

Pachyderm

July – December 2006

Number 41



IUCN**The World Conservation Union**

SPECIES
SURVIVAL
COMMISSION

Editor

Helen van Houten

Assistant Editor

Dali Mwangore

Editorial Board

Holly Dublin

Esmond Martin

Leo Niskanen

Robert Olivier

Nico van Strien

Lucy Vigne

Design and layout

Damary Odanga

Graphics

Phillip Miyare

Address all correspondence,
including enquiries about
subscription, to

The Editor, *Pachyderm*

PO Box 68200 – 00200

Nairobi, Kenya

tel: +254 20 3876461

fax: +254 20 3870385

email: afesg@iucn.org

Website: www.iucn.org/afesg

Reproduction of this publication for
educational or other non-commercial
purposes is authorized without written
permission from the copyright holder
provided the source is fully
acknowledged.

Reproduction of this publication for
resale or other commercial purposes is
prohibited without written permission of
the copyright holder.

Pachyderm

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

July – December 2006

No. 41

1 Chair reports / Rapports des Présidents

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

Holly T. Dublin

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

Martin Brooks

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

*Nico van Strien***20 Research**

- 20 Recensement d'éléphants dans la Réserve
Communautaire du Lac Télé, République du
Congo

*Fortuné C. Iyenguet, Guy-Aimé F. Malanda, Bola
Madzoke, Hugo J. Rainey, Catherine A.
Schloeder, Michael J. Jacobs*

- 30 Human-wildlife conflict in Mochongoi Forest,
Baringo, Kenya: a case study of elephants

*Dorothy A. Amwata, Patrick Omondi,
Elphas Bitok*

- 37 The survival of elephant dung piles in relation to
forest canopy and slope in southern Ghana

*Richard F.W. Barnes, John Naada Majam,
Bernard Asamoah-Boateng, James Agyei-
Ohemeng*

- 44 Première estimation de la densité d'éléphants
dans le Parc National de Monte Alen, Guinée
Equatoriale

Marielle Puit, Andrea Ghiurghi

Cover: Sumatran rhinos Bina (left) and Torgamba in the
Sumatran Rhino Sanctuary, Way Kambas National Park,
Sumatra. Torgamba, the male, is at upper left and Bina, the
female, at lower right. Photos: Nico van Strien

- 53 Human–elephant conflict outlook in the Tsavo–Amboseli ecosystem, Kenya
John Kioko, John Kiringe, Patrick Omondi
- 61 Insurgency and poverty: recipe for rhino poaching in Nepal
Esmond Bradley Martin, Chryssee Martin
- 74 Policies that work for rhino conservation in West Bengal
Esmond Bradley Martin
- 85 Assam leads in conserving the greater one-horned rhinoceros in the new millennium
Bibhab Kumar Talukdar
- 90 Discussion**
- 90 Elephants, woodlands and ecosystems: some perspectives
Norman Owen-Smith
- 95 Field note**
- 95 Mitigating human–elephant conflict in Africa: a lesson-learning and network development meeting
Matt Walpole, Noah Sitati, Belinda Stewart-Cox, Leo Niskanen, P.J. Stephenson
- 100 Rhino notes**
- 100 Rhino population sizes and trends
Richard Emslie
- 105 Black Rhino Range Expansion Project
Pam Sherriffs
- 107 Tributes**
- 107 A jungle in mourning: Nepal loses its leading defenders of large mammals
Eric Dinerstein
- 109 Andries Marthinus (Clem) Coetsee
Russell Taylor
- 111 Guidelines to contributors**

Acknowledgements

The production of this issue of *Pachyderm* was only possible through contributions from a number of organizations and individuals. In particular, we would like to thank the following:



The views expressed herein are those of the authors and can therefore in no way be taken to reflect the official opinion of the individual donors, donor agencies, the World Conservation Union (IUCN) or any of the three IUCN/SSC Specialist Groups.

