Pachyderm

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Pachyderm

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

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Cover: Mother and baby elephant in Masai Mara, Kenya. Photo: Jonathan and Angie Scott

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CHAIR REPORTS
RAPPORTS DES PRESIDENTS

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

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Starting off the new triennium

The first half of 2001 was devoted largely to preparing for the start of a new IUCN triennium. For the Species Survival Commission (SSC), the first step in the process, for all specialist group chairs, is to present to the Chair of the SSC a list of those recommended for appointment as members. The procedure for appointing the new membership is a formal one, requiring extensive preparation and consultation along the way. At the time of going to press, appointment letters had been sent to all new members and those being reappointed. The AfESG Secretariat is awaiting news of their receipt and formal acceptance.

Information and communications

The AfESG Web site

In an effort to respond to the overwhelming, and seemingly insatiable, demand for information on the African elephant, we have been working hard on alternative communication tools. One of the tools under development is the AfESG Web site: http://indaba.iucn.org/external/themes/ssc/sgs/afesg/pachy/**.** While it is clear that this will not be a tool designed primarily to meet the needs of our membership or elephant managers and conservationists across Africa for some time to come, it is an attempt to streamline our ability to provide our broad 'user' public with useful information and tools as well as provide answers to simple but frequently asked questions. We hope that by using this tool to make the process of information

Lancer les trois prochaines années

Le premier semestre de 2001 fut largement consacré à la préparation du programme de l'UICN pour les trois prochaines années. Pour la Commission de Sauvegarde des Espèces (CSE), la première étape du processus, pour tous les présidents des groupes de spécialistes, consiste à présenter au Président de la CSE une liste des personnes recommandées pour être nommées membres. La procédure pour nommer les nouveaux membres est officielle, elle exige une longue préparation et des consultations continues. Au moment de mettre sous presse, les lettres de nomination ont été envoyées à tous les nouveaux membres et aux anciens qui sont reconduits. Le secrétariat du GSEAf attend des nouvelles de leur bonne réception et de leur acceptation.

Informations et communications

Le site web du GSEAf

Afin de répondre à la demande considérable et, semble-t-il, insatiable, d'informations sur l'éléphant africain, nous travaillons intensément à la mise au point d'outils de communication alternatifs. Un des outils en développement est le site web du GSEAf : http://www.iucn.org/themes/ssc/sgs/afesgintro.htm. S'il est clair que ceci n'est pas un outil conçu d'abord pour répondre aux besoins de nos membres ni des gestionnaires des éléphants ou des conservateurs dans toute l'Afrique, pendant encore quelque temps, disons que c'est plutôt une tentative de concentrer notre

dissemination more efficient, AfESG staff will have more time available to devote to the more challenging aspects of providing service to the membership. We envisage that the site will host the various tools developed to address the monitoring and management of human–elephant conflict (including the Decision Support System currently under development), the most up-to-date version of the African Elephant Database and all future additions of *Pachyderm.* The site will also have direct 'hotlinks' to the African Elephant Library: http://www.chebucto.ns.ca/~drigby/eli3.htm, as well as donor sites where these are authorized or required by contractual agreement.

Pachyderm

The saga of *Pachyderm* continues as does its publication. As I had mentioned in earlier Chair reports, it had been my hope to hand over responsibility of *Pachyderm* to one of our fellow specialist groups (African or Asian rhinos) but that was not to be. We have recently been awarded an additional year of editorial costs through the generous contribution of the US Fish and Wildlife Service African Elephant Conservation Fund. So, now that the financial constraints have been addressed, I feel it is time to get the journal on a more stable and professional base. To this end, we are hoping to reconstitute the editorial board, appoint a non-group member to be the chair of this board, to formulate strategic objectives for the journal and to tighten up on quality control in all aspects of its production. It is my hope that in so doing, we can continue the production of this very popular publication while not overly taxing the volunteer network behind its production. To this end, I would also like to extend an open invitation to members of all the three specialist groups involved in *Pachyderm* as well as our broader readership who might be interested in serving on the editorial board or in acting as referees for the interesting topical manuscripts submitted for publication.

The African Elephant Database

I am happy to be able to report that we have recruited a new manager for the African Elephant Database. Although the position is not fully funded for the production of the update every three years, we are confident that this will still be possible. Julian Blanc is in place in the Secretariat offices in Nairobi . He is being met by a

capacité de fournir à notre vaste public des informations et des outils utiles ainsi que des réponses aux questions simples que l'on nous pose souvent. Nous espérons qu'en utilisant cet outil pour rendre plus efficace la diffusion des informations, le personnel du GSEAf pourra consacrer plus de temps aux aspects plus complexes des services que nous devons à nos membres. On prévoit que le site reprendra les différents outils mis au point pour s'occuper du contrôle et de la gestion des conflits hommes-éléphants (y compris le Système de support décisionnel actuellement en préparation), la version la plus récente de la Banque de données sur l'éléphant africain, et toutes les futures éditions de *Pachyderm*. Le site aura aussi des liens directs avec la *African Elephant Library*: http://www.chebucto.ns.ca/~drigby/eli3.htm, ainsi qu'avec les sites des donateurs pour autant qu'ils soient autorisés ou reconnus par accord contractuel.

Pachyderm

La saga de *Pachyderm* continue, tout comme sa publication. Comme je l'avais mentionné dans mes précédents rapports, j'avais espéré transmettre la responsabilité de *Pachyderm* à un des autres groupes de spécialistes (Rhinos africains ou asiatiques), mais cela ne devait pas se faire. Nous avons reçu récemment de quoi financer une année supplémentaire de frais de publication, grâce à la généreuse contribution du Fonds de Conservation pour l'Eléphant d'Afrique du USFWS. Dès lors, puisque les contraintes financières sont levées, il me semble qu'il est temps d'établir la revue sur une base plus stable et plus professionnelle. C'est pourquoi nous espérons reconstituer le bureau de rédaction, nommer comme président de ce bureau quelqu'un qui n'est pas membre du groupe, formuler les objectifs stratégiques du journal et renforcer les contrôles de qualité à tous les stades de sa production. J'espère vraiment que de cette façon, nous pourrons poursuivre la publication de cette revue très appréciée tout en ne pesant pas exagérément sur le réseau de volontaires qui soustend cette production. C'est pourquoi je voudrais aussi étendre mon invitation aux membres de trois groupes de spécialistes impliqués dans *Pachyderm* ainsi qu'à tous ceux de nos lecteurs qui pourraient être intéressés à faire partie du bureau de rédaction ou à faire office de rapporteurs pour les intéressants manuscrits soumis pour publication.

large stack of survey reports from around Africa that AfESG has compiled since the 1998 update. A number of outstanding issues still need to be resolved before the next hard-copy AED update, including improving the reliability, quality and veracity of range data; the integration of some of our data on human–elephant conflict with data on elephant status and distribution; and the use of other important data layers.

Technical matters

Development of reintroduction guidelines

Across the continent, discussions on the movement of 'surplus' elephants from one site to another (either from the wild or from captivity) are becoming commonplace. However, any such moves, whether they are eventually realized or not, are currently planned in a technical vacuum, with no formal guidelines or formulae for 'best practice'. The issues surrounding translocations and reintroductions are extensive and complex. When plans are to move groupings of African elephants, rather than simply individuals, the level of complexity grows significantly. Seeing this as an important emerging issue, requiring technical assistance to inform practitioners (on either the giving or the receiving end), the AfESG Secretariat contacted the Secretariat of the Reintroduction Specialist Group (RSG) for advice. Several years ago, RSG drafted the first reintroduction guidelines, a generalized pamphlet for a broad-based audience that has now been widely adopted. Since that time, RSG has been working with individual groups to develop these guidelines further for specific taxa. Through a successful process of engagement, the two groups (AfESG and RSG) have agreed to work on a joint initiative to draft formal technical guidelines for translocating and reintroducing African elephants. We are hoping to involve the membership as much as possible as we develop these guidelines.

The past six months has been a very active period for MIKE. The CITES Secretariat has hosted two implementation workshops since the beginning of the year. The first, for West Africa, was held in Ouagadougou, Burkina Faso, in February; the second, for the East African subregion in Dar es Salaam, Tanzania, in March 2001. A similar meeting had already been held for southern Africa and the implementation meeting for Central Africa will be held once the pilot phase for the subregion has been completed

La Banque de données sur l'éléphant d'Afrique

Je suis heureuse de pouvoir vous dire que nous avons engagé un nouveau responsable pour la Banque de données sur l'éléphant d'Afrique. Même si le poste n'est pas complètement financé pour la production de la mise à jour tous les trois ans, nous avons bon espoir que ce soit encore possible. Julian Blanc est dêja au travail dans les bureaux de Nairobi. Il y trouvera une pile de rapports d'études venus de toute l'Afrique, que le GSEAf a rassemblés depuis 1998. De nombreuses questions en suspens doivent encore trouver une réponse avant la prochaine édition papier de la BDEA, comme l'amélioration de la fiabilité, de la qualité et de l'exactitude des données de répartition ; l'incorporation de certaines de nos données sur les conflits hommes–éléphants aux données sur le statut et la distribution des éléphants ; et l'utilisation d'autres sources de données importantes.

Questions techniques

Développement de directives en matière de réintroduction

Dans tout le continent, on assiste de plus en plus fréquemment à des discussions sur le déplacement des éléphants « en surplus » d'un endroit à un autre (qu'ils viennent de la brousse ou de captivité). Pourtant, ces déplacements, qu'on les réalise ou non, sont actuellement programmés dans un vide technique certain, sans directives formelles, ni formules de « bonnes manières ». Les questions qui entourent les translocations et les réintroductions sont vastes et complexes. Lorsque l'on prévoit de déplacer des groupes d'éléphants plutôt que des individus isolés, le niveau de complexité augmente significativement. Comme il considère ceci comme une question nouvelle et importante, qui demande l'assistance technique de praticiens expérimentés, le secrétariat du GSEAf a contacté le secrétariat du Groupe des Spécialistes de la Réintroduction (GSR) pour demander conseil. Il y a quelques années, le GSR avait esquissé les premières directives en matière de réintroduction, un fascicule généralisé destiné à une vaste audience et qui est maintenant largement accepté. Depuis lors, le GSR travaille avec des groupes individuels pour adapter ces directives à des taxons spécifiques. Par un processus d'engagement réussi, les deux groupes (GSEAf et GSR)

and the lessons learned compiled, very likely by mid-year. The AfESG Secretariat was fortunate to participate in both the western and the eastern African meetings. The events, attended by practitioners from government and members of the MIKE Technical Advisory Group, proved to be invaluable opportunities to exchange ideas, learn of new and ongoing research initiatives, and obtain information and contact people for recent surveys and those planned for the near future. It is clear that the implementation of MIKE will add significantly to our current knowledge base on the status of elephants across the continent while making great strides towards standardizing data collection across many factors and sites.

The day-to-day life of AfESG

West Africa Programme Office

It has been a truly challenging period for our West Africa Programme Office, ably staffed by Lamine Sebogo. Late in 2000, AfESG obtained support from the US Fish and Wildlife Service to promote the West African Elephant Conservation Strategy throughout the subregion. This heralded the beginning of an odyssey for Lamine, who will devote much of the year to promoting the Strategy with high levels of government, NGOs and donor partners in West Africa. Some significant moves for elephant conservation have taken place since the inception of the Strategy. These have included furthering the process at the national level by Burkina Faso, Côte d'Ivoire, Ghana and Togo. At the field level, more and more elephant-related projects are being initiated in the subregion, most notably in Burkina Faso, Ghana, Mali and Togo. These actions will, no doubt, contribute to and benefit from MIKE, the CITES system for monitoring the illegal killing of elephants, which is currently entering its full implementation phase (see news on MIKE in preceding paragraph).

Central African Programme Office

We are currently recruiting a programme officer for AfESG work in Central Africa. We have a good, strong field of candidates and hope to finalize the appointment by mid-year. The position is particularly timely now, with AfESG actively involved in developing a subregional Strategy for the Conservation of Elephants in Central Africa and the prospects on the

ont accepté de travailler ensemble pour rédiger des directives techniques formelles pour le déplacement et la réintroduction des éléphants africains. Nous espérons impliquer autant que possible nos membres dans le développement de ces directives.

Le dernier semestre fut une période très active pour MIKE. Le secrétariat de la CITES a accueilli deux séminaires d'exécution depuis le début de l'année. Le premier, destiné à l'Afrique de l'Ouest, s'est tenu à Ouagadougou, au Burkina Faso, en février ; et le second, pour l'Afrique de l'Est, a eu lieu à Dar es Salaam, en Tanzanie, en mars 2001. Il y avait déjà eu une réunion semblable pour l'Afrique australe, et la réunion pour l'Afrique centrale aura lieu lorsque la phase pilote pour la sous-région sera terminée et que l'on aura rassemblé les leçons qu'on en aura tirées, probablement au milieu de l'année. Le secrétariat du GSEAf a eu la chance de pouvoir participer aux deux réunions pour l'Afrique de l'Ouest et de l'Est. Ces événements, auxquels ont assisté des praticiens gouvernementaux et des membres du Groupe de Conseil Technique de MIKE, se sont révélés des occasions inestimables pour échanger des idées, pour apprendre les initiatives de recherche nouvelles et en cours, pour obtenir des informations et contacter des gens à propos des recherches récentes et de celles qui s'annoncent. Il est évident que la mise en application de MIKE apportera un supplément d'informations significatif à ce que nous connaissons aujourd'hui du statut des éléphants sur l'ensemble du continent, tout en progressant à pas de géant vers la standardisation de la récolte de données sur toute une série de facteurs et de sites.

La vie quotidienne du GSEAf

Bureau du Programme pour l'Afrique de l'Ouest

Ce fut une période vraiment stimulante pour notre bureau du Programme pour l'Afrique de l'Ouest, où officie avec compétence Lamine Sebogo. A la fin de l'année 2000, le GSEAf a obtenu le support du US Fish and Wildlife Service, pour promouvoir la Stratégie de Conservation de l'Eléphant d'Afrique de l'Ouest dans toute la sous-région. Ceci annonçait le début d'une odyssée pour Lamine qui va consacrer une grande partie de l'année à promouvoir la Stratégie avec les membres haut-placés des gouvernements, les ONG et les donateurs partenaires en Afrique de l'Ouest. Certains changements significatifs pour la

horizon of our upcoming membership meeting to be held in the subregion.

The Secretariat in Nairobi

In the meantime, many changes have been taking place in the Nairobi office. After almost a year of living with unsatisfactory interim measures, we finally have a new programme officer for the Secretariat, Leo Niskanen. Leo swung into action from the first of the year and has contributed immensely in all respects ever since. In the short time since he started, Leo has been to Ouagadougou to visit our programme office for West Africa to get a grip on the extent and needs of AfESG, and in June he travelled to Cameroon to interview candidates for the Central Africa program officer position.

Of course, the Secretariat has also been working hard to organize the first membership meeting of the new triennium. The meeting is scheduled to take place later in 2001, we hope in Cameroon. This will be the first meeting of the entire membership of AfESG to be held in Central Africa, and the logistical gymnastics required to pull it off are putting the entire AfESG staff through their paces. Meetings on the flight arrangements alone seem to occupy hours of their weekly work time!

Before the next *Pachyderm* is out, we will also have replaced our administrative officer, Rowena Costa-Correa. I wish to acknowledge, even before that sad day arrives when Rowena emigrates to Canada, how badly she will be missed. Her ever-effervescent personality and overall positive outlook on life have helped me through some difficult times over the past year. Rowena will be a hard act to follow, but we are already working on recruitment, hoping to have a sufficient handover period for the new administrative officer before Rowena goes.

With all these transitions, I am grateful to have my longstanding right-hand woman, Monica Buyu. Monica has been secretary for AfESG since 1992. Her long institutional memory is helping to fill in those gaps brought on by my increasingly frequent 'senior moments'.

conservation des éléphants ont eu lieu depuis le début de la Stratégie. Ceux-ci comprennent la progression du processus, au niveau national, au Burkina Faso, en Côte d'Ivoire, au Ghana et au Togo. Sur le terrain, de plus en plus de projets liés aux éléphants sont lancés dans la sous-région, surtout au Burkina Faso, au Ghana, au Mali et au Togo. Ces actions pourront sans aucun doute contribuer à et profiter de MIKE, le système de la CITES pour contrôler le massacre illégal des éléphants, qui entre maintenant dans sa phase de pleine exécution (pour des nouvelles de MIKE, voir le paragraphe précédent).

Bureau du Programme pour l'Afrique centrale

Nous sommes occupés à recruter un responsable de programme pour le travail du GSEAf en Afrique centrale. Nous avons déjà un certain nombre de bons candidats et nous espérons finaliser la nomination pour le milieu de l'année. Ce poste vient particulièrement à point au moment où le GSEAf s'implique activement dans la mise au point d'une Stratégie sous-régionale pour la Conservation des Eléphants en Afrique centrale et dans la perspective, qui apparaît à l'horizon, de la prochaine réunion des membres qui se tiendra dans la région.

Le secrétariat de Nairobi

Pendant ce temps, de nombreux changements ont eu lieu au bureau de Nairobi. Après avoir vécu pendant presque un an avec des solutions intérimaires peu satisfaisantes, nous avons maintenant un nouveau responsable de programme pour le secrétariat, Leo Niskanen. Leo s'est rué à l'ouvrage dès le début de l'année, et sa contribution n'a pas cessé d'être de grande valeur. Alors qu'il n'a commencé que récemment, Leo est allé à Ouagadougou visiter le bureau de notre programme pour l'Afrique de l'Ouest, pour se rendre compte de l'étendue et des besoins du GSEAf puis, en juin, il s'est rendu au Cameroun pour interviewer des candidats au poste de responsable de programme pour l'Afrique centrale.

Bien sûr, le secrétariat a aussi travaillé dur pour organiser la première réunion des membres de ces trois prochaines années. La réunion doit avoir lieu plus tard en 2001 ; nous espérons que ce sera au Cameroun. Ce sera la première réunion de tous les membres du GSEAf qui se tiendra en Afrique

centrale, et la gymnastique logistique requise pour sa mise en place met tout le staff du GSEAf à rude épreuve. Les réunions concernant les seules réservations des vols semblent nécessiter des heures de leur temps de travail !

Avant que paraisse le nouveau *Pachyderm*, nous aurons aussi remplacé notre responsable de l'administration, Rowena Costa-Correa. Je dois avouer, avant même que ce triste jour n'arrive où Rowena part pour le Canada, qu'elle nous manquera énormément. Sa personnalité, toujours en effervescence, sa façon toujours positive de voir la vie m'ont aidée à traverser certaines périodes difficiles l'année dernière. Rowena ne sera pas facile à remplacer mais nous cherchons déjà quelqu'un, en espérant que le nouveau responsable disposera d'une période de passage du relais suffisante avant le départ de Rowena.

Avec tous ces bouleversements, je suis heureuse de garder mon fidèle bras droit, Monica Buyu. Monica est secrétaire du GSEAf depuis 1992. Sa longue expérience institutionnelle est précieuse pour combler les trous qui apparaissent de plus en plus souvent dans ma « mémoire défaillante ».

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

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The period under review has been a busy one, reviewing and developing national rhino conservation strategies and plans.

Botswana

On 15 January 2001, a Botswana Rhino Stakeholders Workshop was held at the Khama rhino sanctuary. A draft of the updated national rhino strategy document has since been produced incorporating comments from Botswana's Department of National Parks. This draft has been circulated for additional comment before its ratification is proposed.

La période qui vient de s'écouler a été très occupée avec la révision et la mise au point de stratégies et de plans de conservation nationaux pour les rhinos.

Botswana

Le 15 janvier 2001, un atelier des *Rhino Stakeholders* du Botswana s'est tenu au sanctuaire des rhinos de Khama. Un projet de document sur la stratégie nationale pour les rhinos a vu le jour depuis lors, qui reprend les commentaires du Département de Parcs Nationaux du Botswana. Ce projet est actuellement en circulation afin de recueillir des commentaires supplémentaires avant d'en proposer la ratification.

Cameroon

As I indicated in the last edition of *Pachyderm,* a major initiative is under way to support the Ministry of Environment and Forests in Cameroon in its efforts to prevent the extinction of the critically endangered western black rhino, *Diceros bicornis longipes*. The technical experts meeting chaired by the ministry was held in Yaounde on 13–15 November 2000. It was attended by their cooperating agencies IUCN and WWF and other parties. This meeting agreed on an appropriate conservation strategy and set short-, medium- and long-term goals for the black rhino, with the immediate intention of securing at least five animals in a breeding population. WWF is supporting an intensive survey of the isolated relic populations in mid-2001. If adequate numbers can be found for a founder population, potential sanctuary sites in Cameroon will be investigated and the preferred site selected by the end of 2001. The situation remains extremely tenuous, but the government of Cameroon is strongly committed to the success of the programme, as indicated by its decision to appoint a national rhino coordinator to ensure that appropriate actions are implemented.

Kenya

In the last *Pachyderm,* I reported on the workshop to develop a revised Kenyan black rhino conservation strategy for the next five-year period. Following detailed comments by reviewers on the first edition of the new Conservation and Management Strategy for the black rhino (*D. b. michaeli*) in Kenya (2001–2005), a revised second edition has been circulated and is currently being reviewed. It is expected that the finalized new five-year strategy will be ratified soon.

At the request of the Kenya Wildlife Service and as part of the USAID-funded Kenyan Rhino Management Programme Project, AfRSG organized a knowledge-exchange visit to selected South African black rhino parks, with help from both Kwa Zulu-Natal (KZN) Wildlife and North West Parks and Tourism Board. The tour took place on 19–29 November 2000 with four Kenyans and one external programmer from the Zoological Society of London attending. (For further details see Notes from AfRSG in this issue.)

Cameroun

Comme je l'avais signalé dans la dernière édition de *Pachyderm,* une initiative importante est en cours pour supporter le Ministère de l'Environnement et des Forêts dans les efforts qu'il fait pour empêcher l'extinction du rhino noir de l'Ouest, *Diceros bicornis longipes*, qui est gravement en danger. Il y a eu une réunion d'experts techniques présidée par le Ministère à Yaoundé du 13 au 15 novembre 2000. Les agences de coopération UICN et WWF y ont assisté ainsi que d'autres parties. La réunion a trouvé un accord sur une stratégie de conservation appropriée et a défini des objectifs à court, moyen et long terme pour le rhino noir, avec l'intention immédiate de garantir la présence d'au moins cinq individus dans une population de reproduction. Le WWF soutient la surveillance intensive des dernières populations isolées dès le milieu de l'année 2001. Si l'on peut en trouver un nombre suffisant pour une population reproductrice, on fera des investigations pour des sites de sanctuaires potentiels au Cameroun, et on choisira le site préféré à la fin de l'année. La situation demeure extrêmement précaire, mais le Gouvernement camerounais s'est vraiment engagé à faire réussir le programme, comme le prouve sa décision de nommer un coordinateur national pour les rhinos afin de garantir que toutes les mesures appropriées sont prises.

Kenya

Dans le dernier *Pachyderm,* j'ai fait un rapport sur l'atelier destiné à mettre au point une stratégie révisée pour la conservation de rhino noir de Kenya pour les cinq prochaines années. Pour répondre aux commentaires détaillés de ceux qui ont révisé la première édition de la nouvelle Stratégie de Conservation et de Gestion pour le rhino noir (*D. b. michaeli*) du Kenya (2001-2005), on a fait circuler une deuxième édition qui est en train d'être révisée. On peut s'attendre à ce que la nouvelle stratégie finalisée pour cinq ans soit bientôt ratifiée.

A la demande du Kenya Wildlife Service, et dans le cadre du projet Programme de gestion du rhino au Kenya financé par USAID, le GSRAf a organisé une visite pour des échanges de connaissances à quelques parcs pour rhinos noirs choisis en Afrique du Sud, avec la collaboration de KZN Wildlife et North West Parks and Tourism Board. La visite s'est déroulée du 19 au 29 novembre 2000, avec la participation de

Nambia

Namibia held a major stakeholders workshop to review and examine its national rhino conservation strategy. This workshop was held the third week of June 2001.

Zimbabwe

On 12–13 October, Zimbabwe's Department of National Parks and Wildlife Management held a Rhino Stakeholders Meeting in Harare to review the existing Zimbabwean Rhino Policy and Management Plan. The meeting was attended by DNPWLM staff and stakeholders in the private sector and by the AfRSG scientific officer, the SADC rhino programme coordinator, and representatives of NGOs such as WWF, the Zambezi Society and Marwell Zimbabwe Trust. The meeting concluded that the existing policy and management plan was a sound document needing little modification and that the primary need was to improve its implementation. The workshop identified the need to set up the relevant regional rhino committees as soon as possible.

Rhino Management Group

The Rhino Management Group of Southern Africa (RMG) met in Kruger Park, South Africa, on 24–25 October 2000. In an encouraging development, Zimbabwe's official rhino coordinator attended an RMG meeting for the first time together with representatives from Namibia and South Africa. The meeting discussed a draft introductory RMG guide on managing black rhinos for private landowners in South Africa. A revised version incorporating comments was since compiled and sent out to South African RMG members for comments before it was finalized at the end of June. However the document will be updated to reflect the latest biological management strategies to emerge from the RMG biological management workshop which was held in late July. The meeting also debated issues surrounding how best to manage populations for maximum productivity and how to interpret monitoring data. This topic was especially pertinent, as South African metapopulation performance has been declining in recent years. Some populations in Namibia and Zimbabwe have also been performing suboptimally. The meeting therefore decided that in view of these factors, and as monitoring had been ongoing for a decade, quatre Kenyans et d'un chef de programme extérieur, de la Société Zoologique de Londres. (Pour plus de détails, voyez les Notes du GSRAf dans ce numéro.)

Namibie

La Namibie projetait aussi la réunion d'un atelier pour les principaux *stakeholders* afin de réviser et d'examiner sa stratégie nationale de conservation des rhinos. Il a eu lieu la troisième semaine de juin 2001.

Zimbabwe

Les 12 et 13 octobre, le Département zimbabwéen des Parcs Nationaux et de la Gestion de la Faune a tenu une réunion des *Rhino Stakeholders* à Harare afin de réviser la Politique Zimbabwéenne pour le Rhino et le Plan de gestion actuels. Le personnel du DNPWLM et les dépositaires du secteur privé ont assisté à cette réunion, ainsi que le responsable scientifique du GSRAf, le coordinateur du programme rhino du SADC et des représentants d'ONG telles que le WWF, la Zambezi Society et le Marwell Zimbabwe Trust. La réunion a conclu que la politique et le plan de gestion actuels étaient des documents solides qui ne demandaient que peu de modifications et qu'il fallait d'abord améliorer leur application. L'atelier a relevé la nécessité d'instaurer dès que possible les comités régionaux adéquats pour les rhinos.

Groupe de Gestion des Rhinos

Le Groupe de Gestion des Rhinos d'Afrique du Sud (RMG) s'est réuni au Parc Kruger, en Afrique du Sud, les 24 et 25 octobre 2001. Evolution intéressante, pour la première fois, un coordinateur officiel zimbabwéen pour les rhinos a assisté à une réunion du RMG avec des délégués de Namibie et d'Afrique du Sud. La réunion a discuté d'un projet de guide RMG d'initiation à la gestion des rhinos noirs destiné aux propriétaires privés, en Afrique du Sud. Une version révisée, qui intègre les commentaires, a été produite depuis lors et envoyée aux membres sud-africains du RMG pour de nouveaux commentaires avant sa finalisation, fin juin. Cependant, le document sera mis à jour pour refléter les dernières stratégies biologiques de gestion émergant de l'atelier biologique de gestion de RMG, qui a été conclu fin juillet. La réunion a aussi discuté les questions qui concernent la meilleure façon de gérer les populations en vue d'une productivité maximale, et la

a workshop was needed to review existing and alternative strategies and make recommendations for maximizing metapopulation performance, especially with regard to recommended offtakes and stocking rates. Funding for this workshop has since been secured from the SADC rhino programme, and it was held in the last week of July. Further details will be given in the next edition of *Pachyderm*.

The SADC Regional Programme for Rhino Conservation

The Italian-funded SADC (Southern Africa Development Community) Regional Programme for Rhino Conservation has been active in the period under review. A series of detailed country reviews was completed and used by the programme to identify a number of potential projects for funding. The programme coordinator also visited rhino agencies and parks in Botswana, Malawi, Mozambique, Namibia, South Africa, Swaziland, Tanzania and Zimbabwe in recent months. At the SADC rhino programme consortium meeting in October, 72 proposals or concept proposals were considered, and after the March 2001 SADC Rhino Range States Meeting, a further 36 full project proposals were considered. To date funding, totalling USD 440,000, has been approved by the programme for 33 projects involving 9 of the 10 SADC range states that are part of the programme. As one of five consortium members, AfRSG has been primarily playing a technical role in the programme.

Encouragingly for the most part, official country representatives on AfRSG have been nominated as the nationally identified focal points for the SADC rhino programme (who also attend SADC Rhino Range State meetings). This will enable continuity and good links to be maintained between the SADC programme and AfRSG.

A SADC Rhino Range States meeting was recently held at KwaMaritane in Pilanesberg National Park 6–7 March 2001. One of the major developments at this meeting was the decision to form a new SADC Rhino Recovery Group (SADC-RRG). The meeting also decided that the existing southern African Rhino Management Group should come in under the SADC umbrella as the SADC-RMG. Having two SADC rhino groups will not only be cost effective but will allow each to focus on issues most pertinent to it. The Rhino Recovery Group will concentrate on basic surveys, drawing up national plans, setting up and re-establish-

manière d'interpréter les données sur les contrôles. Cette question était particulièrement pertinente parce que les performances de la métapopulation sud-africaine ont décliné ces dernières années. Au Zimbabwe et en Namibie aussi, certaines populations ont connu des résultats moins bons que prévu. La réunion a donc décidé qu'au vu de ces résultats, et comme la surveillance dure depuis une dizaine d'années, il fallait organiser un atelier pour passer en revue les stratégies actuelles et leurs alternatives et faire des recommandations pour maximaliser les performances de la métapopulation, spécialement en ce qui concerne les prélèvements recommandés et les taux de densité. Cet atelier est deja tenu en dernière semaine de juillet à l'abri du programme de rhino de SADC. D'autres détails seront donnés dans la prochaine issue de *Pachyderm.*

Le Programme Régional du SADC pour la Conservation des Rhinos

Le programme régional du SADC pour la Conservation des Rhinos financé par l'Italie a été très actif pendant toute la période que nous passons en revue. Le programme a terminé toute une série de révisions nationales détaillées dont il se sert pour identifier un certain nombre de projets qui pourraient être financés. Le coordinateur du projet a aussi visité ces derniers mois des agences pour les rhinos et des parcs au Botswana, au Malawi, au Mozambique, en Namibie, en Afrique du Sud, au Swaziland, en Tanzanie et au Zimbabwe. A la réunion du consortium du programme rhino du SADC, en octobre, on a étudié 72 propositions ou propositions de concepts, et après la Réunion du SADC des Etats de l'Aire de répartition qui a eu lieu en mars 2001, 36 nouvelles propositions définitives de projets ont été étudiées. Actuellement, le programme a approuvé le financement, à hauteur de US$ 440.000, de 33 projets impliquant 9 des 10 Etats de l'aire de répartition du SADC qui font partie du programme. En tant qu'un des cinq membres du consortium, le GSRAf joue principalement un rôle technique dans le programme.

Fait très encourageant, les délégués nationaux officiels du GSRAf ont été nominés pour être les points focaux reconnus au niveau national pour le programme rhino du SADC (qui assiste aussi aux réunions du SADC des Etats de l'Aire de Répartition des Rhinos). Ceci va permettre d'assurer la continuité et de bons liens entre le programme du SADC et le GSRAf.

Une réunion du SADC des Etats de l'Aire de Répartition des Rhinos s'est tenue récemment à

ing rhinos in new sanctuaries, and developing capacity in rhino management; the Rhino Management Group will continue to be concerned with issues of ongoing metapopulation management, monitoring, status reporting and rhino use. The two groups will have some shared membership to facilitate exchange of ideas, and will link up with AfRSG in the continent. This arrangement also prevents duplication of work already being done by AfRSG throughout Africa and the RMG in the region.

The SADC programme is also providing technical input towards evaluating and planning new and existing areas in SADC range states (Botswana, Malawi, Zambia) where rhino populations are being re-established or will be reintroduced within the next two years. Expertise from the SADC region is also being provided to Tanzania to assist with surveys and monitoring of remnant populations of southern black rhinos in the Selous Game Reserve.

The SADC programme has produced a new rhino database, WILDb, currently being field tested. A spreadsheet model and manual have also been produced, which will enable ecologists to estimate black rhino carrying capacities like the experts (see Notes from AfRSG for more information). The SADC programme also held a course in rhino identification monitoring techniques using the updated third version of the AfRSG course. The course was held at Ithala Game Reserve 20–22 March, in which delegates gained practical field experience. Delegates from Botswana, Malawi, South Africa, Zambia and Zimbabwe attended the course. Progress has also been made on completely revising and rewriting the RHINO population estimation software; and the next version of the software will be made available free of charge to both SADC and non-SADC rhino range states (such as Kenya) by October 2001. SADC funding was used to facilitate the resuscitation and restructuring of the Rhino and Elephant Security Group in June 2001. Revised terms of reference for the RESG were produced at the meeting. Under the programme, a training manual on techniques for scene-of-the-crime investigation is to be produced and used in training courses.

AfRSG ID training course updated

AfRSG has produced a third edition of the ID training course for field rangers. Fifteen more sets have been produced, and this latest version of the course

KwaMaritane, dans le Parc National de Pilanesberg, les 6 et 7 mars 2001. Un des résultats les plus importants de cette réunion fut la décision de créer un nouveau *Rhino Recovery Group* (SADC-RRG). La réunion a aussi décidé que l'actuel Groupe de Gestion des Rhinos sud-africains devrait se ranger sous l'égide du SADC en tant que SADC-RMG. Le fait d'avoir deux groupes rhinos au sein du SADC sera non seulement plus économique, mais permettra aux deux groupes de se concentrer sur les questions qui leur sont plus appropriées. Le *Rhino Recovery Group* se concentrera sur les études de base, la conception des plans nationaux, l'attribution et la réinstallation des rhinos dans de nouveaux sanctuaires et le développement des capacités pour la gestion des rhinos. Le *Rhino Management Group* continuera à s'intéresser aux questions relatives à la gestion de la métapopulation, aux contrôles, aux rapports sur le statut et à l'utilisation des rhinos. Les deux groupes partageront certains membres, ce qui facilitera les échanges d'idées et fera le lien avec le GSRAf dans tout le continent. Ces dispositions empêcheront aussi la répétition des travaux que le GSRAf fait déjà dans toute l'Afrique, et le RMG dans la région.

Le programme du SADC fournit aussi un apport technique en ce qui concerne l'évaluation et la programmation des zones existantes ou nouvelles dans les Etats du SADC (le Botswana, le Malawi et la Zambie) où l'on est en train de reconstituer les populations de rhinos, ou bien où on va les réintroduire au cours des deux prochaines années. L'expertise venant de la Région du SADC va aussi profiter à la Tanzanie, pour l'assister dans les recherches et le contrôle des populations restantes de rhinos noirs du Sud, dans la Réserve de Faune de Selous.

Le programme du SADC a produit une nouvelle banque de données pour les rhinos, la WILDb, que l'on teste actuellement sur le terrain. Il a aussi produit un modèle de tableau et un manuel qui permettront aux écologistes d'évaluer comme les experts les capacités de charge pour les rhinos noirs (voir les Notes du GSRAf pour de plus amples informations). Le programme du SADC a aussi donné un cours de techniques de contrôle d'ID des rhinos, en se servant de la troisième version, réactualisée, du cours du GSRAf. Le cours s'est donné à la Réserve de Faune d'Ithala du 20 au 22 mars, et les délégués ont pu y gagner une expérience pratique de terrain. Les délégués du Botswana, du Malawi, d'Afrique du Sud, de Zambie et du Zimbabwe ont assisté au cours. On a aussi progressé dans la révision et la réécriture

was used at the SADC training course on monitoring held recently at Ithala Game Reserve. In addition to the whole text being re-edited, the condition assessment module and posters have been extensively revised and an additional clean rhino module added. A fourth edition of the course will be produced incorporating ideas for further improvement gained from experience gained as the course was given. AfRSG is also investigating a cheaper and less labour-intensive method for making ear models.

Declining budgets

Despite all the recent encouraging developments, declining workforce and budgets for state conservation agencies throughout Africa continues to present a major challenge for rhino conservationists. Seen against this background, the targeted support of appropriate projects by donor agencies and NGOs is playing an increasingly valuable role and is enhancing existing field conservation efforts.

Acknowledgements

Once again, I would like to thank WWF-US and WWF-Denmark for partial support of the AfRSG scientific officer's position and to WWF-South Africa for support of the AfRSG chair's running expenses. Without this valued support, the AfRSG Secretariat could not function.

complètes du logiciel sur l'estimation de population RHINO ; la prochaine version du logiciel sera disponible gratuitement pour les Etats de l'aire de répartition des rhinos, qu'ils soient du SADC ou pas (comme le Kenya), en octobre 2001. Le financement du SADC a servi à faciliter la résurrection et la restructuration du Groupe de Sécurité pour le Rhino et l'Eléphant en juin 2001. Le mandat révisé pour le RESG a été fourni lors de la reunion. Dans le cadre du programme, on va produire un manuel de formation aux techniques d'enquêtes sur « les lieux du crime », qui servira dans les cours de formation.

Mise à jour du cours de formation ID du GSRAf

Le GSRAf a produit une troisième édition du cours de formation ID pour les gardes de terrain. On en a produit 15 sets supplémentaires, et cette dernière version a servi pour le cours de formation du SADC sur les contrôles, qui s'est donné récemment à la Réserve de Faune d'Ithala. On a non seulement réédité tout le texte, mais aussi révisé en profondeur le module d'évaluation des conditions et les posters, et ajouté un module bien clair sur les rhinos. Une quatrième édition du cours incorporera les idées de nouvelles améliorations issues de l'expérience acquise lorsque le cours a été donné. Le GSRAf cherche aussi une méthode meilleure marché et plus aisée pour faire des modèles d'oreilles.

