastwards to the districts of Champaran and Purneah in northern Bihar, in the west at Kotdwara near Haridwar in 1789, and in the Pilibhit District until the 1870s (Rookmaaker 1984, 1999a,b,c, 2002). The rhinoceros was mentioned from the terai of Nepal by Blyth (1862:151) and Blanford (1891:473).

From 1846 to 1950, the rhinoceros was protected by order of the Rana family and their prime ministers, who ruled over Nepalese territory. Rhinoceros hunting was strictly forbidden, except to members of the ruling class and their friends. It was also asserted that a rhinoceros was killed every time a rajah died to accompany his body (anon. 1852), pointing at some revered status (a rather dubious statement). It is known, however, that whenever a Rana became a prime minister, for religious reasons he had to kill a rhino in a ceremony called 'blood tarpan'.

The period of Hodgson

The earliest unequivocal references to the rhinos in Nepal were made by Brian Houghton Hodgson (1800–1894), who stayed in the Kathmandu Valley from 1820 to 1843, starting out as assistant resident to become resident in 1833 (Cocker and Inskipp 1988). During this time, he collected a wealth of careful observations on the mammals and birds of the Himalayas. In a paper read to the Zoological Society of London on 26 August 1834, Hodgson enumerated all species of Mammalia that he had found in Nepal, which included *Elephas indicus* and *Rhinoceros unicornis*: 'both abundant in the forest and hills of the lower region, whence in the

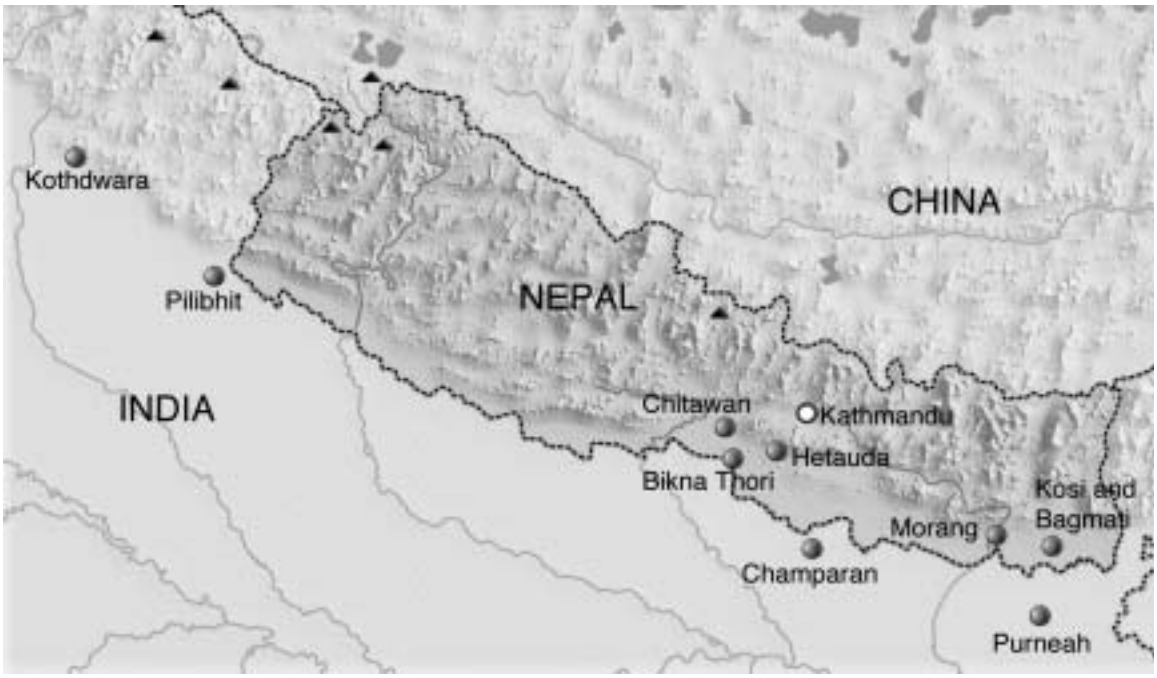

Figure 1. Nepal with some of the turn-of-the-century place names indicated.

rainy season they issue into the cultivated parts of the Tarâi to feed upon the rice crops' (Hodgson 1834:98). As his movements were restricted to the area around Kathmandu, Hodgson had no chance to see the rhino in its original habitat, but he had observed a couple of specimens kept in an enclosure in Kathmandu. This pair produced the first ever rhinoceros bred in captivity in May 1824. The young animal was sold after 10 years to Calcutta, but there it is lost from the records (Rookmaaker 1979, 1998:79). Soon after leaving the country, Hodgson (1844:288) again listed *Rhinoceros unicornis* in a catalogue of Nepalese mammals. A specimen of the Indian rhinoceros that Hodgson obtained is in the collection of the Natural History Museum, London (Gray 1846:35).

Captain Thomas Smith, assistant political-resident of Nepal from 1841 to 1845, and Hodgson's second-in-command during his last years in the country, was proud of his achievements in hunting and other sports. During a visit to the Durbar in the capital, the rajah asked Smith to kill a rogue elephant for him. Setting out in the company of two native chiefs, Sirdar (or 'sardar', meaning 'chief') Bowanee Sing and Sirdar Delhi Sing, he soon reached Hetauda, on the northern edge of the terai. He published some impressions of this hunt in the royal reserve, in the style typical of that age:

'We opened our sporting campaign at Hitounda, the half-way house from Nepaul to the British territory. Many deer, eleven tigers, and seven rhinoceroses, fell to my battery, the two Nepaul chiefs having shown a most religious horror of coming in contact with the last-named formidable animals. The Indian rhinoceros is certainly an ugly customer, evincing a great dislike to being disturbed in his muddy bath. Upon being compelled to move, he at once makes off to another swamp, and, if interfered with on his way, he invariably shows fight, and is not then to be despised; for when he once takes up a position, he will dispute it to the last with the most determined ferocity, neither giving nor receiving quarter. I was much amused, after killing my fifth rhinoceros by being waited upon by the two chiefs in the afternoon, and after the usual compliments, informed by them that they had received an intimation from the Durbar, that the Court was surprised from their own sporting qualifications, they should allow an Englishman to kill so many rhinoceroses in the Terai, without their having destroyed one; and, that if they were either unwilling to attempt, or incapable of achieving such an enterprise, they were immediately to return, to be replaced by other chiefs, who would be more careful not to disgrace themselves as they had done. My chiefs were evidently in a great state of alarm, so I told them, if they felt inclined to distinguish themselves, I would soon procure them a favourable opportunity. They frankly confessed their incapability of profiting by my offers, but earnestly implored me to save their *hoormut* (honour). To this I acceded, and the next day intelligence was brought that there were four rhinoceroses within a mile of us. At their own request, I lent each of the chiefs one of my guns, as they had a firm impression that they were endowed with some kind of *jadoo* (witchcraft). We soon arrived at the head-quarters of the *ghindahs*. They were rolling in the mud, in the midst of a heavy swamp; and, finding themselves disturbed in the midst of their luxurious ablutions, they, as usual, got up, and made for another bath. I immediately intercepted them, and provoked two of the party to hostilities, when down they came to the charge. The brute that rushed at me I killed within six yards of the elephant Megreath, on which I was mounted, and which stood to the charge like a rock. I fortunately hit the rhinoceros in the only vital part, just under the foot of the ear, which is not easily accomplished. The other animal selected my friend Sirdar Delhi Sing's elephant, which immediately turned tail and bolted, but the rhinoceros was too quick for him, came up to the elephant in a few strides, and with his tusks cut the fugitive so severely on the stern—nearly severing his tail—that he attempted to lie down under the pain. But the rhinoceros was again too quick for him, and bringing his horn into play, he introduced it under the elephant's flank; the horn tightened the skin, and then with his two frightful tusks he cut the poor animal so severely, that his entrails came rolling about his legs, as he fell, undergoing the dreadful assaults of his antagonist. The Sirdar now threw himself out of the howdah, and scrambled up a tree (which was close at hand), like a galvanized monkey. The other Sirdar was going across country, at Melton pace, on his elephant. Having disposed of my rhinoceros, I pushed up to the rescue, fearing, indeed, the Sirdar had been killed. On approaching within twenty yards, the rhinoceros relinquished the fallen elephant, and turned to have a charge at me. I brought him on his knees the first shot, but he recovered, and fought me valiantly; and, in consequence of my elephant being a little unsteady, it was not until the fifth shot that he fell to rise no more. The poor mutilated elephant lived about two hours, and died in endeavouring to rise. I should at once have put it out of its misery, had the mahout not assured me, that if he could be got to the tents he should be able to recover it. From

Nepalese 100-rupee banknote, in use since 1961, showing a Chitwan Valley rhino.

this account, it will be seen that the rhinoceros is armed with much more formidable tusks than the boar. These are the weapons he brings into such deadly operation, and not the horn, as many persons are led to believe.' (Smith 1852:87–91)

Early hunting permits

Although the rhinoceros in the Nepalese terai was protected by the Nepalese rulers for over a century after 1846, animals could be shot with a permit from the maharajah or the prime minister. There are no statistics to indicate how frequently such permission was granted. During the 19th century, a few specimens shot in Nepal were added to museums outside the country. The Royal College of Surgeons of England had specimens collected by Sir Jung Bahadoor in 1876 (Flower 1884:417), while the Indian Museum in Calcutta received rhinos from Sir E. Baring in 1875 and J. Anderson in 1880 (Sclater 1891:202). The hunts organized for the maharajah invariably took place in the Rapti Valley and surroundings. When Brown (1912:53) arrived in Hatawa (Hetauda), he said that this 'village is in the heart of the best sporting country, and is usually the starting-point for shikar expeditions. Ordinarily it is a squalid collection of huts, but becomes a bustling centre of life when, as in the days of the great Jung Bahadur, it was made the rendezvous for a tiger, rhino, or elephant hunt.'

One hunt organized at the end of the 1870s for one of the Nepalese ministers is described by Oldfield (1880:235–237) as follows, with references to the local folklore:

'The great beat for rhinoceros is along the valley of the Rapti River, in the neighbourhood of Chitaun (at or near the confluence of the Rapti and the Manhauri rivers). There are large tracts of level country here, covered with dense high grass jungle; in this the rhinoceros lives, constructing runs or burrows in the grass, along which he moves, the grass meeting over his head, so that he is not seen by one out of the run, although he may be very near. Maharaja Jang Bahadur was very successful this year; they killed several and wounded a large number of rhinoceros. Generally the elephants are afraid of them, and were it not that the long grass screens the rhinoceros from the elephant's eye, there are very few would stand the charge. The elephants are stationed in different runs along which the rhinoceros is expected; when he gets very near, if he sees his way blocked up, he makes a peculiar grunt like a boar and charges straight ahead. The elephant almost invariably bolts when he hears this grunt; the great thing is to get a good shot at the brute's head as he comes slowly along his run, before he utters the grunt and before he commences the charge. Bam Bahadur shot one, at Chitaun, just at this moment, the ball entering through one eye and smashing his brain; so that the brute rolled over dead with only one ball in him. The skull and skin were sent up to Nipal, and are now at Thappatalli. Out of the skin, after being cleaned and cured, they make capital water-buckets; these are immensely strong, never break, and are

impervious to water. Out of the horns they manufacture: from the spreading base they make richly carved cups or urgas, which are susceptible of high finish and polish; from the thinner upright part they make handles for kookeries [kukri, a curved Nepalese traditional knife]. Of the rhinoceroses shot on this excursion very few were killed outright; they escaped into the jungle severely wounded and died, some of them almost immediately, others not for two or three weeks. Their bodies were found by men sent to look after them, and their skulls and skins sent up to Nipal.'

The royal shoots

In February 1906, King George of England went on a shoot in Nepal from a camp in Kasra (Ellison 1922:675), which, due to an outbreak of cholera, was away from the more permanent camp originally planned. The area originally set aside for the purpose, 'which had not been shot over for something like thirty years', was subsequently entered in the first months of 1907, when either 27 rhinos were seen and 21 females were shot (Lydekker 1909) or, more likely, 14 males and 14 females were bagged and 6 calves were caught (Manners-Smith 1909). Although Lydekker (1909) thought that the young animals were captured to experiment with rhinoceros racing, Manners-Smith (1909) believed that the maharajah planned to translocate them to the eastern terai where rhinos had become scarce through a disease. This operation was aborted when it was found that all the calves were males. Four of these rhinos were then bought by the German animal dealer Carl Hagenbeck, who sold them individually to an American circus and to zoos in Antwerp, Manchester and New York (Rookmaaker 1998). The rhino population showed 'no appreciable diminution' and in February 1908 Lieut.-Colonel Manners-Smith was joined by the maharajah of Bikaner and another friend in the Naolpur valley bordering on Chitwan in shooting four rhinos (Manners-Smith 1909). In 1911, King George returned and killed a young rhino (Smythies 1942:19).

The next royal shoot was organized in December 1921 for the Prince of Wales, later King Edward VIII. Camping at Bikna Thori on the southern side of Chitwan, the members of the party together shot nine rhinos (Ellison 1922, 1925). The prince himself accounted for two of these, the first at Thoba on the 15th, the second at Sarasoti Kola on the 19th. Other rhinos fell to the rifles of Capt. Dudley North, Capt. Poynder and Percival Landon. On the afternoon of Sunday, 18 December 1921, according to time-honoured custom, the Prince of Wales was presented with a selection of live animals and birds, including a baby elephant, a tiger and a rhino calf. The animals were transported overland to Bombay, where after their arrival on 10 January 1922 they were temporarily housed at Victoria Gardens (fig. 2; Ellison 1922; Rookmaaker 1997). The female rhino, called 'Bessie', lived in the London Zoo from 7 April 1922 to 28 April 1926 (Rookmaaker 1998:87).