CHAIR REPORTS

RAPPORTS DES PRESIDENTS

African Elephant Specialist Group report

Rapport du Groupe Spécialiste des Eléphants d'Afrique

Holly T. Dublin, Chair/Président

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

I am pleased to start this report with some good news, for a change, on the funding front. In addition to the very generous support from the UK Department for Environment, Food and Rural Affairs, which I reported on in the last issue of *Pachyderm*, the United States Fish and Wildlife Service has recently agreed to provide support to several of our core activities from their 2006–2007 funding appropriation. Combined, funds from these two sources will cover the operating costs of our Nairobi Secretariat for another year. I would like to extend my deepest gratitude to both donors for this wonderful support!

I would also like to take this opportunity to welcome Dr Silvester Nyakaana from Uganda to the African Elephant Specialist Group. Dr Nyakaana has done extensive work on elephant genetics throughout the continent. His expertise will be welcomed, especially in light of the many ongoing studies into the taxonomic status of Africa's elephants and associated conservation implications.

But on a sad note and further to the situation report I provided you some time ago, Julian Blanc, manager of the African Elephant Database for the past five years, will be leaving us to join the CITES MIKE programme as their new data analyst, from 1 March 2007. I do not think I need to tell any of you that Julian has been a wonderful friend and colleague, not only to the staff and members of the AfESG but to countless numbers of partners and collaborators as well. Our upcoming African Elephant Status Report will be Julian's second but his contributions go so much further than this. We will all miss his genuine

J'ai le plaisir de pouvoir commencer ce rapport par quelques bonnes nouvelles, pour changer, sur le front du financement. En plus du soutien très généreux que nous a accordé le Département britannique pour l'Environnement, l'Alimentation et les Affaires rurales, dont j'ai parlé dans le dernier *Pachyderm*, le *Fish and Wildlife Service* américain a accepté dernièrement de supporter plusieurs de nos activités de base dans le cadre de l'attribution de ses fonds 2006–2007. Mis ensemble, les fonds provenant de ces deux sources pourront couvrir les frais de fonctionnement de notre Secrétariat de Nairobi pour un an. Je voudrais exprimer toute ma gratitude à ces deux donateurs pour ce merveilleux soutien.

Je voudrais aussi profiter de cette occasion pour souhaiter la bienvenue au Dr Silvester Nyakaana, d'Ouganda, au sein du Groupe Spécialiste des Eléphants d'Afrique. Il a énormément travaillé sur la génétique des éléphants dans tout le continent. Son expertise sera la bienvenue, spécialement à la lumière des nombreuses études en cours sur le statut taxonomique des éléphants africains et des implications qu'elles ont pour la conservation.

Dans un registre plus triste, pour compléter le rapport que je vous faisais il y a quelque temps, Julian Blanc, qui est le gestionnaire de la Base de Données de l'Eléphant Africain depuis cinq ans, va nous quitter pour rejoindre le programme MIKE de la CITES dont il sera le nouvel analyste des données à partir du 1^{er} mars 2007. Je ne crois pas qu'il est nécessaire de vous dire combien Julian a été un ami et un collègue merveilleux, non seulement pour les membres du

collaborative spirit, his creative and probing mind, and his gentle ways. On top of this, his unique technical competence and his unstinting commitment to task will be difficult, if not impossible, to replace. On behalf of IUCN, the SSC, the African Elephant Specialist Group and all our members, I want to thank Julian for being one of our 'dream team' for the past five and a half years and to wish him good luck in his new position. We shall look forward to continuing our work together in new and different ways.

The African Elephant Database

The AfESG's Data Review Working Group met in Nairobi in July to review the draft *African Elephant Status Report 2007* (AESR 2007), and to discuss the future of the African Elephant Database. At the time of writing this report, the AESR 2007 was in its final draft stage and will be made available on the website <http://iucn.org/afesg/aed> early in the New Year.

In a bid to improve the quality of range data in the AED, data from the Landsat 2002 human ambient population density dataset have been used to correct possible anomalies in the AED's range coverage. Areas where possible elephant range overlapped with estimated human population densities of 15 or more persons per square kilometre have been recategorized as 'doubtful' range.