Budgets en baisse

Malgré les récentes évolutions intéressantes, la réduction de la main-d'œuvre et des budgets pour les agences nationales de conservation dans toute l'Afrique continue à poser un grave défi à ceux qui veulent conserver les rhinos. Face à cet état de fait, le soutien bien ciblé des projets appropriés par les organismes et les ONG donateurs joue un rôle de plus en plus inestimable et encourage les actuels efforts de conservation sur le terrain.

Remerciements

Une fois encore, je voudrais remercier le WWF-US et le WWF-Danemark pour le support préférentiel qu'ils accordent au poste de responsable scientifique du GSRAf et le WWF-South Africa qui aide à couvrir les frais de fonctionnement du président du GSRAf . Sans cette aide très appréciée, le secrétariat du GSRAf ne pourrait pas fonctionner.

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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Indonesia

The Rhino Protection Units (RPUs) in Indonesia—Ujung Kulon National Park on Java; Way Kambas National Park, Bukit Barisan Selatan National Park and Way Kambas National Park in Sumatra—continue to operate despite the difficult situation in most conservation areas. The current economic and political uncertainty in the country has a severe impact on the natural resources and renders protection of habitat and wildlife extremely challenging. Encroachment, theft of forest produce and poaching are intensifying, and the ability of the conservation staff to counter such activities is diminishing.

The situation with the Javan rhino in Ujung Kulon is stable; no rhino has been lost to poaching for several years. Yet the rhino population appears not to be increasing, and in a large part of the park rhinos are less common than before. WWF is conducting research to identify possible reasons for this stagnation.

In Way Kambas National Park, rhinos have not yet been poached, but other forms of hunting, encroachment and other illegal activities are on the increase. The number of RPUs will soon be increased from four to five to enable them to cover the northern parts of the park more intensively. The biggest poaching threat is currently from hunters that enter the park by boat along the river forming the park boundary in the north and along the Wako River in the centre of the park.

Bukit Barisan Selatan National Park probably has the highest density of rhinos, and rhinos are now also frequently encountered at the periphery of the forest. Encroachment is severe, and significant parts of the park are lost annually in illegal conversion to farmland. The high density of the rhinos and the shrinking habitat render this population extremely vulnerable to poaching, and recently several rhino traps were discovered and destroyed. One rhino was killed in a

Indonésie

Les Unités de Protection des Rhinos (RPU) en Indonésie, au Parc National d'Ujung Kulon, à Java, au Parc National de Way Kambas, à Sumatra, continuent à travailler malgré la situation difficile qui prévaut dans la plupart des aires de conservation. Les incertitudes économiques et politiques que connaît le pays ont un impact sévère sur les ressources naturelles et font de la protection de l'habitat et de la faune sauvage un fameux défi . Les implantations sauvages, le vol de produits de la forêt et le braconnage s'intensifient alors que les capacités du personnel de la conservation à contrer ces activités vont en diminuant. La situation du rhinocéros de Java à Ujung Kulon est stable ; on ne déplore aucune perte due au braconnage depuis plusieurs années. Mais la population de rhinos ne semble pas augmenter, et dans une grande partie du parc, les rhinos sont moins communs qu'avant. Le WWF est en train de réaliser une étude pour identifier les causes possibles de cette stagnation.

Dans le Parc National de Way Kambas, on n'a encore braconné aucun rhino, mais d'autres formes de chasse, l'envahissement sauvage, et d'autres activités illégales sont en augmentation. Le nombre de RPU passera bientôt de 4 à 5 pour leur permettre de couvrir plus efficacement les parties nord du parc. La plus forte menace de braconnage provient des chasseurs qui pénètrent dans le parc en bateau le long de la rivière qui forme la limite du parc, au nord, et le long de la rivière Wako, au centre du parc.

Le Parc National de Bukit Barisan Selatan abrite probablement la plus forte densité de rhinos ; on en rencontre même souvent à la lisière de la forêt. Les envahissements sont graves, et des portions significatives du parc sont chaque année converties illégalement en terres de culture. La forte densité des rhinos et la réduction de leur habitat rendent cette

poacher's snare, but the animal was discovered before the poachers could collect the bounty. The poachers operate from a village near Kerinci Seblat, where rhinos have now been almost exterminated. The RPU patrols may have to intensify to counter the increasing poaching pressure.

Kerinci Seblat National Park, where two decades ago probably a few hundred Sumatran rhinos were living, now has only a few surviving in a small part of the park in northern Bengkulu Province. These rhinos are so widely dispersed that the sexes may no longer be able to locate mates. The justification of continued RPU activities in this park is under review.

The pair of Sumatran rhinos in the Sumatran Rhino Sanctuary in Way Kambas is doing well. The intensity and the duration of courtship and mating activities gradually increase each time the animals are paired during the female oestrous. The couple has not yet completely copulated, but successful breeding is only a matter of time as both animals, though inexperienced, are healthy and obviously ready to reproduce.

Dusun, the other female in the Sumatran Rhino Sanctuary, who was originally captured at Sungai Dusun in Malaysia, died in February 2001 of a complex of chronic pathological conditions and old age. She had not manifested any reproductive activities for many years and her condition would probably not have permitted a pregnancy. The necropsy revealed major chronic defects in most internal organs, and the wear on her dentition clearly indicated her old age. Interestingly, an old lead bullet was found encapsulated in the tip of one of her lungs.

Nepal

More rhinos have been translocated from Chitwan to Bardia and further translocations are planned for later this year. A major stakeholders workshop was conducted in Kathmandu in April 2001 to advance development of a Terai Arc Ecosystem Program and Trust Fund.

Peninsula Malaysia

As reported in the last issue of *Pachyderm*, serious efforts are in progress to intensify law enforcement in Taman Negara. A meeting of the RPU Coordinating Committee in July 2001 was attended by the director general, the deputy director for protection and the rhino coordinator of the Department of Wildlife

population extrêmement vulnérable au braconnage, et on a récemment découvert plusieurs pièges à rhinos que l'on a détruits. Un rhino a été tué dans un lacet de braconnier, mais on a découvert l'animal avant que les braconniers puissent récolter leur butin. Les braconniers opèrent à partir d'un village près de Kerinci Seblat, où les rhinos sont maintenant pratiquement exterminés. Les patrouilles des RPU devraient peut-être s'intensifier pour contrer la croissante pression du braconnage.

Le Parc National de Kerinci Seblat où, il y a deux décennies, plusieurs centaines de rhinos de Sumatra vivaient sans doute, n'en héberge plus que quelques-uns dans une petite partie du parc, dans la province de Bengkulu, au nord. Ces rhinos sont si dispersés que les animaux de chaque sexe pourraient devenir incapables de localiser un partenaire. On est en train de revoir la justification de la poursuite des activités des RPU dans ce parc.

Le couple de rhinos de Sumatra dans le Sanctuaire des rhinos de Sumatra de Way Kambas se porte bien. L'intensité et la durée des activités de parade et d'accouplement augmentent progressivement, chaque fois que les deux animaux sont réunis quand la femelle est en chaleurs. Le couple n'a pas encore complètement terminé une copulation, mais la réussite de la reproduction n'est qu'une affaire de temps puisque ces deux animaux, bien qu'inexpérimentés, sont en bonne santé et visiblement prêts à se reproduire.

Dusun, l'autre femelle du Sanctuaire des rhinos de Sumatra, qui avait été capturée à Sungai Dusun, en Malaisie, est morte en février 2001 d'un ensemble de complications pathologiques chroniques et de vieillesse. Elle n'avait manifesté aucune activité reproductrice depuis des années, et son état n'aurait sans doute pas permis une gestation. L'autopsie a révélé d'importants défauts chroniques dans la plupart des organes internes, et l'usure de sa denture était une indication claire de son âge avancé. Il est intéressant de remarquer qu'on a trouvé une balle ancienne en plomb logée à la pointe d'un poumon.

Népal

D'autres rhinos ont été déplacés de Chitwan vers Bardia, et l'on en prévoit encore pour plus tard dans l'année. Un atelier important des dépositaires a eu lieu à Katmandou, en avril 2001, pour faire avancer la mise au point d'un Programme pour l'Ecosystème de Terai Arc et un Fonds fiduciaire.

and National Parks as well as the superintendent of Taman Negara, seven state wildlife directors, and the AsRSG chair. The park superintendent reported that no evidence of poacher camps or activity had been detected since the last meeting in April 2001, suggesting that the RPU patrols may be succeeding in preventing the poachers from entering the park. However, patrols along the border outside the park discovered fresh evidence of intended entry into it. The main poachers in Taman Negara appear to be from Thailand. The RPU patrol discovered a message in Thai, which led to significant amounts of concealed foodstuffs. It appears the Thai poachers were prevented entry this time, but vigilance must be maintained. Evidence of rhinos was detected in five different areas of the park; there is also much evidence of tiger, elephant, gaur, tapir and deer. The RPUs are protecting all these species. Indeed, the Save the Tiger Fund has recently provided two vehicles and other equipment to enhance the capability of the protection units to interdict poaching of tigers and other large mammals as well as rhinos.

RPUs are also operating outside Taman Negara. The state of Pahang has three units, including one for the border patrol of Taman Negara. Several areas outside the park have been discovered to contain rhinos, including two females with calves. These are forest reserves and subject to logging. The situation is further exacerbated by local poachers (as differentiated from the Thai poachers in Taman Negara), including aborigines, who use traps mainly for pigs and other bush meat. The RPUs are destroying as many traps as possible and are arresting people who are violating the Wildlife Act. RPUs are also operating in the states of Perak, Kelanatan and Johore.

The rhino breeding activities in Sungai Dusun have continued with great vigour despite limited success. Many more matings are now occurring, but no pregnancies are resulting. Of the five females, several have pathological conditions, one so severe that she probably will never be reproductive. The female that was born, but not bred, in captivity to a female that was captured pregnant (and is still at Sungai Dusun) has developed a fluid deposit in her uterus and her cycles have stopped. Efforts are in progress to correct this situation as soon as possible as this animal and her mother are the females with the best prospects of reproducing. Introductions are being guided by hormonal analyses in conjunction with managed introductions similar to what has proved effective at Cincinnati.

Péninsule Malaise

Comme l'indiquait le dernier numéro de *Pachyderm*, on fait des efforts sérieux pour intensifier l'application de la juridiction à Taman Negara. Une réunion du Comité de Coordination des RPU qui s'est tenue en juillet 2001 a vu la participation : du directeur général, du directeur adjoint pour la protection, et du coordinateur pour les rhinos du Département de la Faune et des Parcs Nationaux, ainsi que du superintendant de Taman Negara, de sept directeurs nationaux pour la faune et du président du GSRAs. Le superintendant du parc a rapporté que l'on n'avait détecté aucune trace de camps ou d'activités de braconniers depuis la réunion d'avril 2001, suggérant donc que les patrouilles de la RPU pourraient réussir à empêcher les braconniers de pénétrer dans le parc. Cependant, des patrouilles faites le long de la limite à l'extérieur du parc ont permis de découvrir des traces récentes de tentatives d'intrusion dans le parc. Les plus importants braconniers de Taman Negara semblent venir de Thaïlande. La patrouille de la RPU a découvert un message en thaï qui l'a conduite à des quantités significatives de nourriture cachée. Il semble que cette fois on a empêché les braconniers d'entrer dans le parc, mais il faut rester vigilant. On a détecté des traces de rhinos dans cinq régions différentes du parc ; on y trouve aussi beaucoup de traces de tigres, d'éléphants, de gaurs, de tapirs et de cerfs. Les RPU protègent toutes ces espèces. En effet, le Save the Tiger Fund a récemment fourni deux véhicules et de l'équipement pour augmenter la capacité des unités de protection, afin d'empêcher le braconnage des tigres et des autres grands mammifères aussi bien que des rhinos.

Les RPU travaillent aussi en dehors de Taman Negara. L'état de Pahang a trois unités, y compris celle qui fait des patrouilles à la limite avec le Taman Negara. On a découvert que plusieurs régions situées en dehors de Taman Negara abritaient des rhinos, y compris deux femelles avec des petits. Ce sont des réserves forestières, soumises à l'exploitation commerciale. Cette situation est encore aggravée par les braconniers locaux (différents des braconniers thaïs de Taman Negara), y compris les aborigènes, qui utilisent des pièges surtout pour les cochons et d'autres gibiers. Les RPU détruisent autant de pièges que possible, et arrêtent les gens qui violent le *Wildlife Act*. Les RPU travaillent aussi dans les états de Perak, de Kelanatan et de Johore.

Les activités de reproduction des rhinos de Sungai

Cincinnati Zoo

Emi is now in her 14th month of gestation and the foetus appears to be very healthy. Hopes are high that by the end of September, a calf will be born, the first captive-bred birth of the current program—in fact, the calf will be the first Sumatran rhino conceived and born in any zoo anywhere in over a century.

Asian Rhinos

Publication of *Asian Rhinos* has again been delayed but work on it is progressing. In the meantime, developments are reported on the AsRSG page of the IRF Website (www.rhinos-irf.org).

Dusun continuent avec beaucoup de vigueur, à défaut de succès. Il y a maintenant beaucoup plus d'accouplements, mais il n'y a encore aucune femelle en gestation. Plusieurs des cinq femelles souffrent d'atteintes pathologiques, si sévères pour l'une d'elles qu'elle ne sera sans doute jamais en mesure de se reproduire. La femelle qui était née en captivité d'une femelle capturée pleine (qui est encore à Sungai Dusun) a développé une accumulation de liquide dans l'utérus et ses cycles sont interrompus. On est occupé à essayer de corriger cette situation aussi vite que possible parce que cet animal est, avec sa mère, le meilleur espoir de reproduction. Les introductions sont régies par des analyses hormonales, en conjonction avec les introductions similaires qui se sont montrées efficaces au zoo de Cincinnati.

Le Zoo de Cincinnati

Emi en est maintenant à son 14 ème mois de gestation et le foetus semble être en très bonne santé. On espère fortement qu'à la fin de septembre, le petit sera né. Ce sera la première naissance en captivité; en fait, le petit sera le premier rhino de Sumatra conçu et né dans quelque zoo que ce soit en plus d'un siècle.

Asian Rhinos

La publication d'*Asian Rhinos* a encore été retardée, mais le travail avance. En attendant, on peut prendre connaissance des développements sur la page du GSRAs du site IRF (www.rhinos-irf.org).

Letter to the editor

Dear Sir,
Recently while going through the pages of *Pachyderm* no. 21 of 1996, I again looked at the photo of the Sumatran rhino published on p. 13. It looks like a Javan rhino with one horn (very clearly visible in the photo) and lack of brownish hair on the body.

I would like to have your comments.

Anwaruddin Choudhury

Reply

It's a common misperception that having two horns and hair are good distinguishing characteristics for the Sumatran rhino, as both characters are usually not visible in the field or on low resolution pictures. The second horn is normally only a knob above the eyes and, when the head is turned away as in the *Pachyderm* picture, not visible. The hair in the wild is very short, 1–2 cm in length except on the ear fringes and tail tip, and Sumatran rhinos are usually covered in mud. Hair is therefore rarely visible in a wild rhino, and the ones in Way Kambas are particularly shorthaired. The long shaggy hair that develops in zoos is an aberration caused by lack of mud wallows and thick vegetation.

The print in *Pachyderm* is clearly a Sumatran rhino even though the second horn and the hair are not visible. The form of body and head, the folds, the skin structure and colour are much better characteristics, but more difficult to quantify or describe. The body form, skin folds and skin structure of a Javan rhino are quite different.

It has happened several times in the past that Sumatran rhinos were misidentified as Javan rhinos because the 'report' does not indicate a second horn or hair. In 1958 the great Grzimek published a picture of a Sumatran rhino walking on a plantation road in Malaysia as a Javan rhino, because the picture does not show a second horn or hair. The first rhino seen in Way Kambas in 1990 was also identified as being a Javan rhino because the guards that saw the rhino reported only one horn, no hair, and 'scales' on the body (most likely cracked mud). The rediscovery of the Javan rhino on Sumatra, believed to have been exterminated in the 1930s, was quickly published. These are only two examples, and there are many more cases where one should doubt the identification.

Also reports of large tracks have in the past been referred to Javan rhino without providing any further evidence. The form of the foot is quite distinct between the two species, even in specimens of about the same size, and from a clear picture, or better a plastercast, one usually can determine whether it's a Javan rhino or an 'overlapper' of a Sumatran.

Great caution has to be taken with any report of 'single-horned', 'hairless' or 'large-footed' rhinos. One needs to have a good picture, or a reliable sketch of the body and the body folds, or a good plastercast of a clear footprint before an identification can be made.

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RESEARCH AND REVIEW

First, do no harm: a precautionary recommendation regarding the movement of black rhinos from overseas zoos back to Africa

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Introduction

The international zoological community considers it important to maintain captive animals for a variety of reasons, including the concept that a captive population may serve as a 'safety net' in the face of *in situ* crisis (Foose 1993; Emslie and Brooks 1999), as well as a potential source of animals to re-establish or reinforce wild populations in the future.

With black rhinos managed in the wild as well as in overseas zoological parks, it would seem prudent, if not essential, to develop consensus on when it does and when it does not make conservation sense for animals to be moved from overseas captivity to protected areas in Africa.

In our opinion, moving black rhinos from overseas zoos to free-range settings in Africa can be considered in the following three situations, *but only after both thorough disease risk and cost-benefit analyses have been specifically undertaken when any such movement is proposed.*

1) When introducing new genetic material is deemed necessary for the recipient population's long-term viability, such as for populations with limited founders. This presumes a reasonable knowledge base about the history and genetic diversity of the recipient population and the genetic origins of the animal or animals being considered for reintroduction. This also presumes that the reintroduced animals will breed effectively in the wild setting.

OR

2) If or when the captive population can contribute *biologically significant numbers* to an area below its estimated ecological carrying capacity, or to an area within the species' historic range but currently devoid of black rhinos. The reasons for the absence of endemic animals must obviously have been dealt with before a reintroduction is considered. Through 'compound growth', early introduction of significant numbers of animals, particularly females, can lead to much faster population expansion, particularly in areas well below their ecological carrying capacity. Generally, one would expect that wild sources of rhinos for such supplementation would be fully utilized before overseas zoological sources would be considered.

OR

3) When captive rhino reintroduction techniques need to be studied well in advance of actually applying them on any significant scale. By testing various methods (ideally using animals considered genetically 'surplus' by the community managing captive animals), the techniques may be refined, increasing the chances of successful reintroductions if and when they are actually deemed to be a conservation intervention of choice (see 1, 2 above) in any given locale. It should be noted that intermittent releases of animals that have been hand reared in Africa for a variety of reasons offer opportunities to evaluate different reintroduction techniques.

While these three scenarios seem relatively straightforward, many caveats are buried within the prerequisite *disease risk* and *cost–benefit analyses*—which must be recognized as two discrete processes.

Our primary objectives here are to point out some unique reintroduction risks related to the state of health of black rhinos in captivity and to emphasize that the prudence of management activities with biological risks can be properly assessed only in light of the actual conservation benefits that are likely to accrue because of such activities. A more general yet useful overview is provided by the 'IUCN guidelines for reintroductions' (IUCN 1998), and veterinary information in the IUCN Veterinary Specialist Group's new 'Quarantine and health screening protocols for wildlife prior to translocation and release into the wild' (Woodford in press) may be of interest.

We further recognize that, beyond disease issues, crucial management and behavioural factors have an impact on the success of any rhino reintroduction program. Rhino managers in Africa, dealing with wild animals, not zoo-born rhinos naïve to free-ranging conditions, have learned that for optimal translocation results, large numbers of rhinos (ideally 20 or more) should be moved into an understocked or vacant protected area within a relatively short time. The numbers give any resident animals, particularly dominant bulls, less opportunity to assert themselves and injure or kill newcomers (Brett 1998). Animals translocated individually or in small groups tend to suffer higher mortalities, usually because of encounters with resident males (Brett 1998). Techniques to acclimatize and reintroduce captive-bred rhinos must of course take these issues into account.

We also feel it is important to critically evaluate financial trade-offs when it comes to the relative costs of supplementing range areas with rhinos from overseas zoos versus obtaining animals from other wild populations that are able to provide them. Finally, we note that the animals *being moved* from overseas captivity are of course exposed to an array of risks themselves during any reintroduction process. It is not within the scope of this paper to discuss, for example, the heightened disease risks that the animals being moved from captivity to African protected areas may face when exposed to what for them may be novel pathogens and parasites at their destination. This issue is also associated with various actual and potential costs (Wobeser 1994). Africa's endemic disease-causing organisms, including parasites, will obviously be novel to zoo-born animals. However, black rhinos coming from captive settings will experience disease risks beyond those of their wild counterparts even when faced with micro-organisms that would be, under normal circumstances, unlikely pathogens—if the rhinos carry with them iron loads significantly beyond normal (Weinberg 1974; Payne and Finkelstein 1978; Paglia and Dennis 1999; Weinberg 1999). This issue is discussed below. 'Normal' iron loads are defined as those seen in wild black rhinos that have never spent significant time in captivity.

Disease-risk assessment

Much has been written on disease risk assessment and its implications in conservation decision-making, and we will not review this material here (see, for example, Wolff and Seal 1993; Armstrong and Seal 2000). Three primary sets of skills are needed to ad-

dress disease-risk concerns associated with moving animals for conservation purposes: 1) disease biology as applied to animals being considered for movement and to any recipient populations, 2) data analysis and decision facilitation, and 3) communications for accurately conveying risk-analysis results to decision-makers (Armstrong and Seal 2000). Armstrong and Seal (2000) also recognize that 'a zero risk tolerance philosophy does not meet the needs for decision making in conservation programs' and acknowledge that 'there is not a comprehensive agreed, unified, broadly applicable set of tools such as protocols, models, policies, guidelines to assist assessment of disease risk associated with needed animal movement decisions'.

Anyone who has participated in thorough risk-assessment exercises knows that they are generally time-consuming and somewhat frustrating processes—usually due more to what the participants do *not* know than related to what they do know. In short, disease-risk assessment is often, uncomfortable as it may seem to decision-makers trying to apply the results, a subjective interpretation of available information by the collective expertise consulted. While computerized modelling exercises can be helpful and are always being refined, the bottom line is that in all too many cases there is much we do not know about the range of diseases affecting or potentially affecting the species of interest, particularly in the wild. So we are forced to make decisions in the face of uncertainty in the real world.

Disease and the captive black rhino

This leads us to the 'first, do no harm' precautionary recommendation in the case of the black rhino. Black rhinos in captivity have suffered from an extraordinary range of syndromes that appear related to the fact that they are captive; these conditions are seldom, if ever, observed in the wild. Conditions include acute episodic haemolytic anaemia, chronic non-haemolytic anaemia, superficial necrolytic dermatopathy, haemosiderosis, haemochromatosis, central nervous system degeneration (leukoencephalomalacia), idiopathic and toxic hepatopathies, stress-induced sudden death, a haemorrhagic disease of the microvasculature (idiopathic haemorrhagic vasculopathy syndrome), a noticeable susceptibility to fungal pneumonias and other infectious agents (*Mycobacterium*, *Salmonella*, *Leptospira*), and other as yet incompletely understood disorders (Miller 1993, 1994; Paglia 1994; Lung et al. 1998; Munson et al. 1998; Paglia and Dennis 1999; Murray et al. 2000; Paglia et al. 2001). In the absence of known causes, most of these disorders remain enigmatic, but accumulating evidence suggests that at least some may be related to dietary management (Dierenfeld et al. 1995; Smith et al. 1995). More specifically, these conditions may be sequelae of diet-related iron overloads that develop progressively in captivity and appear to affect only captive black and Sumatran rhinos, which browse, and not captive white or Indian rhinos, which graze (Smith et al. 1995; Paglia and Dennis 1999; Paglia and Radcliffe 2000; Paglia et al. 2001). Further research, which is ongoing, is essential if we are ever going to be able to better address the plethora of biomedical concerns outlined in this paper.

While we believe the basic problem of iron overload in captivity is related to dietary factors, one of the primary consequences of iron overload in humans and quite likely in black rhinos is increased susceptibility to infectious diseases, or increased virulence of micro-organisms of all types in iron-overloaded hosts (Weinberg 1974; Payne and Finkelstein 1978; Paglia and Dennis 1999; Weinberg 1999). In many instances, it appears as if the animals become immunocompromised.

Two disease conditions in black rhinos merit particular attention here: idiopathic haemorrhagic vasculopathy syndrome (IHVS), which may or may not have an infectious aetiology, and tuberculosis—both *Mycobacterium tuberculosis*, the usual agent of human TB, and *Mycobacterium bovis*, so-called bovine tuberculosis or BTB.

IHVS, first reported in 1995, presents clinically as an acute non-haemolytic anaemia owing to extensive haemorrhage into skeletal musculature and subcutaneous tissues, often associated with extensive swelling of soft tissues (for example, neck, shoulders, extremities), respiratory stridor and dyspnea, laminitis, oronasal ulcers and stressful events (Lung et al. 1998; Murray et al. 2000). The clinical characteristics and underlying pathology, a haemorrhagic microvasculitis, are most consistent with an immune-complex disorder of the type often initiated in humans and other mammals by infectious agents such as the streptococci that have been isolated from about half of the affected rhinos. Attempts to detect IgG and IgA immune complexes with rhino-specific reagents have thus far been unsuccessful, but the possibility of an

undetected infectious component remains. All but one of the seven cases described (Murray et al. 2000) occurred in Texas, again perhaps hinting at an infectious agent. Since we do not know what is causing or triggering IHVS, we obviously cannot test for it as part of pre-shipment or quarantine screening protocols, nor can we guess whether 'it' can be transmitted by arthropods or other potential vectors.

Tuberculosis, for which there is as yet no completely reliable antemortem diagnostic test in rhinos, can be caused by several types of mycobacteria, the strains of which may or may not resemble those found in places like South Africa's Kruger National Park in terms of pathogenicity, host predilections, drug-resistance profiles, and so on. While BTB is now present in Kruger Park and several other protected areas in Africa and affects a wide range of wildlife species, to our knowledge no confirmed cases have been reported in wild rhinos.

Meanwhile, bovine as well as human tuberculosis have been reported in African rhinos in overseas zoological parks, as have *M. avium* and other paratuberculous strains (Stetter et al. 1995). These cases have often eluded a variety of diagnostic techniques employed while the animals were still alive. A black rhino with minimal clinical signs other than weight loss, and harboring *M. tuberculosis* as eventually proven by nasal cultures and PCR amplification, had 17 negative cultures over a 12-month period, including one specimen obtained endoscopically, yet recently died with extensive necrotizing granulomatous pneumonia. It is unclear whether this represents an example of enhanced TB virulence in an iron-loaded host or simply reflects a general tendency for rhinos to suppress outward signs of weakness or vulnerability, almost regardless of the extent of underlying disease. The zoological community is now at a heightened state of alert regarding tuberculosis, not only because of cases in rhinos, but perhaps more so because of the number of cases being recognized in captive elephants over the past few years (Mikota et al. 2000). It is also important to note that tuberculosis is a zoonotic disease, meaning it can be transmitted not only among animals but back and forth between animals and people, an obvious public health concern for zoos and the agencies that regulate them (Dalovisio et al. 1992).

Excess iron in captive black rhinos may well be a major factor contributing to enhanced susceptibility to a wide range of infectious agents, all of which are dependent on host iron for replication and metabolism. Recent reviews of iron overload and its relationship to a wide variety of human diseases, including infections, note that nearly 50 microbial genera, including *Mycobacterium,* contain strains that are more pathogenic in iron-loaded hosts (Moyo et al. 1997; Weinberg 1999).

One might ask whether excess iron will dissipate once a captive black rhino is reintroduced to Africa. Unfortunately, mammals lack any effective physiological mechanisms for excreting such excess iron. Judging both by necropsy pathology and by quantitative serum and tissue assays, black rhinos born in or recently brought into captivity have normal iron stores, but these stores begin rising progressively with time in captivity and can increase 10-fold in three years or even less. Longer periods in captivity can result in adult rhinos with iron loads 100-fold or greater than normal.

In the absence of excretory mechanisms, simple interdiction of additional uptake, such as by release into a natural habitat with a presumably normal diet, unfortunately would not affect excessive iron burdens that the animals would carry from captivity into the wild. These burdens could be modified only by active intervention involving physical removal: 1) by pharmacological chelators, which are used in humans with haemochromatosis but which would be prohibitively expensive in rhinos, or 2) by repetitive phlebotomies, or controlled bleedings, which would be practical only in very tractable, tolerant and chute-trained animals. It seems reasonable to conclude that, for a variety of reasons, if there are scenarios in which it makes conservation sense to reintroduce black rhinos from captivity to the wild, younger animals would generally be more sensible candidates than animals that have been captive for many years. The question 'How many years is too many?' merits further analysis.

In short, even if we employ excellent screening and quarantine procedures for both sending and receiving black rhinos for reintroduction, we run the risk of a captive rhino appearing completely healthy and still serving as a Trojan horse for a strain of TB or BTB or another infectious agent not previously seen in rhinos in Africa. Can we quantify this risk? No. Is there less risk if we move captive rhinos into locales within the historic range of the species but currently devoid of endemic rhinos? Yes, particularly over the short term. All of these issues point to the

obvious fact that we must put more thought into analysing *the conservation benefits* of any such proposed reintroduction before it is undertaken. This type of management intervention is not a trivial one. Should we bring zoo black rhinos into *continentally key or important* wild black rhino populations? Given our incomplete understanding of the true nature of many of the disorders affecting captive black rhinos and of the mechanisms involved**,** we would strongly argue that, at the present time, we should not.

Discussion and recommendations

Disease risks should be assessed case by case in light of specific anticipated conservation benefits before any black rhino reintroductions from zoos are undertaken. All other things being equal, younger (within reason) captive animals are in general likely to pose lower disease risks to any recipient population of conspecifics than older animals from captive settings. Hypothetically, it might make sense to move a particular animal from an overseas zoo to a small, isolated reserve for black rhino restoration or as part of a program to develop better captive black rhino reintroduction methods. It would be ill advised to move that same animal into a continentally key or important black rhino population. *Of course, either way, subsequent movements of animals within Africa could result in any given animal from a captive facility, or the pathogens it brought with it and then passed on to vectors or to other conspecifics, or both, eventually ending up somewhere else.* This is an issue that IUCN AfRSG and the SADC Rhino Program should consider as they assemble guidelines regarding the movement of rhinos within Africa.

We acknowledge that the available information regarding disease incidence and prevalence in wild African rhino populations still has many gaps. We recognize, for example, that the bovine tuberculosis already present in ecosystems important to African rhinos remains a concern meriting further research. AfRSG and SADC will of course consider diseases and vectors already known to be present in different parts of Africa as they develop their translocation guidelines. The need for thorough disease risk assessments *before wild rhinos are moved within Africa* is an extremely important topic, but is beyond the scope of this paper.

Cost effectiveness must be assessed for any black rhino supplementation plan. A comparative overview of the cost effectiveness of *in situ* versus *ex situ* black rhino conservation programs, using costs per rhino as a measure, suggests that conservation in the wild has been more cost effective than overseas captive breeding (Currie unpubl.). Add to any overseas zoo-to-Africa black rhino reintroduction project the various costs associated with quarantine on shipping and receiving ends, transportation, and infrastructure and staff time associated with an acclimatization process likely to require months to years for a zoo rhino to successfully adapt to a plethora of 'lifestyle differences' in its new home, and one is faced with the reality that such operations are quite expensive compared with the sourcing of rhinos within Africa whenever biologically and politically possible. (Moves within Africa, however, should of course be accompanied by some of the same precautionary procedures.) Again, this reality emphasizes the need to carefully evaluate the real conservation benefits anticipated from such a zoo-to-wild exercise before proceeding. For the foreseeable future, it does seem likely that supplementing from stock within Africa will generally be lower in cost than importing rhinos from overseas zoos.

The demand for captive animals for restocking wild areas will likely be largely a function of the number of surplus wild black rhinos that are available, which has been limited in recent years. However, there appears to be a growing number of wild populations across several rhino range states wherein population performance seems to have declined as rhino densities have grown closer to estimated longer-term ecological carrying capacities. A number of these populations are showing such classic signs of density-dependent reduction in reproductive performance as long intercalving intervals, low ratios of calves (animals < 3.5 years old) to adult females and lower population growth rates. Given the growing number of potential donor populations in Africa and the fact that improved biological management to maintain high metapopulation growth rates is a key component of most national black rhino management plans, the densities of many of these currently suboptimally performing populations may be actively reduced by capture and translocation as wildlife officials attempt to increase overall reproductive performance. Hopefully, more wild black rhinos will thus become available for restocking.

Finally, while it is not a primary subject of this paper, we want to acknowledge that rhinos in overseas captive facilities have usually been secured

through formal international agreements with the supplying range countries. The legal ownership and disposition issues surrounding wild-caught zoo rhinos as well as their progeny need to be understood and respected as the types of movements discussed in this paper are contemplated.

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Status and trends of the ivory trade in Africa, 1989–1999

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Abstract

Major surveys of 22 cities in 15 African countries found over 100,000 elephant ivory items for retail sale in the late 1990s. In all countries except Egypt, Gabon and Sudan, this domestic trade is mostly legal. The cities with the largest number of pieces were Abidjan (20,114), Harare (19,958) and Cairo (11,627). The main buyers of African ivory pieces are foreign tourists (mostly from France, Italy and Spain), Chinese and Korean workers and businessmen, French military and their families, United Nations officials, and national diplomats. Except for Zimbabwe, the export of all those ivory commodities is illegal.

There is a significant illicit movement of raw ivory (tusks) within Africa, especially from central to West Africa for the local carving industries. Tusks are the cheapest in the Democratic Republic of Congo, the Central African Republic, Cameroon and Mozambique, where there are still relatively large populations of elephants, and there is little law enforcement. Prices vary for tusks from USD 14/kg in Maputo in Mozambique to over USD 100 in Dakar in Senegal for a tusk weighing 1–5 kg. There is also an illegal trade in tusks off the continent, mostly to China, but also to South Korea and other countries in eastern Asia.

Compared with 1988 the prices for most retail ivory items have decreased in many parts of Africa as a result of the decline in demand (that is, the absence of buyers) and the devaluation of local currencies. There has also been a sharp decline in the price of the tusks in most places. Since the 1990 CITES ban on the international trade in African elephant ivory, the only surveyed African city having an increase in retail sales is Lagos in Nigeria. Since the mid-1990s, there has been an expansion in retail sales in Abidjan in Cote d'Ivoire.

Resume

Des recherches importantes réalisées dans 22 villes de 15 pays africains ont permis de trouver plus de 100.000 objets en ivoire d'éléphant à vendre à la fin des années 1990. Dans tous les pays, sauf l'Égypte, le Gabon et le Soudan, ce commerce intérieur est le plus souvent légal. Les villes où l'on a trouvé le plus grand nombre d'objets étaient Abidjan (20.114), Harare (19.958) et Le Caire (11.627). Les acheteurs principaux d'objets africains en ivoire sont des touristes étrangers (surtout de France, d'Italie et d'Espagne), des travailleurs et des hommes d'affaires chinois et coréens, les militaires français et leur famille, les employés des Nations unies et les diplomates locaux. L'exportation des articles en ivoire est interdite dans tous les pays sauf au Zimbabwe.

Il existe un trafic illégal significatif d'ivoire brut (défenses) en Afrique, spécialement d'Afrique centrale et occidentale vers les industries de sculpture locales. Les défenses les moins chères se trouvent en République Démocratique du Congo, en République centrafricaine, au Cameroun et au Mozambique, où les populations d'éléphants sont encore relativement importantes et où les lois sont peu appliquées. Le prix des défenses varie de USD 14 le kilo à Maputo, au Mozambique, à plus de USD 100 à Dakar, au Sénégal, pour une défense qui pèse entre 1 et 5 kilos. Il existe aussi un trafic illégal en dehors du continent, surtout vers la Chine, mais aussi vers la Corée du Sud et d'autres pays d'Extrême-Orient.

Lorsqu'on les compare avec ceux de 1988, les prix de la plupart des objets en ivoire ont baissé dans de nombreuses régions d'Afrique, suite à la diminution de la demande (c.-à-d., l'absence d'acheteurs) et la dévaluation des monnaies locales. Il y a aussi souvent une forte diminution du prix des défenses. Depuis le ban imposé par la CITES en 1990 sur le commerce international de l'ivoire d'éléphant africain, la seule ville africaine visitée où l'on a constaté une augmentation des ventes au détail est Lagos, au Nigeria. Depuis le milieu des années '90, il y a une augmentation des ventes au détail à Abidjan, en Côte d'Ivoire.

Introduction

The surveys on the domestic trade in ivory, carried out in 22 cities within 15 countries of Africa, were to establish baseline data on various indicators of the ivory trade from which to assess the current status and future trends. Something can also be said about the trend in demand for worked and raw ivory in Africa from comparing the results of this study with data contained in previous reports, beginning in 1989, the year CITES agreed to establish the ban on the international trade in African elephant ivory. It is widely agreed that the CITES ban, which started in 1990, and the associated publicity campaign greatly reduced the volume of trade and demand for ivory. This achieved its intended result of decreasing the poaching of elephants (Dublin and Jachmann 1992, Dublin et al. 1995), at least until recently.

This study was made more urgent by the 1997 CITES decision to transfer some southern African elephant populations to Appendix II and permit a single experimental quota and auction of government ivory stocks for export to Japan (Gray 1997). These auctions were held in April 1999 in Zimbabwe, Botswana and Namibia and 49,735 kg of ivory were sold to Japanese dealers at an average price of USD 103/kg (JWCS 2000). Some have argued, based on information from vendors, that the Appendix transfer stimulated poaching in anticipation of the easing of the ban (JWCS 2000, EIA 2000, AWI 2000, Kantai 2000). Elephant poaching was possibly also stimulated by the proposals made to CITES 2000 in Nairobi by South Africa, Zimbabwe, Botswana and Namibia to sell limited quantities of ivory again to Japan, according to people in the ivory carving industry interviewed in southern Africa.

There are few hard data with which to assess the effects of the 1999 auctions and any future ivory sales. The results of this study show that there have been signs of a recent increase in demand in some parts of Africa, but we cannot conclude that the auctions stimulated this demand because information from the 1996–1998 period is not complete enough. This study can be used to assess changes in future in the ivory trade in Africa in response to any renewed legal international ivory trade, as now the baseline of data is much more solid. This study should be repeated before the CITES Conference of the Parties in 2005 to provide necessary information to the delegates on the status and trends of the trade at that time to assist their making a decision about whether to permit renewed ivory sales, if requested by a party state.