Historical distribution

The rhinoceros was royally protected and therefore allowed to live in relative peace; the occasional shooting of 10 or 20 animals hardly had an impact on the population. Nepal in those days was remote and rarely visited, but at the same time most of the rhinos arriving in zoos and circuses in Europe and America between 1905 and 1939 (around 29 individuals) came from Nepal (Rookmaaker 1998:35). The available historical sources almost invariably pertain to the region now occupied by Chitwan National Park and surrounding areas. Manners-Smith (1909) is one of but a few to comment on the occurrence of the rhinos in other parts of the country, stating that *Rhinoceros unicornis* 'is found in the Nepal *terai*, in Morang, north of Purnea, on the Kosi, at Patharghatta, on the banks of the Bagmati north of Muzaffarpur, and . . . it is even more numerous still farther to the west in the Chitwan and Naolpur valleys along the banks of the Gandak and the Rapti rivers.' All these localities being located in the southern and south-eastern parts of Nepal, it appears that there is not a single reference to the existence of rhinos in the west of the country. Many recent authors believe that the rhinoceros formerly must have occurred in western Nepal, because the species was known across the border in India. In Pilibhit District of northern Uttar Pradesh, the last known rhinoceros was shot in the early 1870s by R. Drummond (Hewett 1938; Rookmaaker 2002). Unfortunately, the picture remains fragmentary.

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Figure 2. A rhinoceros from Nepal kept at the Victoria Gardens in Mumbai, India, in January 1922 en route to London Zoo. Reproduced with the kind permission of the Bombay Natural History Society, from the *Journal*, vol. 26(3), 1922.

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FIELD NOTES

Remote treatment of black rhinos against babesiosis in Ngorongoro Crater, Tanzania

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Abstract

Higher than usual mortality among herbivores in the Ngorongoro Crater was noted beginning in March 2000. In August 2000 a year-old female black rhino (*Diceros bicornis*) was found dead in the crater floor. The carcass was heavily infested with ticks. On 5 and 14 January 2001 two adult resident female rhinos died. The cause of death was suspected to be babesiosis, a tick-borne disease. Microscopic examination of blood smears from the dead rhinos revealed intra-erythrocytic parasites resembling *Babesia* sp. Tissue samples from dead animals analysed using polymerase chain reaction identified *Babesia bicornis*, a previously unknown blood parasite. The life cycle of the parasite is not yet known. The death of the rhinos from tick-borne disease was associated with stress from starvation due to severe drought in the preceding months concurrent with high tick infestation. Two rhinos died from the same disease syndrome. Heavy tick burden at that time was noticeable in both wild animals and Maasai livestock, which are permitted to graze in the crater. Therapeutic treatment of rhinos was undertaken by remote means (darting) using diminazine aceturate (Berenil) to apparent good effect.

Résumé

Au début de mars 2000, on a noté une mortalité plus élevée que d'habitude parmi les herbivores du Cratère du Ngorongoro. En août 2000, on a trouvé le cadavre d'un rhino noir (*Diceros bicornis*) femelle âgé d'un an dans le cratère. La carcasse était très infestée de tiques. Le 5 et le 14 janvier 2001, deux rhinos femelles adultes résidentes sont mortes. On suspecta que la cause de ces décès était la babésiose, une maladie transmise par les tiques. L'examen microscopique de prélèvements sanguins effectués chez les rhinos morts a révélé des parasites des globules rouges ressemblant à *Babesia* sp. L'analyse de tissus des animaux morts par une réaction de polymérisation en chaîne a permis d'identifier *Babesia bicornis*, un parasite du sang inconnu jusqu'alors. Le cycle de reproduction du parasite n'est pas encore connu. La mort des rhinos à cause d'une maladie due aux tiques fut liée au stress de la faim causée par la sécheresse sévère des mois précédents, associée à une forte infestation de tiques. Deux rhinos sont morts de la même maladie. Une forte infestation de tiques était visible à cette époque aussi bien chez les animaux sauvages que chez le bétail des Masai qui peut paître dans le cratère. Le traitement thérapeutique des rhinos entrepris par des moyens utilisés à distance (fléchettes) comprenait du Diminazène (Bérénil) et semble avoir eu un effet bénéfique.

Introduction

Reports of mortality among buffalo and other herbivores in Ngorongoro Crater began in March 2000 (Fyumagwa 2001). The dead animals were heavily infested with ticks but investigators initially suspected rinderpest as the killer due to past experience in the crater. Laboratory analysis performed at the Animal Disease Research Institute (ADRI), Dar es Salaam, Tanzania, and Pirbright, UK, of serum samples collected from 10 immobilized buffalo in the crater ruled out rinderpest (Wiik 2000). Since it is believed that wildlife is fairly resistant to tick-borne diseases (Grootenhuis 2000), ticks were not initially suspected to be a contributing factor in the massive die-off. However, it is known that vector-borne disease epidemics can occur when vector numbers increase due to environmentally favourable conditions or the presence of alternative host species, which amplify vector abundance (Dobson and Hudson 1995).

In 2000 rainfall was below average, resulting in a severe drought in the entire northern zone of Tanzania. Therefore when rinderpest was ruled out, efforts to continue looking for the cause of deaths ceased because it was thought that mortality was a result of starvation. In May 2000 lions took a black rhino calf that was born in the crater floor after her mother (Zakia) failed to protect it. Little attention was paid to the mother's health because the predation was thought to be attributable to the naivety of the mother, who came from Addo Elephant National Park in South Africa where there are no lions.

In early August 2000 a year-old female rhino (Papageno's calf) was found dead with heavy tick infestation. The veterinary staff at Ngorongoro Conservation Area Authority (NCAA) conducted a post-mortem but did not take tissue specimens or blood smears. Meanwhile buffalo and other herbivores continued to die and many carcasses were seen stuck in mud near water sources. This observation led to the suspicion that starvation was the sole cause of the wildlife mortalities. Surprisingly Serengeti National Park, which is adjacent to NCAA, did not record any high mortality among herbivores. In mid-August 2000 an adult female rhino (Zakia, who had just lost her calf) was found dead in the thick bush with her horns intact, thus ruling out poaching as the cause. Unfortunately the carcass was seen when it was at an advanced stage of decomposition and diagnostic samples were not collected.

In early December 2000, two adult resident female rhinos (Fausta and Vicky) exhibited symptoms of red urine and anorexia. In view of the recent rhino mortality over the last few months, NCAA requested a thorough investigation into the condition. Tanzania Wildlife Research Institute (TAWIRI) and NCAA veterinarians went to assess the condition of the two rhinos. This paper discusses the clinical post-mortem examination, results from two animals and treatment that the authorities took to safeguard the remaining small population of rhinos in the crater.

Materials and methods

Clinical examination

The two sick rhinos were seen to be lethargic and anorexic. They passed frothy red urine, and their faeces were unusually dark, almost black. The two affected animals spent an unusual amount of time lying down. After showing these signs for almost two weeks these two rhinos recovered spontaneously. In early January 2001 two adult female rhinos who were original crater residents (Maggie and Bahati) died nine days apart, on 5 and 14 January. Both exhibited similar symptoms of lethargy, anorexia and red urine. These animals both died the same day that the game rangers noticed the symptoms.

Post-mortem examination

The gross pathology in the necropsied rhino carcasses included jaundice in the liver and other visceral organs, frothing in the trachea, bronchi and bronchioles, anaemia, enlarged spleen, haemoglobinuria and dark intestinal contents (melena). Blood smears, brain specimens and lymph node biopsies were collected. Ticks collected from the dead animals were identified as *Amblyomma gemma, A. sparsum, A. tholoni, A. variegatum* and *Rhipicephalus compositus* (Horak 2001; Nijhof et al. 2003). To identify the *Babesia* species involved, blood smears and brain and spleen impression smears were sent to ADRI in Dar es Salaam and duplicates to Utrecht University (Netherlands) for diagnosis using polymerase chain reaction (PCR), a technique that amplifies genetic material enabling identification of the parasites.

Treatment

Following the provisional diagnosis, it was decided in January 2001 to provide therapeutic cover for the re-

maining rhinos in the crater as an immediate temporary solution to the problem. Diminazine aceturate (Berenil® Hoechst) was used to treat the rhinos. Berenil has the advantage of being stable, has a wide safety margin and can be concentrated into a small volume to fit in the 3-ml darts. It has also been administered to black rhino in South Africa without obvious side effects (P. Morkel 2001, pers. obs.). For the injections, 2.36 g Berenil powder was mixed with 1.3 ml sterile water (3 Berenil sachets made up 5 ml of the suspension) and a maximum of 3 ml Berenil suspension was injected per animal. The rhinos received a dose of 2–3 mg kg^{-1} intramuscularly in the neck region. By this time it had started raining and parts of the crater were flooded. Remote injection avoided the stress that might have resulted from immobilizing the rhinos and hand-injecting the drug when they were possibly recovering from drought-related stress.

Results

Diagnosis

The blood smear samples that NCAA veterinary staff submitted to ADRI and those examined on site by NCAA and TAWIRI veterinarians revealed numerous intra-erythrocytic parasites resembling *Babesia* spp. Results confirmed by PCR revealed that the rhinos were infected with a blood parasite, *Babesia bicornis* (Nijhof et al. 2003). The parasite is tick-borne, but the tick species that transmit it are not yet known. Concurrent with the rhino deaths, high tick infestation with a number of different tick species (Fyumagwa and Wiik 2001) was recorded on the crater grassland.

Treated animals

The crater rhinos were treated from 24 to 29 January 2001, with 10 out of 13 animals treated in the operation. Berenil suspension was administered from a distance of approximately 40 to 50 m in nine rhinos; one juvenile rhino was remotely treated at a distance of approximately 15 m while it was moving. The 3-ml darts used had uncollared 40-mm needles as this type of dart falls out easily after its contents are discharged. A Dan-Inject dart gun (JM model) was used; it is quiet and fires relatively light and atraumatic darts.

The post-treatment response was good and no reactions were seen at the injection sites except that one rhino developed an abscess. Fortunately the abscess, in the neck, drained by itself and within two months it was healed.

The three animals that were not treated were orphan calves that were wary and could not be approached, possibly due to the recent loss of their mothers. It was recommended that they be monitored from a distance to see if they formed associations with adults, which would protect them from predators. As their stress levels were probably very high it was also important to monitor their condition in general and watch for clinical symptoms of disease.

Discussion

The disease outbreak among the rhino population in NCA is a newly reported phenomenon. The death of the rhinos was most probably a result of infection with *Babesia bicornis* (Nijhof et al. 2003), which was opportunistic as a result of immunosuppression brought on by stress from severe drought in the preceding months and concurrent with a high level of tick infestation in the crater grassland (Fischer-Tenhagen et al. 2000). Thus the evidence suggests that latent infection with a stress trigger is more likely than sudden exposure to a naïve infection due to poor immune response (Gulland 1995).

It can be argued that conditions of high tick density in the crater and large populations of almost sedentary wild animals in a small area (260 km^2) led to an increase in the prevalence of ticks acting as vectors for blood parasites. Exposure to infection probably increased in rhinos due to sharing the habitat with other wildlife and domestic animals (Fischer-Tenhagen et al. 2000). The total number of rhinos that died from babesiosis is most likely two: the adult cows that died in January 2001. The death of the year-old female calf that died in August 2000 remains unexplained.

A build-up of tick numbers in the crater has been observed since the *El Niño* phenomenon of 1997/ 98 (R.D. Fyumagwa 2001, unpublished data; Cosmas Soombe 2002, pers. comm.). The tick burden was noticeable on animals and in grassland in the crater, where ideal conditions apparently exist for vector-borne diseases (Dobson and Hudson 1995). There was a concurrent increase in tick-borne diseases, especially East Coast fever, anaplasmosis and babesiosis, in cattle that were brought into the crater to water, salt lick and graze (Fyumagwa 2001). The disease called ‘ormilo’ by the

Maasai (cerebral theileriosis) emerged in cattle at the same time that wild herbivores were dying in large numbers (J.O. Mollel 2002, pers. comm.).

Recommendation

As prophylactic veterinary treatment does not allow immunity to develop it is not usually recommended in wildlife. But the course of action decided upon and taken in this case was to counter the disease threat to a small population of endangered and very valuable animals. It is therefore important in future to actively monitor conditions that might predispose to a recurrence of this problem: poor nutrition, induced by drought followed by heavy rains, and the associated high levels of ticks.

Acknowledgement

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Les petites populations d'éléphants du Burkina Faso : statut, distribution et déplacements

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Abstract

Several surveys were conducted in recent years to estimate the larger elephant populations of Burkina Faso. But independently, several other small populations exist, most of which demonstrate transboundary movement. The numerical importance of all these small elephant populations is low at the continental level but quite high at the subregional level. They represent a total population of 225 to 230 elephants, which is greater than all those currently living in Senegal, Togo and Guinea Conakry put together. However, the ranges of some of these small populations currently extend beyond protected areas and corridors between two or more conservation sites. The effect of these small populations, though locally important, has yet to be quantified. This paper outlines the present situation. Further studies are required to elucidate the numbers, movements and conservation issues of these small but not necessarily isolated populations.

Résumé

Depuis quelques années des inventaires ont été menés dans certaines régions du Burkina Faso oû les populations d'éléphants sont importantes. Indépendamment il existe plusieurs petites populations qui effectuent des mouvements transfrontaliers. Leur importance numérique est certes faible au niveau continental, mais assez élevée au niveau sous-régional. Les seules petites populations représentent un effectif supérieur à ceux du Togo, du Sénégal et de la Guinée réunis. Cependant l'aire de distribution de certaines de ces petites populations s'étend au-delà des aires protégées et dans les corridors entre deux ou plusieurs sites de conservation. Au niveau local, leur impact peut se révéler non négligeable. Cet article décrit la situation connue à l'heure actuelle. De futures études sont nécessaires pour déterminer les nombres, les mouvements et les implications d'un point de vue de la conservation de ces populations de petite taille mais pas nécessairement isolées.

Introduction

Depuis quelques années des inventaires ont été menés dans certaines régions du Burkina Faso où les populations d'éléphants sont importantes ; il s'agit notamment de l'Ecosystème naturel W–Arli–Pendjari–Oti-Mandouri–Kéran (WAPOK) (Bouché et al. 2004a), de l'Ecosystème faunique Pô–Nazinga–Sissili (Bouché et al. 2004b), de la Boucle du Mouhoun (Bélemsobgo 2002 a,b ; Marchand 2002) ou de la Réserve du Sahel (Blake et al. 2003). Les efforts menés ont permis de se faire une idée précise de l'importance des grandes populations au Burkina Faso.

En dehors de ces grands ensembles qui regroupent chacun plusieurs centaines d'éléphants, et qui ont fait l'objet de recensements plus ou moins réguliers, il existe plusieurs petites populations peu connues. Pour la plupart ces populations regroupent au plus quelques dizaines d'animaux. A notre connaissance il n'existe aucune information actualisée sur ces populations. Cet article est pour nous l'opportunité de faire la synthèse provisoire de leur statut et de leurs déplacements.