Discussions have been initiated with the Chairs of other IUCN SSC Specialist Groups towards developing a multispecies population-monitoring database, modelled along the lines of the AED. It is hoped that increasing the number of species covered by the AED and turning the enterprise into a wider collaboration within the Species Survival Commission will enhance its effectiveness and future sustainability. The Antelope Specialist Group and, in particular, the International Giraffe Working Group have expressed interest. The Equid Specialist Group also is interested in developing a Grevy's Zebra database.

Managing ecological impacts of elephants

Update from the Local Overpopulation Task Force

At the end of June 2006 AfESG's Local Overpopulation Task Force (LOTF) finalized the first draft of its technical review of main options for managing the

GSEAF mais aussi pour d'innombrables partenaires et collaborateurs. Le nouveau rapport sur le statut de l'éléphant africain sera le second de Julian, mais sa contribution va bien plus loin que cela. Son sens inné de la collaboration, son esprit créatif et pénétrant et sa si aimable façon d'être vont beaucoup nous manquer. Ajoutez-y ses compétences techniques uniques et son engagement sans réserve dans le travail qui seront difficiles, voire impossibles à remplacer. Au nom de l'IUCN, de la CSE, du Groupe Spécialiste des Eléphants d'Afrique et de tous nos membres, je veux remercier Julian qui fut un des nos « *dream team* » des cinq dernières années et demi et lui souhaiter bonne chance à son nouveau poste. Nous espérons pouvoir continuer à travailler ensemble dans d'autres nouvelles circonstances.

La Base de Données de l'Eléphant Africain

Le Groupe de travail du GSEAF chargé de la révision des données s'est réuni à Nairobi en juillet pour réviser le projet du *African Elephant Status Report 2006* (AESR 2006) et pour discuter de l'avenir de la Base de Données de l'Eléphant Africain. Au moment d'écrire ce rapport, l'AESR en est à son projet final et il sera disponible sur le site <http://iucn.org/afesg/aed> au début de l'année prochaine.

Afin d'améliorer la qualité des données sur la répartition dans la BDEA, on a utilisé des données en provenance du set de données Landsat 2002 sur la densité de population humaine ambiante, pour corriger d'éventuelles anomalies dans la couverture de la répartition dans la BDEA. Les zones où l'aire de répartition des éléphants recouvrait des zones où la densité de population humaine dépassait 15 personnes/km² ont été reclassées comme «douteuses».

On a lancé des discussions avec les présidents des autres Groupes de spécialistes des CSE de l'IUCN en vue de développer une base de données de monitoring portant sur de nombreuses espèces, configurée selon les directives de la BDEA. On espère qu'en augmentant le nombre d'espèces couvertes par la BDEA et en transformant cette entreprise en une collaboration plus vaste au sein de la Commission de Sauvegarde des Espèces, nous allons augmenter son efficacité et sa durabilité. Le Groupe Spécialiste des Antilopes et, en particulier, le Groupe de travail sur les girafes ont marqué leur intérêt. Le Groupe Spécialiste des Equidés s'intéresse aussi au déve-

ecological impact of elephants. This document was sent to a number of external reviewers and also placed on the AfESG's website for public review. The document elicited much interest (it was downloaded over 2000 times between July and September) and much constructive criticism. Our thanks to all those who sent us their comments.

LOTF met on 21–22 September 2006, in Cape Town to discuss the feedback received. It was decided that fairly substantial restructuring of the document was necessary and new writing assignments were issued accordingly. If everything goes according to plan, the final document will be ready for dissemination by mid-2007.

Scientific Roundtable on Elephants and their impact in South Africa

In late August 2006, I was privileged to join a dozen leading elephant scientists, who included fellow AfESG member Iain Douglas-Hamilton, for the second gathering of the South African Elephant Scientific Roundtable. This group was convened by South Africa's Minister of Environmental Affairs and Tourism, Marthinus van Schalkwyk, to help provide guidance on South Africa's policy on managing elephant populations. During an earlier session of the roundtable in January, the scientists had concluded that there was 'no compelling evidence to suggest the need for immediate, large-scale reduction of elephant numbers in Kruger National Park, although density, distribution and population structure might need to be managed in some protected areas, including Kruger National Park, to meet biodiversity and other objectives' (SRT 2006).