Save the Elephants, a conservation organization based in the United Kingdom and Kenya, sponsored the 1999 survey, but the authors arrived at the results independently, and we take full responsibility for the findings and conclusions of the study. Further details can be found in Martin and Stiles (2000), although we have revised certain interpretations and conclusions in this article.

Methods

The 15 countries selected for the surveys are the most active in Africa for domestic ivory sales. The Republic of the Congo and Angola reportedly have moderate domestic markets, but they could not be visited because of insecurity. Selected data are used from Madzou and Moukassa (1996) for the Republic of the Congo, however. Thirteen of the countries were visited between May and November 1999, with results of the work given in this paper; Egypt and Sudan were surveyed in 1997 and 1998 by one of us (Martin 1998, 2000) and are referred to in the tables and the conclusion. Martin covered north-eastern and southern Africa while Stiles visited central and West Africa. We visited the capitals of each country, and in some cases other centres of the ivory trade, but time and money constrained a comprehensive survey as the final report needed to be ready before the 2000 Conference of the Parties of CITES.

We each visited as many retail outlets and ivory-carving workshops in each city as we could find in the time available. We then counted every piece seen, obtained representative retail asking prices and the price of raw ivory the workshops paid to middlemen by tusk weight categories, asked about ivory turnover measured by value and weight in both retail outlets and workshops, counted the number of craftsmen, tried to determine their incomes, and asked about past conditions of all of these indicators back to the 1989 pre-CITES ban period. We have also used the results of previous studies in this paper and in tables 1–4. In several places, we engaged in bargaining to assess what the actual going prices for selected worked types would be.

Obtaining good data presented many difficulties. Vendors and craftsmen were often wary and suspicious, particularly in countries in which illegal ivory was being used, but they gave consistent data. The political and security situation in some countries also made work

demanding. Occasionally we did not have time to count every piece and had to make estimates. Nevertheless, we collected sufficient information to present a fairly clear picture of the current status of the ivory trade.

Stiles estimated the weights of the pieces he saw. All ivory items were categorized by type and size, for example, bust 10–20 cm, 20–30 cm, and so on; animal 10–20 cm, 20–30 cm, and so on. The method was to pick up a representative piece and assess its weight, then multiply by the number in each category and add up the total weight for each outlet. Estimated weights were checked with craftsmen as a guide. Since the Martin and Stiles (2000) report has been published, the Madzou and Moukassa (1996) report has been obtained. This report published detailed descriptions and photographs of ivory types in Brazzaville, including the weights obtained by actual scale weighing, which confirmed that the estimates Stiles made were within 10% of the actual weights.

Results

Central Africa's legal position for the trade in ivory

CAMEROON

Selling worked ivory under permit is legal in Cameroon and raw ivory can be possessed, transported and traded internally provided it has a Certificate of Origin issued by the government and it is registered and marked (Dublin et al. 1995). Cameroon joined CITES in 1981. Sport hunting is legal everywhere in the country except for the far north, but elephants with tusks smaller than 10.1 kg are protected.

CENTRAL AFRICAN REPUBLIC

Internal ivory sales are legal in Central African Republic (CAR) if the ivory is certified by the government as either found or confiscated and then sold under licence to users. In practice, however, vendors said that the government sells no ivory under licence. All raw ivory obtained and used by carvers in Bangui is therefore illegal, obtained from poached elephants or from government personnel through corruption. An audit of government-declared ivory stocks in Africa that TRAFFIC reported to CITES in February 1998 revealed that CAR declared 886.2 kg but TRAFFIC found only 121.8 kg at around the same time. CAR joined CITES in 1980. Sport hunting is openly carried out in CAR, in spite of a hunting ban made in 1985 (ELC 1987).

CHAD

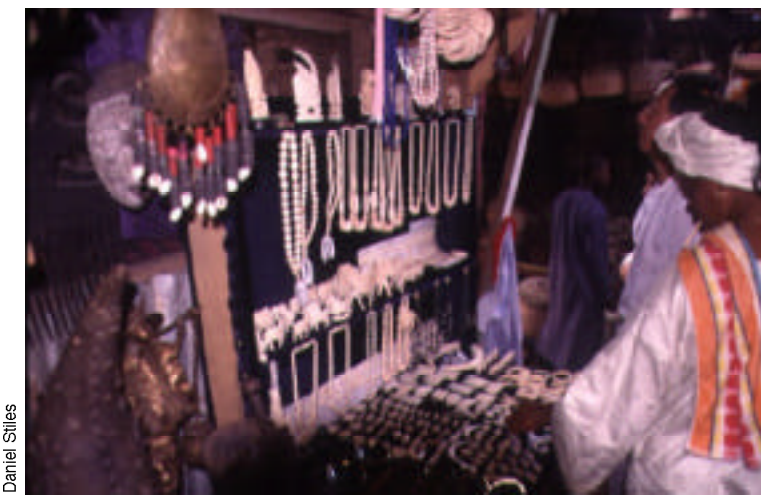
Chad joined CITES in 1989. The sale of carved ivory within the country is legal. Hunting was made illegal in the country in 1999 by presidential decree, except in authorized sites for private investors.

REPUBLIC OF THE CONGO

Elephant hunting in the Republic of the Congo was banned in 1991 and the possession of tusks or other elephant products must be declared to the government within three months. It is legal to sell worked ivory, but the ivory must be marked by the Ministry of Water and Forests and vendors must keep records of purchases and sales. The Republic of the Congo joined CITES in 1983. (This information is from Madzou and Moukassa 1996.)

DEMOCRATIC REPUBLIC OF CONGO

The Democratic Republic of Congo (DRC, formerly Zaire) joined CITES in 1976. Commercial ivory exports have been banned since 1980 (Caldwell and Barzdo 1985) and elephant trophy hunting was banned in 1984 (Caldwell 1987). Selling worked ivory is ap-



Daniel Stiles

A potential customer shops for ivory in the Lagos Ilasan art market.

parently legal as it is sold openly in various places in the capital, and one section of the central craft market is reserved for ivory. Kinshasa was the only place surveyed, as the civil war was going on when Stiles visited the country in June 1999.

GABON

It is illegal to kill elephants, transport raw ivory or sell worked ivory in Gabon (ELC 1987), thus there is little openly displayed. Gabon joined CITES in 1989.

Retail sales of worked ivory in central Africa

In the five countries of central Africa that Stiles surveyed, he visited 129 retail shops and 23 workshops. More than 14,000 worked ivory pieces weighing a minimum total of 1,430 kg (table 1) were seen. The amount of worked ivory displayed has decreased since 1989 according to the data in the places where they are available (Allaway 1989a,b,c), from 2230 kg found in Gabon's capital, Libreville, and in Douala and Yaounde in Cameroon to 698 in 1999. The number of outlets where ivory is sold has also been reduced, and there are fewer workshops in 1999 than there were in 1989 (table 2). Nevertheless, Douala was still the third most active retail ivory market seen in central and West Africa in 1999, after Abidjan and Lagos.

The only place where the sale of worked ivory could be calculated was the Bikeko market in Kinshasa in DRC. Retail sales have plummeted since the CITES ban in 1990, but Stiles calculated a figure of about 1600 kg a month of ivory worked in 1999,

Table 1. Indicators of the ivory trade and prices for raw ivory, mostly as of 1999

City	Retail outlets	Workshops visited	Craftsmen	Raw prices (USD)			Min. no. items	Weight (kg)
				< 1 kg	1–5 kg	> 5 kg		
Dakar	30	2	4	–	100–120?	–	4338	407
Abidjan	52	14 + 1?*	97 + 10?*	4	41–58	65–80	20114	2748
Lagos	40	5 + 1?*	33 + 10?*	< 50	46–50	50	5966	1742
N'Djamena	24	0	0	–	–	–	1000+	33+
Douala	28	7 + 6?*	32 + 12?*	< 27	27–30	30–50	4891	510
Yaounde	15	1?*	6?*	< 30	38	38–50	1124	144
Libreville	8	0	0	< 30	30	42	462	44
Bangui	26	3	12 + 10?*	< 15	15–20	20–25	2219	211
Kinshasa	28	13	116	30	30–50	> 50	4324	485
Brazzaville 1995	–	–	–	–	4–9	8–20	–	–
Djibouti-ville	18	0	0	–	68	–	453	–
Addis Ababa	54	4 + 2?*	10–20	28	37	53	9996	–
Cairo	–	–	–	–	80	137	–	–
Cairo 1998	88	6 + 4?*	100	34	62	98	11627	–
Luxor 1998	33	0 + 1*	< 12	–	–	–	6445	–
Aswan 1998	21	0	0	–	–	–	3388	–
Omdurman & Khartoum 1997	34	3	< 20	15	44	–	1500–3000	–
Harare	23	1 + 6*	30	8	12	17	19958	–
Victoria Falls	10	0	0	–	–	–	517	–
Johannesburg	20	0	0	–	–	–	1361	–
Cape Town	33	0	0	–	–	–	2036	–
Durban	20	0 + 1*	1–3	–	–	–	3989	–
Maputo	52	8 +? *	100	–	14	28	3619	–
Totals	657	67 + 22?*	573–585 + 42?*				109327–110827	

* Workshops and craftsmen told about but not visited.
– no data

Table 2. Comparisons of ivory trade indicators and raw ivory prices for 1983 or 1989 and 1999

CITY	Price for pieces > 1 kg (USD/kg)		Outlets (no.)*		Workshops (no.)		Quantity for sale (kg)	
	1989	1999	1989	1999	1989	1999	1989	1999
Abidjan	–	40–80	56–61	37	12	15	4880	2748
Lagos	14–29	46–50	34	35	–	6	1081.5	1742
Douala	65–81	27–50	~ 50	21	> 3	> 7	880	510
Yaounde	–	38–50	15	14	–	1?	610	144
Libreville	45–65	30–42	> 48	~ 10	> 9	0?	740	44
Kinshasa	40–50	30–50	–	30	21	13	–	485
Harare	105	16	–	–	–	7	–	–
Johannesburg	–	–	–	–	2+[a]	0	–	–
Cape Town	–	–	–	–	2+[a]	0	–	–

* non-workshop outlets
– no data
[a] 1983 data

or 19.2 tonnes a year, which should be considered a rough estimate. Of this amount, approximately 1200 kg of worked ivory per month is exported, taking into account 20% carving waste (Martin and Stiles 2000). Stiles estimated the 1996–1998 amount to be 1300 kg being sold at the Bikeko market, leaving a balance of about 1600 to 1900 kg a month for export before the rebellion. De Meulenaer and Meredith (1989) estimated that Kinshasa factories processed 5 to 10 tonnes of raw ivory in 1989; thus it appears that ivory consumption has at least doubled since then, although it is still considerably below the estimated 60 to 70 tonnes that were consumed in 1988.

Although the data from 1989 are not detailed enough (Allaway 1989a,b,c), it appears that retail prices are slightly less today than in 1989 in absolute terms (table 3). If inflation is taken into account, retail prices are considerably lower in 1999.

The buyers of worked ivory in central Africa vary somewhat from country to country, but the main ones appear to be French, Italian and Spanish among the Europeans, and Chinese, Korean and Japanese from Asia. They are diplomats, UN personnel, businessmen, missionaries and military (French). Tourists buy a small amount. Italians and Spanish ship worked ivory to their countries by air, and African traders take ivory to these countries to sell in street markets. Blank name seals (*hankos*) are popular with many eastern Asians.

The data presented here for the Republic of the Congo are from 1994–1995 (Madzou and Moukassa 1996). Worked ivory is sold in Brazzaville mainly at

Table 3. Average retail price comparisons for selected central and West African cities, 1989–1999

	Lagos (USD)		Libreville (USD)		Douala & Yaounde (USD)	
Item	1989	1999	1989	1999	1989	1999
Necklace, large	20.95	8–35	32.40	13.10–36.10	32.40–48.40	12.30–41
Bracelet < 1 cm	11.40	4–15	16.10	9.80–13.10	12.60–14.50	4.90–9.80
Bracelet > 2.5 cm	28.60	5–50	45.20	19.70	19.35–48.40	9.80–41
Earrings	2.90–5.70	0.50–10	3.20–9.70	1.60	6.45–9.70	1.60–8.20
Human figure 10–20 cm	210	25–150	–	24.60	113	41–164
Human figure 30–40 cm	476	40–400	194	32.80–82	226	57.40–98.40
Animal 20–30 cm	–	25–250	80.65–135	49.20–65.60	194	131–246
Carved tusk 50 cm	–	50–300	565	–	194	148–557

USD 1 = 310 CFA and 10.5 Nigerian naira in 1989
– no data

Table 4. Price comparison of selected worked ivory pieces in north-eastern and southern Africa, 1983 or 1993 and 1999

Addis Ababa (USD)			Harare (USD)			Johannesburg (USD)		
Item	1993	1999	Item	1983	1999	Item	1983	1999
Comb 11 cm	30	19	Animal 2.5 cm	7	2.43	Necklace, beaded	60	30
Pipe 11–20 cm	71	25	Animal 4 cm	18	3	Lighter	45	40
Female bust 12 cm	121	81	Key chain	4–8	1.76	Napkin rings, 6	45	40
Bangle 7 mm	8	4	Bangle 7 mm	10	–	Bangle 1.25 cm	45	40
			Brooch, small	8	3			

– no data

the Plateau market, at the Sofitel and Meridien hotels, at the Score supermarket, in front of the main post office, and at the Maya-Maya airport. The Plateau market has nine tables that display ivory, but no information was given by Madzou and Moukassa on the other outlets. Ivory weights were given for only four tables at the Plateau market. They vary from a minimum of 3 kg to a maximum of 70 kg at each table. The quantities vary by season in response to demand. The average price of all categories for worked ivory was USD 100/kg (350 CFA francs = USD 1). The four sample ivory tables earned a combined annual income of USD 83,759, with a range of USD 40,706 down to USD 1065. The four tables sold a total of 859.3 kg of worked ivory over the course of a year, with a range of 476.6 to 8.3 kg.

The main buyers were Congolese (24%), French (24%), Senegalese (13.7%), Chinese (7.9%), Italians (5.8%) and Russians (5.2%), but in quantity purchased the order was Senegalese merchants first, then French military and diplomats, followed by Chinese, Italians and Russians about equal.

Raw ivory prices in central Africa

Raw ivory prices had been rising over the past two years (1997–1999) and by mid-1999 seemed to be in flux. The reason given was that the war in DRC was cutting off ivory supplies. Bangui in CAR was definitely the cheapest place, where < 1 kg tusks cost less than USD 15/kg depending on size and quality, and mid-range tusks (1–5 kg) went for USD 15–20/kg. Larger tusks, rare these days in CAR, still cost only USD 20–25/kg because of the low demand. Similar tusks in Cameroon and elsewhere ranged at USD 25–50/kg (table 1). Prices were considerably higher in 1989 before the CITES ban everywhere except Lagos (table 2), where prices have risen to USD 50/kg for large tusks. An informant from Bukavu in eastern DRC, encountered in Kenya in October 1999, said that raw ivory was plentiful in eastern DRC. The price was USD 20/kg, and it could be smuggled into Kenya hidden in trucks with imports of crafts. Raw ivory from eastern DRC is currently being smuggled into Kampala in Uganda and exported to Hong Kong by a local craft dealer (Thomas Price, wildlife trader, pers. comm., October 1999).

Daniel Stiles

A typical ivory stall in the Ilasan art market outside Lagos, Nigeria.

The prices in the Republic of the Congo in 1995 seem very low (Madzou and Moukassa 1996), but they support informant statements in this study about recent price rises. Tusks less than 5 kg sold at USD 4.29–8.57/kg, de-

Daniel Stiles

Abidjan, Ivory Coast, not only displayed the most worked ivory of any city visited in the entire study, but the carving styles were also the most varied.

pending on quality, and 5–10-kg tusks cost from USD 8 to more than USD 20/kg (350 CFA = USD 1). Meredith (1989) found that raw ivory in Brazzaville cost USD 16.66–26.66/kg for tusks less than 5 kg and USD 26.66–30/kg for 5–10 kg tusks in 1989, below other central African prices at that time (table 2).

Ivory workshops in central Africa

Stiles visited 23 workshops in central Africa, although there were probably others that could not be found because informants either would not reveal their location, or if they did, would not agree to take the investigator to them. None of the workshops had large ivory stockpiles, and all of the craftsmen complained of a severe ivory shortage caused by the DRC war. Wood, bone, or hippo or pig tusks are replacing ivory in Bangui, Kinshasa and Libreville, although Cameroon still has adequate ivory supplies. Some factories in Douala also manufacture fake ivory antiques, which is a growing business.

The workshops sell much of their output to vendors at the local craft centres and hotels, but resident Europeans and Asians also come directly to the workshops to buy it. Senegalese and Nigerian traders used to come to Kinshasa and Bangui to buy both raw and worked ivory to take out with them, but few do today because of limited supplies. Douala workshops still get quite a few foreign traders coming to buy for export, although Yaounde seems much less involved.

West Africa's legal position for the trade in ivory

CÔTE D'IVOIRE

Côte d'Ivoire has a ban on hunting elephants, and on 7 March 1997 the government banned all domestic trade in ivory tusks and called for strict controls to stop the smuggling of tusks into and out of the country (Anon. 1997). However, it is legal to possess and sell worked ivory in the country. Côte d'Ivoire joined CITES in 1994.

NIGERIA

It appears that the internal trade in both raw and worked ivory is permitted as long as documentation is obtained from the relevant authorities and that the ivory originates from 'mature' elephants, although no definition is provided as to what constitutes a mature elephant (ELC 1987, Allaway 1989c, Dublin et al. 1995). Mature elephants can be hunted under licence in northern Nigeria (Dublin et al., 1995). Nigeria joined CITES in 1975.

SENEGAL

Worked ivory is legally sold in Senegal, but elephant hunting is illegal (ELC, 1987). Senegal joined CITES in 1977.

Retail sales of worked ivory in West Africa

The survey visited 122 outlets and 21 workshops in West Africa. The large number of these for the three countries of Côte d'Ivoire, Senegal and Nigeria is almost equal to the total seen for the five countries visited in 1999 in central Africa, demonstrating that the ivory market is more active in this region. The quantity of pieces seen, some 30,418 weighing at least 4900 kg, was also much greater than that found in central Africa (table 1). Abidjan in Côte d'Ivoire dis-

played more ivory than any other city in the study. The retail prices of worked ivory also tended to be higher than prices in central Africa, particularly those in Dakar in Senegal, which were higher than anywhere except Egypt.

No reliable ivory turnover rates could be gathered from informants, but observation suggested that Lagos and Abidjan had brisker sales and more buyers than elsewhere. Both these cities demonstrated clear evidence of a rise in sales for worked ivory since 1990 and 1994 respectively, after the market crash that the CITES ban caused. The total weight of almost 1.8 tonnes of worked ivory seen for sale in Lagos in 40 outlets in 1999 is a marked increase over 1989 when Allaway (1989c) found 34 outlets displaying 1,081.5 kg, and in 1994 when Dublin et al. (1995) found only 500–700 kg of worked ivory in that city. In Abidjan the pattern is of a drop in displayed ivory from 4880 kg in 1989 to about 1750 kg in 1994, followed by a resurgence to about 2750 kg in 1999. We were not able to evaluate the reliability or comparability of the other reports, however, as they did not describe the method used for either their surveys or estimating ivory weights. The worked ivory domestic market seemed much less active in Dakar in 1999 than in the other two West African cities of Abidjan and Lagos, which were more comparable to Kinshasa.

Daniel Stiles

A craftsman in Douala, Cameroon, shapes an ivory bust with an electric drill.

Retail prices were highest in Dakar. There is no clear evidence of retail price changes between 1989 and 1999, as the data are not detailed enough from 1989 (table 3).

The main buyers in Lagos were Chinese workers renovating the rail system, American oil workers and businessmen from the Middle East. In Abidjan and Dakar vendors would not answer questions about who the main buyers were.

Raw ivory prices in West Africa

Prices increased with distance from the main raw ivory sources in central Africa. Tusks in Lagos at USD 45–50/kg were somewhat more expensive than in Douala, particularly for the smaller sizes, with higher prices still in Abidjan (USD 41–80/kg). Vendors in Dakar would not answer questions concerning raw ivory prices, but judging from prices for polished whole tusks, the raw ivory price would be USD 100–120/kg for 1–5 kg sizes (table 1). Ivory carvers all said that prices had been rising since the conflict started in DRC.

Lagos is the only city with price data from 1989 (Allaway 1989c), and prices have increased from USD 14–29/kg to USD 45–50/kg in 1999 (table 2). Dublin and Jachmann (1992) at the time of their study in 1991 cite a price before the ban of USD 231–264/kg for raw ivory in Abidjan from the first to second middleman (that is, the carver), dropping to USD 99–132/kg for small to medium tusks.

Ivory workshops in West Africa

Six workshops were identified in Lagos, 14 in Abidjan and only 2 in Dakar (table 1). As in central Africa, vendors did not want to reveal the location of workshops. Stiles believes, based on informants' responses, that the survey established the location of all those in Abidjan, but it is probable that others not found exist in Lagos and Dakar. All informants complained of severe ivory shortages, and many carvers were working on alternative materials at the time of the visit. The origin of raw ivory was said to be DRC, CAR and Cameroon, in that order. A couple of people mentioned Gabon, and one craftsman even said ivory was flown in from Mozambique.

The main buyers are the local craft shops. In Lagos some Chinese buy directly from the workshops. In Abidjan, French, Japanese and Lebanese residents sometimes order certain pieces to be made or buy finished pieces on hand from factories. Japanese technical assistance workers and diplomats, even the ambassador, were said to be big buyers of ivory and paid high prices. Art gallery owners from Tokyo and France were said to come annually to buy worked ivory.

The carvers in Lagos and Abidjan said that business was not bad but that the scarcity of raw ivory and increasing prices were hurting them.

Esmond Martin

Most shops that offer ivory for sale in Djibouti-ville are small and are owned and managed by Somalis.

North-eastern Africa's legal position on ivory

DJIBOUTI

Djibouti acceded to CITES in 1992. All ivory items and tusks are imported as there is no carving industry. It is still legal to sell elephant ivory items and raw tusks within the country.

ETHIOPIA

The country became a party to CITES in 1989. Ethiopian law permits internal trade in tusks and carvings from ivory obtained legally from government auctions that were held until about 1990; since then, there has been no legal source of new tusks.

Retail sales of worked ivory in north-eastern Africa

Martin visited almost all the retail ivory shops in Addis Ababa and Djibouti-ville; they numbered 54 and 18 respectively with a total of 10,449 (453 of these in Djibouti-ville) ivory pieces for sale (see table 1). The shops offer a large variety of items including jewellery, wild animals, busts and name seals. Most of the commodities for sale are small, typical of most cities in Africa, because they are easier to hide in luggage. The main buyers in Djibouti are the French military and their families, while in Ethiopia, the customers are French and Italian tourists, Chinese labourers, Japanese businessmen and diplomats, Koreans and a wide variety of foreign diplomats, UN employees and people attending conferences, according to traders interviewed.

Since the beginning of the recent war with Eritrea in May 1998, the ivory business has been very poor in Addis Ababa because most foreign tourists and businessmen have avoided coming to Ethiopia. Thus, the turnover in ivory commodities has declined by about 80%. In Djibouti, the shopkeepers also complained about poor sales, but the French military and their families are still purchasing ivory items.

Raw ivory prices in north-eastern Africa

The prices for raw ivory in Addis Ababa are much cheaper than in Djibouti because Ethiopia has its own elephant populations. Wholesale prices in Addis Ababa vary from an average of USD 28/kg for tusks less than 1 kg to USD 62.50 for large tusks over 25 kg. The raw ivory for the Ethiopian carving industry comes from a decreasing population of elephants within the country, from eastern Sudan and from Kenya. Djibouti-ville shop owners claim that they receive tusks from Somalia and Ethiopia, but as there is no carving industry in Djibouti, the tusks are sold retail in their raw state.

Ivory workshops in north-eastern Africa

Because of the recent collapse in the sales of worked ivory in Ethiopia, the number of craftsmen has also declined. Many have left the business to work on

Esmond Martin

South Africa used to be a major market for ivory commodities such as these in the photograph, but since the CITES ivory ban came into force in 1990, retail sales have plummeted by more than 95%.

wood, silver or gold. There may be 10 to 20 ivory craftsmen remaining in Addis Ababa, but most are not working full time in ivory. In 1999, the immediate future for the crafting and sales of worked ivory seemed bleak in Ethiopia.

Southern Africa's legal position on ivory

MOZAMBIQUE

Mozambique joined CITES in 1981. Internal trade in raw tusks is illegal, but the domestic trade in worked ivory is legal (H. Dublin, pers. comm., 2000).

SOUTH AFRICA

South Africa has been a member of CITES since 1975. Domestic trade in ivory is legal in the country.

ZIMBABWE

In 1981, Zimbabwe joined CITES. After the Tenth Meeting of the Conference of the Parties to CITES in 1997, Zimbabwe was allowed to export elephant hides, elephant leather goods and ivory carvings from September 1997, but for non-commercial purposes (Gray 1997).

Retail sales of worked ivory in southern Africa

Harare's shops have more ivory items for sale (19,958) than any other city in Africa except Abidjan that Martin and Stiles visited (see table 1). However, almost all the items were made before 1990 when the international ban came into force. Since then, the sales of ivory have declined by over 90%.

The craftsmen in Zimbabwe used to make a large variety of ivory commodities, the most common ones being key rings, jewellery, boxes, wild animals and human figures. Less numerous are paper knives, napkin rings, hair clips, name seals and lamps. Now few of these items are bought because of the decline in demand for ivory pieces, and their retail prices are some of the lowest in Africa.

Compared with the late 1980s when the main customers were Americans, British and other Europeans, the main buyers of worked ivory in Zimbabwe now are a few Japanese and European visitors (especially the southern Europeans), and foreign diplomats including those from the Koreas and China.

In South Africa, the ivory business is even more depressed than in Zimbabwe. In the main cities of Johannesburg, Cape Town and Durban, there were at least 7386 ivory items for sale, but business is down by over 95% because of the lack of buyers. In addition to the locally made ivory goods, similar to the items produced in Harare, there are also older pieces made in China, Europe, Japan and Nigeria. The presence of imported old ivory pieces distinguishes the shops in South Africa from those in north-eastern and the rest of southern Africa.

Mozambique may be the only country in southern Africa where the retail ivory trade has not collapsed. This is because after the civil war in Mozambique ended in 1992, the country once again became stable. With amenities for tourists and businessmen improving in Maputo, foreigners are again visiting the capital city. There are about as many ivory items for sale in Maputo (3619) as in Durban. The main buyers in order of importance are Portuguese, Italian and Spanish.

Raw ivory prices in southern Africa

The prices for raw ivory in southern Africa are some of the lowest on the continent as a result of the col-

lapse in the demand for tusks and the sharp devaluation of local currencies. For example, the government of Zimbabwe sold tusks of 10 to 12/kg in the first half of 1999 for only USD 17.57/kg, while the craftsmen in Maputo paid USD 16.58/kg for tusks of similar quality weighing 6 to 10/kg, all from illegal sources.

Ivory workshops in southern Africa

The numbers of workshops and ivory craftsmen in Zimbabwe and South Africa have declined sharply since 1989. For example, in Zimbabwe in the mid-1980s about 200 craftsmen were consuming about 15 tonnes of raw ivory a year (Martin 1984) but in 1999 only 35 ivory craftsmen remained in the entire country. Informants said that there were at least eight workshops in Maputo, which employed approximately 100 carvers. There are no existing data from previous studies with which to compare the Maputo figures.

Summary results of the 1999 study

Table 1 aggregates the data for cities in 15 countries on the African continent to produce figures for the total number of outlets, workshops, craftsmen and items for sale. Also, figures are given on the average prices for various weights of raw ivory in most major cities. Results of surveys in Egypt and Sudan undertaken by Martin in the late 1990s are included in the table, in addition to the 13 countries studied for the 1999 survey, along with data from Madzou and Moukassa (1996) for the Republic of the Congo.

Discussion

Trend in the ivory trade in Africa, 1989–1999

Unfortunately, available data in published and unpublished reports are not complete enough to allow full comparisons between trade now and earlier. In this section, as well as the 13 African countries surveyed in 1999, Egypt and the Sudan are also included from earlier work undertaken by Martin (1998, 2000) to give a more comprehensive understanding of the ivory trade on the continent. Tables 2, 3 and 4 present data on the prices of raw ivory, numbers of workshops, number of craftsmen and the prices of selected ivory items over time, mostly comparing the 1980s with 1999.

Conclusion

This study is the first of its kind aimed at quantifying the number of ivory pieces offered for retail sale in the major ivory markets of Africa and recording the number of retail outlets and ivory workshops and factories in these countries. Follow-up surveys and proper analysis of the data in future years will enable conservationists and government officers to decide whether the demand for ivory has increased or decreased because of CITES-approved sales. Rational decisions could then be made based on scientific data from the surveys on whether future ivory sales should be allowed.

Retail sales of ivory items in Africa

At least 110,000 pieces of worked ivory were seen in the main cities of the 13 countries visited during the 1999 survey, plus Egypt and Sudan, surveyed earlier. Thousands more are found in the Republic of the Congo and other places not visited. The sale of worked ivory is slow everywhere, however, except in Lagos, Abidjan and Douala. Retail sales are down in most of the cities in north-eastern and southern Africa by 65 to 95% compared with what they were in the late 1980s. In central and West Africa, retail sales are down

Esmond Martin

Patrick Mavros, a well-known Zimbabwean artist, is examining one of his ivory animals in his workshop just outside Harare.

Esmond Martin

The sale of ivory items made in Ethiopia has declined sharply in Addis Ababa since mid-1998, because of the Ethiopian–Eritrean War, which scared away foreign tourists.

everywhere from 1989 except for Lagos, where there is a moderate rise.

Personnel from international organizations, such as the UN, and government and military personnel (including foreigners) are today some of the major buyers of ivory. In many cases the actual purchase of raw and worked ivory is legal, but the buyers take the ivory items out of the countries in contravention of CITES and national laws. The main customers for ivory in Djibouti are French army personnel and their families. From mid-1998 to mid-1999, during the Ethiopian–Eritrean war, the number of tourists to Ethiopia declined by at least 80% and by June 1999 the souvenir shops in the capital had almost no customers.

The main retail buyers of worked ivory throughout the continent, excluding the various officials and military personnel mentioned above, are tourists, especially from France, Italy and Spain. There is also increased buying of ivory items by Chinese and Korean workers in several countries such as Sudan and CAR. Fairly significant buyers are Japanese, Portuguese and Latin Americans. The most popular pieces are small items, especially jewellery, as they are easy to hide in luggage. The large carved tusks and other big pieces sell extremely slowly in most places, and many of these were carved before the 1990 CITES ban.

The wholesale market of ivory items and raw tusks in Africa

The main customers for ivory are the Chinese and the North and South Koreans, who transport these goods to sell in eastern Asia. African businessmen, mainly Senegalese and Nigerians, buy substantial quantities of worked ivory in certain central and West African countries to transport to other countries in the region.

Ivory from eastern DRC and CAR goes to north-eastern Africa. Egyptian ivory markets are also partly supplied from elephants poached in Cameroon, and a little ivory is brought in by Muslin pilgrims from Nigeria. The main raw ivory sources for the West African markets are DRC, CAR, Cameroon and Gabon, probably in that order. Ivory from eastern DRC and CAR goes north-west to Nigeria and to Abidjan and Dakar. Maiduguri in northern Nigeria is a main transit centre for the western trade. Ivory from Gabon leaves Libreville by three main routes: by ship, by air or by land across the northern border into Cameroon. The raw ivory leaving by sea and air is destined for Europe and Asia. The ivory from poached elephants in northern Gabon is transported by road to Yaounde where it is sold or transported to Douala or sent on to Nigeria. Some tusks from Cameroon enter Nigeria via Calabar by boat on their way to Onitsha, where some is worked and some is sent on to Lagos to be worked. Ivory from Cameroon and elsewhere that enters northern Nigeria via Maiduguri goes to Kano. Some is crafted and sold there, some goes to Lagos, and some is transported to Abidjan or Dakar by road.

Raw and worked ivory exports off the African continent

Traders in Mozambique, Gabon, Nigeria, DRC, Sudan, and especially Cameroon, illicitly export tusks to Europe (usually in transit to Asia), China, South Korea and Taiwan. North Korean diplomats are notorious for smuggling worked ivory items as well as tusks. They are even supported by their government to do so, probably a unique situation (Kaplan et al., 1999).

Future ivory sales

The authors believe that advertising and holding another auction in Africa, as proposed by four southern

African countries at CITES 2000, would strengthen the current misconception, brought about by faulty reporting, that the international trade in ivory is now condoned, and that this could stimulate the search for additional ivory stocks in anticipation of a more robust market. It is the common perception amongst ivory traders and craftsmen, and probably an accurate one, that many more people would buy more and larger pieces of worked ivory if they could carry or export them legally to their home countries. In many parts of southern Africa this increased trade might be sustainable, but it almost certainly would not be in central or West Africa where wildlife and protected areas management are weak or non-existent. Eastern Africa is a particular situation, where elephants are not threatened with extinction, and their value to tourism exceeds the value of their ivory (Brown and Henry 1993).

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Forest elephant distribution and habitat use in the Bossematié Forest Reserve, Ivory Coast

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Abstract

We studied the influence of human presence and habitat structure on the distribution and habitat use of forest elephants (*Loxodonta africana cyclotis* Matschie, 1900) in the heavily exploited Bossematié Forest Reserve in south-eastern Ivory Coast. From August 1993 to April 1994, we estimated the distribution of elephants by dung counts on transects and documented their habitat use by trail mapping. Elephant dung density increased with the distance to the forest border and to the nearest village. During the study, the elephants used only 60% of the forest regularly. They avoided the rest because of forestry operations and human presence. Forest roads, in light but regular use, had no influence on the elephants' spatial distribution. Elephants avoided coffee and cocoa plantations in all seasons. During the dry season, elephants walked more often through forest parts with greater tree canopy cover than during the wet season, when they avoided valley bottoms. The main influence on the spatial distribution of elephants in the study area was human presence, followed by habitat structure.

Résumé

Nous avons étudié l'influence de la présence humaine et de la structure d'habitat sur la répartition et l'utilisation d'habitat des éléphants de forêt (*Loxodonta africana cyclotis* Matschie, 1900) dans la Forêt Classée de Bossematié (sud-est de la Côte d'Ivoire) qui fut fortement exploitée. De août 1993 à avril 1995, nous avons estimé la répartition des éléphants par des comptages de crottes sur transects et décrit leur utilisation d'habitat par la cartographie de leurs traces. La densité des crottes d'éléphants a augmenté avec la distance de la lisière de la forêt et du plus proche village. Au cours de l'étude les éléphants ont utilisé régulièrement seulement 60% de la forêt. Les éléphants ont évité le reste de la forêt à cause d'opérations forestières et de la présence d'hommes. Les routes forestières en usage léger mais constant n'avaient aucune influence sur la distribution spatiale des éléphants. Durant toutes les saisons, les éléphants ont évité les plantations de café et de cacao. Pendant la saison sèche, les éléphants de forêt ont marché plus souvent dans les parties de forêt avec une canopée plus fermée que pendant la saison des pluies où ils ont aussi évité les vallées. Dans le site de recherche, l'influence principale sur la répartition spatiale des éléphants était la présence humaine suivie par la structure d'habitat.

Introduction

Following poaching and habitat loss, the number of forest elephants in West Africa has declined dramatically during the last decades (Barnes 1999). In 1988/1989, Merz and Hoppe-Dominik (1991) estimated that 200 elephants lived in south-eastern Ivory Coast. In 1993, only about 55 remained (W.E. Waitkuwait, Y. Guiro, J. Theuerkauf, H. Ellenberg, unpubl. data, 1993): roughly 20 in the Songan-Tamin-Mabi-Yaja Forest Reserve complex (1700 km+), 5 in the Béki Forest Reserve (150 km+), and 30 in the Bossematié Forest Reserve (220 km+). For the last of the forest elephants in south-eastern Ivory Coast to survive, it was necessary to implement measures to prevent further poaching and to protect large forest tracts that meet the habitat needs of the animals. To contribute towards establishing conservation priorities for elephants in south-eastern Ivory Coast, we investigated the influence of human presence and forestry operations on the distribution and habitat use of the elephants in the Bossematié Forest Reserve. The study was part of a long-term biomonitoring programme included in a rehabilitation project for the reserve. The project was created to develop methods for the restoration and sustainable use of all formerly overexploited forest reserves in south-eastern Ivory Coast.

Barnes et al. (1991) and Hall et al. (1997) showed that in central Africa elephant densities are directly related to distance from human settlements or roads. We therefore investigated if human presence affected the distribution of the elephants in and around our study area. Elephants that live in large forest complexes prefer habitats with an open canopy and dense herbaceous tangle (see Barnes et al. 1991, Prins and Reitsma 1989, Struhsaker et al. 1996). However, timber extraction had been heavy in our study area (Wöll 1992), and the canopy was much more open than that in the forest complexes where the above-mentioned studies had been conducted. The study area had a low density of fruit trees, an important food source for forest elephants in West Africa (Alexandre 1978, Short 1981, White et al. 1993, Theuerkauf et al. 2000b). The objectives of this study were to determine 1) the influence of roads, villages, the forest border and forestry operations on the distribution of elephants and 2) the habitat types that elephants select. The results were necessary to design management measures aimed at improving the survival chances of the elephants.

Study area

The Bossematié Forest Reserve (Forêt Classée de Bossematié) is a moist, semi-deciduous rain forest in the lowland zone of south-eastern Ivory Coast (6°22' to 6°33' N, 3°24' to 3°35' W). The annual distribution of rainfall is bimodal with peaks in September–October and April–July; August and December–February are dry. Mean annual rainfall for 1961–1990 was 1330 mm but varied significantly from year to year (Schroth unpubl.). The 220-km+ forest block is surrounded by fallow land as well as cocoa, banana and coffee plantations. Human density outside the forest is about 25 inhabitants per km^2 in the north and west of the study area and about 50 inhabitants per km^2 in the south and east (Kientz unpubl.). There are no settlements in the forest itself. Cars, bicycles and pedestrians pass regularly but infrequently on the forest roads, which connect villages situated around the forest.