Leur importance numérique est certes faible au niveau continental, mais au niveau local, leur impact peut se révéler non négligeable. Ces éléphants sont à l'origine de conflits avec l'homme principalement au

moment des récoltes (Drabo 1997 ; Marchand 2002). Dans la Zone de Pama dans l'Est du pays seuls une vingtaine d'éléphant seraient responsables de la majorité des dégâts de culture et de la destruction des greniers (Drabo 1997).

De manière générale les populations d'éléphants en Afrique de l'Ouest vivent dans des habitats morcelés (Roth et al. 1991 ; Blanc et al. 2003). Les connaissances actuelles donnent l'impression que les éléphants restent confinés dans des aires protégées ou des sanctuaires (Blanc et al. 2003). Sur le terrain par contre, on note que les éléphants utilisent saisonièrement ou occasionnellement des espaces qui débordent largement du réseau d'aires protégées existant (fig. 1).

Statut

Le tableau 1 montre que les populations représentent un nombre non négligeable d'éléphants pour le Burkina Faso. Les seules petites populations représentent un effectif largement supérieur à celui du Togo ou du Sénégal ou équivalent à celui de la Guinée (Blanc et al. 2003) voire plus des 2/3 de l'effectif total des éléphants du Mali (Blake et al. 2003).

Le statut des populations est relativement imprécis. Par ailleurs il est peu probable que toutes les populations aient été répertoriées dans le tableau 1. Des mises à jour permettront d'affiner nos connaissances. Une précision du statut serait cependant souhaitable afin de mettre en œuvre des solutions d'aménagement.

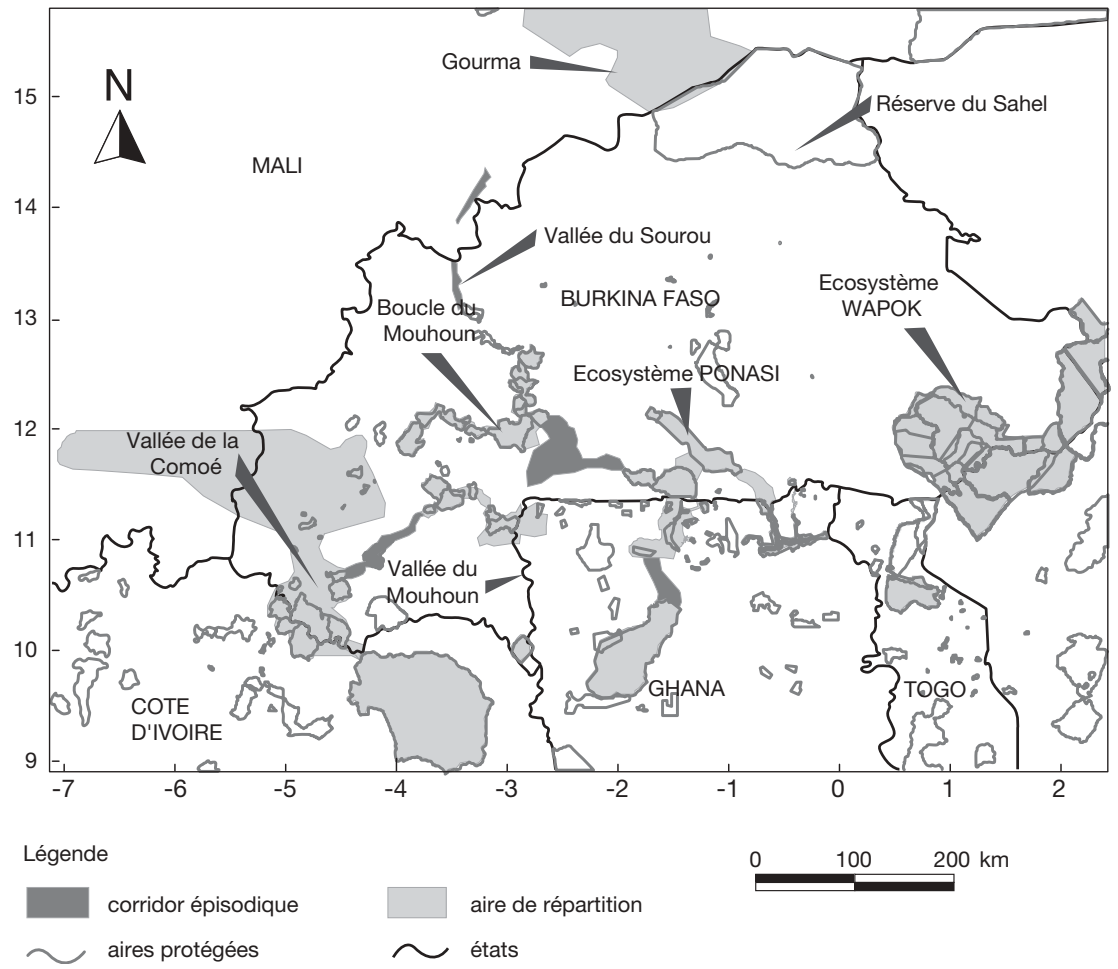

Figure 1. Aire de répartition de l'éléphant au Burkina Faso : situation générale (composition Ph. Bouché).

Tableau 1. Statut des petites populations d'éléphant du Burkina Faso et de quelques populations voisines du Mali et critère de qualité selon l'AED (African Elephant Database)

Localisation	Effectif	Critères AED
Région de Sikasso (Mali)	7 à 10	IG3
Région Bobo et Mouhoun	9	IG3
Région de Bobo Dioulasso Dindéresso	4 et 7	IG1
Région de Darsalamy et Banfora	5	IG3
FC Bontioli, Nabéré, Mou	60	IG1
Région de Dédougou	4 à 5	IG3
FC Koulbi	?	
FC Diéfoula	26	IG3
Bay (Mali)	3 à 4	IG3
Zabré–Red Volta	100	IG3
Total	225 à 230	

IG signifie informed guess ; FC = forêt classée

Distribution et axes de déplacement

Nous connaissons très peu les parcours migratoires actuels. Comme le montre la figure 1 il existe au Burkina Faso un grand nombre d'aires protégées qui semblent être utilisées par les éléphants.

Deux Balés–Pô–Nazinga–Sissili–Zabré–Red Volta (Ghana)

Il est très probable que des éléphants suivent saisonièrement la rivière Nazinon (Volta Rouge) depuis la Red Volta au Ghana en passant souvent à proximité de la ville de Zabré puis le Parc national de Pô où des observations récentes ont confirmé que l'éléphant fréquentait le Parc de Pô du nord au sud (Bouché et al. 2004 b) (fig. 2). Sur base d'observations personnelles et de témoignages concordant de villageois et de chasseurs traditionnels, quelques éléphants rejoignent occasionnellement la boucle du Mouhoun au niveau du Parc National (PN) des Deux Balés via le Ranch de Gibier de Nazinga (RGN) et en longeant la rivière Sissili. Cet éventuel parcours depuis la Red Volta au Ghana jusqu'au PN des Deux Balés représente près de 350 km. Il est également possible que des éléphants poursuivent leur route vers la Forêt classée (FC) de Maro ce qui accroîtrait d'autant plus le parcours.

Par ailleurs depuis le RGN certains individus se déplacent en saison des pluies vers le sud vers les Réserves forestières de Sissili Central, Pudu Hills, Mawbia, Wiaga, Chana Hills, Chasi et Bopong au Ghana. Des ressortissants des villages entre ces zones et le PN de Mole affirment que des éléphants migrent entre le RGN et le PN de Mole avec un retour vers le RGN entre Octobre et Décembre.

Depuis la Red Volta au Ghana, des mouvements d'éléphants ont été signalés par des villageois riverains, le long de la Volta Blanche jusqu'au Burkina Faso, parcours semblant être partagé avec la troisième population relictuelle de damalisque connue en Afrique de l'Ouest (après le WAPOK, et le Nord-est Nigéria / Nord-ouest Cameroun). En dehors de l'effectif recensé au PONASI en 2003 (Bouché et al. 2004b), il est considéré qu'une centaine d'éléphants fréquentent la Red Volta et la zone de Zabré.

A la fin octobre 2004, un éléphant a été observé à 30 km au sud de la capitale Ouagadougou. Cet éléphant a été anesthésié et déplacé vers le PN de Pô situé au Nord du RGN et à quelques 60 km au sud de Ouagadougou. (Ouédraogo L. comm. pers.)

Bobo Dioulasso (Burkina Faso)–Sikasso–Koumantou (Mali) et vallée de la Comoé

Cette zone est fréquentée par plusieurs petites populations. Des greniers et des récoltes sont couramment détruits dans la région de Koumantou (Niagaté B. comm. pers.). En 2003 des éléphants ont été observés dans la ville de Bobo Dioulasso (Ouédraogo L. comm. pers.) (fig. 2)

Des observations confirmées d'éléphants ont été rapportées : 3 troupeaux représentant 4, 7 et 9 individus dans la FC de Dindéresso et au Nord de Bobo Dioulasso (Heymans J-C comm. pers.) ; entre les villes de Darsalami et Banfora, 5 individus signalés près de la ville de Orodara à la frontière du Mali et du Burkina Faso, le long de la Rivière Comoé au niveau de la FC de Boulon-Koflandé ; Diéfoula 26 individus signalés (Traoré 1998 in Blanc et al. 2003), Logoniégué et les FC de Ouarigué et Léraba et au PN de la Comoé en Côte d'Ivoire. Des traces d'éléphants récentes ont été observées dans la zone de Djéfoula-Logoniégué en 2004 (obs. pers.)

Vallée de la Comoé et Mou–Nabéré–Bontioli–Koulbi

Cette population d'au moins 60 individus (obs. pers.) fréquentent la région de Bontioli et l'extrême Nord-

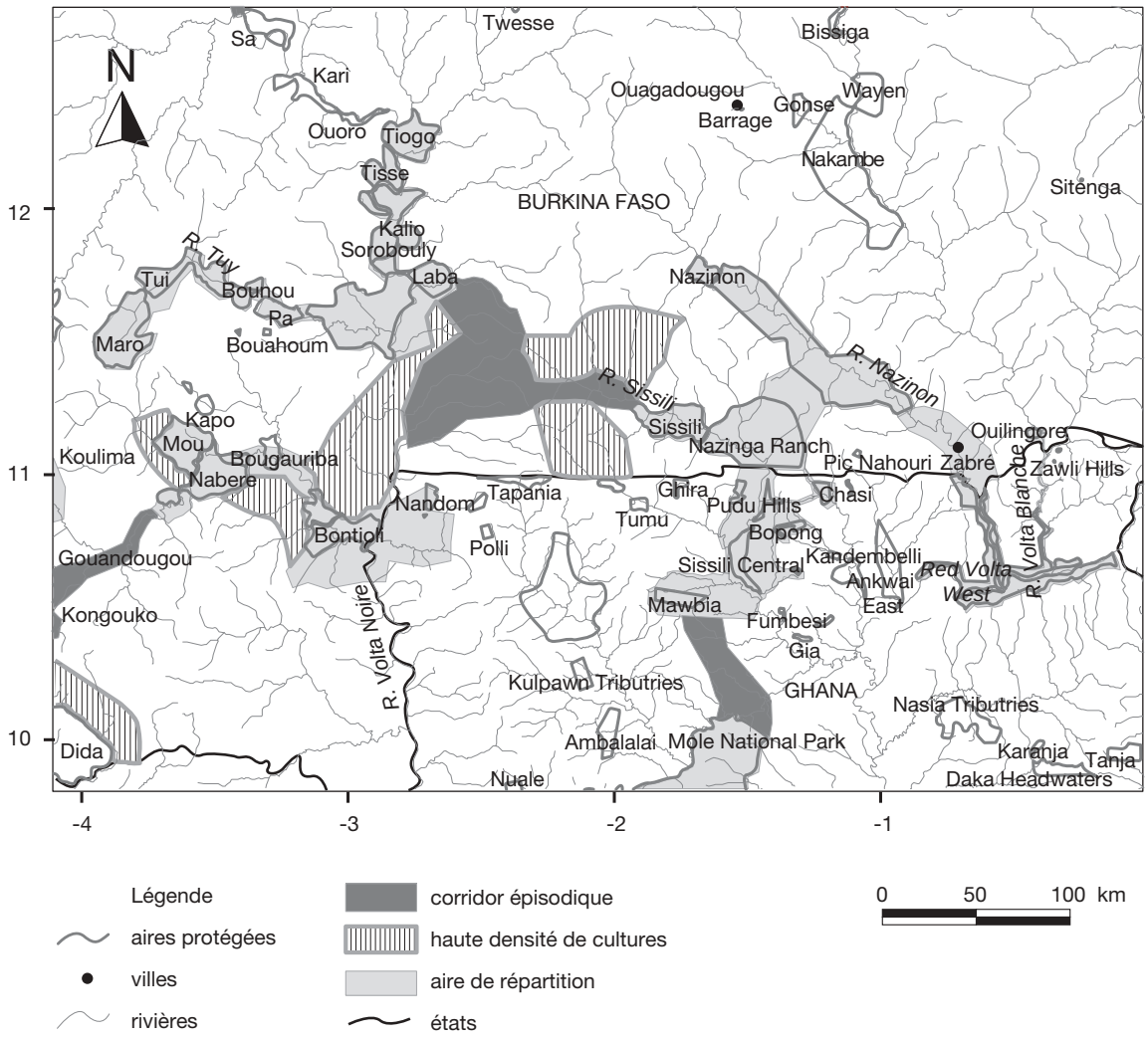

Figure 2. Aire de répartition de l'éléphant au Burkina Faso. Sud, Vallée de Mouhoun (Volta Noire) et du Nazinon (Volta Rouge) (composition Ph. Bouché).

Ouest du Ghana (Wildlife Division 2000). Il est possible d'affirmer qu'il existe au moins 60 individus car ils y ont été observés ensemble à plusieurs reprises le long de la route Diébougou–Gaoua. Il demeure à vérifier que les éléphants se déplacent occasionnellement du Sanctuaire des Hippopotames au Ghana et vers la FC de Koulbi le long de la Volta Noire. Cependant le statut des populations de la FC de Koulbi est mal connu. Il est probable que de Koulbi ces animaux rejoignent le PN de la Comoé en Côte d'Ivoire ou le PN de Mole au Ghana qui ne sont respectivement qu'à 50 et 80 km de la FC de Koulbi. Cependant ces hypothèses restent à démontrer (fig. 3). Par ailleurs les éléphants se déplacent également le long de la Bougouriba vers les FC de Nabéré et Mou (fig. 3).