The second roundtable discussion resulted in a 'Statement of Scientific Consensus' proposing the establishment of a 20-year programme on research and adaptive management to help obtain a better understanding of the short-, medium- and long-term consequence of different management interventions. A comprehensive research proposal is now under development by the South African National Biodiversity Institute, which will outline the research platform for six core areas: 1) scientific assessment of all current data; 2) experiments, such as to establish the likely trajectory of elephant numbers, the relationship between elephant density and a range of ecological consequences in various ecosystems, and the consequences of various management options; 3)

loppement d'une base de données sur le zèbre de Grévy.

Gérer les impacts écologiques des éléphants

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

Fin juin 2006, la Force spéciale pour la surpopulation locale (*Local Overpopulation Task Force* LOTF) a finalisé le premier projet de sa revue technique des principales options pour gérer les impacts écologiques des éléphants. Ce document fut envoyé à un certain nombre de réviseurs externes et placé sur le site du GSEAf pour une révision publique. Il a suscité beaucoup d'intérêt (il a été téléchargé plus de 2.000 fois entre juillet et septembre) et des critiques très constructives. Nous remercions tous ceux qui nous ont envoyé leurs commentaires.

La LOTF s'est réunie les 21 et 22 septembre 2006 au Cap pour discuter les feed-back reçus. On en a conclu qu'il était nécessaire de procéder à une restructuration assez substantielle du document, et les nouvelles rédactions furent confiées à qui de droit. Si tout se passe comme prévu, le document final devrait être prêt vers le milieu de 2007.

Table ronde scientifique sur les éléphants et leur impact en Afrique du Sud

Fin août 2006, j'ai eu la chance d'accompagner une douzaine d'éminents scientifiques spécialistes des éléphants, y compris le membre du GSEAf Iain Douglas-Hamilton, lors de la seconde réunion de la Table ronde sud-africaine sur les éléphants. Ce groupe était convié par le ministre sud-africain des Affaires environnementales et du Tourisme, Marthinus van Schalkwyk, pour aider à donner des conseils pour la politique sud-africaine en matière de gestion des populations d'éléphants. Lors d'une précédente session de la table ronde en janvier, les scientifiques avaient conclu qu'«il n'y avait pas de preuve absolue qui suggère la nécessité de réduire immédiatement et de façon importante le nombre des éléphants dans le Parc National Kruger, même s'il pouvait s'avérer nécessaire de gérer la densité, la distribution et la structure de la population dans certaines aires protégées, dont le Parc National Kruger, afin d'atteindre

predictive modelling; 4) social, political and economic research to explore stakeholder perceptions and attitudes, costs and benefits; 5) capacity building; and 6) adaptive management or orchestration of a close interface between the practical day-to-day management of elephants in parks and the scientific research programmes (SRT 2006).

Human–elephant conflict

Vertically integrated models for human–elephant conflict management

Investigations are continuing into the development of vertically integrated systems for managing human–elephant conflict (HEC) in two pilot countries, Burkina Faso and Tanzania. The final recommendations of this study will become available at the end of this year, but preliminary findings indicate that such national HEC management systems are considered both necessary and desirable by the main stakeholders in these two countries. This study will hopefully contribute to a subsequent five-year pilot project to design and test national HEC management systems in Burkina Faso and Tanzania, subject to approval of funding from UNDP's Global Environment Facility.