During the 30 years up to 1988, the forest had been heavily exploited for timber (Wöll 1992), resulting in a mosaic of degraded forest with few old fruit trees and many small clearings. Only 16% of the forest has a canopy cover over 30%, whereas about 8% of its surface consists of mostly illegal cocoa and coffee plantations, clustered mainly along the southern margin of the forest (Wöll 1992). During the time of this study, forestry operations (cleaning around target trees, replanting, inventorying) were concentrated in the northern part of the forest.

Elephant poaching was common in the 1980s until 1990 when the rehabilitation project for the Bossematié Forest Reserve started and elephant poachers were arrested. During this study, some 27 to 33 elephants lived in the reserve (Theuerkauf et al. 2000a) and no elephant was observed to migrate into or out of the study area.

Methods

We counted elephant droppings on permanent 2-km transects to document the distribution of elephants within the study area. Because the elephants sometimes walked along the permanent transects, we used the presence of elephant droppings in 250-m sectors to represent the relative density of elephants, which ensured that agglomerations of droppings produced by an elephant group that had walked along a transect did not distort the data. We then calculated the proportion of sectors with elephant dung on each transect.

We noted elephant droppings that we could see from the transect line and removed all droppings after counting to ensure an independent sample for the next count. From November 1993 to February 1994, we counted on 8 transects monthly. Before the November count, we had removed droppings in October. In March 1994, we cleared and included in the April counts a further 8 transects. To assess human influence on the distribution of the forest elephants, we compared by regression analyses the percentage of transect sectors with elephant dung with the distances between the centres of the 16 transects and the nearest road, the nearest forest border and the nearest village.

To determine how the forest elephants used the habitat, we searched for fresh elephant trails that crossed forest roads. We then followed and mapped the trail by compass and topofil (a distance-measuring instrument) with the assistance of an experienced elephant tracker. We followed the trails of 16 different elephant groups for distances between 0.8 and 15.7 km (total 82.2 km) and juxtaposed the trails we had followed to a tree canopy stratification map and a soil map.

The tree canopy stratification map of the Bossematié Forest Reserve (Sabenin and Kra unpubl.), based on aerial pictures taken in 1992 and 1993, distinguished between strata of big trees (30–40 m in height) and small trees (up to 20 m). We pooled the strata into five classes: canopy cover < 10%, 10–20%, 20–30%, > 30%, and plantations. The soil map (Gerold and Hetzel unpubl.), which was mainly based on the topography of the study area, identified Ferralsol and Plinthosol on high ground and the upper parts of slopes, Cambisol on the middle and lower parts, and Arenosol and Gleysol in valley bottoms. We distinguished between two classes: high ground (Ferralsol, Plinthosol) and valley (Cambisol, Arenosol, Gleysol).

We measured the length of each trail through the different habitat types to calculate the percentage of the habitats on the trail. To compensate for the different trail lengths, we used a weighting factor when calculating mean percentages and confidence limits. We considered the average trail length (5.1 km) as the standard sample unit. The weighting factor (sample unit) of a trail was therefore not 1 but the length of the given trail divided by the mean length of the 16 trails. We considered that elephants selected or avoided a habitat if the actual (expected) percentage of the habitat in the elephant range was below or above the confidence interval of the mean percentage that elephants used the habitat. To define the elephant range, we drew a minimum convex polygon around the elephant trails and determined the actual percentage of each habitat type in the area of the minimum convex polygon.

Results

The percentage of sectors with elephant dung on transects varied little between months (SD = 2%) but

Table 1. Percentages of 250-m sectors with forest elephant dung on 16 transects, each 2 km long, in the Bossematié Forest Reserve, November 1993 to April 1994

Transect	November	December	January	February	April	Mean
1	–	–	–	–	0	0
2	0	0	0	0	25	5
3	–	–	–	–	13	13
4	–	–	–	–	13	13
5	0	0	0	0	0	0
6	13	0	0	0	0	3
7	0	0	38	0	13	10
8	0	0	25	25	0	10
9	0	0	0	0	0	0
10	–	–	–	–	13	13
11	–	–	–	–	13	13
12	38	25	0	13	13	18
13	–	–	–	–	13	13
14	0	0	0	25	0	5
15	–	–	–	–	0	0
16	–	–	–	–	0	0
all	6	3	8	8	7	7

more between transects (SD = 6%), which reflected the heterogeneous distribution of elephants in the forest (table 1). The percentage of sectors with elephant dung increased with the distance from the middle of a transect to the nearest border of the forest (fig. 1a). The linear relationship was, however, not significant ($P = 0.067$), because there were no elephant droppings on transects in the northern part of the study area in which forestry work was concentrated at the time of the study. When we excluded the northern transects (1, 5 and 9) from the regression analysis, the linear relationship between the distance to the forest border and the percentage of sectors with elephant dung became significant ($P = 0.008$). In 1992, when no forestry work was under way in the northern region, the probability of observing elephant tracks at waterholes in the northern region was dependent ($P < 0.001$) on the distance to the forest border (fig. 1b).

The percentage of sectors with elephant dung also increased with increasing distance to the nearest village when we excluded the northern region ($P = 0.017$) but not when we included all transects in the analysis ($P = 0.246$). There was no linear relationship between the percentage of sectors with elephant dung and the distance to the nearest forest road ($P = 0.988$).

We grouped transects into three zones to draw a map of the forest presenting an estimate of elephant distribution (fig. 2). It appeared that in 1993 and 1994, humans reduced the area available to the elephants to 130 km+ (60% of the forest) in the core of the forest (fig. 2). We found six carcasses of elephants poached before 1990, which were all in the centre of the forest in a mean distance of 600 m from a main forest road (range 500–800 m).

In the dry season, elephants walked more than expected in areas where the canopy cover was higher than 20% and less than expected in more open forest parts (fig. 3). Forest elephants tended to use areas with a high canopy cover more often in the dry season than in the wet season. In the wet season, elephants used open forest (< 10% cover) more than expected. In both dry and wet seasons, elephants strongly avoided plantations (outside 99.8 and 98.6% confidence interval, respectively).

High ground and valleys accounted for 78% and 22% respectively of the minimum convex polygon surface. During the wet season, only 13% of the elephant trails were in valleys, which was less than expected, whereas they walked more on high ground (87%) than expected. The actual percentages of high ground and valleys were both outside the 98.3% confidence interval of the mean percentages of elephant use. During the dry season, elephants used valleys more (35%) and high ground less (66%) than expected but only at the 91.1% confidence interval level. At the peak of the dry season, elephants were observed to leave the forest on two occasions to eat banana plants.

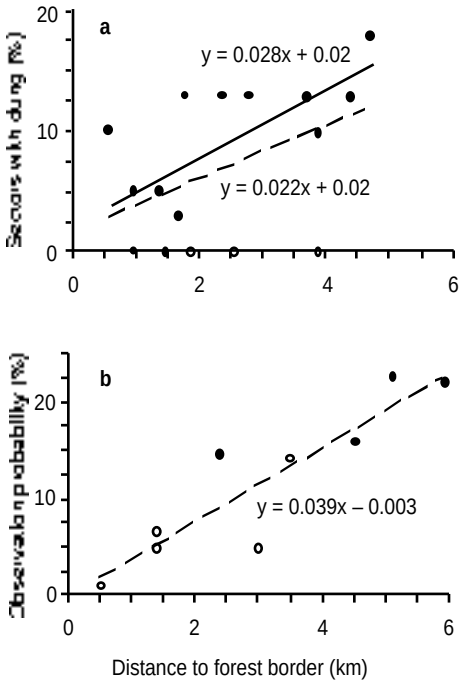

Figure 1. *a)* linear regression between the distances from the middle of a transect to the nearest forest border and the percentages of 250-m sectors with elephant dung on 16 transects in 1993/1994; *b)* linear regression between the distances from waterholes to the nearest forest border and the observation probability of elephant tracks at waterholes in 1992 (data from Mühlenberg et al. unpubl.). Dotted lines: all transects or all waterholes; continuous line: excludes transects of the northern region (1, 5 and 9). Transects and waterholes of the northern region are shown as open circles, those of other regions as closed circles.

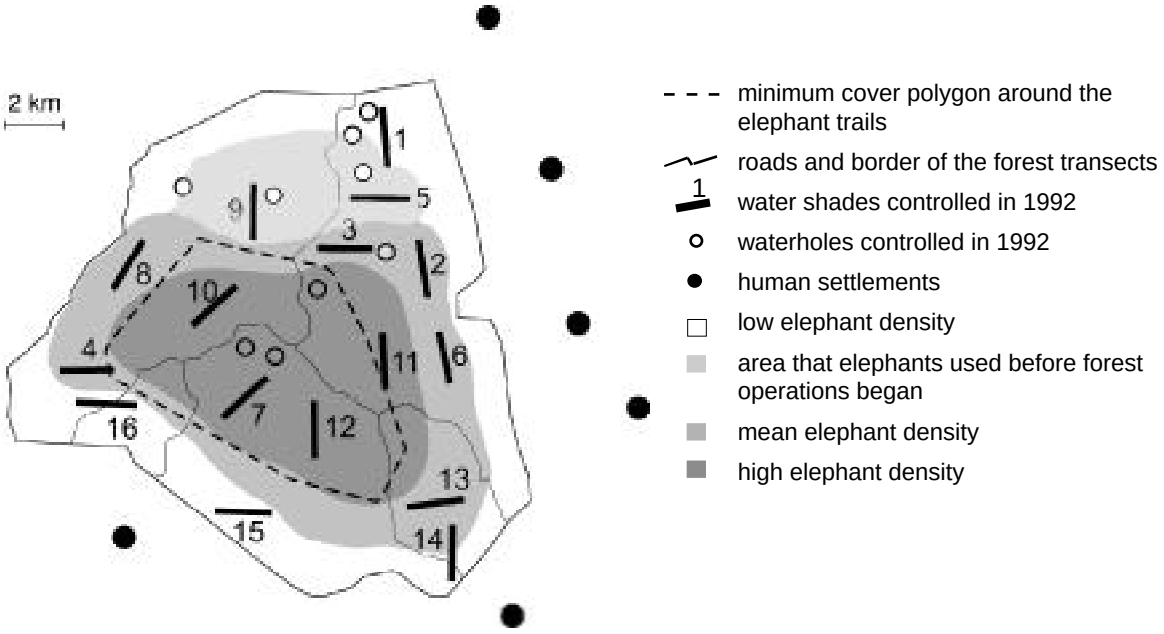

Figure 2. Estimated distribution of forest elephants in 1993/1994 in the Bossematié Forest Reserve and location of human settlements in its surroundings.

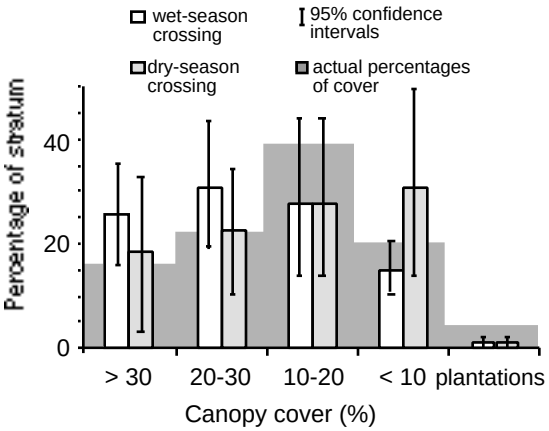

Figure 3. Canopy cover classes crossed by forest elephants compared with the actual percentages present in the used area (minimum convex polygon in fig. 2). The 95% confidence intervals of elephant use indicate avoidance or preference when they are below or above actual percentages.

Discussion

In Central Africa, where elephants range over large forests, their density is directly related to the distance from human settlements or major roads, according to Barnes et al. (1991) and Hall et al. (1997). Both studies found very low elephant densities in the first 10–20 km from settlements. In south-eastern Ivory Coast, conditions are more difficult for forest elephants because of widespread deforestation and ubiquitous land exploitation, which have resulted in small and fragmented forests. In our study, elephants avoided a zone within 4 km of villages and reached their maximum density in the centre of the forest, 7–11 km from settlements. The distance to the forest border was a better measure of human influence than the distance to the nearest village because it reflected the human activity around the forest, which was not limited to villages. The forestry operations during the time of the study also influenced elephant distribution, probably because of the long-time human presence, whereas forest roads did not affect it. Roads, however, seemed to have facilitated poaching, as all elephants poached before this study were killed near roads.

Barnes et al. (1991) found a direct relationship between the density of elephant dung and the percentage of secondary forest, which implies that elephants prefer the parts of the forest with the lowest canopy cover. Elephant preference for forest parts with higher canopy cover in the Bossematié Forest Reserve contradicts these findings and suggests that

the forest has been so heavily exploited that it is now too degraded to offer optimal conditions for the elephants. In Taï National Park of Ivory Coast, Merz (unpubl.) observed higher density of elephants in secondary forest than in primary forest but also intensive use of primary forest parts because of the abundance of fruit trees in the latter. In Bia National Park of Ghana, forest elephants mainly select open areas but eat the bark and fruits of trees in areas with high canopy cover (Short 1981). We suggest that our elephants selected forest parts that had a higher canopy cover to obtain fruits from the remaining mature trees. Furthermore, elephants selected shade-tolerant species (Theuerkauf et al. 2000b), which were rare after the heavy exploitation.

Vanleeuwe and Gautier-Hion (1998) found that the foraging paths of elephants were mostly in forest parts with a canopy cover of 80%, as this provided the elephants with herbaceous plants and fruits. As in our study, those elephants avoided dense forest parts with an open canopy. The elephants they studied, however, fed regularly in clearings. During our fieldwork, we noticed no preference for clearings, which in the study area are usually covered by the introduced neotropical Asteraceae *Chromolaena odorata*, an invasive plant without importance in the elephants' diet. Elephants in our study area also avoided plantations, which were mainly cocoa and coffee and provided them with little food.

It is likely that the selection of open or closed parts of a forest is also influenced by weather. In the dry season, the preference was for closed canopy, perhaps because exposure to the sun would increase water loss. The elephants' avoidance of valleys in the wet season may be a result of the poorer soils (Gerold and Hetzel unpubl.), which could bear vegetation of lower nutritional value than that found on high ground. In the dry season when water is scarce on high ground and soils in valleys remained moister than on high ground, elephants used valleys more frequently. Although the habitat use of elephants changed with the seasons, this did not affect the distribution of elephants in the forest. Waterholes are numerous in the study area and elephants use them often in the dry season (Theuerkauf and Ellenberg 2000). Fruits of different trees (for example, *Desplatsia chrysochlamys*) as well as crop plants (for example, banana) supplement the water requirements of elephants during the driest months (January to March).

We conclude that the heavy timber exploitation and plantation of coffee and cocoa have lowered the habitat quality of the Bossematié Forest Reserve for the elephants. We have suggested that the optimal habitat structure for forest elephants may be found in forests with a canopy cover denser than in our study area. We therefore provided a list of 25 food plants of particular importance to the elephants. This list was included in the management plan for the Bossematié Forest Reserve and the species now stand under protection during forestry operations. Large-scale forestry operations also negatively affected the distribution of elephants. Forest exploitation should therefore be limited to small areas and short periods to prevent elephants from avoiding the areas altogether. However, forestry activity deterred poachers and thus also had a positive effect, which led to the high recruitment of the elephant population observed every year since the protection of the Bossematié Forest Reserve (W.E. Waitkuwait, unpubl. data, 1998).

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Management implications of new research on problem elephants

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Abstract

The pressing problem of human–elephant conflict has attracted considerable conservation interest and is increasingly being studied in Africa under an initiative spearheaded by AfESG. Important ideas are beginning to emerge from recent research that may be directly relevant to managing 'problem elephants'. One of these concerns the persistence of problem elephant behaviour in many populations, even when identified culprit individuals are regularly removed from these populations over a long period. Rather than having a few habitual problem animals that can be removed, it is possible that elephant populations have what may be termed a problem component. As animals comprising this component are removed, for example by killing or translocating them, others take their place. If this problem component theory is true, it implies that either killing or translocation options, if chosen, will have to continue indefinitely. This reasoning is difficult to test but is supported by considerable circumstantial evidence and does agree with accepted principles in agricultural pest control. Merely killing individuals of a pest species seldom has much impact on the problem and most pests are effectively controlled only by denying them either their target food or a nearby refuge.

Resume

Le problème urgent posé par les conflits hommes-éléphants suscite beaucoup d'intérêt dans le monde de la conservation et est de plus en plus étudié en Afrique grâce à une initiative du GSEAf. Des idées importantes commencent à émerger des recherches récentes qui peuvent avoir un rapport direct avec la gestion des « éléphants à problèmes ». Une d'elles concerne la persistance du comportement des éléphants à problèmes dans de nombreuses populations, même lorsque les coupables, identifiés, sont régulièrement écartés de ces populations pendant de longues périodes. Plutôt que d'avoir quelques animaux qui ont l'habitude de faire des problèmes, il est possible que ce soient les populations d'éléphants qui connaissent ce que l'on pourrait appeler une composante à problème. Lorsque les animaux qui ont cette composante sont enlevés, par exemple en les tuant ou en les déplaçant, d'autres prennent leur place. Si cette théorie de la composante à problème s'avère exacte, cela signifie que les options d'abattage comme de déplacement, lorsqu'on les choisit, devraient se poursuivre indéfiniment. Ce raisonnement est difficile à tester, mais il est étayé par des preuves très éloquentes et s'accorde avec les principes reconnus du contrôle des nuisances en agriculture. Le fait de tuer simplement des individus d'une espèce nuisible a rarement un impact sur le problème posé, et la plupart des animaux nuisibles ne sont efficacement contrôlés que lorsqu'on leur interdit l'accès à la nourriture ou à un refuge proche.

Introduction

It is well documented that many African elephant populations conflict with sedentary, agriculturally based people at the edges of their respective distributions and that the resolution of human–elephant conflict is a priority issue in the conservation of the species (WWF 1997; Hoare 2000a). From observations of other agricultural pest species, intuitively one would reason that the proximity of more elephants might mean more problems (that is, that the activity of such 'problem elephants' exhibits some 'density dependence') (Barnes et al. 1995). Very little evidence has so far accumulated, however, to support a hypothesis that levels of problem-elephant activity are dependent on local elephant numbers or densities.

There is evidence to suggest that levels of problem-elephant activity may be more dependent on the

behaviour of individual animals than on the local abundance of elephants. Hoare (1999a) proposes a 'male behaviour hypothesis' to explain the irregular and unpredictable nature of crop raiding and other conflict incidents attributed mainly to bull elephants in many savanna areas of Africa. This agrees with the conclusions of similar, previous work on Asian elephants in India (Sukumar 1991; Sukumar and Gadgil 1988). Even where elephant cow groups are known to raid crops, it is plausible to suggest that individual matriarchal behaviour may be an important factor, especially since few elephant populations are food limited in the wild and crop raiding by females and offspring appears to be concentrated around peak time of the harvest and usually in farming areas close to a natural refuge.

Regardless of any debate, scientific or otherwise, on causal factors, the management of human–elephant conflict goes on in practice across the African continent. But the frequently practised removal of supposedly identified individual culprit elephants by wildlife managers has apparently repeatedly failed to produce any meaningful reduction in conflict incidence.

Recent social and biological research into human–elephant conflict (Hoare 2000b) has now reached the stage where although there is still a lot to learn, it is possible to feed back some important recommendations that should be discussed and field tested by managers responsible for conflict mitigation (AfESG 2001). One of the most far-reaching of these issues involves questioning the assumption that merely removing a problem elephant (by either killing it or translocating it) has any meaningful effect on subsequently alleviating conflict levels at the human–elephant interface.

Killing problem elephants

Killing is a standard problem-elephant control measure that has been applied for many years over much of Africa. It is employed as a quick-fix method, since it is popular with both wildlife authorities and affected people. Its advantages are that it is relatively cheap and quick to carry out, has high public relations value for wildlife authorities (chiefly through the 'retribution factor' and provision of free meat to affected people) and may in fact have some temporary effect. The temporary effect and public relations value have been exploited in many sites by killing individual elephants at intervals during peak seasons of conflict. As this develops into a cycle that is repeated indefinitely, it really amounts to what has been termed a 'ritual palliative' to affected people (Hoare 1995).

Practical disadvantages of killing are being increasingly noted as the problem of human–elephant conflict becomes apparently intractable in some places. First, killing has to be done by trained personnel and can be a dangerous activity. Second, it is particularly difficult to identify culprit animals; even well-organized researchers with technological aids like radio collars and night-vision equipment have great difficulty sexing and identifying many individual animals at night, which is when most elephant raiding occurs.

Most important of all, it seems to have little deterrent effect on other persistent raiders (fig. 1), something that anecdotal reports have attested to for a long time. Wildlife managers often maintain that killing an elephant 'teaches' others to avoid entering farming areas. The example given in figure 1 is one of the most unambiguous of its kind yet produced and clearly does not support this view.

The persistence of elephant raiding almost everywhere where problem elephants have been destroyed, in some cases for decades (such as the area in fig. 1), must call the method into question. Also the rising appreciation of elephants (whether aesthetic, ecological or financial), has led to further doubt about the wisdom of widespread reliance upon killing as a control strategy.

Translocating problem elephants

In some situations, translocating live problem elephants has recently been proposed as a solution alternative to killing them and indeed has been undertaken for this purpose in several parts of Africa (Karindawaro 1998). Elephants can be immobilized fairly easily by teams of specialist people but the subsequent safe transport of such huge animals is a complicated logistical exercise costing large sums of money. But as live capture and translocation of problem elephants is an option especially attractive to the many opponents of destroying them, the required financial resources can sometimes be found. There is much to suggest, however, that this option is far from a panacea.

First, as with any decision to kill an offender, correctly identifying the culprit is very difficult. Also it is impossible to be certain that the problem will not be exported with the animal, especially if the behaviour hypothesis is to be believed. Alternatively,

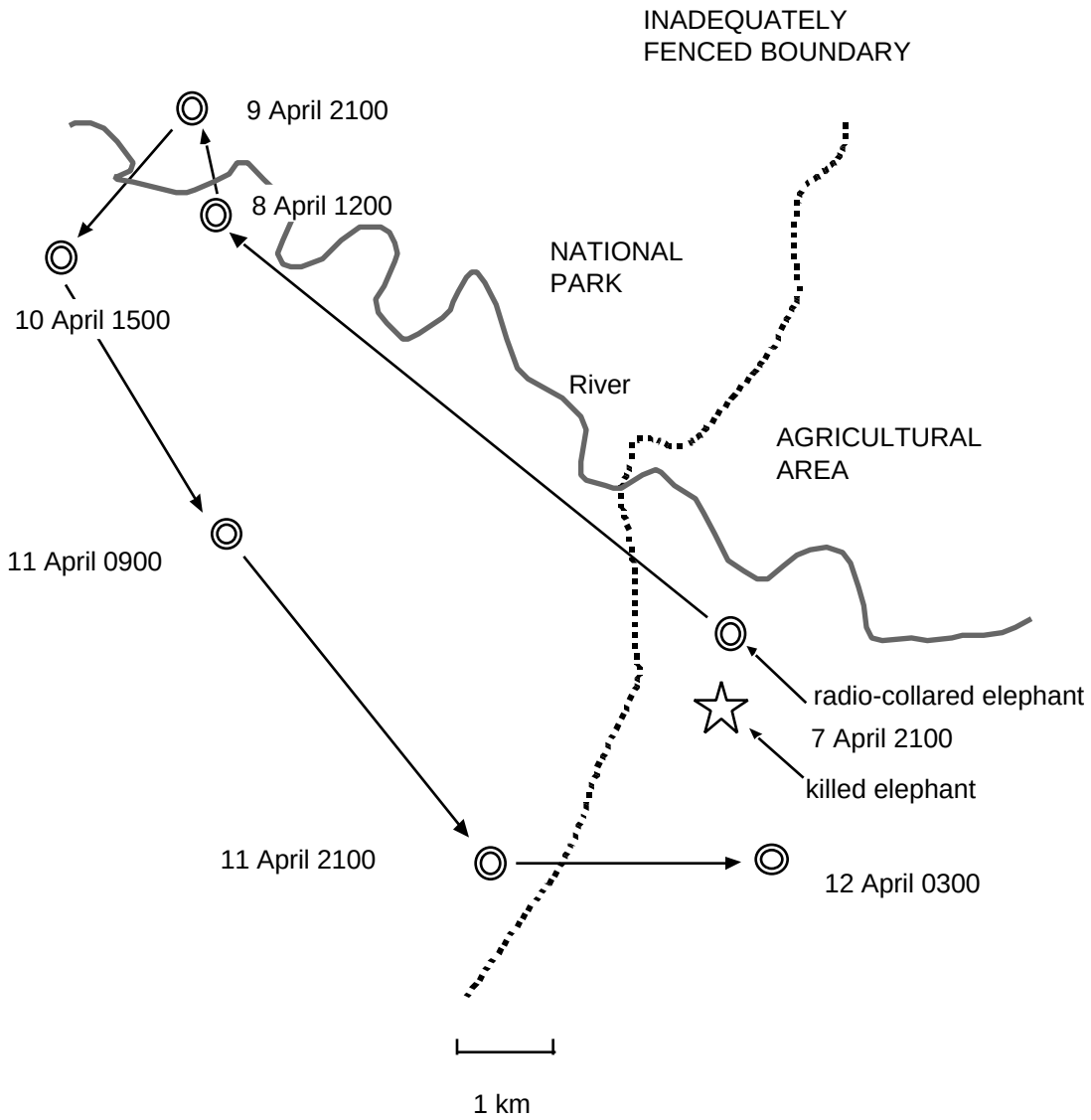

Figure 1. Movements of a radio-collared male elephant tracked by a researcher in Zimbabwe. One of the elephant's group mates was shot dead in the farming area on the night of 7 April. The animal returned initially to the sanctuary of the adjacent national park but four nights later (11–12 April) was crop raiding again in the farming area close to where the shooting took place. April is the peak of the harvest season. (Redrawn with permission from Osborn unpubl.)

the problem animal might return to its former range.

An additional disturbing issue that has emerged with elephant translocation in practice is welfare concerns in transit, which even the closest supportive veterinary care cannot always address. Elephants translocated within Kenya, for example, have had to endure extended, stressful periods of incarceration in vehicles because of logistical problems in road transport (Njumbi et al. 1996). These problems were not fully anticipated at the time of capture.

The problem component idea

Unfortunately, in most human–elephant conflict situations in Africa the extent of the problem has not been monitored systematically or measured quantitatively.

Therefore, judgement of conflict intensity has often had to rely on the scientifically crude but socially very important barometer of tolerance to elephants by affected local communities (Hill 1998). An almost universal demand from human communities affected to any degree is that problem elephants be shot.

As problem elephants have been studied for longer periods by researchers in the field, significant evidence is emerging about why reliance on the removal of such individuals may be flawed as a long-term control method. This is because it now appears that almost any elephant population, rather than having a few habitual raiders that can be successfully removed, may have what might be termed a 'problem component'. As animals comprising this problem component are removed, others replace them (Hoare 1999b). The problem component thus remains. Elephant crop raiding both in Asia (Sukumar and Gadgil 1988) and Africa (Hoare 1999a) has been hypothesized as conforming to the predictions of optimal foraging theory. Therefore there seems no valid reason not to suspect that if those individuals who are in a position to practise crop raiding are removed, others will copy them without having to be 'taught'.

The problem component idea arose out of a study to investigate whether the same individual elephants are usually responsible for most conflict incidents at any given site (habitual raiders) (Hoare 1999b). It was arrived at by working backwards, as it were—asking why the removal of culprits (especially males) seemed to have so little lasting deterrent value. What is not clear at present is whether the problem component idea is equally applicable in larger elephant populations where there is scope for immigration as well as in those that are small and greatly range restricted (pocketed populations).

Implications for problem-elephant management

If the problem component idea is true, the removed animal will probably be replaced by another problem animal from within the same population, thus implying that either killing or translocation options, if chosen, will have to continue indefinitely. At present the theory rests only on strong circumstantial evidence since adequate manipulative experimentation to prove it would be impossible in most countries with elephants. Nevertheless, the management implications from the general line of reasoning presented here are twofold and solid enough to be seriously considered.

First, the likelihood of a problem component in any elephant population should be taken into account. In many cases if you have elephants, some of them will cause problems for neighbouring people. Second, such an inevitability having been accepted, elephant problems are best managed in situ, but removing culprit individuals increasingly appears to be an ineffective way to manage them.

Doubts about the effectiveness of problem-elephant removal are in line with an accepted principle of agricultural pest control, which states that merely killing individuals of a species of pest that is numerous is seldom effective (Caughley and Sinclair 1994). In some other species (notably some feral mammals, wild birds and wild rodents), enthusiastic bouts of pest destruction have failed to have an impact on the problem because reduced intraspecific competition increases the fecundity of survivors. Notwithstanding that elephants are slow breeding compared to most pest species and that their problem activity may not show density dependence anyway, a logical principle still applies: what needs to be controlled in the case of most agricultural pests is not the pest itself but *the effects* of the pest. To adequately control the effect of an agricultural pest you need to do one of two things around the farming system where it is being a nuisance: either deny it the source of food or deny it a place to live nearby.

Multiple countermeasures against problem elephants

Applied research across Africa has revealed a whole suite of countermeasures that can be used against problem elephants (Hoare 2000a, AfESG 2001). These can be grouped into 10 broad categories: traditional methods applied by farmers, disturbance of problem elephants, killing of individual elephants, various forms of fences and barriers, olfactory and sound repellents, translocation, compensation schemes, revenue-generating wildlife utilization programmes, increased research effort, and land planning with land-use zonation.

Any one of these is not necessarily very effective on its own, but a whole package of individual measures derived from these categories can act synergistically and make a difference. Killing does have a place amongst these control measures (for example, for very aggressive animals or persistent fence breakers) but the traditional, widespread reliance upon it should be decreased by the combined use of appropriate non-fatal alternatives.

Dealing in such complicated ways with problem ele-

phants and the effects they have on people is one of the most difficult scenarios that wildlife managers in Africa face. Appreciating, planning, funding and implementing integrated packages of widely differing individual countermeasures against problem elephants becomes a complex discipline, as much an art as a science.

What may have contributed to this overall difficulty is the way human–elephant conflict has traditionally been viewed as a problem in isolation. A recent analysis and synthesis of management options for human–elephant conflict (AfESG 2001) suggests that the subject should be incorporated more vigorously into the broader issues of elephant conservation. Human–elephant conflict mitigation should rank alongside other routinely applied elephant management activities like census of elephant populations, law enforcement against poaching and monitoring of elephant effects on crucial wildlife habitats. In particular, the topic should be included in the multifaceted national management plans or programs for elephant conservation that are increasingly being drawn up to suit individual African elephant range states, such as Kenya (MGM 1998), Mozambique (MADR 1999) and Ghana (GWD 2001).

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Dual-season crop damage by elephants in eastern Zambezi Valley, Zimbabwe

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Additional key words: spatial patterns

Abstract

An elephant-focused crop-damage reporting scheme was developed and tested in Muzarabani District, Zimbabwe, for two consecutive years, to produce information that would improve elephant management. The scheme assessed wet- and dry-season crop damage, identifying spatial and temporal patterns, and developing a measure of severity for each incident. Within Muzarabani the majority of elephant crop-raiding incidents occurred during the wet season. Dry-season crop damage, considered an unusual phenomenon, was found to be common. Wet-season crop damage occurred primarily in farmland along the edge of a protected wildlife area, and dry-season crop damage occurred along the major rivers of the district. Although fewer in number, dry-season incidents were generally more severe than wet-season incidents. Crop damage in the dry season may have a greater impact on rural farmers as that is when food is scarce. The system of crop-damage reporting developed in this study provided objective and practical management information for the local district council.

Résumé

On a mis au point un système pour rapporter les dommages causés aux cultures par les éléphants, et on l'a testé dans le District de Muzarabani, au Zimbabwe, pendant deux ans de suite, pour disposer d'informations qui amélioreraient la gestion des éléphants. Ce système a évalué les dommages causés aux cultures en saison sèche et en saison des pluies, en précisant les schémas spatiaux et temporels, et en mettant au point une mesure de la gravité pour chaque incident. A Muzarabani, la majorité des incidents survenaient pendant la saison des pluies. Les dégâts aux cultures survenant en saison sèche, que l'on considérait comme un phénomène inhabituel, se sont avérés communs. Les dommages en saison des pluies affectaient principalement les fermes situées le long d'une aire protégée pour la faune, et ceux qui avaient lieu en saison sèche survenaient le long des principales rivières du district. Moins nombreux, les incidents de saison sèche étaient cependant généralement plus graves qu'en saison des pluies. Les dommages causés aux récoltes pendant la saison sèche peuvent avoir un plus fort impact sur les fermiers parce que c'est alors que la nourriture est plus rare. Le système mis au point par cette étude pour rapporter les dommages aux récoltes a fourni au *District council* local des informations objectives et pratiques pour une bonne gestion.

Introduction

The destruction of crops by elephants is a major conservation concern across Africa. Farmers and elephants are increasingly coming into conflict as elephant habitat is converted to farmland. Crop damage can have a serious impact on subsistence farmers' livelihoods. In some semi-arid rural farming areas of Zimbabwe and Kenya, elephant damage to food crops accounts for 75 to 90% of all incidents by large mam-

mal pest species (Hoare and Mackie 1993; Waithaka 1993).

In the savanna, elephant crop raiding is usually considered a wet-season problem, with a defined peak of activity at the end of the season that coincides with crop maturation. The majority of crop-raiding incidents involve elephants destroying mature food crops (Kangwana 1995; Tchamba 1995), as the crops are most palatable when they are mature (Bell 1984). There is some evidence for elephant crop damage during the dry season in Zimbabwe (Osborn unpubl.), but it is considered an unusual phenomenon.

Crop damage is a major problem in farmland adjacent to wildlife areas. Bell (1984) described these border farms as the 'front line', because he found crop-damage incidents were concentrated along the boundary and declined as the distance from the wildlife area increased. A study by Hawkes (1991) documented that only those villages at the boundary of a national park were affected by elephant crop raiding, and communities farther away were unaffected. Elephants generally require a large wilderness refuge for survival and tend to make only brief trips to settled areas to raid crops (Bell 1984).

The management of human–elephant conflict is a complex and logistically challenging problem. In Zimbabwe the responsibility increasingly falls to rural district councils (RDCs), many of which have managed their wildlife since 1990 under a national programme called CAMPFIRE (Communal Areas Management Programme For Indigenous Resources). Often administering large areas of land, the RDCs struggle to ameliorate the problem of widespread crop raiding with the limited resources at their disposal. Muzarabani is a CAMPFIRE district in the eastern Zambezi Valley of northern Zimbabwe. In 1997 Muzarabani RDC wanted more information on its elephant population to improve management strategies, with crop raiding being identified as a high priority. In response, the Mid Zambezi Elephant Project (MZEP) designed and established a district-wide crop-damage reporting system. The major objective was to identify spatial and temporal patterns of crop damage in the wet and the dry seasons.

General patterns of crop raiding have been documented in a number of studies, but every site has its unique characteristics. The development of a straightforward and management-oriented data collection system that describes site-specific characteristics, but that may also contribute to the general understanding of human–elephant conflict, is considered important. This scheme aimed to assess a large area rapidly, at low cost to the management authority.

Frequency and distribution measurements are commonly used in crop-damage assessment schemes (Hoare 1999), and they provide useful indicators of the geography of the crop-raiding problem. The severity of crop damage can vary considerably, particularly when considering incidents over a large area. A measure of severity was developed in this study, as it was considered important when setting priorities about human–elephant conflict at a macro scale.

Study area

Muzarabani District encompasses an area of 2774 km^2 in the eastern Zambezi Valley, northern Zimbabwe (31° 05' E, 16° 25' S) (fig. 1a). The district is divided into three distinct geographical regions: the flat Zambezi Valley to the north (altitude 350–500 m), the broken mountainous plateau of the highveld to the south (800–1300 m), and a 10-km band of escarpment mountains (900–1650 m), which runs east–west and separates the two.

Rainfall in the Zambezi Valley is low (650–850 mm per year), falling between December and mid-March. The rainfall of the highveld is greater (1000 mm) and falls in a longer wet season from November to mid-March. There is a long dry season from April to November. Most rivers within the district drain north from the escarpment towards Mozambique. The major rivers, which are a perennial source of water for humans and wildlife, are the Utete, the Musengezi and the Hoya (Cunliffe 1992) (fig. 1b). The Zambezi Valley is dominated by mopane-terminalia woodland (*Colophospermum mopane* and *Terminalia stuhlmanii* and mopane-combretum woodland (*Colophospermum mopane* and *Combretum apiculatum*), with dense riverine thickets of mixed species along the major rivers. In the escarpment there is a mixture of escarpment woodland and miombo (*Brachystegia* spp. and *Julbernardia* spp.) woodland (Cunliffe 1992).