La connexion entre la FC de Bontioli et le corridor qui joint PONASI et le PN des Deux Bâlés est sans doute difficile car la pression démographique est importante au nord de Bontioli. Il en est de même pour une éventuelle connexion entre les FC de Mou et Maro.

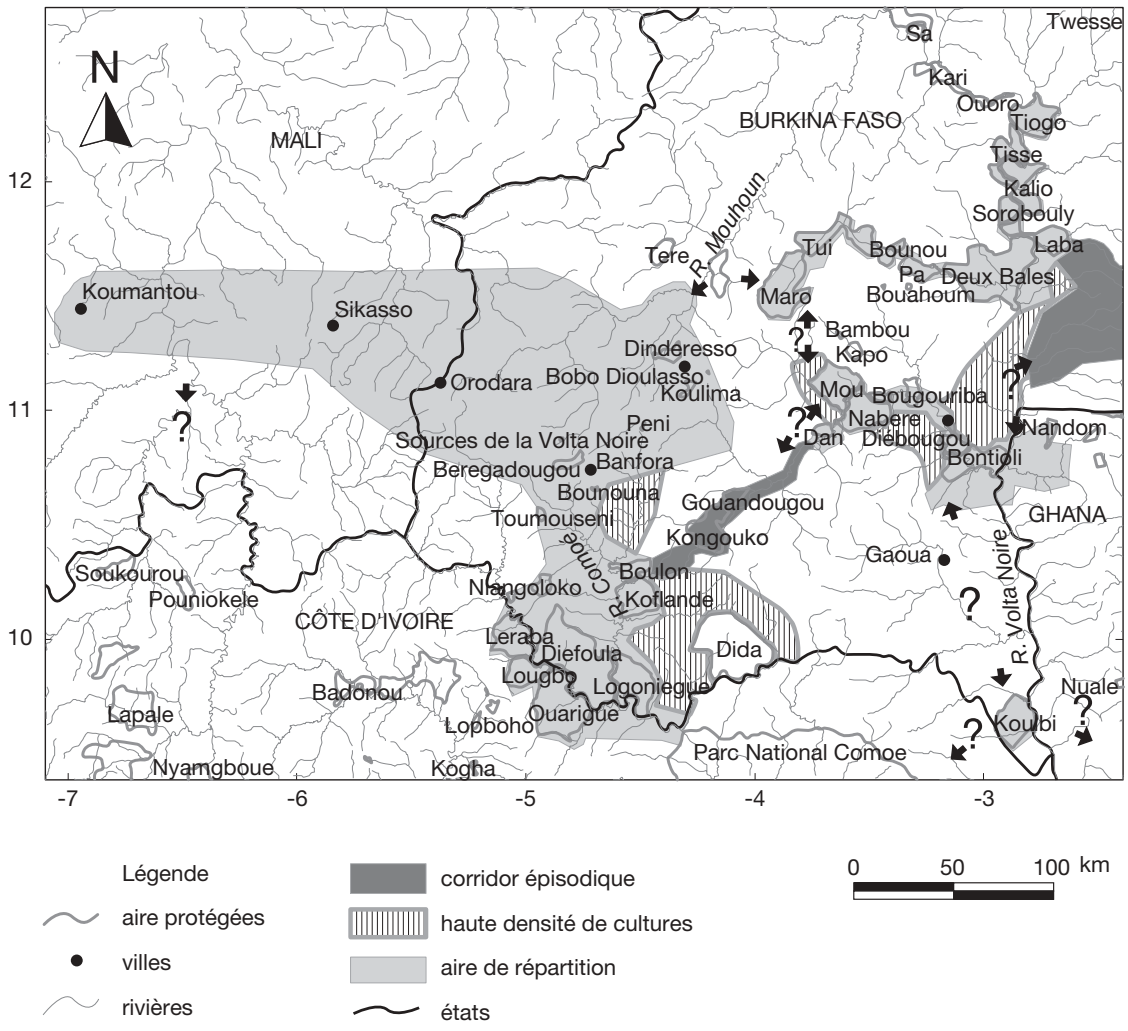

Figure 3. Aire de répartition de l'éléphant au Burkina Faso, Sud-ouest, Vallée de la Comoé et Mouhon (Volta Noire) (composition Ph. Bouché).

Région de Dédougou (Burkina Faso)–Bay (Mali) Réserve du Sahel

Deux petites populations de 3 à 5 animaux remontent périodiquement le long de la rivière Sourou (fig. 4). Il est peut être possible que ces populations se rencontrent occasionnellement ou plutôt que ces animaux font partie des éléphants de la Boucle du Mouhoun.

Par ailleurs des traces d'éléphant ont été enregistrées à proximité du Forage Christine (Portier B. comm. pers.) ce qui étend le domaine vital des éléphants du Sahel connu jusqu'ici (Blake et al. 2003). Il a été démontré que la taille importante de ce domaine vital est la conséquence de l'obligation pour ces éléphants de parcourir de grandes distances pour trouver la meilleure qualité de nourriture possible mais il est surtout défini par la distribution de l'eau au cours de l'année (Blake et al. 2003).

Avenir des petites populations

L'éléphant est intégralement protégé au Burkina Faso.

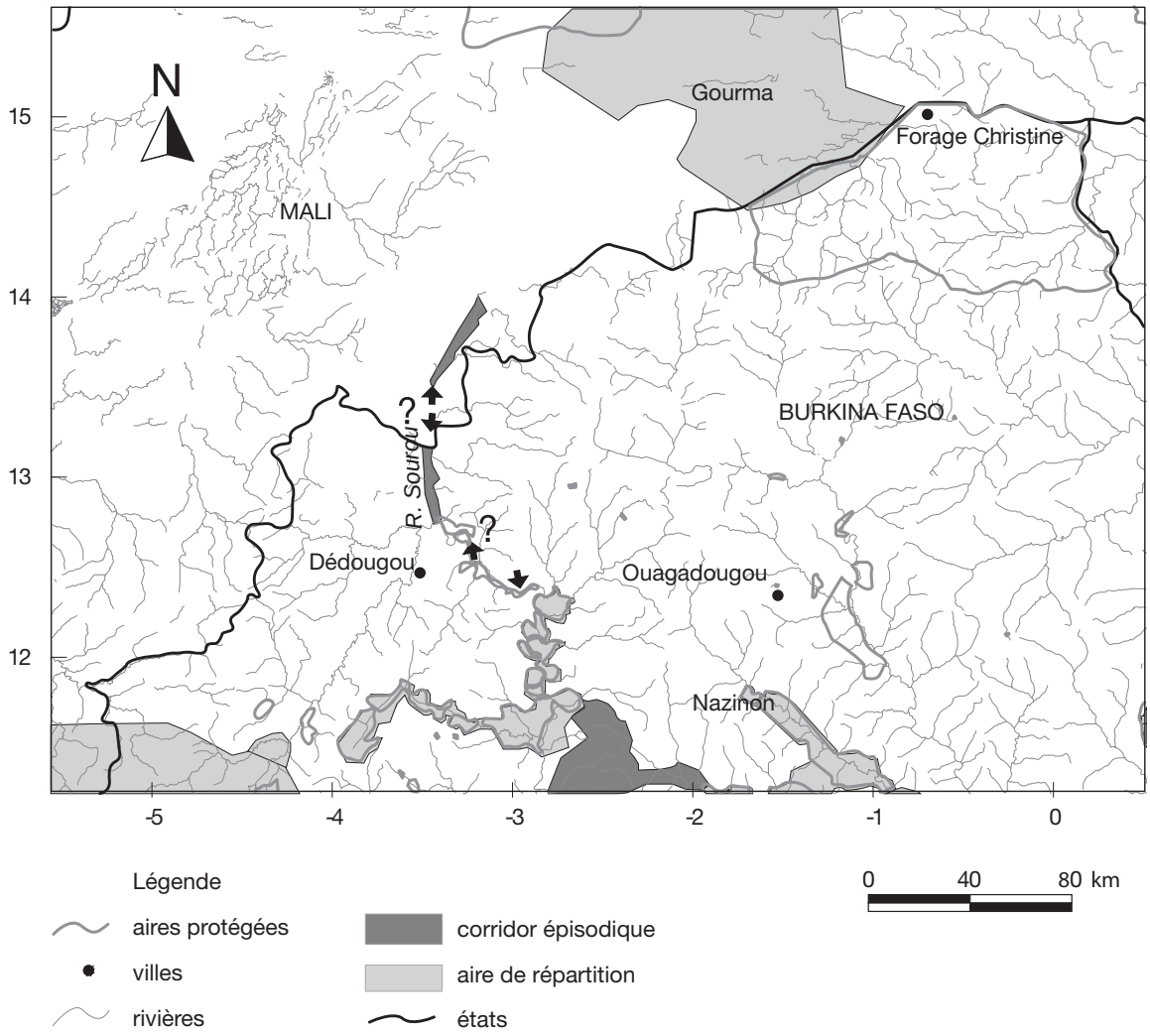

Figure 4. Aire de répartition de l'éléphant au Burkina Faso, Sourou et Sahel-Gourma (composition Ph. Bouché).

Des lois régissent également la protection des habitats des aires protégées, mais la mise en œuvre de cette protection nécessite des fonds importants que l'Etat n'a pas toujours les moyens de fournir. Par ailleurs les agents des Eaux et Forêts n'ont pas que la protection de la faune dans leur prérogatives, mais aussi toute une série d'activités sylvicoles, qui ne leur permettent pas toujours de consacrer le temps nécessaire et souvent important au suivi des populations d'éléphant. Même s'il est vrai qu'au Burkina Faso le braconnage d'éléphant est relativement réduit par rapport aux années antérieures, chaque année plusieurs cas sont signalés essentiellement pour la vente de viande toujours très appréciée.

Il n'est pas encore certain que les troupeaux décris ci-dessus qui migrent en dehors des aires protégées sont des populations indépendantes ou si elles font partie de sous-groupes des autres grandes populations dont la plupart sont plus sédentaires. Les populations sont apparemment de petite taille et leur avenir semble compromis. Cependant il faut rester prudent car nos connaissances sont maigres : il est possible que

les effectifs exposés ci-dessus soient sous-estimés, d'autre part il est également probable que plusieurs populations soient en contact les unes avec les autres au Burkina Faso ou avec les populations des pays voisins.

Si les corridors sont maintenus, ils pourraient contribuer à assurer le brassage des petites populations entres-elles. Dans ce cas nous ne pourrions plus parler de petites populations car ces petites hardes seraient en mesure de rencontrer les hardes de populations plus importantes de la Boucle du Mouhoun, de Nazinga, voire du PN de la Comoé (Côte d'Ivoire).

Ces petites populations utilisent le réseau d'aires protégées. Cependant ce réseau est morcelé et l'augmentation de la pression démographique humaine risque à terme de se révéler fatal pour certaines populations.

Si ces populations d'éléphant venaient à disparaître, il en résulterait la perte non seulement d'une richesse naturelle et culturelle mais également la perte d'une opportunité d'activité économique potentielle pour les populations de la région. Le fait est que les populations locales ont des niveaux de vie relativement bas et que l'éléphant pourrait constituer une source de revenus dans le cadre d'un tourisme de vision organisé par celles-ci.

En dehors des possibilités connues de safari de vision des écosystèmes WAPOK, PONASI, de la Boucle du Mouhoun et de la Réserve du Sahel, la zone de Bobo Dioulasso, de Banfora et du pic de Sindou sont des zones fréquemment visitées par les touristes. Avec quelques moyens supplémentaires il serait possible d'initier le tourisme de vision organisé par les populations locales dans les zones fréquentées par les éléphants.

Par ailleurs il pourrait être envisagé des corridors entre les différentes aires protégées du pays afin de garantir une préservation minimum de l'habitat et donc augmenter les chances de survie des petites populations.

Conclusion

En dehors des grandes populations d'éléphants connues au Burkina Faso, il existe encore un nombre non négligeable d'éléphants quoique dispersés en petits groupes, vivant dans un réseau d'aires protégées. Cependant leur statut et habitudes sont peu connus. Il semble évident que certaines populations utilisent des corridors pour passer d'une aire protégée à l'autre, ce qui pourrait permettre d'assurer les contacts entre éléphants de différentes aires protégées.

Avec l'augmentation de la population humaine et la généralisation de l'agriculture, les corridors sont à terme menacés si aucune mesure n'est prise. Des corridors devrait être sécurisés afin de garantir le brassage des populations d'éléphant, ce qui est important pour la vigueur génétique de l'espèce dans le cadre de sa conservation effective.

Le développement d'un éco-tourisme de vision pour l'éléphant mis en œuvre par les populations riveraines permettrait de contribuer à la conservation de l'éléphant dans les différentes régions oô il subsiste encore.

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RHINO NOTES

Black rhino hunting quotas approved for Namibia and South Africa at CITES Conference of the Parties 13

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The 13th Conference of the Parties (CoP13) of the Convention in Trade in Endangered Species of Fauna and Flora (CITES) was held from 2 to 14 October 2004 in Bangkok, Thailand. The first two rhino items to be debated concerned quota applications by Namibia and South Africa to sport hunt 5 and 10 surplus male black rhinos per year respectively.

As could be expected, the proposed use of hunting as a conservation tool generated much debate. This is primarily due to philosophical differences of opinion on 1) whether it is right to kill individual animals to further overall conservation objectives for the greater good of a population or species (Leader-Williams et al. in press) and 2) whether one supports the principle of sustainably using wildlife and resources to generate revenue to help fund conservation management programmes and to create positive economic incentives to encourage the private sector and communities to conserve wildlife and habitats. Those whose primary focus is on the welfare of individual animals targeted for hunting, as opposed to the broader issues of how best to conserve viable populations of species and their related habitats, tend to be against hunting, irrespective of whether it can be demonstrated to be sustainable and/or create positive incentives to encourage people in developing countries to conserve wildlife (Leader-Williams et al. in press).

The surplus male problem

At first glance, it seems inconceivable that anyone would want to hunt *Vulnerable* (Namibia) and *Critically Endangered* (South Africa) subspecies of black rhino when so much effort is going into protecting these animals and breeding them up as rapidly as possible. The presenters of the two quota applications at CoP 13 therefore spent some time explaining the problem of surplus male black rhinos and arguing the conservation merits of their proposals. As misleading information has been published in the press regarding these proposals, it is worth examining the rationale behind them in some detail.