AfESG-certified training course for human–elephant conflict mitigation

A comprehensive HEC training course is being developed by AfESG in collaboration with the Elephant Pepper Development Trust and funded by WWF International. This course, which will carry AfESG certification, will consist of five primary training modules: 1) what is HEC and whose responsibility is it? 2) an overview of elephant ecology and behaviour in HEC situations; 3) overview of current mitigation measures; 4) recording, reporting and analysing problem incidents, and 5) developing community-based HEC mitigation projects. Participants are expected to attain the core skills and competencies required to develop and implement effective community-based mitigation strategies. These should in turn, put the participants in a good position to train others in the theory and application of various mitigation measures. In February 2007, a group of AfESG-selected practitioners from both anglophone and francophone range states will be attending a training workshop at the Elephant Pepper Training Facil-

ity les objectifs en matière, notamment, de biodiversité» (SRT 2006).

La seconde discussion de la table ronde a abouti à une Déclaration de Consensus Scientifique proposant l'établissement d'un programme de recherche et de gestion adaptative sur 20 ans, pour tenter d'arriver à une meilleure compréhension des conséquences à court, moyen et long terme des différentes interventions de gestion. Une proposition de recherche globale est en cours de préparation au *South African National Biodiversity Institute* qui délimitera la plateforme de recherche dans six domaines centraux: 1) l'évaluation scientifique de toutes les données actuelles, 2) les expérimentations, comme tenter d'établir l'évolution probable du nombre d'éléphants, la relation entre la densité des éléphants et toute une gamme de conséquences écologiques dans divers écosystèmes et les conséquences de diverses options de gestion, 3) la modélisation prédictive, 4) des recherches sociales, politiques et économiques pour étudier la perception et l'attitude des personnes intéressées, les coûts et les bénéfices, 5) le renforcement des capacités et 6) la gestion adaptative ou l'orchestration d'une interface étroite entre la gestion pratique au jour le jour des éléphants dans les parcs et les programmes de recherche scientifique (SRT 2006).

Conflits hommes-éléphants

Modèles verticalement intégrés pour la gestion des conflits hommes-éléphants (CHE)

Les investigations se poursuivent pour le développement de ces modèles dans deux pays pilotes, le Burkina Faso et la Tanzanie. Les recommandations finales de cette étude seront disponibles à la fin de cette année, mais les résultats préliminaires indiquent que de tels systèmes de gestion des CHE sont considérés comme étant aussi nécessaires que souhaitables par les principales parties concernées des deux pays. Cette étude contribuera, nous l'espérons, à un projet de cinq ans pour préparer et tester des systèmes nationaux de gestion des CHE au Burkina Faso et en Tanzanie, soumis à l'approbation pour financement du GEF/PNUD.

Formation certifiée par le GSEAf en mitigation des conflits hommes-éléphants

Le GSEAf est occupé à développer une formation complète en CHE en collaboration avec le *Elephant*

ity in Livingstone, Zambia, where these new modules will be used for the first time.

Recent technical workshops on HEC

'Mitigating Human–Elephant Conflict in Africa: A Lesson-Learning and Network Developing Meeting' took place at the Kenya Cooperative College in Nairobi from 26 to 27 September 2006. This meeting was widely attended by HEC practitioners from eastern and southern Africa and South-East Asia. The AfESG was represented by Dr Richard Hoare, the Chair of the AfESG's Human–Elephant Conflict Working Group and Leo Niskanen, AfESG's Senior Programme Officer. Other AfESG members attending the meeting included Dr Noah Sitati, Mr Patrick Omondi and Mr Moses Litoroh. The meeting provided a useful forum for HEC practitioners from different range states across Africa and Asia to share lessons learned from latest research and mitigation trials. For a more detailed account of the discussions and outcomes, see the special report on page 95 of this issue.

Damage caused by a few small herds numbering no more than eight elephants is becoming a major problem in villages around the Sikasso region of western Mali. It appears that these elephants have recently returned from neighbouring Burkina Faso and Côte d'Ivoire after many years absence and are finding much of their historical range settled by farmers. Damage to crops, killing of livestock and competition over water is increasing. In August, a local NGO, Association Malienne pour la Conservation de la Faune et de l'Environnement (AMCFE), with funding from the Netherlands Committee of IUCN convened a meeting of local communities, government officials and technical experts to find ways to deal with the situation. The main output of this workshop was a recommendation to develop a HEC mitigation plan involving land-use planning measures and suitable farmer-based deterrence methods. AfESG, represented at this workshop by Lamine Sebogo, hopes to be able to assist these efforts by making available its full range of HEC tools and expertise.