Muzarabani District comprises communal farmlands, large-scale commercial farmland, and the Mavuradona Wilderness Area (MWA), a formally protected wildlife area. It covers 650 km^2 of the escarpment mountains and is bordered to the south by commercial farms on the highveld, to the east and west by communal farms in the mountains, and to the north by a near-continuous boundary of communal farms

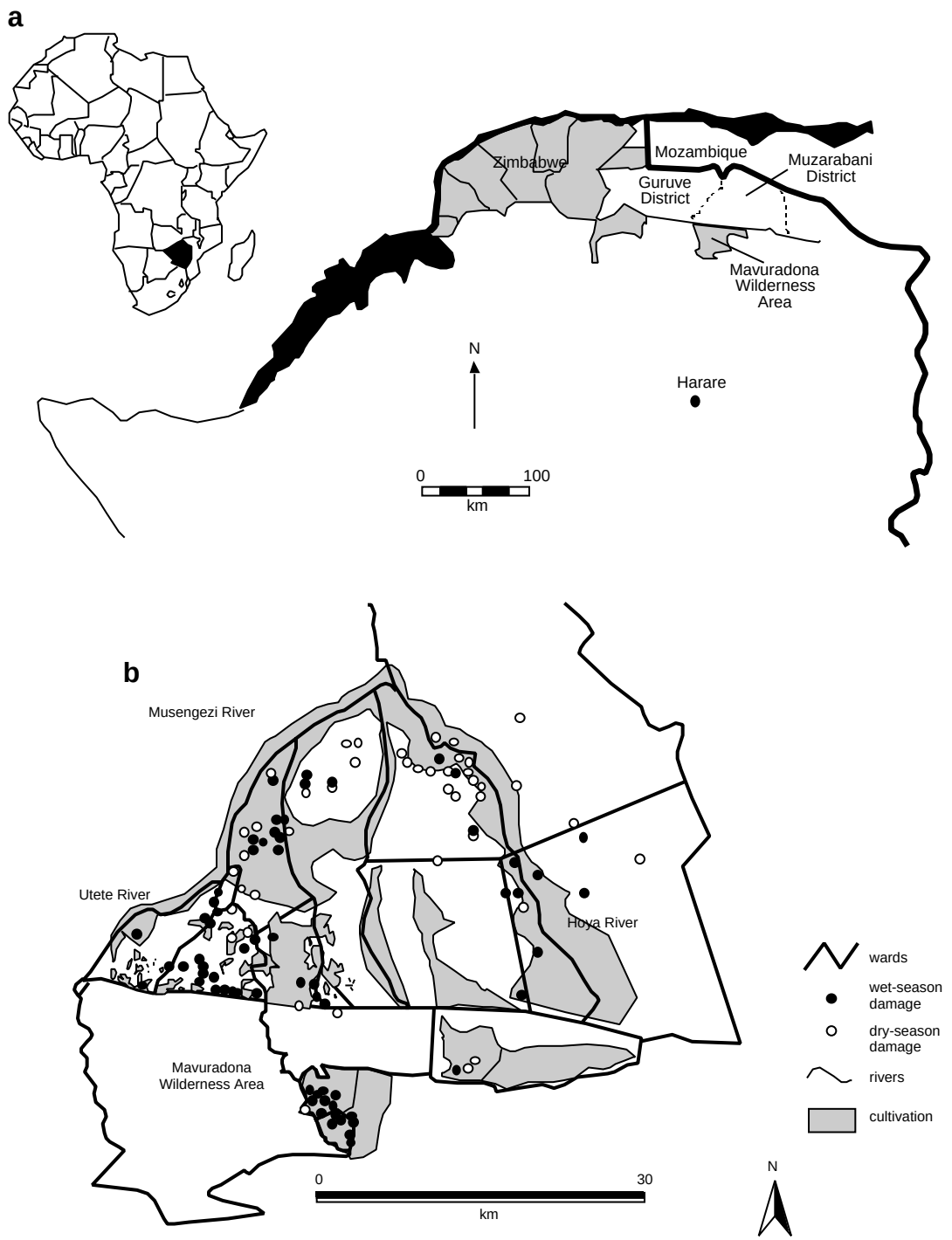

Figure 1. Muzarabani District, showing major rivers, cultivation and the Mavuradona Wilderness Area. Wet-season crop-damage incidents are shown as black dots and dry-season incidents as circles. In areas with many crop-damage incidents, the symbols are overlaid.

in the Zambezi Valley. Cultivation in the communal lands occurs mainly along watercourses and in areas with fertile soils. In the escarpment these correspond to the flat terrain where deeper soils have developed. In the Zambezi Valley, cultivation occurs on the colluvial soils along the base of the escarpment and the alluvial soils bordering the major rivers (Cunliffe 1992). As a result, the district comprises a mosaic of cultivation and bush. Most farming is small-scale dryland cultivation, and the main wet-season crops include maize (*Zea mays*) and cotton (*Gossypium hirsutum*). These rainfed crops are planted extensively in November and harvested between April and June. During the dry season small-scale bucket-irrigated gardens are established along the rivers. Assorted vegetables and green maize are planted in small plots in April and May and harvested up until October.

Agricultural activities are expanding rapidly, because of the profitability of cotton and the associated clearance of new land, and people from other parts of the country are being resettled here. The elephant population is centred around MWA, but elephants move extensively through the communal farmlands, making use of dense thickets as temporary refuges. The elephant population of Muzarabani District is contiguous with populations in the neighbouring Guruve District to the west, and Magoe District in Mozambique to the north (MZEP and ZamSoc 2000) (fig. 1a).

Materials and methods

Crop-damage reports were collected across the entire district area by 10 local enumerators, each representing an administrative area called a ward. The enumerators were trained and supervised by MZEP to record every incident of elephant crop damage within their area. An incident was defined as an occasion where an elephant or elephants caused damage to communal farmers' crops. The format for the reports was modified from those used by Osborn (unpubl.).

The probability of data error increased with the number of people collecting data. MZEP conducted regular and intensive field supervision throughout the two-year period to standardize data collection techniques and to minimize the risk of false or biased reporting.

Data covering two years were analysed, as large between-year variation is common in crop-damage studies (Taylor 1999). The data were pooled, as similar seasonal patterns were exhibited in both years of research. We categorized the season of each incident by the type of crop affected. Incidents affecting rainfed crops (mainly maize and cotton) were considered wet-season crop damage, and those affecting bucket-irrigated crops (vegetables and green maize) were considered dry-season crop damage. The separation of season by crop type was considered more accurate than a time-based categorization, as some overlap in the period of cultivation of these crops occurred.

The crop-damage incidents were plotted along a 12-month time series to study the temporal distribution (fig. 2). Incidents were separated into those affecting wet-season crops and those affecting dry-season crops. Each crop-damage report detailed the life stage of the crops affected as seedling, intermediate or mature. The percentage of incidents involving each life stage was compared.

Crop-damage incidents were displayed first in map form (fig. 1b). A seasonal trend of distribution was found among the incidents, which was explored further. The relationship between wet-season incidents and MWA was examined first, with each incident categorized by its distance from the MWA borders. Distance was measured using 1-km bands up to a total of 5 km from the borders. A graph of the number of incidents in each distance class was plotted (fig. 3). A non-linear negative regression was fitted to the data as a tool to describe the shape of the graph. The strength of the fit reflected the similarity between the graph (frequency of crop-damage incidents in each distance class) and the regression model. A distance of 5 km was selected as it captured all incidents immediately associated with the MWA borders (fig. 1b). Beyond 5 km, crop damage may have been caused by elephants from other areas, so these incidents were considered separately.

The same method was used to examine the relationship between dry-season incidents and the major rivers of the district. Each incident was allocated to a 1-km band up to 5 km from the closest major river, and the number of incidents per distance class was plotted (fig. 4). A negative non-linear regression was fitted to the data to describe the shape of the graph. It was decided that any incidents occurring more than 5 km from the major rivers might be unrelated to the river systems in question, and these were considered separately.

The severity of each incident was measured using two indicators. For the first, the 'extent' indicator, the proportion of the field damaged was measured by pacing both the total field and the damaged portion and

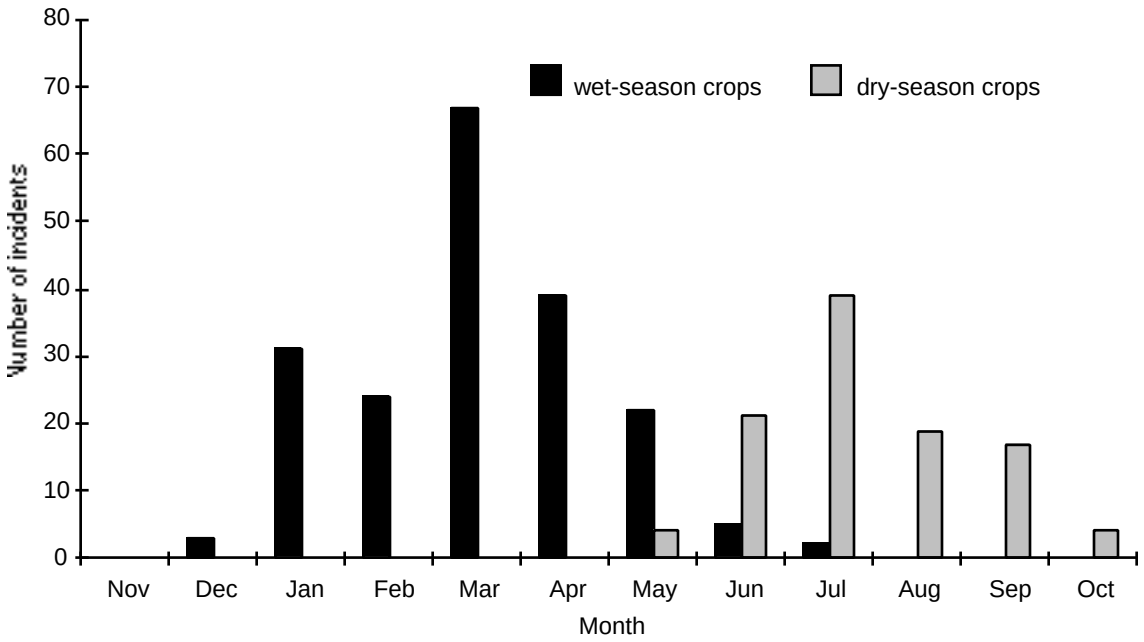

Figure 2. The number of crop-damage incidents per month in Muzarabani District.

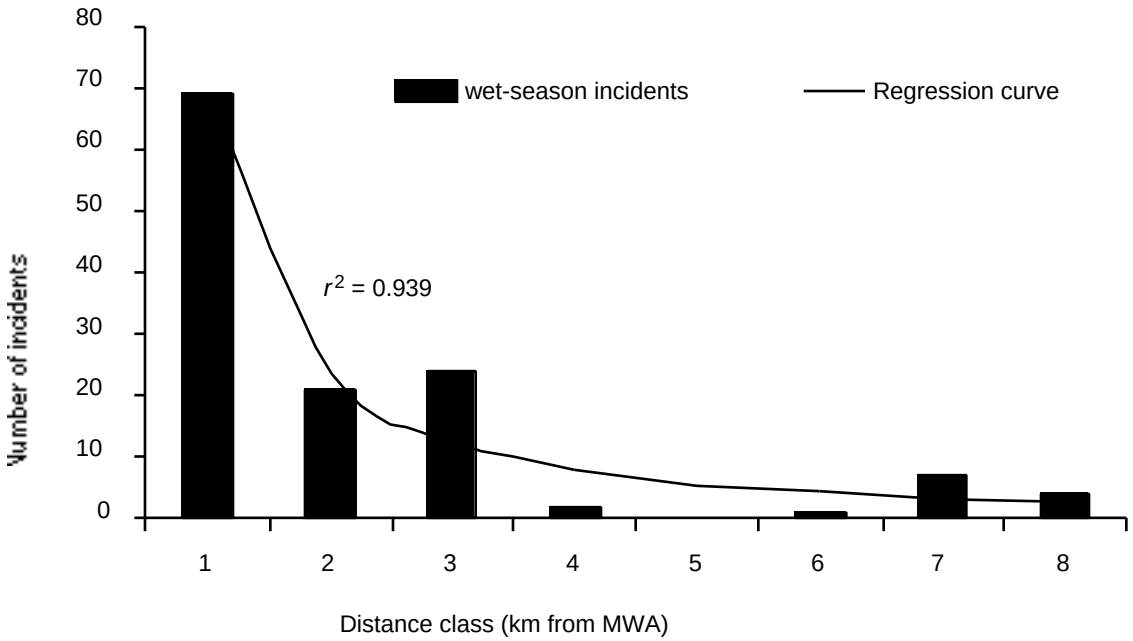

Figure 3. The number of wet-season crop-damage incidents per distance band from the Mavuradona Wilderness Area. The solid black line represents the non-linear regression model for the wet-season data.

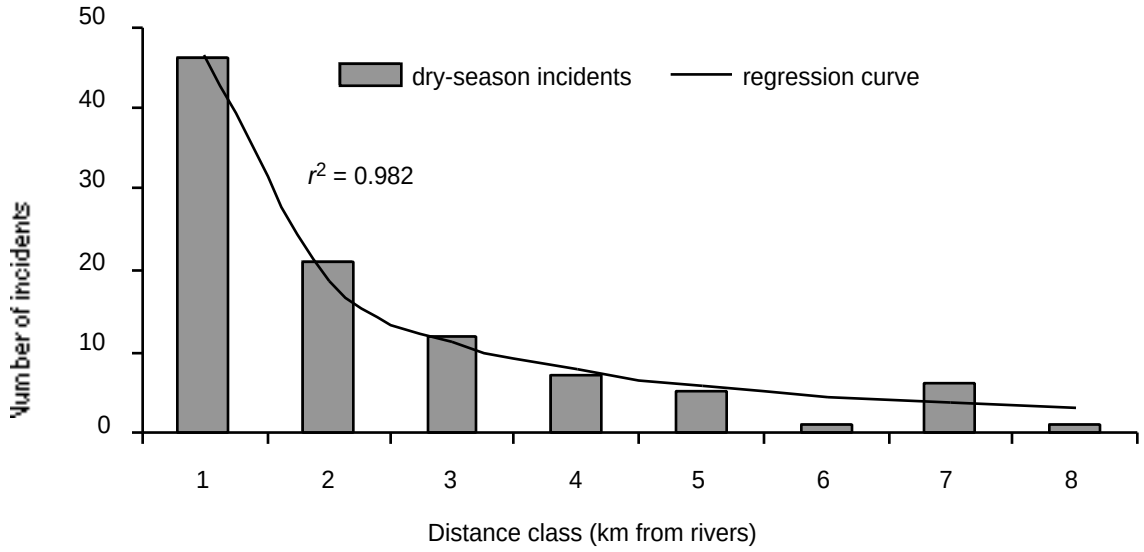

Figure 4. The number of dry-season incidents per distance band from the major perennial rivers. The solid black line represents the non-linear regression model for the dry-season data.

calculating the percentage of the damaged area. Each incident was placed into one of five categories, based on percentage of damage: 0–10%; 11–25%; 26–50%; 51–75% and 76–100%. The second indicator, a subjective measure of the intensity of damage to the crops within the damaged area, was assessed visually. Grade 1 intensity indicated that the damage was not critical to the survival of the plants (some leaf and fruit damage), grade 2 intensity involved some critically damaged plants (some fruit destroyed and stems broken), and incidents of grade 3 intensity were typified by serious plant damage (fruit destroyed, stems broken and plants uprooted). Both measures were used to construct a matrix (table 1). Each crop-damage incident was placed into a severity category based upon a combination of its 'extent' and its 'intensity' scoring, using the matrix. The severity categories were low, medium and high, and the percentage of incidents in each category was presented for each season.

Table 1. Severity matrix showing the level of severity assigned to each combination of 'extent' and 'intensity'

Intensity	Extent (%)				
	0–10	11–25	26–50	51–75	76–100
1	low	low	low	med	high
2	low	med	med	med	high
3	low	med	high	high	high

Results

In Muzarabani District, elephant crop damage was a dual-season phenomenon, affecting both wet- and dry-season crops. Of the 312 crop-damage incidents in total, 204 incidents affected wet-season crops and 108 incidents affected dry-season crops. Damage to wet-season crops occurred over seven months, beginning in December, peaking in March and ending in July. Damage to dry-season crops lasted six months, starting in May, peaking in July and ending in October (fig. 2).

With wet-season crops, 2% of the incidents occurred at the seedling stage, 23% at the intermediate stage, and 75% when crops were mature. Dry-season crops were affected similarly: no incidents occurred at the seedling stage, 7% occurred at the intermediate and 93% when crops were mature.

Grouped around the northern and eastern borders of MWA, 58% of the wet-season incidents occurred within 5 km of the area. There was a strong negative non-linear relationship between distance classes and frequency of incidents (corrected $r^2 = 0.939$), indicating that the

number of incidents decreased rapidly with increasing distance from the border (fig. 3). Grouped mainly along the western boundary of the district with some incidents were scattered on the eastern side, 42% of wet-season incidents occurred outside the 5-km limit.

Occurring within 5 km of the major rivers were 82% of the dry-season incidents, grouped mainly along the Musengezi River and the northern section of the Hoya River. There was a strong negative non-linear relationship between distance classes and frequency of incidents (corrected $r^2 = 0.982$), indicating that the number of incidents rapidly decreased with increasing distance from a river (fig. 4). Outside the 5-km limit, only 18% of the incidents occurred, these being scattered widely to the east of the river systems and to the south of the district in the mountains.

Classified as low severity were 59% of wet-season crop-damage incidents, 26% as medium, and only 15% as high severity. In comparison, dry-season incidents exhibited greater severity: only 29% were low, 40% were medium, and 30% were classed as high.

Discussion

In Muzarabani District the rapid expansion of agricultural activities and the existence of a stable and mobile population of elephants are conducive to the occurrence of human–elephant conflict. During this study, elephant crop damage was common and widespread, occurring in 11 months of the year and affecting both wet- and dry-season crops.

Wet-season patterns of crop damage agreed closely with those documented in recent research. The peak of crop-raiding activity observed during March corresponded to the maturing period of cotton and maize crops. Elephants resident in MWA damaged crops along the boundary by raiding fields close by in short trips from the refuge. The rapid decrease in incidents with distance from the refuge may reflect increased risks of venturing deeper into farming land.

Incidents occurring more than 5 km from MWA along the western boundary of Muzarabani District may be attributable to elephants moving from Guruve District. Large-scale movements of elephants between the two districts have been identified in the wet season (MZEP and ZamSoc 2000), and elephants may use small thickets as refuges within the communal lands at this time. The broad distribution of incidents reflects widespread cultivation and large-scale elephant movements during the wet season.

Dry-season crop damage exhibited a peak of activity that corresponded to the maturing period of vegetables and green maize. Most crop-raiding incidents occurred along the major rivers, reflecting the fact that dry-season agriculture is limited to the beds of the major rivers and their tributaries, where alluvial soils and water are available. The rapid decrease of incidents at a distance from the major rivers may be linked to the decreasing potential for agriculture as one moves farther away from the main riverbed, or it may reflect increasing risks associated with moving greater distances from the main riverine refuges. Few incidents occurred more than 5 km from the major rivers, indicating that in the dry season the geographical extent of crop damage is more limited than during the wet season.

Elephants may use riverine areas in the dry season because water is available there at a time of year when it is generally scarce. They may also be attracted by fruiting trees, specifically the *masawu* (*Ziziphus mauritiana*) tree, which grows extensively along the river lines and produces a sweet fruit that elephants feed on during the months of June to September (Funkhauser unpubl.). Thick riparian vegetation provides browse and also concealment and shade for elephants during daylight hours. A range of resources may attract elephants, and once they are nearby they opportunistically raid vegetable gardens. Alternatively the vegetable gardens may attract elephants to riverine areas in the first place. At this stage it is impossible to state the relative attractive values of each resource, but this may be the subject of further research. However, dry-season crop damage may be more common in Muzarabani District that other areas because of the abundance of fruiting masawu trees, which are uncommon elsewhere in Zimbabwe.

Incidents of crop damage in the wet season were generally less severe than those during the dry season. Farmers actively defended fields during the rains, and crop-raiding elephants were frequently chased away. Dry-season vegetable plots in the riverbeds were not actively defended and so were often heavily damaged or destroyed. In addition, wet-season fields were large, and the proportion of damage in a single crop-raiding incident was generally low. Dry-season cultivation areas were small, and the proportion of damage in a single incident was therefore generally higher.

Dry-season crop damage may affect communal farmers' livelihoods to a greater degree than wet-season damage, as dry-season crops supplement the farmers' diet at a time of year when food is scarce. Elephants may

also target food stores at homesteads, and these incidents affect food security for the farmer until the crops are harvested the following year. To determine whether dry-season crop damage has a greater effect upon the farmer than wet-season damage, a detailed socio-economic study would be required.

The severity measure developed in this study adds a further dimension to the assessment of crop-damage incidents. It gives an indication of the actual impact of crop raiding upon the farmer, and when combined with 'frequency' and 'distribution' measures, it forms a useful tool for determining priorities of crop-damage incidents.

By studying crop damage over a large land area, it was possible to identify the broad seasonal patterns that existed within Muzarabani District. The information yielded was designed to assist the rural district council with macro-scale management issues, including planning future land use, deploying problem animal control units, distributing wildlife revenues according to conflict, and placing conflict amelioration projects. This study represents the first phase of ongoing research within Muzarabani District. Crop-damage information continues to be collected in the most heavily affected wards of the district, to update management decisions and to evaluate crop-damage intervention projects.

The methods developed in this study have been adopted and used by the AfESG Human–Elephant Conflict Task Force as a basis for its crop-damage data collection protocol across Africa (Hoare 2000). The data collection system is practical and straightforward, and ideal for large-scale assessments. It is also efficient, as it requires only a few trained enumerators to cover a wide area. The major cost is associated with the time and effort required to train and supervise the enumerators, to ensure that the information collected is of high quality and ultimately is comparable.

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Elephant crop damage and electric fence construction in the Maputo Elephant Reserve, Mozambique

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Abstract

An electric fence is at present being constructed around the Maputo Elephant Reserve, Mozambique, to protect farmers from elephant raids. Elephants cause crop damage estimated at 8800 yr^{-1}, or USD 8800 $elephant^{-1}$. Elephants preferred maize, melons and beans, and their raid frequency increased during harvest seasons. The proportion of elephant crop damage was higher on more productive fields than the less productive ones. In the most affected areas, 90% of the farmers reported elephant crop damage and 26% of the crops was lost to elephants. The total damaged area was estimated at 10% of 983 ha of cultivated fields. The farmers, who felt that traditional methods of frightening elephants were not effective, chose the option of constructing an electric fence. The construction and maintenance of the 38-km electric fence is estimated at USD 41,100 per year. At present, annual fence construction costs are much higher than the costs of crop damage. However, eventually the fence should not only lead to a decrease in crop damage by elephants but also contribute to better control of poaching and of access by people to the park.

Résumé

On est en train de construire une clôture électrique tout autour de la Réserve à éléphants de Maputo, au Mozambique, pour protéger les fermes contre les éléphants. Les éléphants causent chaque année aux récoltes des dommages estimés à USD 8800, ce qui fait USD 50 par éléphant. Les éléphants préfèrent le maïs, les melons et les haricots, et la fréquence de leurs incursions augmentait quand venait la saison des récoltes. La proportion des dommages dus aux éléphants était plus élevée dans les champs plus productifs que dans les moins productifs. Dans les zones les plus touchées, 90% des fermiers faisaient état de récoltes endommagées par les éléphants, et 26% des récoltes étaient perdus à cause d'eux. La superficie endommagée totale était estimée à 10% des 983 hectares cultivés. Les fermiers, qui ont estimé que les méthodes traditionnelles pour effrayer les éléphants n'étaient plus efficaces, ont opté pour la construction d'une clôture électrique. La construction et l'entretien des 38 km de clôture électrique sont estimés à quelque USD 41 100 par an. Pour le moment, la construction coûte beaucoup plus cher que les dommages causés aux récoltes. Toutefois, la clôture ne devrait pas seulement entraîner une diminution des dommages dus aux éléphants, mais aussi contribuer à un meilleur contrôle du braconnage et des personnes qui pénètrent dans le parc.

Introduction

The fragmentation of habitats and escalating human population growth contribute to frequent elephant (*Loxodonta africana* Blumenbach) raids on cultivated fields (Dey 1991; Hoare 1995; Tchamba et al. 1995; Campbell et al. 1996; Kiiru 1996; Lahm 1996). The local authorities seek solutions such as shocking or shooting the elephants, compensating the farmers monetarily, and constructing electric fences (Hoare 1995; Thouless and Sakwa 1995; Lahm 1996; Osborn unpubl.). These measures have not always been totally successful. Shooting does not deter elephants from raiding fields (Bell 1986 cited in Mkanda 1994; Hoare 1995; Lahm 1996; Osborn unpubl.), people and animals break down the electric fences (Deodatus and Lipiya unpubl.;

Thouless and Sakwa 1995), and compensation does not decrease the conflicts between humans and elephants. Local communities living around protected areas often bear the costs of living with wildlife (Sukumar 1990; Swanson and Barbier 1992; Skonhoft 1995; de Boer and Baquete 1998), sometimes without benefiting from this coexistence (Kiss 1990; Lewis et al. 1990; Happold 1995; Rihoy 1995; Heinen 1996). People sometimes leave the area if elephant crop raids become severe (Ostrosky unpubl.; Lahm 1996; Naughton-Treves 1997). This can lead to increased conflict between local people and park authorities.

Electric fencing is a possible long-term solution for decreasing crop damage (Hoare 1995; Thouless and Sakwa 1995). An electric fence constructed in the Maputo Elephant Reserve (MER), Mozambique, is primarily aimed at reducing the frequent elephant raids in the surrounding agricultural area (de Boer and Baquete 1998). In this paper we compare the cost of crop losses with that of constructing an electric fence.

Materials and methods

Study area

The MER is in south Mozambique (fig. 1). It was established in 1932, although its current boundaries were redefined in 1960. It is not fenced. The average annual rainfall is 690–1000 mm; the average temperature 20–26° (DNFFB unpubl.). The soils are mainly sandy. The six vegetation types are dune, mangrove, riverine, forest, woodland, and grass plains (Tello 1973; de Boer et al. 2000). A population of about 180 elephants (I.White, pers. comm. 1998) is found in the area. Other herbivores that live in the MER are hippos *(Hippopotamus amphibius)*, red duiker *(Cephalophus natalensis)*, common duiker *(Sylvicapra grimmia)*, reedbuck (*Redunca arundinum)*, and suni *(Neotragus moschatus)*. Poaching in the last decades has reduced the animal population considerably. The elephants are distributed relatively close to the human settlements, and they hide in the dense forest patches (de Boer et al. 2000). They are mainly responsible for crop damage in the area. These incidents influence the attitude of the local population negatively (de Boer and Baquete 1998). Elephants do not cross the Maputo River, where the majority of the agricultural fields are found. Therefore, crop damage is reported only between Salamanga and Massuane, on the eastern side of the Maputo River and the western side of the Futi River (fig. 1).

The electric fence (fig. 1) was constructed by Blanchard Mozambique Enterprises, a private enterprise that obtained a long-term lease for the MER. The Maputo River, acting as a natural boundary for the park, forms part of a deflecting fence system (Hoare 1995). The agency intended to develop the area for tourism, but its lease was not continued after 2000. However, its plans are still valid and are being used here as an example for similar initiatives.

Study method

Elephant crop raiding was studied using data sheets that were distributed to 12 informants living in different villages: Bela Vista, Lagoa Piti, Chia, Zitundo, Mvukunza, Salamanga, Fábrica de Cal, Futi River (which was divided into four areas) and Massuane (fig.1). The study was carried out over 13 months, from January 1996 to January 1997. The informants asked the villagers to report to them any incidents of crop raids by elephants in the area. The mean monthly raid frequency was calculated from the monthly percentage of days when crop raids occurred in each village. The average number of raids was calculated using data from all 12 villages.

In January 1996, just before the harvest, 100 people from each village were asked to attend a general meeting. They had no prior knowledge of the subject to be discussed. At Lagoa Piti only 19 people were present. These people were asked once if they had experienced elephant crop damage to their agricultural fields in the past 30 days. We visited and accessed the crop damage on the fields that were accessible of all the people who responded positively to this question. Crop type was determined, total field area measured, and the destroyed and non-affected areas in the fields assessed using the method described in Mettrick (1993). Elephant damage was distinguished from hippo damage by identifying footprints. The people were asked about the methods they used to deter elephants and the specific effectiveness of each method. They were also asked to mention alternative measures for reducing elephant raids. It was assumed that the total cultivated area of farmers who suffered crop damage by elephants and those who did not report crop damage was equal. Total crop damage was calculated from the combined results of questionnaires, field measurements and data on the existing total number of families in the area and agricultural fields. Crop losses (replacement costs) were estimated in US dollars, using local market prices.

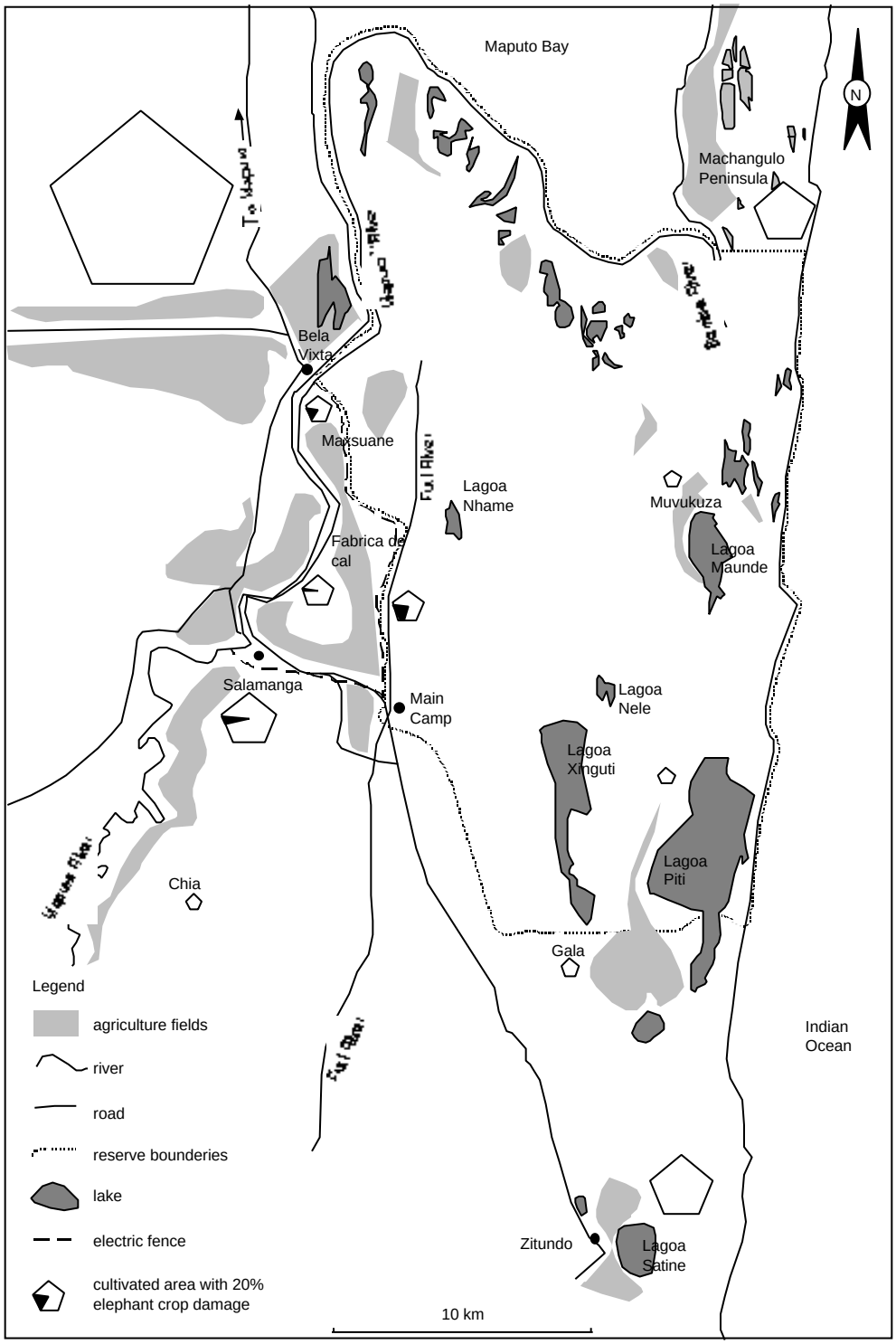

Figure 1. Location of the study area and occurrence of crop damage. The relative size of the pentagons represents the relative size of the cultivated area, with percentage of area raided by elephants indicated by the black section of the pentagon.

Compensation records provided a second data source on crop damage caused by elephants. The degree of damage to specific areas in March 1997 was estimated visually in percentage by staff from the Ministry of Agriculture, who are experienced in human–elephant conflict. The crop type was identified, and the potential expected production from each specific field was estimated. Total crop damage in kilograms was calculated by multiplying area (ha) x damage (%) x potential production (kg ha^{-1}). The fields of all farmers reporting crop damage were visited.

Fence construction

The fence is supposed to protect agricultural fields between Salamanga and Massuane, along the Futi River (see fig. 1). It was made of three-strand electric wire mounted on a game fence 2.5 m high and powered with solar energy. The fence is 38 km long and cost USD 228,000, which is USD 6000 for each kilometre of construction (E. Gouws, pers. comm. 1998). We assumed that the investment was financed from a loan, and that the loan would be repaid by the investor at an interest rate of 5% over 20 years of equal annual instalments. The annual maintenance costs are estimated at 10% of the initial investment. The annual costs of fence construction cover the fixed annual repayment of the loan including interest of USD 18,300 (calculated following Emmanuel et al. 1990), and maintenance costs of USD 22,800, totalling USD 41,100 per year.

Results

Crop damage assessment

Crop damage is not evenly distributed in the area (fig. 1). In Massuane, 90% of the household were affected, which is the highest percentage of crop raiding (table 1). The mean area of agricultural fields on which elephant damage was reported was 38% of the total field area. Among the farmers who reported elephant damage, 17% lost more than half their cultivated area. Extrapolating the percentage of respondents with crop damage and the average damaged area per field, we estimated 100 ha to have been destroyed by elephants in the 30 days before the questionnaire was administered. This area represents 10% of the total area cultivated in Salamanga, Fábrica de Cal, Massuane and alongside Futi River. The area around the river was most affected, with a quarter of the total destroyed by elephants. Productivity of the fields was estimated at 402 kg ha^{-1}, of which 375 kg was maize and the

Table 1. Results of the crop-damage assessment carried out in January 1996 in four areas with elephant raids around the Maputo Elephant Reserve, Mozambique. Total field size and area destroyed by elephants are given; total crop damage is estimated

	Area				Total
	Salamanga	Fábrica de Cal	Futi	Massuane	
Questionnaire data					
Total questionnaires	100	100	100	100	400
People with crop damage (%)	8	2	70	90	43
Fields with crop damage					
Mean field size (ha)	0.6	2.0	0.9	0.6	1.0
Mean destroyed area (ha)	0.3	0.8	0.4	0.1	0.4
Area destroyed (%)	50	38	41	22	38
Total area					
Total cultivated area (ha)	410	256	213	104	983
Total destroyed area (ha)	16	2	61	21	100
Total area destroyed (%)	4	1	26	20	10
Estimated average potential production (kg ha^{-1})	402	402	402	402	402
Total production loss (kg)	6,430	800	24,520	8,440	40,200
Total production loss (USD)	1,008	126	3,843	1,323	6,300

remaining 27 kg associated crops (cassava, bean, sweet potato and other vegetables). This production was equivalent to USD 63 ha^{-1}, of which 81% was maize. A total loss of production caused by elephants of 40,190 kg was estimated during the previous 30 days, equivalent to USD 6300 (table 1).

Figure 2 gives the mean monthly elephant raid frequency over the year and the development stage of the main crops.The raids show a bimodal pattern corresponding to the two peak production periods of maize and cassava. Elephant crop raids are less frequent in periods when crops are still immature. The elephants' preference for certain crop species was analysed by comparing the crop species on an agricultural field with the crop species that were actually eaten by elephants (fig. 3). The highest number of raids was reported for fields with maize, melon and bean, but the elephants preferred maize and melon to bean. The elephants also consumed pumpkin, rice, banana and cucumber. However, the total area cultivated with rice, banana or cucumber was very low.

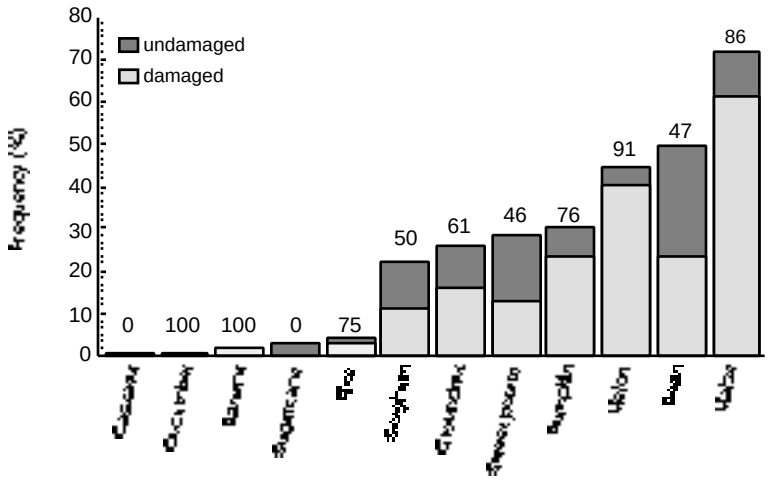

Figure 3. Cumulative frequency of agricultural fields with and without elephant crop damage. The values given above the bars are the percentages of agricultural fields in which the specific crop was raided by elephants and are a relative measurement of preference.

The second data source of information on crop damage incidents was the records used to compensate for crop damage in March 1997 (table 2). Damage was less in 1997 than in 1996; the mean damaged area was 0.024 ha per field, on which 58% of the crops was estimated to have been damaged. Total damaged area was 4.5 ha, and total crop loss was estimated at 12,530 kg, or 31% of the 1996 estimates. This crop damage is equivalent to USD 2500. Elephant damage was not evenly distributed over the fields (fig. 4). The more productive fields had a relatively higher percentage of elephant damage, while on the less productive fields, elephant damage was 40% or less. A positive significant correlation confirmed this relationship between field production and elephant damage ($r = 0.341$, $t = 4.00$, $n = 185$, $P < 0.0001$).

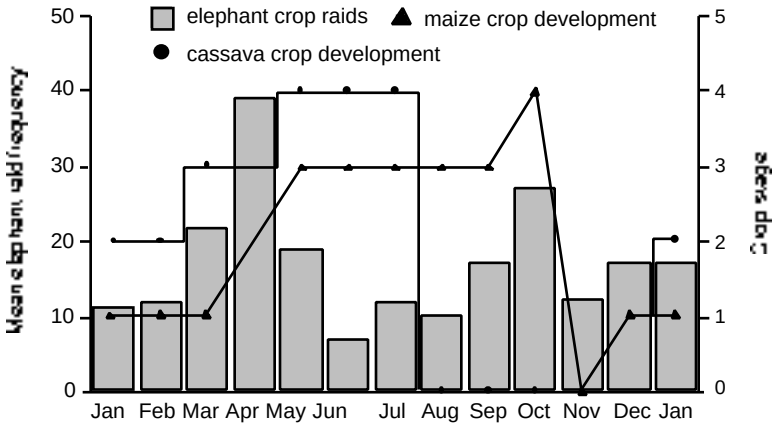

Figure 2. The frequency of elephant crop raids from January 1996 to January 1997 in relation to crop development. Crop stage is classified in five categories from 1 (seedlings) to 5 (harvest).