Surplus black rhino males are not a new problem. The issue has been discussed by IUCN's African Rhino Specialist Group (AfRSG) since 1992.

The problem is that some populations can end up with markedly skewed sex ratios in favour of males. These skewed sex ratios can occur either by chance in some populations (with many more males than females being born), or if removals from donor populations are biased in favour of females (as was the case in setting up the highly productive Namibian custodianship populations). The problem is compounded by an apparent slightly skewed sex ratio at birth in favour of males, although this is often later reversed because of the higher adult male mortality rates due to fighting.

The problem is that the social carrying capacity of adult male black rhinos is limited. If no action is taken in markedly male-biased populations, fight-related mortalities are likely to increase once these surplus males grow up. If surplus males killed only other males then perhaps they could just be left to fight it out and let natural selection take its course. However, conservationists have expressed concern that in such

populations, valuable breeding females and calves may be injured or even killed as well as other males, as appeared to have been the case in Pilanesberg National Park in the past (Keryn Adcock pers. comm.). Surplus males also use valuable food resources that may affect female breeding performance. Although not yet conclusive, preliminary evidence from annual SADC Rhino Management Group status reporting suggests that female reproductive success may also be slightly higher in populations with a higher proportion of adult females to males. Thus many field managers in southern Africa have for some time now sought to find a way to reduce the number of surplus males in such populations. Somewhat counter-intuitively the hunting of a limited number of surplus males may end up stimulating metapopulation growth rates and hence overall rhino numbers.

Only some populations have a surplus male problem. Owners or management agencies conserving populations that end up with skewed sex ratios in favour of females over males are invariably happy for this to remain the case as long as possible, as percentage growth rates and calving production will be higher. This is similar to productive cattle farming where the number of bulls in a herd is limited to maintain rapid population breeding rates. Managers of such female-skewed black rhino populations are simply not keen to accept males.

The corollary is that while populations that end up with markedly skewed sex ratios in favour of males usually want to obtain more females, sourcing additional females is very difficult. Many donor populations, not unexpectedly, are loathe to provide females only, as this would negatively affect the donor population's sex structure and potential future performance. In practice, it is hard for the populations that have by chance ended up with more males to source and obtain additional females.

It is also known that specific rhino males can dominate the breeding and sire a large proportion of the calves in smaller populations. The removal of such animals after a period of say 10–15 years may therefore reduce the risk of father–daughter matings and contribute positively to the genetic management of such populations,

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Namibia and South Africa have each been given an export quota to hunt five surplus male black rhinos per year.

in the same way that a cattle farmer is unlikely to keep the same breeding bull for an extended period. In addition, the hunting of an old post-reproductive male that has been pushed out of his territory will not affect his contribution to the gene pool of that population.

Attempted solutions to the surplus male problem

A number of alternatives to hunting surplus males have been tried over the years including sending surplus males to zoos, attempting to sell them, and creating male-only populations in reserves that are too small to hold breeding populations. This last approach has not been particularly successful or popular. For example, in Makasa, KwaZulu-Natal, South Africa, a bull in a small male-only population killed the other two males. For the approach to have a better chance of success it is recommended that males that 'know' each other be introduced together.

Attempts to exchange or introduce adult males to bring in new blood to populations have also not had much success, with the result that it is recommended that adult females be introduced instead.

The argument that surplus males can be used to 'test' potential new areas for reintroduction also has limited applicability. This is because breeding females need to be on a higher nutritional plane than males to successfully conceive and raise calves at a rapid rate. A 'survival' diet for a small number of male rhinos is not the same as a diet for optimal breeding. Therefore, the mere fact that a few surplus males survive in a new area is no guarantee that females will breed well if introduced (which in the process will raise stocking rates higher).

In addition, mortality risks when setting up new populations appear to be reduced if founder animals are introduced at the same time. Concerns have been expressed by some that if male-only populations were to be established, and females introduced at a much later date, mortality rates of females following introduction may increase. If an area is big enough to set up a breeding population of black rhinos, ideally one should proceed straight to setting up the breeding population and not start with males only. If one starts with males, the problem remains of sourcing more females than males in future.

Demand for surplus males has been limited, and as a result these males have not generated much revenue to help fund conservation. Live males auctioned in KwaZulu-Natal in 2004 fetched an average price of USD 21,130.

Another problem—declining budgets for conservation

The reality facing many conservation management agencies in Africa is that their budgets have been declining in real terms. Successful rhino management is also expensive, requiring concentrated field protection and law enforcement, running of intelligence networks, monitoring, maintenance of fences and waterholes, and biological management (including translocating groups of surplus rhino to set up new breeding populations). These activities are required to meet national metapopulation goals and rapidly increase the number of black rhinos in national metapopulations. Intensively managing and successfully protecting rhino populations can cost as much as USD 1000 per square kilometre (Nigel Leader Williams and Tony Conway pers. comm.).

Hunting of surplus southern white rhino has been sustainable

Proponents of the two proposals argued that hunting limited numbers of southern white rhino in South Africa (and to a much lesser extent in Namibia) has to date clearly been sustainable. White rhino numbers have increased rapidly in both countries despite limited sport hunting. When white rhino hunting started in earnest in 1968 there were an estimated 1800 southern white rhinos in South Africa. Following good protection and translocations to set up many new populations, numbers in South Africa have increased to around 10,530 in the wild with a further 780 in other African countries and 750 in captivity worldwide. All 12,000-odd southern white rhinos alive today are derived from a single population of only 20–50 animals in South Africa in 1895, and the rescuing of this subspecies from extinction has been widely acclaimed as having been one of the world's greatest conservation success stories. The hunting of limited numbers of southern white rhino has been seen in southern Africa as playing an important role in funding conservation by stimulating live sale prices (with state conservation areas being the primary beneficiaries) as well as promoting wildlife conservation as

an economically viable form of land use (Emslie and Brooks 1999). One of the reasons white rhino hunting has been sustainable is that hunting levels have on average been low—in the region of 0.5–0.6% per annum in South Africa (Adcock and Emslie 1994).

Given the high cost of successful rhino conservation, the demonstrated sustainability of southern white rhino hunting, and the fact that other attempts to deal with the surplus male problem have met with limited success and generated little revenue to help fund conservation, it was to be expected that proposals to hunt surplus male black rhinos would eventually emerge. Indeed, the possibility of starting hunting has been discussed for a number of years in the SADC Rhino Management Group. A number of conservation agencies in southern Africa had suggested that such a move could be a win–win strategy—solving the surplus male problem while at the same time generating additional much-needed income to help fund necessary field conservation efforts. It has been estimated that a black rhino trophy hunt would fetch about USD 200,000, almost 10 times the current live price. It is expected that this would create a positive economic incentive for the private sector and communities to conserve black rhinos. The live value of black rhinos is also likely to increase, which will most benefit the state conservation agencies with surplus breeding animals.

The original South African proposal set out to hunt a higher proportion (0.85%) of the country's most common subspecies of black rhino (*D.b. minor*) than did the Namibian proposal (0.40%). The original proposed level of offtake in South Africa was therefore slightly higher in percentage terms than the average level of white rhino hunting being undertaken in South Africa, but still under the suggested maximum of 1%. By comparison, Namibia's proposed quota was slightly lower. In the light of this and following representations by AfRSG, TRAFFIC and WWF, South Africa proposed at CoP 13 to reduce its quota to five, in line with Namibia, as a precautionary measure.

Proponents of limited hunting argued that hunting such a small number of such surplus males will not lead to a reduction in overall rhino numbers, but for the reasons outlined above rather could contribute to improving population growth rates. They also have noted that the combined number of black rhinos now in Namibia and South Africa (2530) is greater than the number of southern white rhinos when hunting started in South Africa in 1968 (1800).

Differences between the two proposals

While Namibia and South Africa proposed a joint draft resolution on the establishment of export quotas for black rhino hunting trophies, there were important differences in the two countries' proposals.

In Namibia all black rhinos belong to the state. Thus Namibia's Ministry of the Environment and Tourism would decide which specific surplus males would be hunted. It was explained that many individual rhinos in Namibia are individually known, enabling the ministry to target specific surplus male animals. Namibia also indicated it would hunt only adult male black rhinos. The Namibian representative committed that 100% of all proceeds from any black rhino hunted on communal conservancy land would be made available for use in conservation programmes by respective community conservancies through the Namibian Game Products Trust Fund, thereby proposing a mechanism whereby communities that did not own the rhinos but had successfully conserved them would benefit directly from the hunting. The largest community-managed black rhino population in Africa occurs in Namibia, and it was explained that communal land representatives have shown high interest in this scheme. At CoP 13, Namibia stated that it was keen to increase benefits to communities.

In South Africa some black rhinos are privately owned, and in addition to South African National Parks there are nine different provincial conservation agencies with different levels of skill and competency. There is also room for improvement in the management of privately owned horn stockpiles. As a result, a number of NGOs including TRAFFIC and WWF have expressed concern about how and who would control and issue hunting permits in South Africa. In response to these concerns, the South African delegation at CITES indicated that permits for black rhino hunting would be issued only at a national level by the Department of the Environment and Tourism (DEAT) following the receipt of applications from the provinces. All trophies would be microchipped. The South African delegation also verbally indicated they would start hunting only when a new Act comes into force in mid-2005, which legally requires permitting of endangered species and their products. TRAFFIC and WWF still had reservations about the

proposed control mechanisms and felt that the proposal from South Africa was premature and should be considered only once control mechanisms were in place and demonstrably operational.

The presentation of the South African proposal was not clear on how it would be decided which five rhinos to hunt. The DEAT representatives at CITES were encouraged to adopt a strategy that created positive incentives for good conservation and maximized conservation benefits along the lines outlined in the paper by Leader-Williams et al. (in press).

Concerns were expressed about where the trophy fees would go and how funds raised would be used to further rhino conservation. While surplus male rhinos in South Africa would be hunted on private sector land, some parastatal state conservation agencies would have the potential to hunt black rhinos and keep the proceeds. The North West Parks Board (who have hunted white rhino in their parks) and Ezemvelo KZN Wildlife (who have hunted white rhino in controlled hunting areas adjacent to their parks) are such agencies. State conservation agencies are also likely to be the main recipients of any benefits obtained by increases in live sale prices to follow the start of limited sport hunting.

Debate on the Namibian hunting quota proposal

The Namibian proposal was debated first. The delegations of Argentina, Benin, Botswana, Brunei Darusalaam, Cameroon, Cuba, Guinea, Indonesia, Japan, Qatar, South Africa, Trinidad and Tobago (also speaking on behalf of St Lucia), the United Republic of Tanzania and Zimbabwe supported the proposal, variously citing its sound scientific basis, the effective management and monitoring systems already in place, the involvement of stakeholders, and the benefits to local communities. While supportive, the delegate from Nigeria emphasized the need for effective monitoring. The delegation from the Netherlands, speaking on behalf of the 25 member states of the European Union, also stated that the EU would support the proposal and draft resolution as long as it was specified that only adult males would be exported and that all trophies would be marked. Namibia agreed to this and proposed suggested wording changes to specify only adult males, and that all parts to be exported would be individually marked with reference to the country of origin, species, quota number and year of export.

The delegations of Chad and Nepal had reservations about the proposal, believing that poaching and illegal trade still posed major problems. Nepal recommended that a stringent monitoring system be established before an export quota was allowed. While believing the Namibian proposal had merit, the delegations of the Central African Republic and Pakistan thought it premature, and that it should be delayed by 10 years. The delegations of India and Kenya did not support the proposal, drawing attention to the fact the species was *Critically Endangered* in the IUCN Red List. (Interestingly, while the species rates as *Critically Endangered* the Namibian subspecies of black rhino *Diceros bicornis bicornis* is listed only as *Vulnerable*). They were supported by observers from Born Free Foundation and Save Foundation Australia.

The CITES Secretariat suggested that a better way of accommodating the provisions set out in the Annex to CoP 13 Doc 19.3/19.4 Addendum would be to insert them as an annex in the existing Resolution Conf. 9.21 rather than adopt a new, separate resolution as proposed by Namibia and South Africa.

On account of the majority of Parties speaking in favour of the proposed amended draft resolution (equivalent to 41 countries for and five against) the Chair of Committee I moved that the export quota be approved by consensus. Kenya requested that the issue be put to the vote, but as no other range state raised an objection, the amended Namibian proposal and amended draft resolution (as applying to Namibia) were accepted by consensus.

Debate on the South African hunting quota proposal

In introducing their proposal, the South African delegation revised their annual quota to five as a precautionary measure. They also amended the criteria that defined the animals that could be hunted to exclude sick and injured animals, as hunting such animals would be unethical and against the spirit of fair chase.

The debate on the South African proposal followed a pattern similar to the earlier discussion of the Namibian proposal.

The delegations of Botswana, China, the Democratic Republic of Congo, Egypt, Gabon, Guinea, Iceland, Japan, Nigeria, Norway, Swaziland, Switzerland, Zambia and Zimbabwe supported the proposal, citing South Africa's sound rhinoceros management. Qatar noted it would support the proposal for post-reproduc-

tive males. The delegation from the Netherlands speaking on behalf of the 25 member states of the EU once again stated the EU would support the proposal and draft resolution as long as they specified that only adult males would be exported and that all trophies were marked. South Africa agreed to this.

The delegation of India opposed this proposal, expressing concern that the species was listed as *Critically Endangered* in the IUCN Red List. Mali and Central African Republic also opposed the proposal, urging South Africa to instead use surplus rhinos to repopulate other countries. Aside from issues of introducing the appropriate subspecies, such operations would have to be funded and the required protection and management would first have to be in place. Nor did these Parties explain how male-only populations set up in other countries would breed. Nepal noted that their concerns regarding this proposal were the same as for the Namibian proposal. Observers from Born Free Foundation, Save Foundation of Australia, and WWF on behalf of WWF and TRAFFIC also opposed the South African proposal.

On account of the majority of Parties speaking in favour of the proposed amended proposal and draft resolution (equivalent to 39 countries for and 4 against) the Chair of Committee I moved that the amended export quota and amended resolution (as applied to South Africa) be approved by consensus, and this was accepted.