Illegal killing and ivory trade

Update on the CITES MIKE programme

At the end of September 2006, the MIKE Central Coordination Unit was moved from its offices next to

Pepper Development Trust et financé par le WWF-International. Ce cours, qui aura la certification du GSEAf se composera de cinq modules de base: 1) que sont les CHE et qui en a la responsabilité? 2) aperçu de l'écologie et du comportement de l'éléphant dans des situations de CHE, 3) aperçu des mesures de mitigation actuelles, 4) relevés, rapports et analyses des incidents problématiques et 5) développement de projets communautaires de mitigation des CHE. Les participants devraient acquérir les capacités de base et les compétences requises pour développer et appliquer des stratégies efficaces de mitigation communautaire qui devraient, ensuite, les rendre capables de former d'autres personnes à la théorie et à l'application des diverses mesures de mitigation. En février 2007, un groupe de praticiens choisis par le GSEAf et venant de pays anglophones et francophones de l'aire de répartition assistera à un atelier de formation au centre de formation d'*Elephant Pepper* à Livingstone, en Zambie, où ces nouveaux modules seront utilisés pour la première fois.

Ateliers techniques récents sur les CHE

«Résoudre des conflits hommes–éléphants en Afrique: une réunion sur les leçons à tirer et le développement d'un réseau» a eu lieu au *Kenya Cooperative College* de Nairobi les 26 et 27 septembre 2006. Cette réunion a vu la participation de nombreux praticiens des CHE d'Afrique de l'Est et du Sud et d'Asie du Sud-Est. Le GSEAf y était représenté par le Dr Richard Hoare, le président du Groupe de travail du GSEAf sur les Conflits hommes–éléphants, et par Léo Niskanen, responsable de programme senior du GSEAf. Parmi les autres membres qui ont assisté à cette réunion, on compte le Dr Noah Sitati, M. Patrick Omondi et M. Moses Litoroh. La réunion constituait un forum pour les praticiens des CHE venus de différents états de l'aire de répartition d'Afrique et d'Asie pour qu'ils puissent partager les leçons tirées des dernières recherches et des procès de mitigation. Pour plus de détails sur les discussions et les résultats, voyez le rapport spécial à la page 95 de ce numéro.

Les dégâts causés par quelques petits troupeaux qui ne comptent pas plus de huit éléphants commencent à devenir un problème majeur dans les villages qui entourent la région de Sikasso, dans l'ouest du Mali. Il semble que ces éléphants soient revenus récemment du Burkina Faso et de la Côte d'Ivoire voisins après de longues années d'absence et qu'ils aient retrouvé leurs

the AfESG Secretariat to UNEP's Division of Environmental Conventions at UNEP Headquarters in Gigiri, Nairobi. Edison Nuwamanya, the MIKE Sub-regional Site Support Officer (SSO) for eastern Africa, is temporarily housed at the AfESG Secretariat in Nairobi, while his counterparts in Central and West Africa remain at the respective IUCN regional offices, pending final outcome of negotiations between CITES and IUCN.

The long-awaited report on the baseline levels of illegal killing across MIKE sites in Africa and Asia was presented at the 54th meeting of the CITES Standing Committee (SC 54) in Geneva during the week of 2 October. The provision of this baseline information was one of the preconditions for the one-off sale of 60 tonnes of ivory from government stocks in Botswana, Namibia and South Africa, as agreed at the 12th Conference of the Parties (CoP 12) to CITES. However, the Standing Committee found the baseline information incomplete because of missing data from six Southeast Asian MIKE sites, and referred the matter to the 55th session of the Standing Committee, which will take place immediately before CoP 14 in June 2007 in the Netherlands. The sales of stockpiles of the three southern African countries could therefore not be authorized, although Japan, having now complied with the relevant CITES requirements, was approved as a designated trading partner for the eventual sales. China was deemed not to meet the criteria at this point.