Landowners ($n = 79$) were asked what methods they used for deterring elephants. All respondents (100%) replied that they drummed on tins and pots to frighten them off, but only 52% of the people affirmed that this method was effective. About half of the people (55%) also used clothes and rags tied to poles and trees to frighten off elephants, but this was generally found to be the least efficient method, with only 15% of the people confirming success. The only method consid-

Table 2. Crop damage caused by elephants in March 1997 around the Maputo Elephant Reserve

Variable	Value
Households with crop damage	185 no.
Damaged fields with maize	97%
Damaged fields with bean	73%
Average destroyed area	0.024 ha
Total destroyed area	4.5 ha
Estimated average potential production	201 kg ha^{-1}
Average loss	58%
Total production loss	12,530 kg
Total production loss	USD 2490

Data as determined by the Blanchard Mozambique Enterprises and the Mozambique Foundation

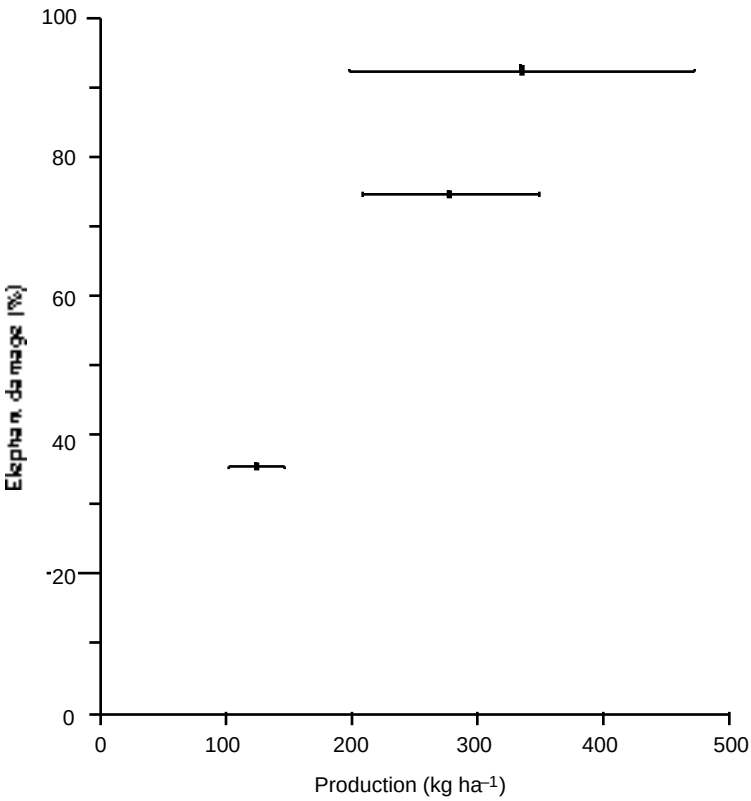

Figure 4. The percentage of elephant crop damage found on an agricultural field in relation to the estimated potential production of that field (data from Blanchard Mozambique Enterprises and the Mozambique Foundation).

ered 100% successful was for game wardens to fire shots. However, only 22% of the respondents said that this way of frightening off elephants was used on their fields. Farmers suggested the following as measures for dealing with elephant crop raids: installation of an electric fence (81% of respondents), compensation payments (46%), regular patrols by game wardens (23%), and the shooting of problem elephants (9%).

Discussion

Elephants, although generalist feeders, prefer certain crops. The food preferences that both Deodatus and Sefu (unpubl.) and Lahm (1996) have reported are similar. No relation could be found between the percentage of crop damage and the total area under cultivation, as documented by Sukumar (1990) (see fig. 1). Instead, damage seems related to proximity to the MER boundary and hence the presence of forest patches that can be used for shelter. A similar situation where crop damage was higher near park bounderies and in the vicinity of forest patches was described for Uganda (Naughton-Treves 1997, 1998). Elephants raid the fields and damage the growing crops mainly at night (Sukumar 1990; Hoare 1995; Lahm 1996). Raids that occur outside the gowing season might be related to the browsing of trees in communal areas (Sukumar 1990; Naughton-Treves 1997; Osborn unpubl.).

Elephants clearly prefer the more productive fields to the less productive ones. Figure 4 shows that elephants stay longer and consume more from more productive fields. Equal amounts of forage could be left on the more productive as well as the less productive fields after a raid. This corresponds with the marginal value theorem (Charnov 1976), which assumes that an animal

will leave a patch when the grazing intake averages that overall mean of all patches combined. This means that animals stay longer in patches of higher quality (Jiang and Hudson 1993; Wildhaber et al. 1994). However, more data are needed to test this hypothesis.

The crop damage estimates were USD 6300 for 1996 and USD 2500 for 1997. Differences in these estimates can be explained by the different methods used for the estimations as well as by the different years of study. The mean damage of the two estimates is USD 4400. However, this figure is certainly an underestimation, as it is based on two one-month field studies. The damage that occurred outside the sampling period was not taken into account in either study. Therefore, it needs to be multiplied by a factor of two at least because of ongoing agricultural activities and crop raids by elephants throughout the year (see fig.2). The total annual cost, therefore, increases to USD 8800.

Paying compensation may, in the long run, encourage farmers to cultivate in areas with a high record of elephant crop damage, because compensation payments exclude production risks. According to Hoare (1995) compensation schemes are not successful. The total annual costs are not evenly spread among the human population, and some farmers experience considerably more loss from elephant raids than others (see also Naughton-Treves 1997).

Most people (81%) favoured construction of an electric fence because traditional methods were not effective.

The negative attitude of people towards the MER has largely been influenced by loss from elephant crop damage (de Boer and Baquete 1998). Although the fence may also decrease the raid frequency of bush pigs *(Potamochoerus porcus)* and hippos from the Futi River, damage by antelopes and hippos coming from the Maputo River will continue. People complain about large, aggressive, nocturnal animals (Deodatus and Sefu unpubl.; Hill 1997; Naughton-Treves 1997). However, small rodents generally cause more crop damage than the large animals (Lahm 1996). The fence will probably decrease crop damage, but fence-breaking elephants and other crop-raiding animals will still cause problems (Thouless and Sakwa 1995).

The proposed fence will not entirely enclose the MER. A deflecting fence will be constructed in the favoured crossing area of elephants on their way from the reserve to the agricultural area. The protected area is only a small section where crop damage is highest. The MER benefits from its natural boundaries formed by the Futi River, Maputo Bay and the sea. These natural boundaries minimize the amount of fencing required, thus making the project cheaper. Costs for the area are still relatively high, however, when compared with the construction cost of fences in other countries (compare with Hoare 1995; Thouless and Sakwa 1995).

Fence construction costs will be partly compensated by the decreasing crop damage. The break-even point depends on the amount of crop damage. Presently estimated at USD 8800 per year, this figure is much less than the costs of constructing and maintaining the fence, estimated at USD 41,100 per year. Fence construction is therefore not economically viable for the present amount of crop damage. The fence, however, will also improve the protection of other animal species presently in the reserve and species that it is planned to reintroduce. The fence will also help control human activities such as cultivating and exploiting natural resources in the reserve (see de Boer and Baquete 1998). These extra benefits are not included in the calculation. The cost–benefit analysis could also be improved by including the cost of fence breaking by elephants (Thouless and Sakwa 1995) and the decrease in elephant poaching. De Boer and Ntumi (unpubl.) analyse the financial costs and benefits of an electric fence where such factors other than crop damage are taken into account.

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Mode de dissémination des espèces les plus appétées par les éléphants dans la zone cynégétique de la Djona, les forêts classées de Gounguon, de la Sota et des environs, Nord-Bénin

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Résumé

Les formations végétales de la zone soudano-sèche du Bénin constituent un habitat et une réserve alimentaire importante pour la faune sauvage. Les animaux sauvages ont l'avantage de tirer partie de tous les végétaux disponibles à différents niveaux. L'éléphant a été l'animal de base pour le présent travail. Les éléphants s'adaptent extrêmement bien et occupent divers habitats allant du désert à la savane et les forêts galeries.

Abstract

The vegetation of the dry-Sudan zone of Benin is an important habitat and a significant food reserve for wild animals. Wild animals benefit at different levels from the available plants. Elephants have adapted extremely well and occupy various habitats: from the desert to the savanna to the forest reserves.

Introduction

La zone soudano-sèche du Nord-Bénin est l'une des régions où se concentre la plus importante diversité biologique de notre pays.

« La nature est si belle, si luxuriante et si généreuse, qu'elle nous recrée et nous entretient tout le long de notre vie ». Les éléphants s'adaptent extrêmement bien et occupent divers habitats allant du désert à la savane et les forêts galeries (Lausen and Bekoff 1978).

En effet la nourriture de l'éléphant comprend les différentes herbes, l'écorce, les fruits, et les feuillages des arbres. Les arbres représentent les 3/4 des espèces de leur régime alimentaire (White et al. 1993), et à l'encontre des éléphants de savane, les fruits sont un élément important du régime alimentaire de l'éléphant des forêts (White et al. 1993 ; Alexandre 1977). Les éléphants ne digèrent que 40% des quantités consommées (Laws et al.1975). Ils influencent la structure de la végétation.

Les études écologiques ont toujours été programmées et exécutées en république du Bénin, mais elles sont rarement menées de manière continue et intensive sur un même site à l'instar des stations de recherches écologiques des pays anglophones d'Afrique.

Le manque de données écologiques de base des écosystèmes en Afrique de l'ouest constitue une grande lacune qui oblige le plus souvent les spécialistes à faire de l'extrapolation. La recherche écologique est nécessaire pour une gestion durable de la diversité biologique, des écosystèmes des pays en voie de développement en général et de l'Afrique de l'ouest en particulier.

Afin de répondre à cette préoccupation, le présent article donne les résultats d'un programme de collecte de données sur l'écologie et l'éthologie de la faune sauvage des aires protégées du Bénin. L'objectif prin-

cipal est d'avoir une bonne connaissance : de l'interaction végétation–animaux sauvages (cas des éléphants).

Démarche méthodologique

Des observations directes et indirectes nous ont permis d'étudier l'interaction végétation ligneuse–éléphants dans un milieu naturel (Zone Cynégétique de Djona, forêts classées de Goungoun et de la Sota) et dans les villages limitrophes. Les éléments de travail ont été la petite harde d'éléphants (99 individus) de la zone, les crottes et les espèces ligneuses.

Ces observations ont été effectuées à pieds, à moto, à partir des couloirs de passage des éléphants. Une boussole de précision, une paire de jumelles, un mètre ruban et un appareil photo, ont été utilisés, pour mieux saisir l'interaction végétation–éléphants et bien apprécier le degré de dissémination des espèces ligneuses appétées ; des relevés de germinations spontanées ont été faits.

Milieu d'étude

La zone d'étude est située au nord du Département du Borgou, République du Bénin et s'étend entre 11' 20" et 11' 50" de latitude Nord ; à 2' 50"et 3' 20" de longitude Est.

Climat

La température moyenne annuelle gravite autour de 28 °C, le pouvoir évaporant de l'air est élevé pendant la saison sèche avec une humidité relative moyenne inférieure à 50 %, l'insolation est de 2600 heures en moyenne. Deux types de vents dominants se succèdent dans la zone au cours de l'année : l'alizé maritime et l'harmattan.

Les moyennes pluviométriques annuelles varient de 1000 à 900 mm du sud au nord. Deux saisons se succèdent dans la zones : une saison des pluies et une saison sèche. La saison sèche, caractérisée par les feux brousse annuels s'étend d'octobre–novembre à mars–avril et la saison pluvieuse de mars–mi avril à octobre avec le maximum de précipitation en août–septembre.

Végétation

La zone d'étude est couverte par un ensemble de formations éco-floristiques variant des forêts claires à *Isoberlinia doka* aux différents types de savanes garnies par endroit de galeries forestières et de plages de jachères arbustives. Les essences dominantes sont : *Acacia sieberiana, Adansonia digitata, Afzelia africana, Anogeissus leiocarpus, Burkea africana, Cassia sieberiana, Daniellia oliveri, Detarium microcarpum, Entada africana, Lannea acida, Lannea microcarpa, Piliostigma reticulatum, Piliostigma thonningii, Prosopis africana, Pterocarpus erinaceus, Sclerocarya birrea, Tamarindus indica. Parkia biglobosa* et *Vitellaria paradoxa* sont les deux espèces épargnées lors des défrichements.

Géomorphologie, réseau hydrographique et sols

La géomorphologie de la zone d'étude est celui qui couvre le centre et le Nord Bénin habituellement dénommée le plateau cristallin. C'est le domaine des roches grenues consolidées datant généralement du précambrien.

Le réseau hydrographique est constitué de quelques grandes rivières temporaires et d'un tissu très réticulé de petites rivières qui leur sont raccordées en de maints points. La zone d'étude appartient au bassin versant du Fleuve Niger qui coule plus au nord. La Sota et l'Alibori sont les principales rivières qui drainent la zone, elles prennent leur source vers le Niger.

Les sommets des interfludes majeurs portent des sols profonds qui sont remplacés en aval par des sols peu profonds et beaucoup moins évolués. Du sud au nord, la proportion relative des sols peu profonds augmente au détriment des sols profonds.

Résultats

Mode de dissémination

Le mode de vie apparemment destructeur des éléphants crée une végétation variée qui fait vivre bien d'autres espèces animales (ongulés, primates, rongeurs et oiseaux). Nous avons observé et analysé les différentes formes de dissémination des espèces végétales relevées dans les crottes des éléphants. Ces différentes formes de dissémination observées sont : la dissémination par la zoochorie, par l'anémochorie et par l'hydrochorie. Lorsque le nombre des éléphants n'est pas excessif, ils apportent une contribution

essentielle au rajeunissement des peuplements et au maintien d'une dynamique régulière des formations végétales naturelles.

Ils contribuent dans une large mesure à assurer la dispersion spatiale et la régénération naturelle des arbres qu'ils exploitent. En effet, leurs excréments contiennent des graines non digérées de certains arbres.

La composition de ces excréments varie d'une saison à l'autre. Pendant la saison sèche, nous avons les résultats suivants : 75 % de graines et de gousses, 15 **%** de feuilles et 10 % d'eau et de sable ; mais quant à la saison des pluies nous avons : 45 **%** de graines et de gousses, 20 % de feuilles et 35 % d'eau et de sable. Ce qui montre que pendant la saison des pluies le taux de dissémination est faible (45 %) par rapport à la saison sèche où beaucoup d'espèces de savane soudanienne sont en fruit (75 %). Mais par contre on observe un taux très élever de germination (100 % des graines dispersées et qui ont transité par l'organe digestif des éléphants).

Après leur transit dans le tube digestif, ces graines enrobées dans le fumier, germent plus facilement là où les éléphants ont déféqué et donnant naissance à un nouvel arbre (soit zoochore, soit anémochore ou soit hydrochore). En comparant nos résultats aux différentes études réalisées par divers auteurs (White et al. 1993, Alexandre 1977, Laws 1975, Kortland 1984, Western 1989), il est évident que le régime alimentaire d'un éléphant comprend une diversité d'espèces. Pour White et al. (1993) nos pouvons compter jusqu'à 230 espèces, dont plus de 90% sont constituées par des feuilles, branches, écorces et fruits. Les observations faites nous montrent que de nombreuses espèces végétales appétées par les éléphants dépendent pour leur régénération des types de diffusion ci-dessus cités. Les espèces les plus observées et relevées au cours de l'étude sont : *Aca-*

Tableau 1. Liste des espèces et des différentes parties consommés par les éléphants de février à mai

Noms des espèces	Feuille	Fruit	Grains	Rameau	Racine	Ecorce
Acacia sieberiana	++	–	–	+	–	–
Adansonia digitata	+	+++	–	+	–	–
Balanites aegyptiaca	+	+++	–	–	–	–
Burkea africana	++	–	–	++	–	+
Combretum glutinosum	++	–	–	++	–	–
Combretum molle	+	–	–	–	+++	–
Crossopteryx febrifuga	–	–	–	+	–	–
Danielia olivera	+	–	–	+	–	+
Detarium microcarpum	–	+	–	–	–	–
Dichrostachys cinerea	+	–	–	+	–	–
Entada africana	+	+	–	++	–	–
Gardenia erubescens	+	++	–	–	–	–
Isoberlinia doka	–	–	–	–	–	–
Kigelia africana	+	+++	–	+	–	–
Lannea acida	+	–	–	+	–	++
Lannea microcarpa	+	–	–	+	–	++
Pericopsis laxiflora	+	–	–	+	–	–
Prosopis africana	+	+	–	++	–	–
Sclerocarya birrea	++	++	–	++	–	+++
Strychnos spinosa	+	+++	–	–	–	–
Syzygium guineense	+	+++	–	–	–	–
Tamarindus indica	+	+	–	+	–	–
Vitellaria paradoxa	–	–	–	+	–	+
Vitex doniana	+	–	–	+	–	–
Ziziphus mucronata	+	+	–	+	–	–

Source : Analyse des données de terrain l'auteur
+ : consommation faible
++ : consommation moyenne
+++ : consommation élevée
– : consommation négative

cia sieberiana, Adansonia digitata, Balanites aegyptiaca, Burkea africana, Cassia sieberiana, Crossopteryx febrifuga, Danielia oliveri, Detarium microcarpum, Dichrostachys cinerea, Diospyros mespiliformis, Entada africana, Isoberlina doka, Kigelia africana, Lannea acida, Lannea microcarpa, Parkia biglobosa, Pericopsis laxiflora, Piliostigma thonningii, Piliostigma reticulatum, Prosopis africana, Sclerocarya birrea, Strychnos spinosa, Tamarindus indica, Vitellaria paradoxa, Vitex doniana, entre autres.

Cette diversité d'espèces dans le régime alimentaire des éléphants contribue en grande partie dans la diversité des espèces au cours de la dissémination.

Les tableaux 1 et 2 illustrent parfaitement les différentes parties des espèces végétales apprécier par les éléphants selon la période de l'année.

Conclusion

Une bonne connaissance des écosystèmes devient de plus en plus indispensable pour une gestion communautaire durable de nos aires protégées. Depuis la conférence de Rio de Janeiro, plusieurs conventions ont été élaborées, adoptées et signées par les Nations Unies ; il s'agit dans ce cadre : de la convention de lutte contre la désertification, de la convention sur la diversité biologique où un accent particulier a été mis sur la recherche et la formation. Malgré ces grands efforts, certains Etats africains ne veulent pas s'y investir, d'où l'éternel problème de ne mener de manière continue et sur un même site des recherches écologiques. Le programme de suivi éco-éthologique des animaux sauvages qui a motivé la présente étude, dont les résultats offrent une opportunité pour mieux connaître et mieux gérer nos ressources naturelles est un exemple

Tableau 2. Liste des espèces et des différentes parties consommés par les éléphants de Juin à Janvier

Noms des espèces	Feuille	Fruit	Grains	Rameau	Racine	Ecorce
Acacia sieberiana	++	+++	++	++	–	–
Andansonia digitata	+++	+	–	+++	–	–
Balanites aegyptiaca	++	+++	–	+	–	–
Burkea africana	++	+	–	+++	–	+
Combretum glutinosum	++	+	–	++	–	–
Combretum molle	+	–	–	+	+++	–
Crossopteryx febrifuga	+	++	+	+	–	–
Danielia olivera	+	–	–	+	–	–
Detarium microcarpum	–	++	–	+	–	–
Dichrostachys cinerea	+	+	–	++	–	–
Entada africana	++	+	–	++	–	–
Gardenia erubescens	+	+	+	+	–	–
Isoberlinia doka	+	+	–	++	–	+
Kigelia africana	++	+	–	++	–	–
Lannea acida	++	+++	+	++	–	++
Lannea microcarpa	++	+++	–	++	–	++
Parkia biglobosa	++	+++	++	++		++
Pericopsis laxiflora	++	++	–	+	–	–
Prosopis africana	+	++	–	+	–	+
Sclerocarya birrea	++	+++	+	++	–	+
Strychnos spinosa	+	+++	–	++	–	–
Syzygium guineense	++	++	–	++	–	–
Tamarindus indica	+	+++	+	+	–	–
Vitellaria paradoxa	++	+++	+++	++	–	–
Vitex doniana	+	+++	–	++	–	+
Ziziphus mucronata	+	+	–	+	–	–

Source : Analyse des données de terrain l'auteur
+ : consommation faible
++ : consommation moyenne
+++ : consommation élevée
– : consommation négative

d'initiative qu'il faut soutenir et encourager pour une meilleure gestion du milieu-cadre dans lequel vit la faune et du milieu-ressource dont elle se nourrit.

Nous saisissons cette occasion pour lancer un appel à tous les acteurs du développement rural, à tous les partisans de la conservation de la diversité biologique tant au niveau national qu'international à soutenir nos travaux qui constituent un atout pour une gestion durable des ressources naturelles.

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Elephants as seed dispersal agents in Aberdare and Tsavo National Parks, Kenya

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Additional key words: elephant dung

Abstract

Various studies on elephants show that they perform several functions: they increase habitat mosaics in forests, diversify mammalian communities, promote biodiversity, play a vital role in maintaining links in food webs, and support many ecosystem functions and processes. This study aims to show the role of the elephant as an agent of seed dispersal. The results indicate that many plant species are dispersed by elephants and for some of these species elephants may be the obligate agents of dispersal. Removing elephants from their natural ranges or restricting their movements using electric fences may result in serious implications with far-reaching ecological impact on species diversity in the long term.

Résumé

Les différentes études réalisées sur les éléphants montrent qu'ils remplissent diverses fonctions : ils augmentent la mosaïque des habitats dans les forêts, diversifient les communautés de mammifères, accentuent la biodiversité, jouent un rôle majeur en maintenant des liens entre les réseaux alimentaires et supportent de nombreux processus et fonctions de l'écosystème. Cette étude tend à montrer quel est le rôle de l'éléphant comme agent de dispersion des semences. Les résultats montrent que de nombreuses espèces végétales sont dispersées par les éléphants ; pour certaines de ces espèces, les éléphants sont même des agents de dispersion incontournables. Le fait d'enlever les éléphants de leurs aires de répartition naturelles ou de limiter leurs déplacements par l'usage de clôtures électriques pourrait avoir de graves implications dont l'impact écologique à long terme se répercuterait sérieusement sur la biodiversité.

Introduction

Poaching of elephants in Kenya reduced the elephant population from 167,000 to about 20,000 between 1969 and 1989 (Cumming et al. 1990; KWS 1991). The onslaught resulted in numerous elephants withdrawing from many of their traditional ranges. In many districts, all elephants outside protected areas were exterminated (KWS 1991).

The absence of elephants from their natural ecosystems is likely to have far-reaching ecological consequences considering that they play a vital role in maintaining links in food webs and in supporting many ecosystem functions and processes. Various studies have shown that elephants increase habitat mosaics in forests (Kortland 1984), diversify mammalian communities (Western 1986) and promote biodiversity in general (Western 1989; Waithaka unpubl.; Mwathe 1997).

This study investigated the role of elephants in seed dispersal in the high-rainfall forests of the Aberdare Mountains and the semi-arid savanna grasslands of Tsavo National Park.

The study areas

Aberdares National Park has a population of over 4000 elephants and Tsavo has more than 8000. These parks are increasingly being isolated by the erection of electric fences and other barriers that are effec-

tively keeping elephants away from dispersal areas where they have been the chief ecological architects.

Aberdares National Park

Aberdares National Park is located in central Kenya, between latitudes 0° 08' S and 0° 42' S and longitudes 31° 31' E and 36° 55' E. The park is mountainous, with peaks rising up to nearly 4000 m. The centre of the park consists of high-altitude moorlands with deep gorges and magnificent waterfalls. Below the moorlands lie dense bamboo and montane forests. The park constitutes more than 10% of Kenya's forests (Doute et al. 1981) and holds a unique variety of wildlife and submontane to alpine vegetation (Schmidt unpubl.).

The boundaries of the 765.7-km^2 Aberdares National Park follow approximately the 3048 m contour line. However, a fingerlike projection called the Salient (67 km^2) stretches down to 1920 m. Rainfall ranges from 1000 to 2200 mm per year, with the amount increasing with altitude.

Tsavo

The Tsavo ecosystem is located in south-eastern Kenya between 2° and 4° S and 37° 30' and 39° 30' E. It comprises approximately 40,000 km^2 of arid bushland at an altitude of 200 to 1000 m. About 21,000 km^2 of the ecosystem are contained in the Tsavo National Parks. The landscape consists of flat plains, lying on various kinds of parent rock material. The climate is typically semi-arid with average annual rainfall of 200 to 700 mm, falling in two short seasons.

The semi-arid climate is reflected in the vegetation structure, which shows an open, woody canopy with varying degrees of cover. It consists mainly of deciduous species. The ground layer is composed mainly of some short and medium-tall perennial grasses and several annual grasses and herbs (Wijngaarden 1985).

Methods

One hundred fresh dung piles from each Aberdares and Tsavo National Parks were collected in 1991 during the long rainy season (between April and July).

The samples from Aberdares were collected from the forests, glades and bushlands in the Salient while the Tsavo samples were collected from Ndara and Irima areas. The samples were transported to a greenhouse at Kenyatta University where the environmental conditions that favour seed germination were simulated. The seeds in the dung germinated and the seedlings were monitored for about 90 days. The species were identified and categorized into herbs, shrubs or trees with assistance from the University of Nairobi Herbarium. Seedlings for each species from the dung collected from Aberdares National Park were counted.

Results

Tsavo

Eighteen plant species belonging to 12 families germinated from the samples obtained from Tsavo National Park (table 1). Three species were from the family Gramineae and two each from the families Acanthaceae, Amaranthaceae, Compositae and Cucurbitaceae. Out of the 18 species, 2 were shrubs and 1 a tree; the other 15 were herbs.

Aberdares

The species that emerged from the Aberdares samples were twice as many as those found in the dung

Table 1. Species from Tsavo that germinated from seeds in elephant dung

Species name	Family	Growth form
Acanthospermum hispidum	Compositae	herb
Amaranthus graecizana	Amaranthaceae	herb
Amaranthus hibridus	Amaranthaceae	herb
Barleria sp.	Acanthaceae	herb
Bidens pilosa	Compositae	herb
Boerhavia erecta	Nyctaginaceae	herb
Chloris roxburghiana	Gramineae	herb
Commiphora schimperi	Burseraceae	tree
Cucumis aculeatus	Cucurbitaceae	herb
Cucumis sp.	Cucurbitaceae	herb
Digitaria sp.	Gramineae	herb
Eragrostis ciliata	Gramineae	herb
Euphorbia inaequilatera	Euphorbaceae	shrub
Grewia virosa	Tiliaceae	shrub
Ipomoea spaltulata	Convolvulaceae	herb
Talinum sp.	Portulacaceae	herb
Tephrosia hildebrandtii	Papilionaceae	herb
Thunbergia guarkeana	Acanthaceae	herb

samples from Tsavo. They represented 19 families: seven Gramineae species, four Compositae and three each of Acanthaceae, Solanaceae and Urticaceae. The other families each had one or two species. Out of the 36 species, 27 were herbs, 6 were trees and 3 were shrubs (table 2). A total of 422 seedlings germinated from 100 dung piles from the Aberdares, with an average of about 4 species per dung pile.

It is notable that three families, Gramineae, Compositae and Acanthaceae, contributed the greater proportion of species dispersed by elephants in both areas (58% in Tsavo and 74% in Aberdares). Graminoids of the genera *Chrolis, Digitaria* and *Eragrostis* were the only grasses found in the dung samples in Tsavo. All three were also found in the Aberdares samples.

The results show that more plant species were dispersed by elephants in the Aberdares than in Tsavo. This may be explained by the difference in the overall species diversity between the two ecologically distinct areas (Waithaka 1994). Only one tree species was identified from Tsavo samples while the Aberdares samples had six tree species. *Ficus thonningii*, for which the elephant is an obligate seed dispersal agent (Brahmachary 1995), had the highest number of tree seedlings in the Aberdares samples.

Table 2. Plant species from Aberdares that germinated from seeds in elephant dung

Species name	Family	Growth form	Seedlings (no.)
Achyranthes aspera	Amaranthaceae	herb	11
Allophylus abyssinicus	Sapindaceae	tree	1
Barleria ventricosa	Acanthaceae	herb	7
Bidens pilosa	Compositae	herb	2
Cassipourea malosana	Rhizophoraceae	tree	1
Cerastium afromontanum	Caryophyllanceae	herb	6
Chloris virgata	Gramineae	herb	3
Convolvulus kilimandschari	Convolvulaceae	herb	3
Cynodon dactylon	Gramineae	herb	12
Cyperus rigidifolius	Gramineae	herb	4
Cyperus sp.	Cyperaceae	herb	1
Digitaria velutina	Gramineae	herb	9
Diospyros abyssinica	Ebenaceae	tree	2
Dovyalis abyssinica	Flacourtaceae	tree	1
Droguetia debilis	Urticaceae	herb	4
Eleusine jaegeri	Gramineae	herb	12
Eragrostis tenuifolia	Gramineae	herb	8
Ficus thonningii	Moraceae	tree	15
Galium spurium	Rubiaceae	herb	1
Hibiscus vitifolius	Malvaceae	shrub	1
Hypoestes verticillaris	Acanthaceae	herb	12
Justicia striata	Acanthaceae	herb	10
Lagunaria cylindrica	Cucurbitaceae	herb	8
Laportea alatipes	Urticaceae	herb	3
Microglossa pyrifolia	Compositae	herb	6
Oxalis corniculata	Oxilidaceae	herb	24
Pennisetum clandestenum	Gramineae	herb	4
Schefflera sp.	Araliaceae	tree	4
Senecio hadiensis	Compositae	herb	1
Sida cuneifolia	Malvaceae	herb	1
Solanum aceleastrum	Solanaceae	shrub	21
Solanum nigrum	Solanaceae	herb	5
Solanum schumannianum	Solanaceae	shrub	14
Stipa dregeana	Gramineae	herb	3
Tagetes minuta	Compositae	herb	2
Urtica massaica	Urticaceae	herb	200

Discussion

Although we attempted to collect samples from the existing habitats, the location of dung piles was unlikely to bias the results because elephants are known to forage widely within the study areas. Furthermore, considering that food in elephant gut is retained for an average of 33 hours (Spinage 1994), the habitat from which the dung was collected was not necessarily the source of the foliage.

This study shows that elephants are important agents of seed dispersal for many plant species. Although the study did not go into experimental detail to show whether elephants are obligate dispersal agents for particular species, the results highlight the importance of elephants in seed dispersal, in both high- and low-rainfall areas.

The potential for the elephants to disperse seeds in the Aberdares is high. A hundred dung piles produced 422 seedlings, an indication that the number of seeds dispersed in this manner was quite large, considering that there are over 4000 elephants in the area (MGM Envi-

ronmental Solutions 1999) and each defecates roughly 17 times a day (Barnes and Jenzen 1987). By extrapolation, elephants in the Aberdares have the potential of 'planting' 272,000 viable seeds daily in the park. Such dispersal at a much lower scale is true for Tsavo and may be the case for other intermediate rainfall areas.

Judging from this study, the loss of elephants in many parts of Kenya (KWS 1991) can be expected to have far-reaching consequences. The results indicate that many plant species that are dispersed by elephants—and for some of these species elephants may be the obligate agents of dispersal—are likely to be affected if elephants are exterminated or excluded from their habitats. This implies that, among other factors, the absence of elephants may create a species-poor community, negatively affecting species associations and other ecological processes.

The role of the elephant as an agent of seed dispersal has been discussed by a few authors. Alexandre (1978) found 21 out of 71 species he sampled in Tai Forest, Ivory Coast, were adapted to dispersal by elephants. Elephants have also been identified as important dispersal agents of *Balanites wilsoniana*. When they are absent, fruits that are generally toxic to other animal species rot and fail to germinate (Waring and Schlesinger (1985). Similarly, Jansen (1979) observed that *Simaba cedron* trees growing in tropical forests of Central America share fruit characteristics with *Balanites* and concluded that the present restricted distribution of *Simaba* was related to the extinction of the mastodons in the last 10,000 years.

Jansen and Martin (1982) suggested that megafaunal extinction in the Pleistocene resulted in loss of dispersal agents for a number of tree species in the central African dry forests, resulting in habitat impoverishment. Jansen (1981) made a similar case for the drier rangelands of Central America, where plants resilient to browsing by smaller ungulates have proliferated since the extinction of the megafauna. Owen-Smith (1987) advanced a key hypothesis to account for the cascade of extinctions among the smaller mammals during the Pleistocene, which saw the disappearance of 50% of the mammalian species. He suggested that the extermination of the megamammals had a domino effect as the vegetation closed up and eliminated the habitat for small mammals. He cited Hluhluwe Game Reserve in South Africa as a modern analogue where, since the elimination of the elephants a century ago, the local extinction of three grazers and a sharp reduction of several others to vulnerable levels coincided with the invasion of woody vegetation.

Seen in a larger context, the implication of losing elephants from their natural ranges may have far-reaching ecological impact in the long term. Removing elephants from areas where their interactions with ecosystem components have evolved over thousands of years may be extremely catastrophic. To avoid such eventualities, elephants should be recognized as a biological species that plays a key role in ecosystem functions, and every effort should be made to allow them to move freely. In many parts of Kenya where their survival is threatened by incompatible land-use practices, possibilities of initiating conservation programmes that promote coexistence between people and elephants should be explored. This would be more appropriate than the current widespread effort to restrict elephant movements using electric fences.

This paper does not explore several issues. For example, the rate of seed germination between field and experimental conditions could be different. Probably some of the seeds that germinated under experimental conditions would not have done so in the wild. Similarly, it would have been interesting to compare germination rates between the seeds of the same species that had gone through the digestive system with those that had not. However, plans are under way to undertake these studies.

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Elephants as seed dispersal agents in Arabuko-Sokoke Forest, Kenya

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Additional key words: *Loxodonta africana,* diet, fruits, germination, cultivated crops

Abstract

Seed dispersal by elephants (*Loxodonta africana*) in Arabuko-Sokoke Forest was studied by examining their dung piles for seeds or fruit remains and from seedlings that germinated from dung. Seeds were recovered from 64.5% of the elephant dung piles examined between August 1996 and October 1997. Seeds of 42 plant species were distinguishable in elephant dung. At least 52 plant species germinated naturally from elephant dung in Arabuko-Sokoke Forest. Seedlings of 84 plant species germinated from irrigated elephant dung. Our study showed that elephants are important seed dispersal agents in this ecosystem. Since cultivated crops comprise part of the elephant diet here, this constitutes a source of conflict with the local community.

Résumé

On a étudié la dispersion des graines par les éléphants (*Loxodonta africana*) dans la Forêt d'Arabuko-Sokoke, en examinant les restes de graines et de fruits dans les crottes et les jeunes plants qui y germaient. On a trouvé des graines dans 64,5% des crottes d'éléphants examinées entre août 1996 et octobre 1997. On a pu identifier des semences de 47 espèces végétales dans les crottes. Au moins 52 espèces végétales ont germé dans les crottes d'éléphants dans la forêt d'Arabuko-Sokoke. On a pu faire pousser des plants de 84 espèces en arrosant des crottes d'éléphants. Notre étude montre que les éléphants sont des agents importants pour la dispersion des semences dans cet écosystème. Etant donné que les plantes cultivées composent une partie du menu des éléphants, ceci constitue une source de conflit avec la communauté locale.

Introduction

Fruits form an important component of elephant (*Loxodonta africana* Blumenbach 1797) diet in forest environments (Wing and Buss 1970; Short 1983; Tchamba and Seme 1993; White et al. 1993; White 1994) and have a marked influence on their ranging patterns (Short 1983). Consequently, seeds of many plant species are found in elephant dung (Merz 1981; Tchamba and Seme 1993; White et al. 1993). Passage of seeds through an animal's gut increases the speed and probability of germination (Estrada and Coates-Estrada 1984; Idani 1986; Chapman et al. 1992; Wrangham et al. 1994). The quantity of seeds in elephant dung can reveal the importance of cultivated crops in elephants' diet (Tchamba and Seme 1993). Fruits are important in elephant diet in Arabuko-Sokoke Forest, and elephants may be playing an important role as seed dispersal agents in the forest.

Materials and methods

Study area

Arabuko-Sokoke Forest (fig. 1) is in Kilifi and Malindi Districts, Coast Province, Kenya at 3° 50' to 3° 10' S and 39° 50' to 40° E. It lies along the Mombasa–Malindi highway between Kilifi and Malindi towns and has an area of approximately 400 km^2 including forest plantations. The forest experiences two rainy seasons, the long rains (late March to June) and the short rains (October to December), with the annual mean rainfall ranging from 900 mm to 1100 mm. The driest period is between January and March. Monthly average temperatures range from 27° C to 30° C (Fairclough et al. 1995). The vegetation of the forest can be classified into three broad categories: *Brachystegia, Cynometra* and mixed forests (fig. 1). In addition, forest plantations cover 800 hectares. The forest supports a diverse fauna (Britton and Zimmerman 1979; Dreves 1992; Chira unpubl.; Fairclough et al. 1995).

Recovery of seeds from elephant dung

From August 1996 to October 1997, 736 elephant dung piles were examined for seeds and fruit fragments. Samples ranged from 27 to 85 dung piles per month.

Germination of seeds from elephant dung

Natural germination of seedlings in elephant dung. Seedlings that naturally germinated in 176 elephant dung piles were recorded in November 1996 and May 1997.

Germination experiments. From November 1996 to October 1997, 30 fresh elephant dung piles per month (33 in January and February 1997) were taken to the Kenya Forestry Research Institute tree nursery at Gede Forest Station. They were sown on individual plots and watered daily. The sample plots were inspected every week for about three months and the seedlings that germinated identified.