Attempt to reopen debate in plenary

Some NGOs, and in particular Save Foundation of Australia, lobbied that the debate on black rhino hunting should be reopened in plenary. Chad proposed that the debate be reopened, but the required third of votes to do so was not obtained with 14 (13.6%) votes in favour of reopening the debate, 89 (86.4%) against and 24 abstentions. This margin was similar to the debates where an equivalent of 49 (87.5%) countries spoke in favour of approving the hunting quotas and only 7 (12.5%) against. Thus the amended Namibian and South African proposals and amended joint resolution were adopted by consensus at CoP 13.

Speculation about the impact of these decisions on poaching

There has been some speculation in the press that these decisions will send a message to poachers and perhaps lead to an upsurge in rhino poaching and widespread slaughter of rhino. It is perhaps worth pointing out that in general trade experts do not feel that this argument is credible. In part this is because as far as the illegal end-user markets are concerned, there is no major distinction between black and white rhino horn when making dagger handles, or when horn is used as an ingredient in traditional Chinese medicine. The main difference is between how Asian rhino horn is viewed, valued and used compared with African horn. The annual export of 10 black rhino trophies will in effect simply add to the existing export of around 70-odd southern white rhino trophies per year. If the controlled export of a few black rhino hunting trophies were going to stimulate rhino poaching, one would have expected this to have happened long before in response to the ongoing export of white rhino trophies.

Trade experts also point out that the dynamics of the controlled export of a limited number of marked and CITES-permitted hunting trophies is not the same as the illegal killing of rhinos in an attempt to supply rhino horn for an illegal demand to make dagger handles and to use in traditional Chinese medicine. Had CITES CoP 13 approved the reopening of a legal rhino horn trade (which it did not) this would have been a very different matter.

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Update on WWF/Ezemvelo KZN Wildlife Black Rhino Range Expansion Project

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Fifteen black rhinos were released onto Mun-ya-Wana Game Reserve in northern KwaZulu-Natal this month in the first phase of the WWF/Ezemvelo KZN Wildlife Black Rhino Range Expansion Project.

The project aims to increase numbers of the critically endangered black rhinos by increasing the land available for their conservation, thus reducing pressure on existing reserves and providing new territory

Mike Reid, Ezemvelo KZ-N Wildlife

Small steps for a black rhino; a giant leap for black rhino conservation in KwaZulu-Natal. The first black rhino of the founder population of 15 runs out on to Mun-ya-Wana Game Reserve, with members of Ezemvelo KZN Wildlife's elite game capture team looking on.

The animal turned, stopped, then briefly attacked the door of the crate before running away into the bush.

in which they can breed up quickly. This is being done by forming partnerships with landowners within the historic range of the black rhino but outside formal protected areas. Mun-ya-Wana Game Reserve consists of almost 20,000 hectares of barrier-free habitat, the result of internal fences having been dropped between Conservation Corporation Africa's Phinda Reserve and three of its neighbours (Zuka, Bumbeni and Phumalanga).

'We're thrilled to have found a large new area for black rhinos, which have been bumping up against the edges of the formal protected areas of the province,' says WWF's project leader Dr Jacques Flamand. 'This is a historic partnership between the state and private sectors in KwaZulu-Natal, which sets the tone for future cooperation.'

The animals on Mun-ya-Wana Game Reserve form the core of what is hoped will become a significant new black rhino population.

'The releases went better than we could have hoped,' said Dr Flamand. 'There is always the risk that further down the line there might still be conflict between some of the animals, but so far we have been delighted with how they have settled.'

Because of the feisty nature of black rhinos, releasing them onto new land always carries risk so efforts were made to reduce the likelihood of conflict between them. All of the animals were released during a three-day period, ensuring that they were all newcomers simultaneously. Animals in neighbouring bomas were released at neighbouring sites in the field. Dung from each animal was spread around its allotted release site to make it feel more familiar in the hopes that it would settle more quickly. The largest and most dangerous bulls were sited at extreme ends of the reserve in the hope of minimizing aggressive contacts.

Each animal had a radio transmitter implanted in its horn to allow intensive monitoring. This helps understand the existing population and will also provide invaluable information for the release of the next founder population.

Transfer of Swaziland's southern white rhino from CITES Appendix I to Appendix II

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The Kingdom of Swaziland's Big Game Parks not only subscribe to the sustainable use of their renewable natural resources but indeed depend upon it. The kingdom's wildlife depends on the revenues its parks generate for its survival. The Big Game Parks, which manage all of Swaziland's black and white rhinos, have had to become self-sustaining without tax support, and miraculously we have achieved this. This has been possible only because of dedicated staff and the unfailing moral support of the head of state.

The rhino reproduction strategy is exactly in line with the strategy developed by the SADC Rhino Management Group (RMG) and endorsed by IUCN's African Rhino Specialist Group (AfRSG). Swaziland is committed to promoting maximum reproduction of the species to increase its rhino numbers as rapidly as possible.

Swaziland believes a usable surplus of rhinos will encourage increased investment in propagating the species. It will encourage land owners to open additional range, which would be good news for rhino conservation. The South African experience is a supporting example. A direct consequence of such a scenario would be to expand the tourism potential, thus providing job opportunities.

Law enforcement

The southern white rhino became extinct in Swaziland before the turn of the last century. The subspecies was reintroduced in the mid-1960s from South Africa.

After a period of excellent population growth the rhino population was massively reduced due to commercial poaching between 1988 and 1992. While southern white rhinos became extinct for a second time in some countries, Swaziland successfully addressed the poaching problem. Legislative changes made are widely considered to be some of the toughest in existence for protecting wildlife. Swaziland's legislation and effective anti-poaching measures in the field have not gone unnoticed by the traffickers, and we have it on good intelligence that some traffickers avoid Swaziland as a result.

With committed and diligent field anti-poaching efforts and cooperative regional law enforcement, Swaziland has been able to turn things around. We have not lost a single rhino to poaching in 12 years.

Recent recovery and importance of growth

We have also improved our biological management by actively reducing the density of some competing grazers, thus creating more favourable conditions for white rhinos. The collective results of all these efforts is that Swazi's population of white rhinos has rebounded from a low of 27 animals to the present 61 animals in just 10 years.

Swaziland's two white rhino populations have increased to the level that both now qualify to be rated by IUCN's African Rhino Specialist Group as *Continentally Important*. Taking into account removals, the underlying growth rate is calculated at 9.4% per annum. This is well above the continental minimum target of 5% recommended by AfRSG. Swaziland fully supports this target, because experience has shown that failure to achieve this level of growth, if even for a few years, can result in significantly fewer numbers of rhinos in future. Suboptimal biological management is similar to poaching—one ends up with fewer rhinos.

Take Swaziland's 61 white rhinos as an example. If we achieve only a suboptimal growth rate of 3%, in 10 years the net gain will be only 20 rhinos. However, if we can maintain a rapid growth rate of 8%, then numbers will more than double with a net growth of 71 rhinos (50 more rhinos in just 10 years). This highlights the critical importance of rapid growth.

Geneticists also advise that maintaining rapid population growth helps minimize loss of genetic diversity.

How to achieve and maintain good growth

Achieving and maintaining a high metapopulation growth rate can be done only if the land is not overstocked with rhinos and other competing herbivores. This is achieved by translocating surplus animals to maintain the density of rhino populations at productive levels.

There are signs that the present high density may be affecting our two populations negatively, and that therefore we should increase the number of removals from our two populations to keep them productive. First, mortality rates due to bull aggression have increased from 1.7% (1992–1997) to 4.2% (1998–2003). Second, while our underlying growth rates are still high, they have declined from an estimated 10.8% (1993–1997) to 8.4% (1997–2003).

We need to be proactive and increase removals from the inhabited range to prevent the inevitable decline in growth that will occur if densities build up. Swaziland has based its proposed safe minimum and maximum offtake levels on the harvesting strategy for maximizing growth recommended by the IUCN AfRSG and the SADC Rhino Management Group.

This strategy is based on original work on population dynamics by the late Grahame Caughley (1977), reinforced by modelling of rhino population dynamics by Peter Goodman (2001, 2002) and John Hearne. The basic principle is that the population density of rhinos harvested at a fixed annual percentage will eventually adjust and stabilize at a level that can be sustained if it does not exceed the maximum possible rate of reproduction that the species can sustain in the long term. This rate is around 9% for an established population of rhinos without a skewed sex ratio. Importantly, much evidence from the field supports this harvesting theory.

It may seem counter-intuitive, but conservative low levels of removal are not actually 'safe', but rather will ultimately lead to low population growth and hence significantly fewer numbers of rhinos. This is obviously highly undesirable.

The key lesson is that to get long-term growth of at least 5%, an average of at least 5% of the popula-

tion should be removed annually. This percentage is a safe minimum and will prevent under-harvesting. As a precaution, both AfRSG and SADC RMG have recommended that the maximum offtake of rhinos not exceed 8% per annum, and Swaziland subscribes to this recommendation.

Harvesting a set percentage requires accurate population estimates, which we have, as Swaziland's rhino populations are intensively monitored to fulfil security, anti-poaching and biological requirements. Designated field rangers actively track down every rhino every day, and all sightings are reported and recorded. The fact that we manage to see every single rhino on most days makes our monitoring among the most intensive in Africa.

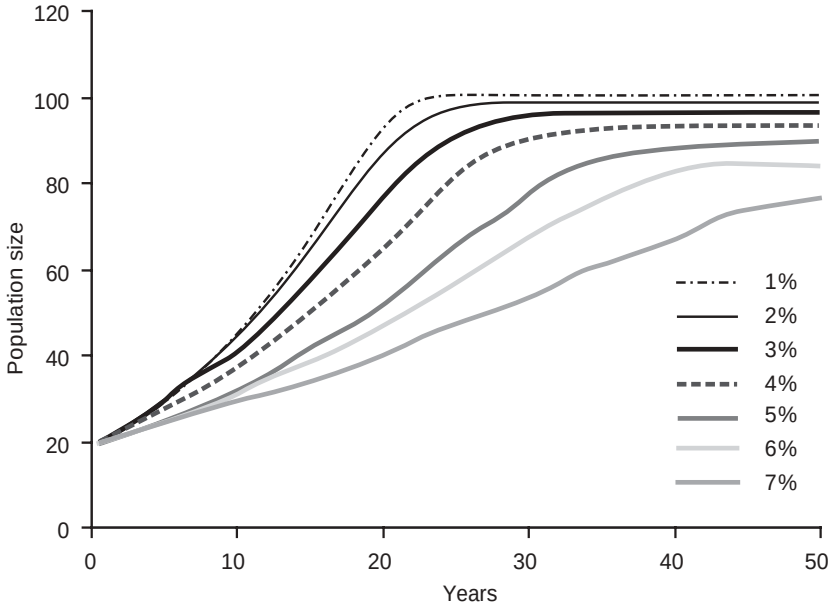

Figure 1. Modelled trends in numbers in rhino populations harvested at different set percentages per annum (from 1% to 7%), starting with 20 rhinos and ecological carrying capacity set at 100 (with acknowledgements to Peter Goodman and John Hearne, who did the modelling).

The proposed harvesting levels are in line with recommended best practice and have built-in safeguards to prevent under- and overharvesting—both of which would reduce population growth rates (fig. 1).

Following a period of growth, population sizes eventually stabilize at levels that can sustain the specific levels of set percentage harvesting. For example, by harvesting at 6%, the model in figure 1 indicates numbers would eventually stabilize at around 85% of the ecological carrying capacity. The lower the set percentage offtake per year, the nearer the eventual rhino density will be to ecological carrying capacity.

Most importantly, experience from the field supports the theory. Populations in a number of range states have been harvested at conservative, low levels (0–3% per annum). Given good protection, these populations have invariably shown an initial period of rapid growth, followed by a marked levelling off in growth, and sometimes even a decline in numbers, as populations have approached, reached or exceeded estimated ecological carrying capacity. The eventual falling off in population performance in populations harvested at 0–3% per annum (such as the two in fig. 2) is as expected by the theory.

The effect of the CITES listing

Swaziland faced a difficulty. South Africa downlisted its rhino population to Appendix II in 1994. With our continued Appendix I listing, we were prevented from selling white rhinos to South Africa—the country that currently has the greatest potential for taking additional rhinos. This was because under CITES rules any sales to South Africa are deemed to be for primary commercial purposes (as the South African rhino market is commercially driven). South Africa accordingly denied Swaziland CITES import permits, reducing Swazi ability to fully integrate and manage its populations as part of a bigger regional metapopulation. South Africa, however, recognizes the conservation merit of the Swaziland proposal, and the South African delegation at CoP 13 supported our proposed annotated downlisting, as this would allow South Africa to issue CITES import permits for southern white rhinos from Swaziland.

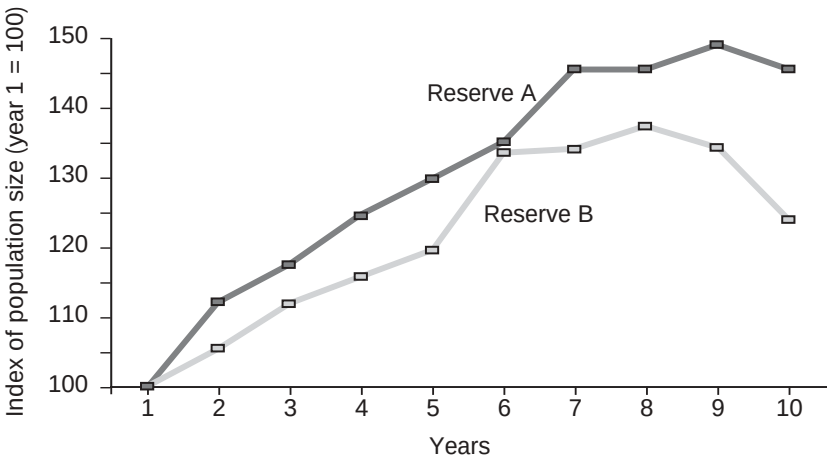

Figure 2. Trends in numbers in two major black rhino donor populations where offtake levels were conservative in the past. The conservation agency managing these populations has since incorporated set percentage harvesting into its management policy, with a minimum offtake of 5% and maximum of 8%, in an attempt to return these populations to productive levels.

Recommendations

After discussion with other delegations to CoP 13, and in particular with those from other African rhino range states and the European Union (EU), Swaziland sought to amend the annotation to its proposal to downlist its white rhinos from Appendix I to Appendix II, as follows:

- Swaziland's annual harvest and export of live white rhinos to appropriate and acceptable destinations will be limited to an upper safe limit of 7% of the population. Such offtake will go to national parks, game reserves, game farms and other conservation projects. Most of the animals should go to southern Africa and remain part of the managed metapopulation. There would also be an exchange of animals for genetic management,
- Only post-reproductive males or identified problem animals[1] will be exported as trophies, but not more than 1% of the population will be exported annually for this purpose, and then only if the live removal option is not practical.
- All exported specimens will be marked with microchips.