Control of domestic trade in African elephant ivory

The Elephant Action Plan (Decision 13.26), adopted at CoP 13 of CITES to help close down the large domestic ivory markets in Africa that are contributing to the killing of thousands of African elephants each year, was also discussed at SC 54. This action plan gives the CITES Secretariat the power to recommend suspension of trade in all CITES-listed species with any country that fails to introduce the measures required to curb domestic ivory trade. Citing resource limitations and communication problems, the CITES Secretariat admitted that it has taken longer than anticipated to implement the action plan. Although all Parties should have reported to the Secretariat by 31 March 2005 on their implementing progress, at the time of the Standing Committee meeting 18 countries had still not submitted their reports. Despite these

territoires historiques occupés par des fermiers. Les dommages aux récoltes, le massacre du bétail et la compétition pour l'eau augmentent. En août, une ONG locale, l'Association malienne pour la Conservation de la Faune et de l'Environnement (AMCFE), avec le financement du Comité néerlandais de l'UICN, a organisé une réunion des communautés locales, d'officiels du gouvernement et d'experts techniques afin de trouver des moyens pour gérer la situation. Le principal résultat de cette réunion fut une recommandation pour développer un plan de mitigation CHE qui implique des mesures de planning pour l'utilisation des terres et des méthodes de dissuasion adéquates au niveau des fermiers. Le GSEAf, représenté alors par Lamine Sebogo, espère qu'il pourra contribuer à ces efforts en proposant toute la gamme des outils et des expertises dont il dispose en matière de CHE.

Massacres illégaux et commerce d'ivoire

Mise à jour du programme MIKE/CITES

Fin septembre, l'Unité centrale de coordination de MIKE a quitté ses bureaux situés près du Secrétariat du GSEAf pour s'installer à la Division du PNUE des Conventions environnementales, au Quartier général du PNUE à Gigiri, Nairobi. Edison Nuwamanya, le Responsable sous-régional du support sur site de MIKE (SSO) pour l'Afrique de l'Est, est logé temporairement au Secrétariat du GSEAf à Nairobi, alors que ses homologues d'Afrique centrale et de l'Ouest restent dans leur bureau régional respectif de l'UICN, en attendant le résultat des négociations entre la CITES et l'UICN.

Le rapport très attendu sur les niveaux de référence des massacres illégaux dans les sites MIKE d'Afrique et d'Asie a été présenté lors de la 54^{ème} réunion du Comité permanent de la CITES (SC 54) à Genève pendant la semaine du 2 octobre. La fourniture de cette information sur la situation de départ était une des conditions pour la vente unique de 60 tonnes d'ivoire provenant des stocks des gouvernements du Botswana, de Namibie et d'Afrique du Sud, comme agréé lors de la 12^{ème} Conférence des Parties (CoP 12) à la CITES. Cependant, le Comité permanent a trouvé que les informations de départ étaient incomplètes parce qu'y manquaient les données sur six sites MIKE d'Asie du Sud-Est, et il a reporté la question à la 55^{ème} session du Comité permanent qui aura lieu juste avant la CoP 14, en juin 2007, aux Pays-Bas. La vente des stocks des

problems, and in spite of the power to recommend cessation of all commercial trade with non-compliant Parties, the CITES Secretariat has so far chosen not to invoke these powers.

Concerns were also raised at SC 54 over the role that China continues to play in illegal trade in ivory, allegedly facilitated by the increasing number of Chinese citizens based in Africa. For example, a large number of containers originating in Central Africa with concealed compartments for smuggling ivory have recently been intercepted en route to China.