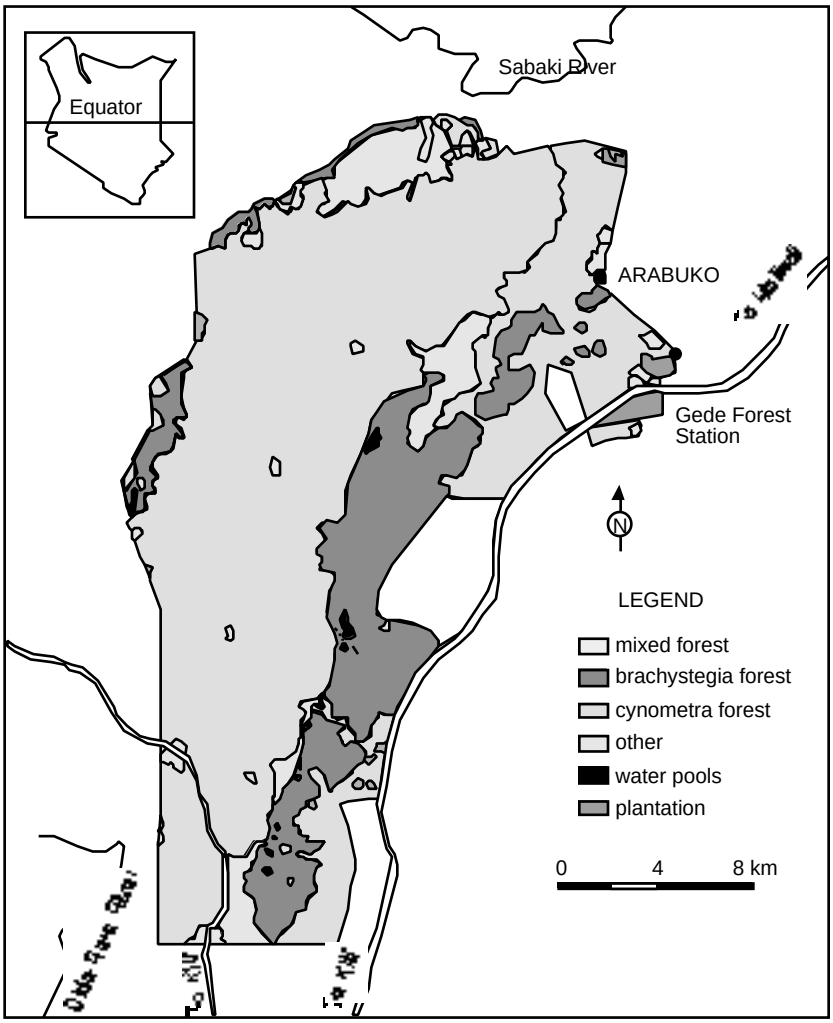

Figure 1. Map of Arabuko-Sokoke Forest showing vegetation types. Inset indicates the position of Arabuko-Sokoke Forest in Kenya.

Results

Prevalence and species diversity of seeds in elephant dung

Seeds were recovered from 64.5% (n = 736) of the elephant dung piles examined between August 1996 and October 1997. Seeds of 42 plant species were distinguishable in the dung (table 1). Plant species whose seeds occurred in dung frequently over the months were those of *Balanites wilsoniana* (11 months), *Grewia holstii* (7 months) and *Landolphia kirkii* (6 months). Fruit use was low from March to May 1997. In May 1997, none of the dung piles had fruit remains or seeds. Several cultivated crops constituted part of elephant diet in this period; these included maize (*Zea mays*), mango (*Mangifera indica*), cowpea (*Vigna unguiculata*) and cashewnut (*Anacardium occidentale*).

Germination of seeds from elephant dung

At least 52 species germinated naturally from the elephant dung in Arabuko-Sokoke Forest (table 2). However, some of the seedlings could not be identified to species level because they were damaged before they were big enough to be positively identified. Seeds of *Kedrostis leloja* germinated 22%, *Grewia holstii* 20%, *Rytigynia* spp. 19% and *Carica papaya* 11%. Cultivated crops that germinated naturally from the elephant dung were papaya, watermelon and pigeonpea (*Cajanus cajan*); under improved nursery conditions, 84 plant species germinated (table 3). The number of species that germinated was lowest from February 1997 to July 1997 and again in October 1997. Seedlings of cultivated crops that germinated included guava (*Psidium guajava*), papaya (*Carica papaya*), mango, cashewnut, maize, watermelon (*Citrullus lanatus*) and cowpea.

Discussion

In our study, seeds or fruit remains were recovered in 64.5% (n = 736) of all the dung piles examined. Other studies show a similar situation. For example, 82% (n = 311) of the dung piles examined at Lopé Reserve, Gabon, contained fruit remains (White et al. 1993). In that study, elephants fed on fruits of 72 plant

Table 1. Frequency at which seeds were recovered from elephant dung from August 1996 to October 1997 in Arabuko-Sokoke Forest (n = 736 dung piles)

Plant species	Dung piles with seeds (%)	Plant species	Dung piles with seeds (%)
Grewia holstii	19.6	*Strychnos panganensis*	0.7
Balanites wilsoniana	13.7	*Tephrosia pumila*	0.5
*Mangifera indica**	13.7	*Lecaniodiscus fraxinifolius*	0.5
Landolphia kirkii	7.1	*Vitex ferruginea*	0.3
Psychotria amboniana	5.6	*Salacia* spp.	0.3
Manilkara sulcata	4.3	*Cajanus cajan**	0.3
*Zea mays**	3.9	*Commelina* spp.	0.3
Croton pseudopulchellus	3.5	*Crotalaria laburnifolia*	0.1
Uvaria acuminata	3.0	*Dichrostachys cinerea*	0.1
Rytigynia spp.	3.0	*Grewia stuhlmannii*	0.1
Strychnos spinosa	1.8	*Carica papaya**	0.1
Grewia plagiophylla	1.8	*Strychnos madagascariensis*	0.1
*Anacardium occidentale**	1.8	*Heinsia crinata*	0.1
Monanthotaxis fornicata	1.6	*Brachystegia spicaeformis*	0.1
*Vigna unguiculata**	1.4	*Kedrostis leloja*	0.1
Cissus spp.	1.0	*Drypetes reticulata*	0.1
Tamarindus indica	0.8	Unidentified (7 species)	
Acacia brevispica	0.8		

* cultivated crop. Unidentified species were distinguished as different species based on characteristics like morphology, colour and texture.

Table 2. Seedlings that germinated naturally from elephant dung in Arabuko-Sokoke Forest (*n* = 176 dung piles)

Plant	Seeds (no.)	Piles with seeds (%)
Acacia brevispica	1	0.6
*Anacardium occidentale**	1	0.6
Balanites wilsoniana	4	0.6
Boerhaavia spp.	2	0.6
*Cajanus cajan**	1	0.6
*Carica papaya**	38	10.8
Cissus spp.	7	2.3
*Citrullus lanatus**	7	2.3
Commelina spp.	55	9.1
Croton pseudopulchellus	41	1.1
Flueggea virrosa	7	4.0
Grewia holstii	115	19.9
Grewia sulcata	18	3.4
Indigofera trita	3	1.1
Kedrostis leloja	147	22.2
Manilkara sulcata	1	0.6
Phyllanthus reticulata	1	0.6
Rytigynia spp.	552	18.8
Solanum incanum	19	5.7
Strychnos spinosa	6	3.4
Tephrosia pumila	11	4.5
Tremnus labialis	6	2.8
Unidentified (30 species)	87	

* cultivated crop. Unidentified species were distinguished as different species based on characteristics like morphology, colour and texture.

species. Merz (1981) found that elephants at Tai National Park, Ivory Coast, fed on fruits of 44 plant species. Short (1983) documented large-scale migration of elephants in response to seasonal fruiting patterns. At Santchou Reserve, Western Cameroon, 65% of all dung piles examined (*n* = 250) had some trace of fruits with 22 plant species being recorded (Tchamba and Seme 1993).

The large number of plant species whose seeds were found in elephant dung and that germinated implies that elephants contribute to seed dispersal in Arabuko-Sokoke Forest. However, germination success for *Balanites wilsoniana* was low. Its seeds were encountered in 20% (*n* = 736) of all dung piles examined but germinated naturally in only one (*n* = 176 dung piles); even under improved conditions, its seeds germinated in only five (*n* = 366). Chapman et al. (1992) demonstrated that passage of these large seeds through elephants greatly improved their germination success. Further research on the dispersal and germination of this seed in the forest is needed.

Other studies have shown that mammals are important seed-dispersal agents in tropical forests (Estrada and Coates-Estrada 1984; Chapman et al. 1992; White 1994; Feer 1995). Seed-dispersing mammals concentrate seeds of diverse plant species in their dung (Tchamba and Seme 1993; White et al. 1993; Wrangham et al. 1994; Remis 1997). Passage of seeds in animal gut increases their speed and probability of germination. This has been demonstrated in many animals including howler monkeys (Estrada and Coates-Estrada 1984), birds (Barnea et al. 1990), elephants (Chapman et al. 1992), pygmy chimpanzee (Idani 1986), baboons (Lieberman et al. 1979), chimpanzees (Wrangham et al. 1994) and gorillas (Voysey et al. 1999 a,b). Some plant species rely almost exclusively on one animal disperser (Chapman et al. 1992; White 1994). It is important to find out whether there are plant species in the forest that are exclusively dispersed by elephants. This would help in designing conservation policies for the forest.

Seeds from maize, cowpea, cashewnut and mango were recovered from elephant dung, and seedlings of guava, papaya, mango, cashewnut, maize, watermelon, and cowpea were germinated. This substantiates community claims that elephants do invade their cultivated crops. Examination of elephant dung and germination of seedlings from it can provide useful information about the role of cultivated crops in elephant diet.

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Table 3. Plants that germinated from irrigated elephant dung in Arabuko-Sokoke Forest from November 1996 to October 1997 (*n* = 366)

Plant species	T	Pw (%)	Plant species	T	Pw (%)
Landolphia kirkii	463	15.0	*Hibiscus* sp.	7	0.8
*Psidium guajava**	103	6.3	*Indigofera hirsuta*	7	1.4
Tremnus labialis	97	1.9	*Polysphaeria parviflora*.	6	1.1
Flueggea virosa	73	8.2	*Garcinia livingstonei*	5	1.4
Hoslundia opposita	59	1.9	*Ximenia americana*	5	0.3
Ficus sycomorus	57	12.6	*Cajanus cajan**	5	0.3
Solanum incanum	57	6.6	*Anacardium occidentale**	4	0.8
Strychnos spinosa	56	4.6	*Haplocelum inopleum*	4	0.8
Trema orientalis	49	9.0	*Chamaecrista* sp.	4	0.8
Rhynchosia spp.	44	4.9	*Indigofera vohemarensis*	3	0.6
Kedrostis leloja	42	4.6	*Ipomoea* spp.	3	0.6
Salacia spp.	42	0.8	*Manilkara sulcata*	3	0.6
Commelina spp.	40	6.6	*Asystasia gengetica*	3	0.8
Drypetes reticulata	40	3.4	*Mundulea sericea*	2	0.6
Grewia holstii	33	5.7	*Hibiscus micranthus*	2	0.6
Cissus spp.	24	6.0	*Acacia adenocalyx*	2	0.3
Agathisanthemum bojeri	22	3.3	*Maerrua tryphylla*	2	0.3
*Carica papaya**	22	1.9	*Zea mays**	2	0.6
Indigofera trita	21	3.3	*Vigna unguiculata**	2	0.6
Bourreria petiolaris	20	4.1	*Manilkara zansibarensis*	2	0.6
*Citrullus lanatus**	20	2.5	*Teclea trichocarpa*	2	0.6
Metaporana densifloria	19	1.6	*Nesogordonia africana*	1	0.3
Phyllanthus reticulatus	15	2.5	*Ficus tremula*	1	0.3
Celosia hursuta	15	1.9	*Dichrostachys cinerea*	1	0.3
Acacia brevispica	13	1.1	*Abutilon mauritianum*	1	0.3
Tephrosia pumila	13	2.7	*Psychotria amboniana*	1	0.3
Balanites wilsoniana	13	1.4	*Kitia* spp.	1	0.3
Monanthotaxis fornicata	12	2.2	*Crotalaria laburnifolia*	1	0.3
Allophyllus alnifolius	8	0.8	*Ruellia prostrata*	1	0.3
*Mangifera indica**	8	1.4	*Rytigynia* sp.	1	0.3
Guatenbergia pembensis	7	1.6	Unidentified species (23 species)	104	

T – number of seedlings that germinated; Pw – percentage of dung piles in which seedlings germinated; * cultivated crop. Unidentified species were distinguished as different species based on characteristics like morphology, colour and texture.

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Erratum: In issue no. 29, p. 50, table 1 of the field note 'Population estimate of elephants in Arabuko-Sokoke Forest': the range for elephants in the first row of the last column should read 111–144 (not 111–114).

A new method for implanting radio transmitters into the horns of black and white rhinoceroses

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Abstract

The most successful method of attaching radio transmitters to both white and black rhinoceroses has been to implant them into either the anterior or the posterior horn of the animals. This paper describes a procedure by which the transmitter plus the antenna is implanted inside the anterior horn, thereby protecting them from being damaged through horn rubbing. Transmitters placed following this procedure were still functioning 22 months after being implanted.

Resumé

La méthode la plus efficace pour attacher un émetteur radio aux rhinocéros, tant blancs que noirs, consiste à l'implanter à l'intérieur de la corne antérieure ou postérieure de l'animal. Cet article décrit un procédé grâce auquel l'émetteur et l'antenne sont implantés dans la corne antérieure, ce qui les protège lorsque l'animal se frotte les cornes. Les émetteurs placés de cette façon fonctionnaient encore 22 mois après leur implantation.

Introduction

The factors that influence the movements of subadult white rhinos (*Ceratotherium simum simum*) in the Umfolozi Game Reserve were the purpose of a study started in April 1999. To achieve the aims of the study, we found it necessary to use radio telemetry to locate specific subadults at regular intervals.

Radio telemetry has been used previously in research projects on both black (*Diceros bicornis*) (Anderson 1971; Anderson and Hitchins 1971; Hitchins 1971; Pienaar and Hall-Martin 1991) and white rhinos (Owen-Smith 1971). Previously transmitters have been attached by using collars or ear tags or through implanting the transmitter into either the anterior or the posterior horn. The shape of the neck of both black and white rhinos, however, has made attaching and using radio collars problematic (Hofmeyr 1998). A rhino's head is smaller than its neck, and thus the collar slips over the rhino's head and falls off (Anderson and Hitchins 1971). If the collar is attached tightly, it may be prevented from slipping off, but it may cause lesions on the animal's neck (Hofmeyr 1998). Eartag transmitters have also been tried, but they are suitable only in small reserves that use aerial telemetry (Hofmeyr 1998).

The method that has had the most success and is most widely used with rhinos has been to implant the transmitter into either the anterior or the posterior horn (Anderson 1971; Anderson and Hitchins 1971; Hitchins 1971; Owen-Smith 1971; Pienaar and Hall-Martin 1991). Early studies implanted transmitters into the posterior horn as it was felt that the anterior horn should not be damaged because it was the rhino's main

weapon (Anderson and Hitchins 1971). However, recent implantations of transmitters into the anterior horn have not weakened the horn or compromised the rhino's ability to use it (Pienaar and Hall-Martin 1991).

The implantation method discussed in this paper adapts the method described by Pienaar and Hall-Martin (1991) but improves on it by addressing two problems: 1) damage to the transmitter antenna if the rhino extensively rubs its horn, and 2) the difficulty associated with routing grooves up the back of the rhino's anterior horn.

Methods

The equipment used consisted of a 750-watt drill, two drill bits, a tungsten hinge-rebating bit 35 mm in diameter, and an 8-mm bit that was 300 mm long with the flute along the whole bit (fig. 1), a portable petrol generator, a hacksaw with 18 or 24 teeth per 25 mm in the blades, dental acrylic, and the radio transmitters that were to be inserted (fig. 2).

For the white rhino movement study, MOD-125 transmitters from Telonics[1] were used. To insure that the antennae would fit into the short anterior horns of the subadults, we reduced the transmitter antennae to 250 mm (10"). The shortened antennae, however, reduced the range of the transmitters. To compensate for this, the amperage of the transmitter was increased to 18 mA. As the study was to be conducted over a two-year period, the battery life of the MOD-125 transmitter, which is 9 to 18 months, had to be increased. This was achieved by duty cycling the transmitter so that it was on for 15 hours (0400–1700) and off for 9 hours (1700–0400). This adjustment resulted in a projected battery life of 22.7 months.

We drilled a 35-mm hole (the transmitter chamber) horizontally into the side of the anterior horn using the hinge-rebating bit powered by the portable generator (fig. 3). To prevent the drill bit from becoming jammed inside the horn, we removed it periodically when drilling. This removed any excess horn shavings and thus kept the hole clear. The transmitter chamber was drilled so that it sat at approximately 90 degrees in relation to the side of the horn (fig. 4a). We determined where to locate the chamber by measuring the diameter of the base of the horn, dividing this distance in half (thus obtaining the radius), and then using the radius as the distance between the bottom of the horn and the lowest point of the transmitter chamber (fig. 5). The minimum radial distance must be 7 cm, even if the diameter of the horn is less than 14 cm. This is because 7 cm is the minimum safe distance, for both subadult and adult rhinos, to avoid drilling into the bone of the skull or into the

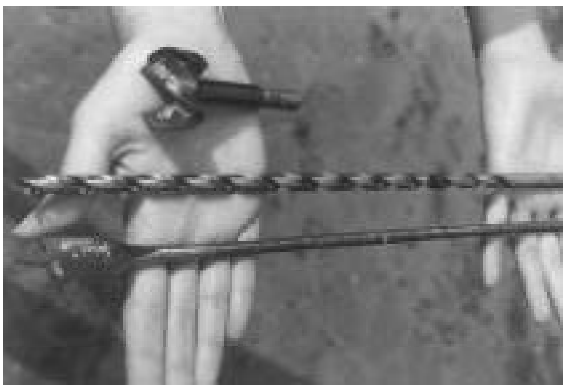

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Figure 1. Hinge-rebating (top), 300 x 8-mm (centre) and 19-mm spade drill bits used in the implantation procedure. A standard 19-mm bit similar to the 300 x 8-mm bit is recommended over spade bits (as pictured), as the shaft on a spade bit can bend.

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Figure 2. MOD-125 (above) and MOD-050 (below) radio transmitters, which are implanted into the horns of rhinos.

[1] Telonics, 932 E. Impala Ave., Mesa, AZ, USA; tel: +1 480 892 4444; www.telonics.com

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Figure 3. Drilling the transmitter chamber into the anterior horn of a white rhino.

germinal layer of tissue, which lies between the bone and the horn (Peter Morkel pers. comm. April 2001).

If the animal had a long horn, we used a distance a little greater than the radius to prevent drilling into the germinal layer of tissue for the transmitter chamber. The transmitter chamber was drilled so the transmitter, once inserted, would sit centrally with a minimum distance of 20 mm from the end of the transmitter to the edge of the horn (fig. 4a).

Once the transmitter chamber was drilled, we removed the tip of the horn using a hacksaw to provide a flat surface from which to drill the antenna chamber (fig. 4a, b). Factors that influenced the amount of horn that needed to be removed were the length of the 8 x 300-mm drill bit and horn curvature. In horns that were relatively straight, only the length of the bit determined the amount of horn that was removed. However, with horns that had a high curvature, precisely how to position the antenna chamber was the main factor that influenced the amount of horn to be removed. The antenna chamber was drilled so that it would run through the middle of the horn down into the transmitter chamber (fig. 4a, b, fig. 6.).

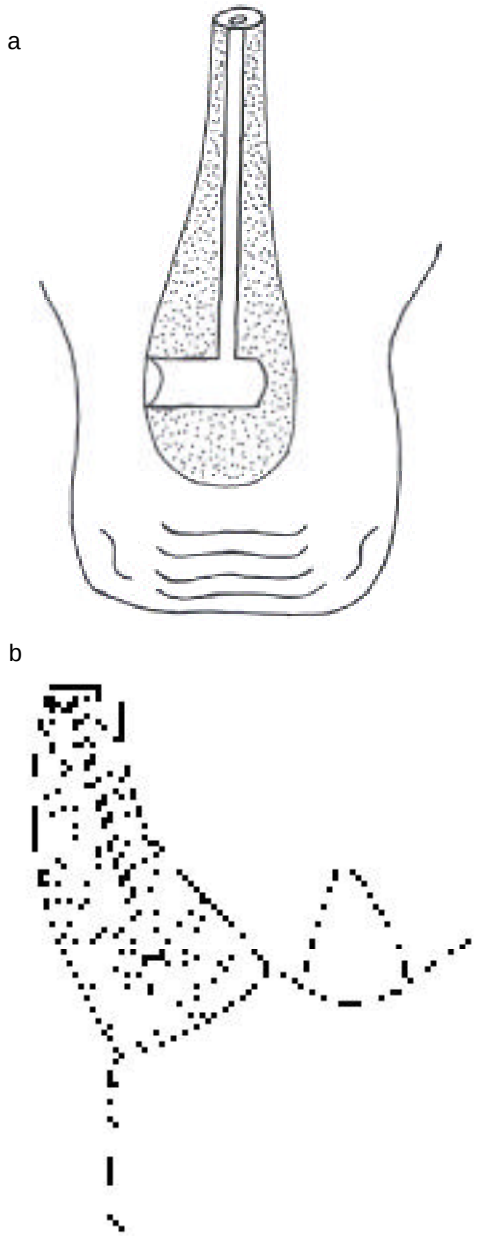

Figure 4 (a and b). Front (a) and side (b) views of anterior horn showing how both the transmitter and the antenna chambers are placed for MOD-125 and MOD-080 transmitters.

After blowing the dust out of both chambers, we placed the transmitter into the horn by feeding the antenna through the transmitter chamber up into the antenna chamber and then pushing the transmitter into the transmitter chamber. The transmitter was positioned with the side where the antenna was attached to the transmitter towards the centre of the horn.

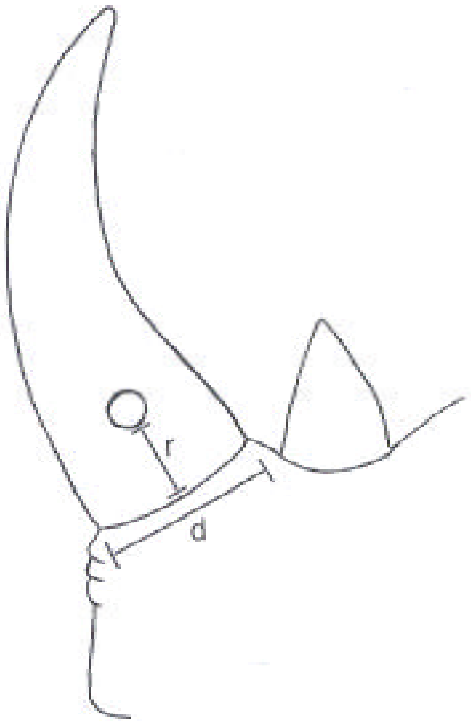

Figure 5. Side view of a white rhino's anterior and posterior horns showing how the transmitter chamber is placed in the anterior horn. The chamber is drilled so that the distance separating the bottom of the horn from the bottom of the chamber (the radius (r)) is a minimum distance of 7 cm. This minimum distance is used even if the diameter (d) of the horn is less than 14 cm.

Both chambers were then filled with dental acrylic, poured into both chambers while it was fluid. The acrylic took approximately 30 to 45 minutes to solidify and harden. To prevent it from draining out before then, we dammed up the transmitter chamber by wrapping masking tape around the horn. When both chambers were filled, we completely covered both holes with masking tape before reviving the animal. The entire implantation procedure took approximately 20 minutes from the moment the unconscious rhino was approached until it was revived.

The horns of black rhinos are smaller than those of white rhinos, so either the Telonics MOD-080 (33 x 18 x 23 mm) or the MOD-050 (cylindrical, 17 mm diameter x 56 mm; fig. 2) with a 213-mm (8.5") antenna can be used. For the MOD-080 a smaller diameter tungsten hinge-rebating bit is used to drill the transmitter chamber (as in fig. 4a, b). For the MOD-050, however, we used a drill bit of 19 x 300 mm to drill a single chamber (transmitter and antenna combined) from the tip into the centre of the anterior horn (fig. 7a, b). The transmitter was then placed in the chamber and the chamber filled with dental acrylic.

When the MOD-050 transmitter is placed into the chamber it should not be placed so that the top of the transmitter (where the antenna is attached) is toward the centre of the horn with the antenna bent so that it runs back up the side of the transmitter. If the antenna touches the transmitter, it effectively shortens the length of the antenna and thus reduces the signal range.

Both the MOD-080 and the MOD-050 have a shorter battery life than the MOD-125 (MOD-080, 6–8 months; MOD-050, 4–6 months) and thus which

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Figure 6. Drilling the antenna chamber down through the middle of the anterior horn of a white rhino.

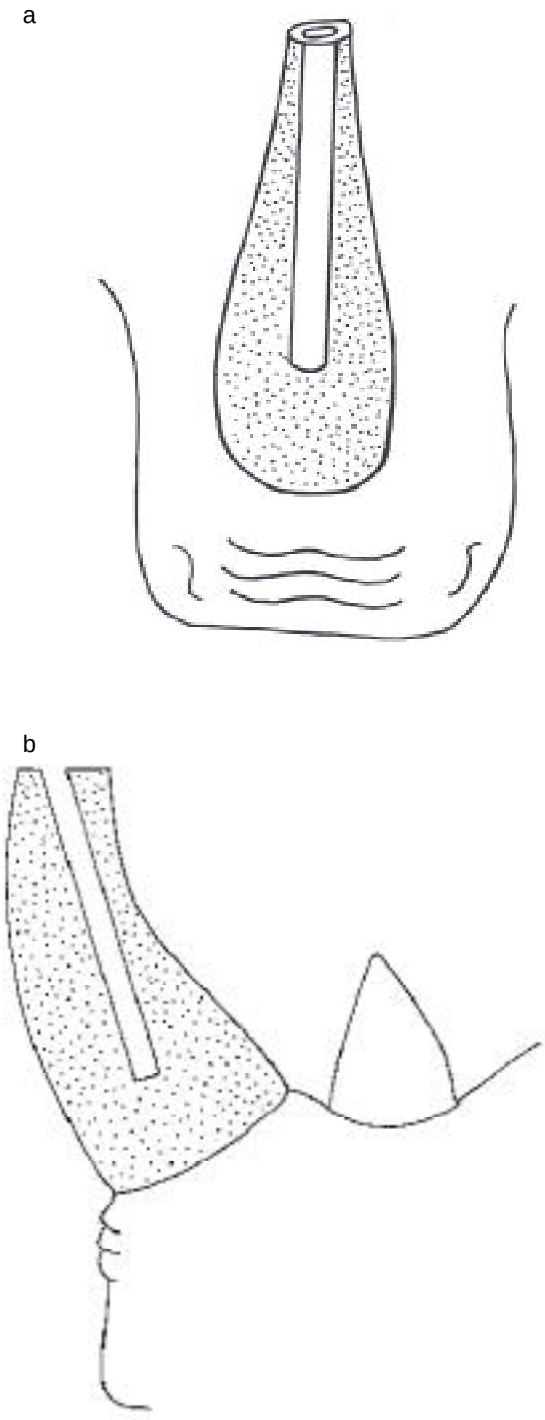

Figure 7 (a and b). Front (a) and side (b) views of anterior horn showing how the combined transmitter and antenna chamber for the MOD-050 transmitter is placed.

transmitter is used will depend on how long the animal is to be monitored. However, like the MOD-125, the battery life of both transmitters can be extended through duty cycling.

Discussion

All the rhinos used in the study had rubbed the masking tape off their horns within two days of implantation and the dental acrylic had dried. An added advantage of wrapping the horn with masking tape was that animals that already had radio transmitters implanted could easily be spotted from the helicopter and thus were not redarted.

Despite the shortened lengths of the transmitter antennae, rhinos were located easily from the ground with signal ranges between 5 and 8 km, the longest at approximately 12 km. This study, however, was conducted in open rolling savanna (Natal lowveld bushveld; Low and Rebelo 1996). In Addo Elephant Park, the range of implanted transmitters was less because of thicker vegetation (xeric succulent thicket; Low and Rebelo 1996), with signal ranges of only 3 to 4 km on foot and 6 to 8 km from the air (Michael Knight, pers. comm. April 2001).

After 22 months all 10 transmitters that had been implanted were still functioning. Observations made of each individual showed no noticeable signs of damage either to the dental acrylic covering the transmitters or to the horns. A problem with the Pienaar and Hall-Martin (1991) method was that by placing the transmitter's antenna in a groove up the back of the anterior horn, the rhinos could rub through the dental acrylic and damage the antenna. If, however, the antenna is placed up through the middle of the horn, rubbing cannot damage it. The second concern with the Pienaar and Hall-Martin (1991) method was that routing up the back of a horn with large curvature could be extremely difficult and time consuming. Eliminating this aspect of the procedure and placing the antenna up through the middle of the horn reduces the time required to conduct the procedure and thus the time required to keep the rhino sedated.

As with the Pienaar and Hall-Martin (1991) method, implanting a transmitter using this method is an irreversible procedure. Once the dental acrylic has hardened, the transmitter cannot be replaced or removed. The only way a new transmitter can be placed in the same animal is if the previous transmitter has grown

out of the horn. However, as the intrinsic anterior horn growth of both white and black rhinos is only between 36.5 and 59.9 mm annually (Pienaar et al. 1991), it is unlikely that implanting a second transmitter will be a viable option for most studies.

In this study, the MOD-125 proved to be too large for subadult white rhinos that were five years of age or younger. In future, a smaller transmitter, possibly one of the ones used for black rhinos, will be used.

Acknowledgements

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Closing down the illegal trade in rhino horn in Yemen

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Abstract

This study of Yemen's rhino horn trade showed that, for the first time since surveys started in 1978, no new rhino horns were being made into dagger (*jambiya*) handles in the Sanaa souk. This is a major conservation success as Yemen until recently was a main end-market for African rhino horn. Rhino horn traders complained that the government ban on rhino horn imports had harshly affected their business. Despite the lack of rhino horn on the Yemeni market, prices have not risen, strongly suggesting a sharp decline in demand. The wholesale price for rhino horn in Djibouti (which acts as an entrepot for Yemen) remains the same since the late 1990s at USD 700/kg, and the price offered for rhino horn by jambiya makers in the Sanaa souk is USD 1300/kg, slightly less than in the previous year. This is because Yemenis are not prepared to pay more for a jambiya with a new rhino horn handle as the per capita income in the country has continued to fall and people have become cautious about spending money. Furthermore, jambiyas with older rhino horn handles are still available. If customers have money to spare, they prefer jambiyas with older rhino horn handles, as compared with those having new rhino horn, as they regard these as more prestigious and a better investment. At the cheaper end of the market, more jambiyas with handles made of horn from the Indian domestic water buffalo are being made and offered for sale in Sanaa compared with five years ago as the human population steadily expands. Efforts to provide information on the plight of the rhino were initiated in Sanaa with posters and other educational materials dispersed in schools and public places as a start towards improving public awareness to reduce the demand for new rhino horn further.

Résumé

Cette étude du commerce de corne de rhino au Yémen a montré que, pour la première fois depuis le début des enquêtes en 1978, aucune nouvelle corne de rhino n'avait été transformée en manche de poignard (*jambiya*) dans les souks de Sanaa. C'est un succès majeur pour la conservation étant donné que le Yémen était jusqu'il y a peu une importante destination finale pour les cornes de rhinos d'Afrique. Les marchands de cornes de rhinos se sont plaints que le ban gouvernemental imposé sur les importations de cornes avait durement affecté leurs affaires. Malgré le manque de corne de rhino sur le marché yéménite, les prix n'ont pas augmenté, ce qui laisse supposer une diminution radicale de la demande. Le prix de gros des cornes de rhinos à Djibouti (qui sert d'entrepôt pour le Yémen) est resté constant depuis la fin des années '90, à US$ 700/kg, et le prix qu'offrent les fabricants de jambiyas dans les souks de Sanaa est de US$ 1300/kg, légèrement inférieur au prix de l'année dernière. La raison en est que les Yéménites ne sont pas disposés à payer davantage pour une jambiya avec un nouveau manche en corne de rhino étant donné que le revenu *per capita* a continué à baisser dans le pays et que les gens réfléchissent plus avant de dépenser leur argent. Qui plus est, il reste sur le marché des jambiyas avec de vieux manches de corne. Si les clients ont un peu d'argent de côté, ils préfèrent acheter ces derniers plutôt que ceux dont le manche est neuf parce qu'ils les considèrent comme plus prestigieux, et donc comme un meilleur investissement. Meilleur marché, on trouve à Sanaa des jambiyas dont le manche est fait de corne des buffle d'eau domestiqués en Inde, mis en vente en plus grand nombre qu'il y a cinq ans parce que la population s'accroît rapidement. On a fait des efforts à Sanaa pour fournir des informations sur le sort des rhinos, au moyen de posters et d'autres supports éducatifs distribués dans les écoles et les lieux publics, afin de commencer à améliorer la sensibilisation publique et de réduire ainsi davantage la demande pour des nouvelles cornes de rhinos.

Introduction

Since the early 1970s, Yemen has been the largest importer of rhino horn in the world (Martin et al. 1997), where the horn is used for the handles of traditional curved daggers. Small quantities of the horn are still being smuggled into Yemen from eastern and central Africa. It is thus important to continue pressure against the illegal rhino horn trade, encourage the use of alternative materials and monitor the *jambiya* (dagger) industry.

Methods

We collected information, sometimes with the help of informers, on various issues. Trade routes for rhino horn reaching Yemen from Africa were investigated to ascertain whether any new routes or new main buyers are emerging. Data were collected on the price of rhino horn, quantities coming into the country, numbers of jambiyas being made, numbers of workers and workshops, and the prices of jambiyas with different handles, mainly in Sanaa, the centre of the jambiya industry. Certain towns in the north and south of the country were also surveyed.

Alternative materials to rhino horn for dagger handles were promoted. A public awareness campaign was initiated on the plight of the rhino; pictures, posters, slide packs, and videos were distributed to schools and institutions.

We held discussions with the prime minister of Yemen, Dr Abdul Karim al-Iryani, concerning legislation to discourage further rhino horn trade. Penalties with a fine or a prison sentence are needed for people still found to be importing rhino horn or using new rhino horn to make jambiya handles, and the main Sanaa souk where jambiyas are made and sold should be inspected regularly to deter further use of new horn.

Results

Rhino horn trade investigations and monitoring

From discussions with the main jambiya-trading family in Yemen, we learned that Djibouti remains the major entrepot for rhino horn from eastern Africa to Yemen. Traders say that rhino horn can be smuggled from Mombasa by boat or by train from Addis Ababa to Djibouti. From there it is smuggled by boat across the Red Sea to the Yemen coast and then transported by four-wheel-drive vehicle to Sanaa. Many goods are smuggled from Djibouti to Yemen, and rhino horn pieces can be easily concealed. Controls to prevent smuggling are weak, and the main trading family in Sanaa can buy rhino horn from Djibouti. In early 2001 the price the family offered was USD 700/kg. This is the same price as in 1999 (Vigne and Martin 2000). If the horn was brought directly to Sanaa, the family offered USD 1300/kg. From 1985 to 1997 the price for rhino horn in Sanaa remained between USD 1000 and USD 1200/kg but rose to USD 1400/kg in 1999 (see table 1). The price has stayed roughly the same despite the increasing scarcity of rhino horn on the market. Traders are unwilling to pay more than USD 1300/kg today in Sanaa, partly because of the poor economic climate of the country. According to Yemen government statistics, per capita income fell throughout the 1990s. In 1990 it was USD 696, in 1993 it was USD 409, and by 1999 it had fallen to USD 368 (Yemen 2000a). However, the Yemeni rial has remained stable at 165 to the US dollar since 1999.

No new main buyers of rhino horn have come onto the jambiya market in Sanaa. The industry continues to be dominated by one family based in Sanaa,

Table 1. Prices paid by the main jambiya merchants in Sanaa for raw rhino horn, 1980–2001

Year	Price per kilogram	
	Yemeni rials	US dollars
1980	3,500	766
1981	3,500	766
1982	3,600	788
1983	4,100	897
1984	4,300	782
1985	8,300	1122
1986	10,000	1031
1987	ca 12,000	ca 1039
1988	ca 12,400	ca 1035
1989	ca 13,000	ca 1040
1990	15,000	1042
1991	30,000	1220
1993	ca 60,960	ca 1200
1995	135,000	1200
1997	ca 152,400	ca 1200
1999	182,000	1400
2001 (Jan.)	214,500	1300

Source: surveys taken by the authors

Lucy Vigne

A jambiya trader in Amran, north of Sanaa, holds up his own dagger, which he offered to us at USD 12,000.

which laments the loss of the rhino horn trade, blaming wildlife conservationists. Handles made from water buffalo horn, the only alternative substance this family claims it now uses, they say is far less profitable. Imported from India, one cut piece of water buffalo horn the size of a cigarette pack and weighing 150 to 250 g costs USD 0.25 to 0.50, and once made into a handle it is priced at only a dollar. Plastic pieces for handles imported from Taiwan, which a few craftsmen use, cost only USD 0.15 each before being crafted into a handle, so these too provide little profit. Rhino horn handles, apart from being valuable in themselves, were also used to provide extra profits as the waste was sold. The traders still are waiting for permission to sell their remaining large stocks of rhino horn chips and shavings, left over from the handle-making process, that they registered with the government in 1993. We learned, however, that an Indian businessman living in Hong Kong who also has enterprises in Oman and Dubai comes several times a year to Yemen to buy the highest quality chips from the main jambiya family in Sanaa for USD 600/kg. Powder is worth less than chips, because powder gets mixed with dirt during filing; the Indian trader buys it for USD 400/kg (table 2).

During our 14-day visit to Yemen in January 2001, we saw no new rhino horn being made into dagger handles—for the first time in 14 survey visits to Yemen since 1978. The production of new rhino horn handles has decreased to its lowest level since 1970. However, the growing human population in Yemen means that jambiya- making in general continues unabated. Yemen's population was 11.9 million in 1991, and by 1999 it had reached 17.7 million with an annual population growth rate of 3.5% (Yemen 2000b). The main trading family estimates that in the Sanaa old souk, 300,000 water buffalo horn, 30,000 wood and 4000 plastic handles are made each year. Half the 40 or so handle makers in the souk are members of this family or are employed by the family, and they employ another 40 or so blade makers. In January 2001, we counted 69 shops (half of which belong to this family) open at any one time in the Sanaa old souk and 101 workers making and repairing jambiyas (table 3). These figures have slightly increased in the last decade. This is because, although buffalo horn handles take far less time

Table 2. Wholesale prices of rhino horn shavings (chips and powder) in Sanaa, 1978–2001

Year	Price per kilogram	
	Yemeni rials	US dollars
1978	1,000	200
1983	1,000	219
1986	2,454	253
1990	4,896	340
1993	20,000–30,000	394–590
1994	38,500	500
1995	60,375	525
1999	84,500	650
2001 chips	99,000	600
2001 powder	66,000	400

Source: surveys taken by the authors

Table 3. Jambiya shops with craftsmen working on jambiya handles in the Sanaa old souk, 1971–2001

Year	Workshops (no.)	Craftsmen (no.)
1971	47	?
1983	41	61
1986	51	84
1989	57	87
1993	56	91
1994	65	92
1995	55	88
1999	59	100
2001 (January)	69	101

Source: surveys taken by the authors; for 1971, Dostal (1983)

to make than handles of rhino horn, the craftsmen are producing many more for the growing population, so they are kept employed, even if profits are not as great as when rhino horn was readily available. As expected, prices of daggers with different handles have remained about the same as two years ago (table 4).