For Swaziland, however, trophy hunting is a management option less preferred than live removals.

Swazi rhinos as part of a regional metapopulation

We contend that for a number of reasons, it is logical for the Swaziland population to be managed as part of a larger southern African metapopulation. In the past, Swazi white rhinos have been managed on this basis.

- Swaziland's populations are within 80 km of some South African populations, while many South African populations are separated by much greater distances.
- In spite of our need to increase removals from our populations to maintain rapid growth, we have recently imported two white rhino females from South Africa for genetic conservation.
- In the past two white rhinos were given to South Africa's Kruger National Park. When we were still able to do so, we sold white rhinos to South Africa. We have also done rhino exchanges with South Africa and Zimbabwe.

Swaziland pointed out that these translocations, both into and out of the country, adequately demonstrated that this population is part of the larger southern African white rhino metapopulation. Furthermore, this population was originally reintroduced from South Africa in the 1960s. Good cooperation in wildlife law enforcement exists between Swaziland and its neighbours, South Africa in particular, with whom Swaziland shares this metapopulation of southern white rhinos.

Split listing and trophy hunting

Swaziland also pointed out that for this species, precedents have already been set of split listing (being listed in both Appendix I and Appendix II) and tro-

[1] An especially aggressive male that has killed cows or calves is an example of a problem animal. It should not be translocated. Our intensive monitoring enables Swaziland to be entirely confident that post-reproductive and problem animals can be positively identified.

phy hunting, and no detrimental effects have been experienced as a result. Since South Africa's downlisting to Appendix II, the South African population of southern white rhino has increased by almost 50%. Since hunting of southern white rhinos started in 1968, rhino numbers have increased over sixfold, indicating that limited hunting has clearly been sustainable. Thus experience indicates that the annotated downlisting proposed by Swaziland will not lead to increased illegal demand for rhino horn and a resultant increase in poaching.

Furthermore, southern white rhinos are no longer listed in any of the IUCN Red List Threatened categories but are instead classified as *Near Threatened*.

Non-detriment finding

A recognized rhino expert was commissioned by the management authority to conduct an assessment of the effects of this proposal if implemented. This expert found that implementing it would create positive incentives for rhino conservation (Adcock 2004).

The importance of creating an economic climate conducive to private sector participation was identified, given the massive contribution that the private sector has made to South Africa's white rhino population and the resultant benefits this has generated for formal conservation areas.

National and legislative compliance with CITES

Swaziland has been placed in Category 3 of the CITES National Legislation Project, and Swaziland's chief justice has undertaken steps with the United Nations Environmental Law Branch to address this situation. Swazi legislation adequately protects all species listed in the schedules of the Game Act, which is the principal legislation protecting wild animals and particularly rhinos. The process of making the legislation compliant with CITES is already under way.

In the meantime, rhinos remain extremely well protected under Swazi legislation. Rhino poaching carries a mandatory minimum jail term of five years without the option of a fine. In addition, failure to replace the rhinos poached will result in an additional mandatory two-year jail term. Trafficking rhino products is an even more serious offence, attracting a mandatory minimum seven-year sentence. The Game Act prohibits suspension of any part of any sentence.

Perspective

It was stressed that Swaziland's proposal be considered in the correct perspective.

- Swaziland at 17,000 km^2 is one of Africa's smallest countries, substantially smaller even than South Africa's Kruger National Park. Consequently, rhino and wildlife populations in Swazi parks are small and therefore require intensive and expensive pre-emptive management.
- Traded rhinos will benefit those that remain.
- Due to financial constraints, Swaziland's rhino parks are only partially fenced, limiting the safe range available. Revenues derived from traded rhinos will go a long way towards allowing us to increase the size of our fenced rhino sanctuaries, thereby securing additional range for populations to grow into.
- Appendix I listing has proved to be highly damaging in terms of mortality to this population, as outlined in the proposal.
- Retention of this population in Appendix I is counterproductive to the greater conservation goals of this species in Swaziland and the wider metapopulation.
- Swaziland has demonstrated that this population does not meet the criteria for Appendix I listing.
- Africa's parks and the animals that inhabit them must continue to demonstrate that they are national assets rather than national liabilities that drain taxpayers' money. In the face of fierce demand for alternative, economically driven land uses, it must be demonstrated that conservation is an economically valid form of land use. Doing so will secure its place in the future and help ensure political support in the long term.
- Importantly, this proposal is based on good science, with theory supported in practice.

Negotiations and voting

Initially, Swaziland was put under pressure to apply absolute numbers to its proposed removal of rhinos. During negotiations with the EU, Swaziland pointed out that it intended managing its populations for maximum growth and that a fixed-number removal would quickly become obsolete with a growing population and would require bringing another proposal to a future CoP to adjust this number. Using an offtake figure based on harvesting by set percentage rather than a fixed absolute annual offtake allows for flexibility in adjusting to

changing ecological carrying capacity. After enlisting the expert scientific advice of Dr Richard Emslie of AfRSG (who compiled the proceedings of a SADC RMG workshop, 'Biological Management to Meet Continental and National Black Rhino Conservation Goals'), it was agreed to integrate the principles of the set percentage harvesting strategy into the annotation. An information document was generated that covered metapopulation management and harvesting white rhinos for maximum growth and was circulated to all parties. This can be viewed online (www.biggameparks.org).

Due to administrative misunderstandings, the proposed annotations were included with the information document, and the document was circulated only in English, and not translated into the other working languages of the convention, French and Spanish. In addition, the language used in the proposed annotations needed to be adjusted to conform with that used in the convention. The chair of Committee I at CITES CoP 13 drew attention to these issues. Time constraints precluded the opportunity to reproduce the proposed revised amendments in all the working languages. The chair therefore proposed that the annotations in the original proposal be put to the vote, but on the basis that Swaziland undertakes to implement harvesting its rhinos in accordance with the proposed amended annotations agreed with the EU, and that the minutes of the proceedings reflect this. This was accepted by all parties after Swaziland indicated that this was acceptable, and the EU indicated that it was prepared to accept Swaziland's promise to implement the annotations as modified.

The annotated proposal that was voted on stood as follows:

- The Swaziland population of the southern white rhino (*Ceratotherium simum simum*) be downlisted from Appendix I to Appendix II to allow international trade in live animals to appropriate and acceptable destinations, and to allow limited trophy hunting.
- All other specimens shall be deemed to be specimens of species included in Appendix I and trade in them shall be regulated accordingly.

While the Swaziland proposal was supported by SADC range states (including South Africa) and the EU, there were a few objections from the floor.

Kenya objected to the proposal on the grounds that Swaziland's national legislation is not generally compliant with that of the convention (Category 3), and because the population of white rhinos in Swaziland is small.

Israel also contended that the Swaziland population was small and that on genetic grounds, the Swazi proposal was not based on good science and should be rejected.

We feel that this argument misses a number of key points. First, Swaziland's 61 white rhinos are in fact being managed as part of a much larger metapopulation with new blood having been recently introduced for genetic conservation, as recommended by geneticists. Second, conservation biologists have advised that to minimize loss of genetic heterozygosity one should seek to maintain rapid population growth rates. Preventing Swaziland from exporting surplus rhinos (as proposed by Israel) would lead to a build-up of numbers in Swazi parks and inevitably reduced growth rates, which would negatively affect genetic diversity. Third, as mentioned earlier, the generation of additional revenue from live sales would allow us to increase the area of fenced and safe rhino range in Swaziland, enabling us to increase the number of rhinos. Fourth, Franklin (1980) and Soulé (1980) estimated that the minimum effective population size (n_e) for the long-term conservation of metapopulation genetic viability is 500 (Franklin 1980; Soulé 1980) and that below this number it is likely that genetic variance for complex traits will be lost at a significantly faster rate than it can be replaced by mutations. An n_e of 500 is equivalent to at least 2000 and more probably around 5000 rhinos (Peter Goodman pers. comm.).

Lande (1998) has argued that desirable minimum effective population size may be as much as 10 times higher. A recent paper by Reed et al. (2003) also recommended, based on extensive modelling, that conservation programmes for wild populations of vertebrates need to be designed to conserve approximately 6000–7000 adults to ensure long-term persistence. It is not possible for Swaziland to conserve such large numbers of white rhinos on its own. Therefore, to contribute to the goal of achieving long-term genetic viability, Swaziland simply has no option but to manage its small number of rhinos as part of a bigger metapopulation. Our proposal is designed to facilitate this.

Finally, Swaziland's white rhinos are all ultimately descended from the same original Umfolozi founder stock, as are all other white rhinos in the southern African metapopulation. There is therefore no compelling reason to conserve Swazi animals in isolation from those in the rest of the region.

For all the above reasons, we contend that the fact Swaziland has only 61 white rhinos does not repre-

sent a valid reason for rejecting our proposal. As we have explained, our proposal was based on recommended best practices for metapopulation management of rhino as advocated by the IUCN SSC AfRSG. Instead of our proposal being based on bad science, it is rather Israel's objection to our proposal that demonstrates a lack of appreciation of the principles of managing a rhino metapopulation for growth and long-term conservation of genetic viability, on which our proposal is based.

It must also be remembered that the entire worldwide population of southern white rhinos—now over 12,000 animals—has grown in just over a century from only 20 to 50 animals (Emslie and Brooks 2002), a number that is approximately half of Swaziland's current population. This widely acclaimed conservation success story could not have been achieved had it not been for innovative management, including translocations, removals, metapopulation management, trophy hunting and private ownership. Swaziland's proposal is simply following tried and tested approaches.

The proposal was put to a vote; results were 88 in favour, 15 opposed and 21 abstaining. The required two-thirds majority being more than obtained, the proposal was accepted. The proposal and all documentation can be viewed on www.biggameparks.org.

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CITES Rhino Resolution 9.14(rev)

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At the recent 13th CITES Conference of the Parties (CoP13) in Bangkok, CITES Rhino Resolution 9.14(rev) was retained and revised, transferring reporting responsibility to IUCN SSC's African and Asian Rhino Specialist Groups.

The CITES Secretariat introduced a document that drew attention to the requirement for reporting to it. Reports were required at least six months prior to a CoP detailing the following:

- the status of captive and wild rhinoceros populations
- a summary of incidents of illegal hunting
- a summary of incidents of illegal trade in rhinoceros parts and derivatives
- the status, type and frequency of law-enforcement

activities and monitoring programmes for all major rhinoceros populations
- the status of development and implementation of national legislation and national conservation action plans
- the status of marking, registration and control of rhinoceros horn stocks

Once again, the CITES Secretariat noted the low level of reporting by Parties, noting that no reports had been received before the deadline, and only four Parties, although late, had submitted reports at all: China, Namibia, South Africa and Swaziland. The Secretariat argued that this continued low level of reporting showed that reporting to the Secretariat under Resolution 9.14 (rev) was seen as an administrative burden. The Secretariat in its document recommended either the repeal of the Resolution or an amendment to remove the requirement of reporting to the CITES Secretariat.

The delegations of the Netherlands, on behalf of member states of the European Community, supported by the delegations of India, the United States of America and Vietnam, wished to retain the resolution but agreed with the deletion of the paragraphs relating to reporting to the Secretariat.

The delegation of Namibia, supported by Botswana, South Africa and Swaziland, also supported deleting the reporting requirements. However, they recognized the value of the information called for under Resolution 9.14(rev), noting that similar information was being provided by range states to IUCN's African Rhino Specialist Group. These African range states all supported retaining the Resolution as they felt it was an important instrument that focused attention on the importance of conserving African and Asian rhinos, highlighting the need for active conservation programmes. Delegates felt that it was critically important to have an integrated international approach to rhino trade and conservation and that Resolution 9.14(rev) encouraged this, and was bearing fruit.

The delegation from Italy mentioned the Italian-funded SADC Regional Programme for Rhino Conservation (RPRC) and that Italy hoped to provide additional funds for rhino conservation in the near future. Botswana, Namibia, South Africa and Swaziland all thanked Italy for funding the SADC RPRC, which they felt had significantly contributed to rhino conservation in the SADC region.

Malaysia strongly supported the repeal of the resolution, whereas delegates from Mexico and Nepal and the observer from Fund for Animals favoured its retention.

The observer from IUCN—the World Conservation Union—confirmed that the IUCN African and Asian Rhino Specialist Groups would be willing to share information but warned that some confidential data may not be available. The Chair requested that the Secretariat and IUCN collaborate in preparing a draft decision about reporting requirements. The resolution was then retained after two paragraphs on reporting to the CITES Secretariat were deleted, as suggested by the Secretariat.

The wording of the decision on reporting which was adopted was as follows:

Directed to the Secretariat

The Secretariat shall:

a) invite the IUCN SSC African and Asian Rhino Specialist Groups to share information on the national and continental conservation status of African and Asian rhinoceros species, the legal and illegal trade in rhinoceros and rhinoceros products and their derivatives, incidents of illegal killing of rhinoceros, and management strategies and actions; and
b) submit a written summary of the information for consideration at the 14th Conference of the Parties that will include recommendations for further reporting arrangements on the conservation and trade in African and Asian rhinos.

Directed to Parties

Range states of African and Asian rhinoceros species are encouraged to support the IUCN SSC African and Asian Rhino Specialist Groups in collecting and collating the information referred to in Decision 13.XX.

Understanding that the IUCN SSC African and Asian Rhino Specialist Groups operate on a voluntary basis and may be constrained by lack of resources, Parties and other donors are urged to provide support to these groups for undertaking the activities.

Rhino population sizes and trends

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The population statistics for all wild populations of black and white rhino as at the end of December 2003 are presented in tables 1–3. These statistics were revised and compiled at the AfRSG meeting held at Serena Kilaguni Lodge, Tsavo West National Park, Kenya, in June 2004. Estimates based on speculation or old data (speculative guestimates) are not included in the population totals given in these tables. Only country totals by subspecies are presented here as individual population details are kept confidential for security reasons.

White rhino

Table 1 shows that the number of northern white rhinos (C*eratotherium simum cottoni*) has declined markedly in response to increased poaching pressure by Arabic horsemen from the Sudan. Recent surveys (Kes Hillman-Smith pers. comm.) suggest that in 2004 numbers may have dropped to as low as 15. This subspecies currently faces the greatest threat to its continued existence since 1984. Emergency meetings have been held by local conservationists and stakeholders to develop an emergency action plan, and to raise additional funds for the conservation effort in Garamba National Park.

The total number of southern white rhinos (*C.s. simum*) in Africa is slightly lower than the estimated total number compiled at the 2002 Malilangwe AfRSG meeting. However, this does not reflect an actual decline in numbers. The difference is due to a lower population estimate for the biggest population (Kruger National Park). There is no evidence of any actual decline in numbers in Kruger as there are no signs of lack of breeding, increased mortalities or widespread poaching in this park, which would be expected if there had been an actual decline in numbers. Rather, the lower Kruger estimate is due to the use of a more conservative figure and is almost certainly an artefact of the sampling variability inherent in the method used to estimate numbers for this large population. In the remaining southern white rhino populations, numbers have increased by 13.5% over the two-year period, December 2001–December 2003. In reality, southern white rhino numbers are therefore likely to have continued to increase overall since 2001.

Black rhino

Numbers of the *Critically Endangered* rare western black rhino (*Diceros bicornis longipes*) in Cameroon remain small and are not adequately known. Some supposed photographic evidence of the presence of more western black rhinos does not appear to be spoor of black rhino according to a number of experts who have seen the photos. There may well be more western black rhinos remaining than the figure of five, but this requires confirmation. Plans are being developed to continue to survey rhino range areas in Cameroon to record signs and frequency of rhino signs and spoor.

The number of eastern black rhino (*D.b. michaeli*) continues to increase slowly. With an increased focus on improving biological management, it is hoped metapopulation growth rates can increase. A single rhino has also been found in Rwanda with a further two to four being recorded in Ethiopia.

Encouragingly, improved population estimation in the biggest south-western (*D.b. bicornis*) black rhino population has confirmed that numbers are higher than previously thought. Demographic (age and sex structure) data indicate that this population is also increasing. Numbers have increased in other populations of south-western rhinos, with the Namibian custodianship programme being especially successful in increasing rhino numbers rapidly through breeding.

Numbers of south-central black rhinos have also increased. However, conservative biological management in several key donor populations in South Africa has resulted in reduced metapopulation growth rates for a number of years in some populations. With the

Table 1. Numbers of white and black rhinos in Africa as of 31 December 2003 by country and subspecies

	White rhino				Black rhino					
	C.s.cottoni (northern)	*C.s.simum* (southern)	Total	Trend	*D.b.bicornis* (south-western)	*D.b.longipes* (western)	*D.b.michaeli* (eastern)	*D.b.minor* (southern-central)	Total	Trend
Botswana	–	67	67	up+intro	–	–	–	5	5	intro
Cameroon	–	–	–	–	–	5?	–	–	5?	?
DR Congo	22	–	22	down	–	–	–	–	–	–
Ethiopia	–	–	–	–	–	–	4 *D.b.bruceii*?	–	4	?
Kenya	–	218	218	up	–	–	439	–	437	up
Malawi	–	–	–	–	–	–	–	8	8	up+intro
Mozambique	–	2	2	?	–	–	–	0?	0	extinct?
Namibia	–	186	186	up	1,238	–	–	–	1,238	up
Rwanda	–	–	–	–	–	–	1	–	1	down
South Africa	–	10,536	10,536	up	71	–	36	1,177	1,284	up
Swaziland	–	61	61	up	–	–	–	15	15	up
Tanzania	–	–	–	–	–	–	42	24	66	up
Zambia	–	3	3	down	–	–	–	5	5	intro
Zimbabwe	–	250	250	up	–	–	–	536	536	up
Totals	22	11,320	11,350	up	1,310	5?	520	1,770	3,610	up

Compiled by IUCN SSC African Rhino Specialist Group. Table excludes speculative guestimates.
Numbers primarily compiled at (SADC RPRC and WWF funded) IUCN SSC AfRSG meeting held in Kenya 6–11 June 2004.
Numbers of *D.b. minor* in Tanzania, *D.b. bicornis* in Namibia, *D.b. michaeli* in Kenya, *D.b. longipes* in Cameroon and *C. cottoni* in DRC may be higher but this requires confirmation.
White rhino trend is up but total numbers down 2.5% compared with 2001 due to estimate for largest population of southern white rhino (Kruger NP) declining due to using more conservative figure for 2003 than 2001, and undoubtedly in part due to sampling error (95% confidence levels around the 2003 estimate = ±23.3%).
South African total = 2003 figures used for state and defence force areas and 2002 figures for private, municipal, zoo and biosphere reserves.
The number of southern white rhinos outside Kruger has increased by 809 (+13.5%) over the last two years and there is no evidence of an actual decline in Kruger.
Subspecies totals > 500 rounded to nearest 10 rhinos.
Exact Swaziland numbers of *D.b. minor* given to AfRSG but are being kept confidential until authority is obtained to release them. In the meantime the table shows an approximation to the true number.
Poaching continues in Garamba NP and the latest estimate as of September 2004 is only 15.

adoption of a new black rhino biological management policy by Ezemvelo KwaZulu-Natal Wildlife, it is hoped that growth rates of South Africa's *D.b. minor* metapopulation can once again increase above the minimum target figure of 5% per annum. Encouragingly there are signs that South African metapopulation growth rates are starting to increase again. The estimated number of black rhinos in Kruger National Park is conservative and may well be higher. While poaching and increased snaring in some Zimbabwe populations of south-central black rhino is cause for concern, underlying growth rates in a number of Zimbabwean populations continue to be among the highest in Africa.

Overall the steady increase in the number of black rhinos continues, with numbers reaching 3610 by December 2003, up from the continental low of 2410 in 1995. This increase of 1200 in the wild in eight years represents an annual growth rate of 5.2% per annum. Some of this growth will be due to a much-improved population estimation in Africa's biggest black rhino population, and it may be that the actual underlying growth in numbers is just below the minimum target of 5% per annum.

Poaching levels

While the overall trend in rhino numbers in Africa was still up, it is of concern that the reported numbers of rhino poached increased to 54 in 2002 and 84 in 2003. The massive increase in poaching of northern white rhinos in Garamba is especially serious as it threatens to eliminate the last remaining wild population of this subspecies if not checked. Declining manpower and declining budgets in a number of areas remain a cause for concern. Although the overall trend in numbers is encouraging there is no room for complacency.

Key- and Important-rated populations

The increase in rhino numbers since 1995 is reflected in the steady increase in numbers of *Key*- and *Important*-rated rhino populations (assessed using AfRSG criteria) in Africa, from a total of 60 in 1995 to 99 in 2003 (table 2). In eight years (1995–2003) the number of *Key*-rated rhino populations has increased from 11 to 14 for black rhinos and 12 to 17 for white rhinos. The number of *Important*-rated rhino populations has also increased from 16 to 22 for black and 21 to 46 for white.

Table 2. Number of *Key* and *Important* African rhinoceros populations by country at 31 December 2003

	White rhino			Black rhino			Total
Rating	Key 1	Key 2 + (Key 3)	Imp.	Key 1	Key 2 + (Key 3)	Imp.	Key & Imp.
Botswana	0	0	2	0	0	0	2
Cameroon	–	–	–	1	0	0	1
DR Congo	1	0	0	–	–	–	1
Ethiopia	–	–	–	0	0	0	0
Kenya	1	0	2	0	2	7	12
Malawi	–	–	–	0	0	0	0
Mozambique	0	0	0	–	–	–	0
Namibia	0	1	2	2	0	2	7
Rwanda	–	–	–	0	0	0	0
South Africa	4	8	35	2	2(1)	6	58
Swaziland	0	0	2	0	0	0	2
Tanzania	–	–	–	0	0	1	1
Zambia	0	0	0	0	0	0	0
Zimbabwe	0	2	3	0	3(1)	6	15
Total 2003	6	11	46	5	7(2)	22	99
Total 2001	5	9	44	5	11	19	93
Total 1999	5	6	36	5	6	18	76
Total 1997	5	7	15	5	6	33	71
Total 1995	6	6	21	5	6	16	60

The 5 black and 6 white *Key 1*-rated populations conserved 1727 (47.9%) of Africa's black rhinos and 7265 (63.4%) of its white. The 9 *Key 2* and *Key 3* black rhino populations conserved an additional 690 (6.08%) rhinos with the 9 *Key 2* white rhino populations conserving 701 (19.44%) more rhinos. Thus the *Key*-rated populations conserved 67.02% black rhinos and 70.21% white rhinos.

Ownership and management models

Table 3 provides a summary of the distribution of rhinos of the different subspecies according to management or ownership models. While the state-run conservation agencies continue to manage most of the rhinos in Africa (75.1% black rhinos and 70.0% white rhinos) the private sector also manages a significant proportion (22.6% of black rhinos and 28.7% of white). As before, while the majority of black rhinos on private land remain state owned and are managed on a custodianship basis, white rhinos on private land are privately owned.

Table 3. Number of African rhinos under various management systems in Africa, December 2003

Number of rhinos	White rhinos						Black rhinos										Total white & black	
	C.s.cottoni northern		*C.s.simum* southern		Total		*D.b.bicornis* s-western)		*D.b.longipes* (western)		*D.b.michaeli* (eastern)		*D.b.minor* (s-central)		Total			
	no.	%	no.	%	no.	%	no.	%	no.	%	no.	%	no.	%	no.	%	no.	%
Communal	–	–	32	0.28	32	0.28	142	10.85	–	–	1	0.19	2	0.11	145	4.02	177	1.18
Other defence force/ zoo NRs	–	–	48	0.42	48	0.42	–	–	–	–			6	0.34	6	0.17	54	0.36
Municipal/county council	–	–	39	0.34	39	0.34	–	–	–	–	36	6.90	–	–	36	1.00	75	0.50
Privately owned	–	–	3252	28.72	3252	28.66	17	1.30	–	–	34	6.51	106	5.99	157	4.35	3409	22.80
Private custodianship	–	–	0	–	0	–	116	8.86	–	–	152	29.12	390	22.03	658	18.25	658	4.40
State	22	100	7943	69.95	7943	70.01	1034	78.99	5	100	292	55.94	1110	71.41	2595	71.96	11223	75.07
State and privately owned	–	–	13	0.11	13	0.11	–	–	–	–			–	–	0		13	0.09
State owned with joint state and contractual management	–	–	18	0.16	18	0.16	–	–	–	–	7	1.34	–	–	7	0.19	25	0.17
Total	22		11323		11345		1309		5		522		1770		3606		14951	

Table excludes speculative guestimates.
Rhinos within Kruger National Park listed under 'State' while those in adjoining three private reserves listed under 'Privately owned'.

BOOK REVIEW

Evolving Eden: an illustrated guide to the evolution of the African large-mammal fauna

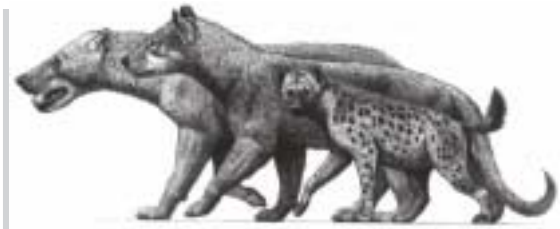
Alan Turner and Mauricio Anton

Columbia University Press, New York, 2004, 269 pages, ISBN 0 231 11944 5

review by Richard Kock

Technical Assistant to the African Union, Inter-African Bureau for Animal Resources, and the Zoological Society of London Conservation Programmes

Alan and Mauricio have produced a very readable (and viewable) volume on a potentially turgid subject. Fossils, zoological classification and anatomical drawings in the context of evolution are not usually attractive to most people but through relatively simple explanations, excellent line drawings and without losing scientific fact the authors have achieved what I presume to be one of their objectives—providing for lay people and interested professionals something fascinating to chew on. I will not remember the convoluted names of the long-extinct ancestors of familiar African fauna and would fail the exam on who is directly related to whom, but I will retain many of the concepts. For example, the Afrotheria, original inhabitants of the continent (the elephant, shrew and aardvark) and the idea of species after species crossing land bridges over specific ecological time periods to colonize, and the complexity and gaps in our knowledge on human origins. This book provided new evidence (to me) for a number of ancestral primates in advanced states of skills development (other than humans and their direct ancestors). This has dispelled, at least in my mind, the myth that humans were that unique in evolutionary development. Another interesting hypothesis is that other species that we assume as uniquely African—modern-day antelopes, carnivores and the like—appear to have roots in Eurasia, from where they have long since disappeared.



from *Evolving Eden*

The drawings dramatically show how little, in fact, the basic form of animals has changed over the millennia in many families—only size and a few odd protuberances. As modern humans, if we were able to go back in time and visit our great-great-grandparents, *Homo erectus* and cousins in Africa, we would have recognized pretty much all the animals and habitats. Surely something no other continent can claim. Nevertheless the subtle changes that have occurred in morphometrics are fascinating. For instance, where did the saber tooth go and why? After reading *Evolving Eden,* I will gaze at impala in a different way on my next trip into the African bush and I would recommend a look at this book if you want to know why.

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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Letters to the editor: Letters are welcome that comment on articles published in *Pachyderm* or on any other issue relating to elephant and rhino conservation in the wild.

Journal conventions

Nomenclature

Use common names of animals and plants, giving scientific names in italics on first mention; 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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Adams, J.X. 1995b. Seizures and prosecutions. *TRAFFIC Bulletin* 15(3):118.

Dobson, A.P., and May, R.M. 1986. Disease and conservation. In: M.E. Soulé, ed., *Conservation biology: the science of scarcity and diversity*. Sinauer Associates, Sunderland, MA. p. 123–142.

Struhsaker, T.T., Lwanga, J.S., and Kasenene, J.M. 1996. Elephants, selective logging and forest regeneration in the Kibale Forest, Uganda. *Journal of Tropical Ecology* 12:45–64.

Sukumar, R. 1989. *The Asian elephant: ecology and management*. Cambridge Studies in Applied Ecology and Resource Management. Cambridge University Press, Cambridge.

Cite unpublished reports as follows:

Tchamba, M.N. 1996. Elephants and their interactions with people and vegetation in the Waza-Logone region, Cameroon. PhD thesis, University of Utrecht, The Netherlands. 142 p. Unpublished.

Woodford, M.H. 2001. [Title]. [*Journal* or publisher]. Forthcoming. [if publication date is known]

Woodford, M.H. [Title]. [*Journal* or publisher]. Forthcoming. [if publication date is not known]

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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