In the main jambiya retail section of the Sanaa old souk, fewer shops were selling daggers in 2001 than in 1999. Several shops that previously sold rhino horn daggers are now selling men's Arabic cotton clothing instead. The tables that used to line the central area of this market displaying jambiyas with rhino horn handles have gradually dwindled in number over the last 10 years until there are none today. Most of the remaining retail shops now sell a mixture of rhino horn, water buffalo horn and a few plastic or camel nail daggers, whereas in the 1990s and before they sold predominantly rhino horn ones. Two shops are still selling jambiyas with the paler cream-coloured new rhino horn handles. These are less popular than the older rhino horn handles made in the 1980s or before and are thus harder to sell. Very few rhino horn jambiyas are sold outside the old souk. The shops outside the souk sell mostly jambiyas with handles made of water buffalo horn.

Table 4. Retail price of various types of handles of jambiyas for sale in Sanaa, 1978–2001

Year	Price per kilogram	
	Yemeni rials	US dollars
Plastic (newly made)		
1986	100–200	10.31–20.62
1990	70–100	4.86–6.94
1992	150 (average)	4 (average)
1993	200–250	3.94–4.92
1999	500 (average)	3 (average)
2001 range	500–1000	3.03–6.06
2001 average	860	5.21
Water buffalo horn (newly made)		
1984	100–400	18.18–72.53
1986	150 (average)	15.46 (average)
1987	150 (average)	13.04 (average)
1990	150–500	10.42–34.72
1992	150–450	4–12
1996	1125 (average)	9 (average)
1999	2000 (average)	12 (average)
2001 range	400–5500	2.42–33.33
2001 average	2219	13.45
Camel nail (newly made)		
1993	650–1000	12.80–19.69
1996	1875 (average)	15 (average)
1999	2500 (average)	15 (average)
2001 range	1500–2200	9.09–13.33
2001 average	1900	11.51
Rhino horn (newly made)		
1978	3000 (average)	656 (average)
1983	2000–8000	438–1,750
1990	5000–9000	347–625
1992	9000–25,000	240–667
1993	10,000–50,000	197–984
1996	39,375 (average)	315 (average)
1999	65,000 (average)	394 (average)
2001 range	35,000–120,000	212–727
2001 average	68,333	414

Source: surveys taken by the authors

Although most of the jambiyas in Yemen are made in Sanaa, many towns, especially in the north, have retail outlets for them. Amran, which is just north of Sanaa, has three retail dagger shops in its souk selling almost entirely water buffalo horn jambiyas made in Sanaa. In addition, there are 19 rhino horn ones priced at 30,000 rials (USD 182) to one million rials (USD 6060). Another rhino horn jambiya that is supposedly 400 years old is priced at 2 million rials (USD 12,121). These shops in Amran are small and sell pistols and rifles as well. Most men in Amran wear jambiyas, and many carry guns also.

Sadah, a town in the far north near the Saudi Arabian border, has a relatively large number of outlets selling and repairing daggers (table 5). Sadah receives fewer tourists than several years ago because of the tourist kidnappings that tribal men inflict to annoy the central government. We were escorted to and from Sadah by an army pickup truck carrying eight soldiers with automatic weapons, and during our investigations in the souk, we had an armed guard with us.

Table 5. Sadah jambiya shops and stalls, January 2001—survey details

Shops and pavement stalls	No.
Shops selling jambiyas	33
Pavement stalls selling jambiyas	5
Of these 38 retail outlets:	
Shops also making jambiyas	4
Shops also repairing jambiyas	6
Pavement stalls also repairing jambiyas	2
Shops also polishing and shining blades	3
Pavement stalls also polishing and shining blades	2
Jambiyas for sale in the 33 shops	1352
Jambiyas for sale in the five pavement stalls	210

Jambiya sale prices	Average price	
	Yemeni rials	US dollars
New buffalo horn jambiya	1,686	10
Old buffalo horn jambiya	16,433	100
New rhino horn jambiya	63,125	383

Source: survey taken by the authors

For much of the time, we were the only foreign visitors in the town. The jambiya business, which is not much affected by tourist fluctuations, increased until about five years ago and since then has remained stable.

As well as supplying jambiyas to men in this far northern region of the country, traders take some of the jambiyas across the border into Saudi Arabia to the town of Najran. This area was part of Yemen until 1934 when it was incorporated into Saudi Arabia after a war. In 1988 nearly 10% of the men in Najran, ethnically Yemenis, were wearing jambiyas. At that time 15 of the 27 small jambiya shops in Najran were repairing daggers and belts as well as selling them (Martin 1990). Sadah used to be famous for its Jewish silversmiths, some of whom decorated jambiya handles and sheaths. Today only one Jewish craftsman remains who works on silver for jambiyas; he makes silver bands for where the handle and blade meet. In and around the old walled souk, 38 shops and pavement stalls are selling jambiyas. Four of these shops also make jambiyas with water buffalo horn handles from pieces obtained from Sanaa (table 5). Three craftsmen said that until the early 1990s, they also made handles from rhino horn, and one claimed he had recently obtained rhino horn from the main trading family in Sanaa.

Most of Sadah's jambiyas are made in Sanaa and Dhamar. The former have wider handles while the latter have smaller handles that are often rounded at the top. The Bedu or rural people wear jambiyas with smaller handles. Dhamar craftsmen produce them not only for Sadah but also for the Shabwa region in southern Yemen.

In Shabwa, people prefer old jambiyas. The craftsmen refurbish the rhino horn handles by coating them in sesame oil and then polishing them for a long time to get a dark pinkish-brown colour and bring out the contrast of the grain. This work is carried out in Bayhan and Ataq, the administrative capital of Shabwa Province, where there are several dagger shops. A lot of men in Ataq are wearing jambiyas today. It is a town that is quickly expanding, because many people in the Gulf are sending money back to their homes there, and oil companies in Yemen employ people from the area. Although wearing a jambiya was banned in 1967 in South Yemen, the ban was lifted when it joined North Yemen in 1990, and more people are again wearing daggers. This is also the case in Upper Yaffa where

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A medieval mud wall surrounds the old town of Sadah where the jambiya shops are to be found.

Lucy Vigne

This ancient gateway is still the main route into the medieval town of Sadah.

there are shops that repair and polish blades (Renaud Detalle, long-term resident political scientist, pers. comm. 1999 and 2001).

We visited Shihr on the south coast of Yemen, once a flourishing dhow port exporting dried and salted fish to East Africa. The people in this area were originally from the Hadramout farther north; some settled on the Kenya and Tanzania coast. The town today is small with little development and a small workforce. Most people remaining are elderly, and a survey of the men in the town revealed no one wearing a jambiya.

The beautiful island of Socotra is one of the most isolated and least visited places in the world. The prime minister of Yemen wished us to visit the island as external aid is coming in to develop the island's infrastructure. The government hopes to develop tourism, and this fascinating island would be an excellent site for eco-tourism and diving. Some conservationists call it the Galapagos of Arabia as it is so rich in endemic fauna and flora. The people are mainly traditional pastoralists living in the mountains in stone huts and caves, surviving on a diet mainly of dates, milk and imported rice. They are a peaceful people and know little of the outside world. They have never worn jambiyas. However, they do carry knives with handles made of goat horn for general use. As the development of the island progresses, such as the tarmacking of roads, not only may the fragile ecosystem be damaged, but also Yemenis from the north, who come to work on the island, may encourage the Socotrans to emulate the power elite in Sanaa. They may even open a jambiya shop as occurred in Aden after unity (Vigne and Martin 2000).

Policies to encourage alternatives and publicity against using rhino horn

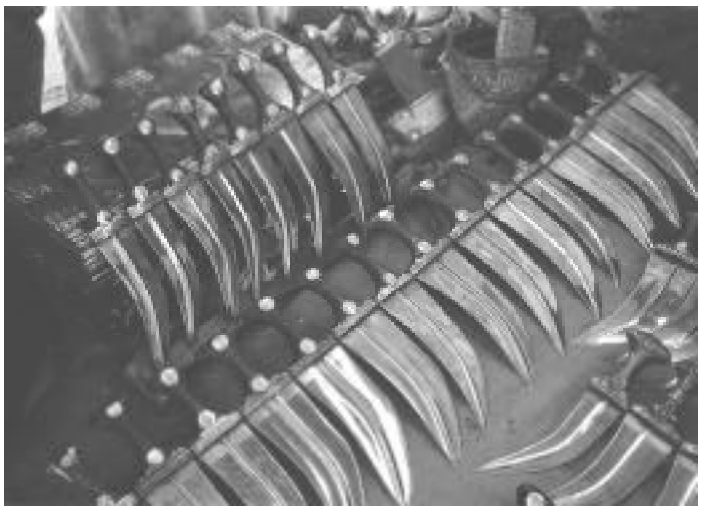
For the demand for new rhino horn to remain low in Yemen and to avoid an increase in price (which would encourage more poaching of rhinos in Africa) we initiated a publicity campaign on the rhino's plight and on the importance of using alternative materials. We held press interviews and gave photographs to journalists on rhino poaching and the rhino horn trade. Posters with Arabic captions covering as-

Esmond Martin

Only one Yemeni Jewish craftsman remains working as a silversmith in Sadah, making silver bands that cover the join of the handle to the blade.

Esmond Martin

A Sadah jambiya craftsman drills holes into a water buffalo horn handle, which has the curved top that is typical of the Sadah style.



Lucy Vigne

A Sadah pavement stall displays an array of jambiyas of various styles and materials, showing mostly water buffalo horn and some rhino horn handles.

pects of rhino conservation were framed and hung at some of Sanaa's museums and institutes. The Environment Protection Council (EPC) of the Yemen government displayed posters in 10 large schools where EPC has started environmental clubs. Exhibit boards were made for EPC to use for posters at meetings and conferences. The display of these posters was organized by Sadek Yahia al-Osaimi, the EPC manager for public awareness. Among the pictures on these posters was a copy of the photograph of the religious edict or *fatwa* written by the grand mufti, which stated that killing rhinos was against the will of God. Enlarged photographs were framed of a prestigious jambiya with an expensive agate handle for EPC to display in various ministries to encourage the use of this valuable alternative to rhino horn. Slide packs on the rhino horn trade with captions were given to EPC. These are to be shown at the 10 schools and at various institutes. EPC also was given copies of a WWF video in Arabic on the rhino horn trade in Yemen, and EPC agreed to organ-ize the showing of this video on Yemeni television. Other ideas for posters and more educational materials were discussed for future visits. There are close to two million people in Sanaa alone, but few know about the effect of Yemen's rhino horn trade on Africa's rhino population because they lack information.

During a meeting with us at his office, the prime minister of Yemen telephoned the governor of Sanaa, Hussein al-Maswari, about our wish to hang posters at the zoo, one of the few public recreational places in the city. When we visited the zoo with Mr al-Maswari, we brought him five posters, which he agreed to frame and hang near the main gate. These are the only posters so far to be hung in the zoo. The zoo authorities also asked for leaflets and brochures on rhinos and other animals, as at present they have none. The zoo attracts many visitors, who can now start to learn about the plight of the rhino through information supplied at the zoo. The governor of Sanaa also agreed to build a lecture room at the zoo, and we gave him slide packs and a video to show to visitors when such an education centre is built. The zoo is still being developed, and this year the government has allocated 40 million rials (USD 242,424) to spend on expansion.

Postcards of rhinos were given to various craftsmen and traders in Sanaa's old souk to increase their awareness about the rhino. During discussions with the main traders in the souk, they explained that they

need a comparable alternative to rhino horn, one that would give them more profit. Although agate handles are an expensive alternative, they can break if dropped so are less popular for daily wear. Craftsmen thus need another material as a substitute for rhino horn pieces with a similar appearance and texture to meet the demand for a substance that is durable as well as attractive. The material need not be horn shaped but should have filaments similar to the keratin in rhino horn. Craftsmen carve a handle out of a piece of horn no larger than a cigarette pack, and traders would welcome any suitable substitute material in this shape now that rhino horn is so scarce. The merchants also said they would like customs duty (tax) to be removed from their large imports of Indian domestic water buffalo horn, to make this alternative material more profitable for them. EPC agreed to organize a workshop in Sanaa to discuss alternative materials.

Although Yemenis are a traditional people, they are also adaptable. Changes have occurred in recent years in men's dress. For example, the jambiya sheath and belt for the two major northern tribes, the Bakil and the Hashid, were brown and green respectively, but now these are mixed, especially in town, as are the black and red headscarves. Certain drivers working for the main tour company in Sanaa recently sold their inherited rhino horn jambiyas to buy their tourist vehicles. They had been happy to purchase instead jambiyas of good quality old water buffalo horn with silverwork, which they had seen when visiting the Hadramout.

Esmond Martin

Because of the current risk of kidnappings in the far north of Yemen, an army escort accompanied us on the long journey from Sanaa to Sadah and back.

Lucy Vigne

Straight knives with handles made of goat horn are worn on the island of Socotra.

Legislation and law enforcement

No rhino horn has been confiscated or intercepted by Yemeni officials in the last few years, partly because the Yemenis are still waiting for the CITES authorities to train them in law enforcement. Sadek al-Osaimi of EPC is responsible for CITES management in Yemen and he inspects the Sanaa old souk personally at every Idd. Idd is the time to buy new jambiyas for the celebrations after Ramadan and after the Haj. He has seen no new rhino horn on the market.

After our discussions with the prime minister about introducing penalties for the possession and use of new rhino horn and having inspections to enforce the regulations, the prime minister said he would talk to the minister of Supply and Trade during a cabinet meeting while we were in the country. Unfortunately, the prime minister developed a high fever and could not attend the meeting. He agreed to follow up the issue as soon as possible.

As customs officials are not yet trained to recognize rhino horn, Dr Yusuf Abdulla of the General Organization for Antiquities, Museums and Manuscripts, which helps to protect Yemen's antiquities from

illegal export, suggested he could help to train them to intercept the horn. He has six officers working for him at the airport.

Conclusions and recommendations

The study shows that little rhino horn is now coming into Yemen. Quantities have been dwindling over the past few years. Yet prices for rhino horn have not risen because of the decline in demand. Jambiyas with new rhino horn handles are not as popular because people prefer the older ones, but they are not so readily available now.

This research trip is the first in which we found no new rhino horn being made into jambiya handles in Yemen. This is very encouraging for the future of eastern African rhinos. Although water buffalo horn handles take far less time to produce than rhino horn handles, the numbers of craftsmen working in the Sanaa old souk have slightly increased because more handles are now being produced for the expanding population. Thus, few craftsmen have lost their jobs as a result of the extreme shortage of rhino horn.

The demand for jambiyas, mainly with water buffalo horn handles, continues elsewhere in the country such as in the far north, especially in Sadah, and in some regions of the south where development is most prevalent, such as Ataq. Most of the jambiyas are made in Sanaa, Dhamar and Taiz with craftsmen in other towns mainly carrying out repair work.

The plan to implement a new public awareness campaign to bring information to Yemenis about the plight of the rhino because of the rhino horn trade was willingly accepted by all concerned. Yemenis are keen for educational materials. Awareness is lacking, and all the posters, slide packs, videos, postcards and framed photographs were widely distributed in Sanaa. To do a fuller and more effective campaign, many more posters and other materials are required in Sanaa and other main towns, along with regular showings of the video on television.

Efforts to introduce new legislation on penalties and inspections for the possession and use of new rhino horn were unsuccessful and follow up is needed with the prime minister and the minister of Supply and Trade. The government has been agreeing to bring in this new legislation since the early 1990s. The delay indicates the difficulties in passing legislation, let alone enforcing it. It took many years to encourage the government to join CITES, which Yemen finally did on condition that international support and training were forthcoming. But this has still not happened. The government is aware of its limitations, and with no international wildlife conservation body based in Yemen to give assistance, the issue of the rhino horn trade falls near the bottom of the government's priority list. Constant reminders and assistance to the government on laws and their enforcement are necessary if they are to be effective.

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NOTES FROM THE AFRICAN RHINO SPECIALIST GROUP

Deaths in Ngorongoro Crater, Tanzania

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The Ngorongoro Crater black rhino population (*Diceros bicornis michaeli*) has lost five animals since mid-2000. Lions preyed upon one calf in May 2000, and the mother of the ill-fated calf died in September 2000. The mother might have died of serious injuries, possibly following an encounter with an elephant or sustaining injuries in a fall off the crater rim, according to information the Ngorongoro Conservation Area Authority has received.

Perhaps more dramatically during the last year, unconfirmed babesiosis (a tickborne protozoan disease) is suspected to have claimed the lives of a one-year-old female calf in August 2000 and two cows, both in January 2001. The permanent secretary and the director of wildlife have visited Ngorongoro to inspect the situation. A prolonged drought that claimed the lives of many herbivores, including some 300 buffalos on the crater floor, is suspected to have greatly contributed towards poor animal health, and consequently the animals in poor condition were more susceptible to tickborne attack.

Measures have been taken to safeguard the crater population. Between 23 and 29 January 2001, Dr Pete Morkel with Tanzanian veterinarians embarked on prophylactic treatment of the remaining crater population, darting the rhinos with a dose of Berenil.

Fortunately, the crater has since received good rains, and it is hoped the population will soon again begin to increase.

Kenya implementing a new black rhino information management system

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In 1992, Kenya Wildlife Service (KWS) developed a database to improve knowledge of Kenyan rhino numbers and to address the needs of rhino security. Though the database met its initial objectives, it did not adequately incorporate the biological considerations that have recently become paramount for managing and conserving Kenya's growing black rhino populations. In 1998, KWS, in collaboration with private and community sectors, assessed how the existing database addressed key conservation needs. This review resulted in a detailed specification being drawn up for a new information management system that would significantly assist in the daily and longer-term conservation management of Kenya's various black rhino populations.

It was decided that such a system should operate at both the sanctuary level and KWS headquarters. It should enable rhino staff at headquarters to effectively monitor progress and coordinate conservation efforts across all rhino sanctuaries and parks (public and private) by collating and analysing up-to-date field data.

To make informed management decisions, comparative data were needed for the different populations on key performance indicators such as age structure, age at first calving, average intercalving intervals, mortality rates and rhino body condition. Mark-recapture analysis of both ID and clean animal sighting data was also needed to produce accurate estimates of true rhino population sizes and densities. All these data could then be used to help manage populations for maximum growth so that rhino numbers will increase rapidly towards the overall metapopulation target, as well as to maximize genetic diversity and enhance Kenya's future ability to withstand any limited poaching outbreaks. It was decided that the system should also assist sanctuaries in rhino security and improve overall knowledge of their population. For example, information obtained on patrol routes, rhino sightings, movement and home ranges could be used to deploy patrols.

Effective operation of such a system requires high-quality field data, which in turn can be achieved only by improving rhino monitoring. It was recognized that by obtaining items of equipment such as GPS receivers and digital cameras, and by training rangers in the use of standardized AfRSG-recommended monitoring techniques, the quality and conservation value of monitoring data obtained could be improved.

While KWS developed the initial version of the system, financial support of USD 100,000 from the United States Agency for International Development (USAID) has enabled KWS to further enhance the system and then to implement it in the 12 Kenyan rhino sanctuaries and parks.

Development commenced early in 1999, and by the end of that year the first version of the database was completed. A nine-month pilot study of the information system followed in Nairobi National Park, which also included use of GPSs and a digital camera. This trial was very successful, and good quality biological data on the population were gathered. Rhino managers at Nairobi are now effectively planning patrols using the system and scouts are confidently using the GPS receivers and digital cameras in their daily monitoring. Further enhancements to the system have been made based on the experience gained from the pilot study, a five-day rhino monitoring and management workshop, and the output of the Kenya rhino conservation strategy development workshop held in September 2000. AfRSG has also contributed vitally to the development. Its contribution included a visit to South Africa by KWS rhino staff in November 2000 where they exchanged expertise with counterparts in southern Africa to make the Kenyan system complementary with those of the southern African range states. A one-day rhino database symposium was organized at KwaZulu-Natal Wildlife headquarters, where the system was demonstrated and necessary amendments incorporated, which included standardized performance indicators and automated queries to facilitate annual status reporting.

The required information system and monitoring equipment have now been acquired for all the parks and the system was fully implemented following a training workshop in May 2001. Other partners in rhino conservation have also provided additional project support.

KWS would like to sincerely thank USAID for the financial support, and the Zoological Society of London and AfRSG for their important contributions towards developing the system.

Black rhino dung DNA analysis

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The International Rhino Foundation (IRF) on behalf of the Selous Rhino Trust and in collaboration with the Smithsonian Conservation and Research Center is processing proposals submitted to support developing and applying a faecal DNA methodology that will be generally applicable in assessing and managing black rhino populations and that specifically will be applied to analysing the Selous black rhino population. Proposals are under review. Updates on this project will appear in future editions of *Pachyderm*.

Rhino database workshop

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A one-day rhino database workshop organized by AfRSG was held at KwaZulu-Natal Wildlife headquarters to coincide with the visit of a Kenyan delegation on a knowledge-exchange visit in October 2000. Delegates were exposed to the new Kenyan rhino data management system (a variant of Peter Erb's Namibian rhino database system), the rhino components of KZN Wildlife's corporate wildlife database, the new SADC-funded WILDb database, and an HTML-based system for storing and managing rhino photographs and sighting data. A presentation on KZN Wildlife's intelligence database system was also given. The meeting enabled database developers to see what their colleagues had been doing as well as give each other ideas of good features that could be added to improve their systems. Seeing the basic structure of the databases was also useful for the developers of RHINO software, who can now use this knowledge to help create data files and import them into RHINO from these Access-based databases.

Rhino security matters

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During the Kenyan knowledge-exchange visit to South Africa, discussions were held regarding the possibility of Rod Potter of KwaZulu-Natal Wildlife holding a scene-of-the-crime workshop in Kenya to train local KWS staff in techniques to use, and so maximize the chance of successful arrest and prosecution in rhino poaching cases. Mr Potter briefed the meeting of the southern African Rhino and Elephant Security Group (RESG) on these techniques. As part of the SADC rhino program, he will produce a manual on crime-scene techniques and hold hands-on training courses on them in the region. Simon Milledge of TRAFFIC and Mr Potter gave presentations at the RESG meeting on horn stockpile control, registration and microchippping. Richard Emslie also gave a presentation on rhino horn fingerprinting, giving results to date and outlining current work.

Since the AfRSG's one-day rhino database workshop, the WWF-funded KZN Wildlife intelligence database system has been completely rewritten in Access, enhancing the program's capability to answer queries. Potentially this intelligence database system could be used with minor modifications in other range states. Representatives from Namibia visited KwaZulu-Natal to examine the system, and Samantha Watts gave a presentation on the database at the RESG meeting.

Resuscitating RESG also creates opportunities for greater cooperation between range states on security issues such as transponder capacity, intelligence databases, forensic investigative techniques and scene-of-the-crime training. It is a forum for learning what approaches have resulted in successful convictions and sentencing of those involved in rhino poaching or illegal horn dealing.

As part of the process of developing horn fingerprinting analysis techniques, Richard Emslie presented a paper at the South African Statistical Association Conference in November 2000. Progress to date and suggested approaches for dealing with outstanding statistical problems were discussed. Useful discussions were also held with professional statisticians and horn fingerprinting staff at Anglo American Research Labs. Potential ways to simplify and reduce the cost of lab analyses are being investigated with AARL, and further expert statistical help is being sought to deal with analytical problems. Novelty detectors will be examined to see if they can successfully identify if samples come from areas not yet covered in the horn fingerprint database. At recent rhino workshops in both Kenya and Zimbabwe, appeals were made to collect horn samples to fill in the gaps in the continental horn database.

Announcing the RMG Carrying Capacity Model version 1.0 for black rhinos

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Estimating the ecological carrying capacity (CC) of an area for black rhino is important. It allows the rhino population to be managed at around 75% of the CC level. This minimizes density-dependent effects such as reduced calving success and increased mortalities, and it allows rhino population productivity to be maximized. With knowledge of an area's CC, introductions to new areas can be planned at well below CC densities, to minimize rhino social problems and maximize their future breeding potentials. Assessing CC is therefore central to biological management of the black rhino, but its estimation has not been straightforward. Estimates of CC have differed widely between different people, and in particular non-experts have tended to grossly overestimate CC.

Based on the need to improve CC estimation to facilitate biological management of black rhino, Keryn Adcock has been investigating the broad-scale determinants of black rhino carrying capacity and performance. The focus to date has been on 13 South African and 2 Namibian baseline areas, which range in rainfall and habitat from deserts to moist coastal forests and cover a variety of soil types. The research has taken place through the Rhino Management Group in collaboration with relevant national, provincial and private black rhino conservation authorities. Initial work was funded by Wild Solutions and WWF-SA. Building on these investigations, the SADC Regional Programme for Rhino Conservation has funded the production of an RMG Carrying Capacity Model (version 1.0).

The model provides software and a practical and theoretical framework for understanding and roughly determining the carrying capacity of an area for black rhino. Six variables—annual rainfall, rainfall concentration, minimum July temperature, soil fertility, browse availability, and browse suitability—are used in the model to predict a black rhino CC density that would be similar to what experts in the field would predict (fig. 1). Predicted CCs can also then be used to estimate the likely average home range size of an adult male black rhino and the likely numbers of dominant bulls that can reside in the area (fig. 2).

The software and accompanying manual indicate how to gather raw field data for CC assessment and guide how to enter data into the computer program. Substantial guidelines are provided on how to evaluate southern African soil fertility and geology, what are the known black rhino dietary profiles and preferences in different kinds of habitats, and the theoretical background behind the CC concept and CC determinants as used in the model. Sound ecological knowledge is, however, still required to use the model.

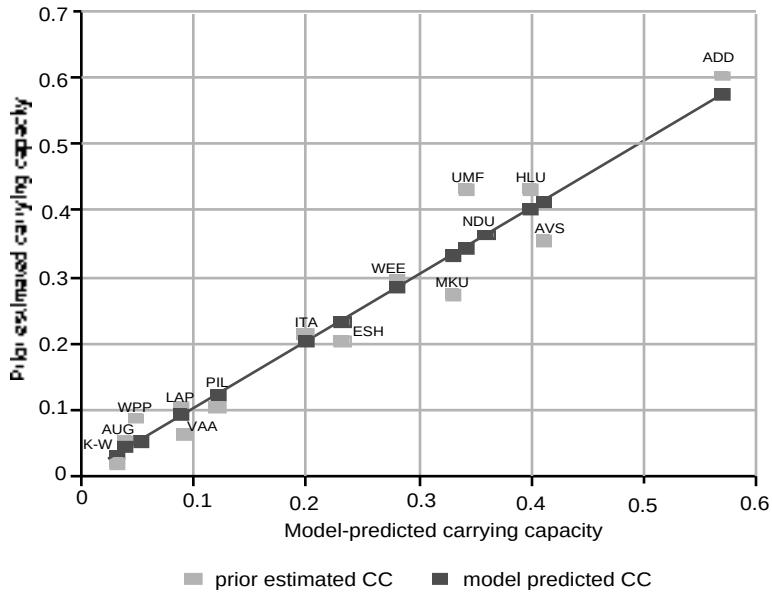

Figure 1. Regression line of 15 areas as computed by the RMG Carrying Capacity Model version 1 compared with prior carrying-capacity estimates made by experts in the field. The regression is highly significant, with an adjusted *r*-square of 0.879.

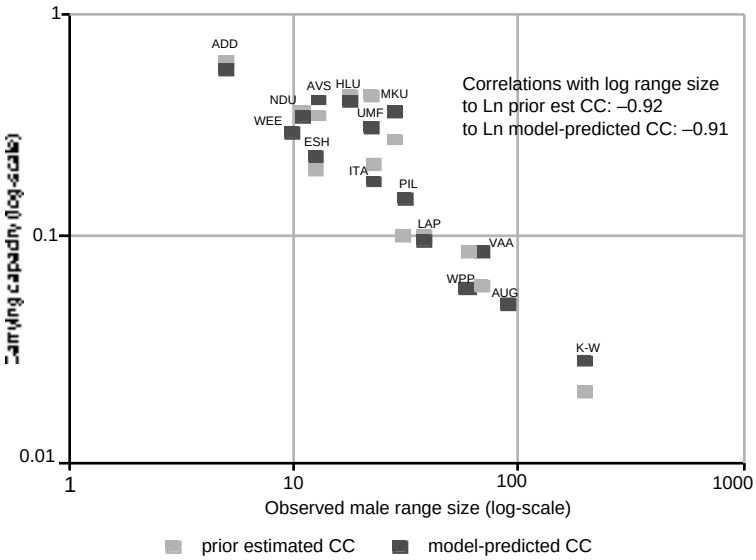

Figure 2. Relationship between CC estimates made by experts and model-predicted CC, and estimates of average male home range sizes. This strong relationship acts as independent confirmation of the general appropriateness of the carrying-capacity model.

As this is the first comprehensive CC estimation model for black rhino, several prominent workers in black rhino ecology and conservation or browser ecology are to evaluate the model and make suggested improvements. Additional work to refine the model is being funded by the SADC Regional Rhino Programme. This will include improvement of the browse-availability index used in the model, and it will incorporate better data from several of the benchmark sites where other workers have recently completed more detailed studies of black rhino. Zimbabwean and Kenyan rhino conservation workers have also indicated they plan to undertake similar research and model building, to cover CC predictions for black rhinos in their areas. In future, we hope to expand the model to cover an even wider range of habitat types.

WILDb rhino database

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A new rhino database, WILDb, has been produced by the SADC programme and is currently being field tested in several rhino areas in Zimbabwe, including populations in government IPZs and conservancies. The database comprises components for use in monitoring and tracking the performance of individual rhino populations both locally and nationally. It is designed so that it can be readily customized for use in different rhino population areas in SADC rhino range states. Anyone interested in obtaining a copy should contact Dr Rob Brett at the above address.

RHINO rewrite: an update

Richard H. Emslie[1] *and Rajan Amin*[2]

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Since 1991, RHINO Bayesian Mark-Recapture software has been used in an increasing number of populations, to produce annual rhino population estimates (with confidence levels) by analysing sighting data

of both identifiable and clean rhino. RHINO is designed to deal with various violations of classical mark-recapture assumptions (such as births, deaths, ear-notching, removals, introductions, sighting-happy rhinos, non-independence of calves and calves becoming independent). Over the years, RHINO has worked well in practice. However, the software was last revised in 1993 (version 1.21) and is written in the now fossilized DOS-based PAL language. While RHINO 1.21 was still usable on Windows NT and older versions of Windows 95, it no longer ran on Windows 98 machines. This is a problem, given that the software is used annually to produce population estimates for a number of annual status reports to the Rhino Management Group. The need was therefore urgent to produce a revised version of the software that can run on Windows 98 machines. Over the years there have also been a number of suggestions from field users on how the software could be improved and made more useful. The time was therefore opportune for a major revision of the software.

(Recently KZN Wildlife's Owen Howison did what many in the IT world had failed to do—figure out how to get RHINO 1.21 to run under Windows 98. Thus in the interim until RHINO ver 2.0 is released, RHINO 1.21 can continue to be used. Windows 98 users should contact the AfRSG Scientific Officer, Richard Emslie, for details of how to configure Windows 98 to enable RHINO 1.21 to run.)

The original developer of RHINO, Richard Emslie of Ecoscot Consultancy Services, has teamed up with a statistician and programmer at the Zoological Society of London, Raj Amin, to completely rewrite and produce a major revision of RHINO. This work, currently under way, is being funded by the SADC regional rhino conservation programme. RHINO 2.0 is scheduled for release by the end of September 2001. As with previous versions, the software will be available free of charge to all rhino managers and scientists who want it, both inside and outside of SADC.

RHINO 2.0 is being recoded in MATLAB 6 and will be computationally much more efficient than earlier versions. Documentation will also now be bundled with the software on CD-Rom. In developing design specifications for the new version, all the main users of RHINO through the years were canvassed for suggestions as to how they would like to see the software improved.

The new version is being designed to accept data in Access or Excel formats. The plan is to add enhanced automated identification routines for trap-happy animals. The simulation capabilities of the package will be significantly enhanced to help users assess the costs and benefits of notching more animals as compared with hiring a dedicated observer to increase the number of sightings. These simulation options should also help improve the guidelines on the minimum percentage of animals that should be identifiable in populations of different sizes. As a measure to reduce bias, automated routines are to be included to identify cross-boundary movers and to allocate all their sightings to the section of a park in which they spend most of their time. Additional planned options include testing for differences in population size over time and making it easier to combine population estimates for different sections into a combined park population estimate.

In 1991, RHINO 1.0 became the first mark-recapture population estimator to account for clean rhinos and so provide a total population estimate. Later that same year Gareth Stead produced an alternative Bayesian Mark-Recapture estimator, which also dealt with clean rhino, and many, but not all, of the major violations of classical mark-recapture assumptions. The Stead estimator was written for a mainframe only and thus has not been suitable for field use on PCs. RHINO and the Stead estimator use different algorithms to estimate both independent and dependent (calf) population segments. To determine 1) whether it would be worth developing the Stead estimator further to enable it to deal with more major violations of classical mark-recapture assumptions (like RHINO), and 2) whether or not the Stead estimator should be offered as an analysis option, and perhaps be made the recommended analysis option, it was first necessary to assess the relative performance of the two estimators. The Stead estimator and some of the main RHINO routines have been coded in MATLAB. Provisional modelling has revealed that RHINO (by virtue of its narrower confidence levels) appears to outperform the Stead estimator. RHINO 2.0 will therefore continue to be built using the RHINO rather the Stead algorithms.

Training courses in the use of the new version of RHINO will be held when it is has been completed.

IMPORTANT NOTICE

Information needed on elephant sightings

The African Elephant Specialist Group (AfESG) is continually seeking more information on the status of elephant populations across range states. This information is used to update the *African Elephant Database*, a computerized information system that stores population estimates and other geographic information on the African elephant, *Loxodonta africana*.

Owing to political strife, lack of resources or other constraints to collecting data, definitive information on elephant populations is completely lacking from a number of range states. Therefore, AfESG is appealing to the readership for ***georeferenced information on sightings of elephants or their signs*** from the following countries:

Angola
Liberia
Sierra Leone
Somalia
Sudan

The AfESG Data Review Task Force (DRTF) monitors the quality of data entered into the database**.** For DRTF to be able to use the data, any information on sightings must include the following details:

1) Reporter contact details (name, address, phone, fax, email)
2) Observer details (if different from 1)
3) Date of observation
4) Location name, including country
5) GPS location, preferably in digital degrees, or the most accurate description possible
6) Map of the area, if possible
7) Type of sighting
   a) from air
   b) from ground
8) Description of sighting
   a) direct observation
   b) dung
   c) footprints
   d) crop-raiding reports
   e) vegetation damage
   f) carcass
   g) other observation
9) Group size and structure, if known
10) Habitat where sighting was made
   a) grassland
   b) savanna woodland
   c) swamp
   d) broadleaf woodland
   e) forest
   f) forest clearing

Please report all sightings that meet these criteria to

African Elephant Database Manager
IUCN/SSC/African Elephant Specialist Group
P.O. Box 62440, Nairobi, Kenya
Tel: +254 2 572630/1 or 577355
Fax: +254 2 577389
E-mail: afesg@wwfeafrica.org

Pachyderm
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).

Submission of manuscripts

Where possible, manuscripts should be submitted both in hard copy and on floppy disk. Alternatively, the text can be submitted by email. Whatever media are used, the hard copy of the script must be identical to floppy or email version.

Contributions should be sent to:
The Editor, *Pachyderm*
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PO Box 62440
Nairobi, Kenya
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fax: +254 2 577389
e-mail: afesg@wwfeafrica.org

Preparation of manuscripts

Manuscripts are accepted in both English and French languages. Where possible, the abstract should be provided in both languages.

Title page: The title page should contain the following: 1. title, 2. name(s) of author(s), 3. full postal address(es), 4. name of corresponding author to whom proofs and editorial comments will be sent; give post, fax and email addresses for the corresponding author. Give additional key words, if any, that are not included in the title.

Research papers: Should be not more than 5000 words and be structured as follows: 1) Title page (as above), 2) Abstract of not more than 200 words (informative type, outlining information from the Introduction, Materials and methods, Results, Discussion, but not detailed results), 3) Introduction, 4) Materials and methods, 5) Results, 6) Discussion, 7) Conclusions if appropriate, 8) Acknowledgements (optional, brief), 9) References, 10) tables, 11) figure and photo captions, 12) figures and photos. Papers may be reports of original biological research or they may focus more on the socio-economic aspects of conservation, including market surveys.

Preferably provide figures and maps in their original form, for example, Excel files, maps as eps or tif files (17 x 15 cm, 600 dpi), when submitting in electronic form. Indicate clearly the author or source of figures and maps and the credit for photographs.

Review papers: Should be not more than 5000 words. A review paper is usually heavily referenced to give a historical basis for the review and to compare or contrast previous research findings. We encourage narrative style using the first person.

Notes from the field: The journal welcomes notes from the field. They may contain figures and tables but should be brief, 1000 words or less.

Book reviews: *Pachyderm* invites reviews of newly published books, which should be no more than 1500 words long.

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

Journal conventions

Nomenclature

Use common names of animals and plants, giving scientific names in italics on first mention. Include the authority if the paper subject is taxonomic; otherwise, it is optional.

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 's' for words ending in –yse, such as 'analyse', 'paralyse'.

Numbers

Use SI units for measurement (m, km, g, ha, h) with a space between the numeral and the unit of measurement; use the same unit for singular and plural (do not add 's') and place no full stop after the unit. Give measurements in figures, for example 12 mm, 1 kg, 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.