Illegal trade is also being exacerbated by poor control of government-held ivory stockpiles in some range states. For example, last July the source of a shipment of one tonne of ivory, also destined for illegal export to China, was traced to legal government stocks in Zimbabwe. This ivory was acquired by licensed traders during one of the routine and lawful domestic auctions of ivory and then found its way to third-party buyers, apparently in violation of Zimbabwe's domestic controls. Although this incident led to the voluntary suspension of ivory auctions in Zimbabwe, the CITES Secretariat remains concerned about the adequacy of the authorities' response. This could negatively affect any future assessments of Zimbabwe's eligibility for international sales of ivory.

Finally, recent reports by TRAFFIC (<http://www.traffic.org/content/617.pdf/>; <http://www.traffic.org/content/204.pdf>) show the ready availability of ivory, presumably from illegal sources, in markets in Angola and Egypt. The permanent missions to the United Nations of these two countries have been provided with the TRAFFIC reports and copies of the CITES Elephant Action Plan. The CITES Secretariat has also offered technical assistance to the two countries in regulating this trade.

Updates on conservation and management strategies and action plans

WWF's African Elephant Programme strategy

Earlier this year several AfESG members and staff participated in evaluating the first phase of WWF's African Elephant Programme, which ran from 2001 to 2006. Based on the recommendations that emerged from this exercise, WWF is now developing an action plan for the next five years. This plan sets out

trois pays d'Afrique australe pourrait donc être refusée même si le Japon, qui a maintenant satisfait aux exigences de la CITES en la matière, a été accepté comme le partenaire commercial désigné pour les ventes éventuelles. On a estimé que la Chine ne répondait pas à ces critères jusqu'à présent.

Contrôle du commerce intérieur de l'ivoire d'éléphant d'Afrique

Le Plan d'action pour l'éléphant (Décision 13.26), adopté à la CoP 13 de la CITES pour aider à mettre fin aux importants marchés intérieurs d'ivoire en Afrique qui contribuent au massacre de milliers d'éléphants chaque année, a aussi été discuté au SC 54. Ce Plan d'action donne au Secrétariat de la CITES le pouvoir de recommander la suspension du commerce de toute espèce reprise dans les listes de la CITES avec tout pays qui n'introduirait pas les mesures requises pour réduire le commerce intérieur d'ivoire. Invoquant la limitation des ressources et des problèmes de communications, le Secrétariat de la CITES a admis qu'il avait fallu plus longtemps que prévu pour appliquer le plan d'action. Bien que toutes les Parties eussent dû signaler au Secrétariat avant le 31 mars 2005 les progrès de leur mise en application, au moment de la réunion du Comité permanent, 18 pays n'avaient pas encore soumis leur rapport. Malgré ces problèmes, et malgré qu'il a le pouvoir de recommander l'arrêt de toute transaction commerciale avec les Parties que ne rempliraient pas leurs obligations, le Secrétariat de la CITES a choisi jusqu'à présent de ne pas faire usage de ce pouvoir.

Lors du SC 54, on a aussi évoqué les préoccupations quant au rôle que la Chine continue à jouer dans le commerce illégal de l'ivoire, facilité - semble-t-il - par le nombre de citoyens chinois qui sont basés en Afrique. Par exemple, on a récemment intercepté un grand nombre de containers, en provenance d'Afrique centrale et à destination de la Chine, qui contenaient des compartiments secrets pour passer de l'ivoire.

Le commerce illégal est aussi accru en raison du manque de contrôle efficace des stocks d'ivoire gouvernementaux dans certains états de l'aire de répartition. Par exemple, en juillet dernier, on a fait remonter la source d'une tonne d'ivoire, aussi destinée à l'exportation illégale vers la Chine, jusqu'aux stocks gouvernementaux légaux du Zimbabwe. Cet ivoire a été acquis par des commerçants autorisés, au cours d'une des ventes aux enchères internes, de routine et parfaitement légales, puis il a été détourné vers des

WWF's institutional priorities for the species. AfESG members and staff have again been asked to provide their comments.

CENTRAL AFRICA

I recently received an official letter from the Secretariat of COMIFAC (Commission des Forêts d'Afrique Centrale) endorsing the Central African Elephant Conservation Strategy (CAECS) and noting the synergies this provides with the biodiversity conservation objectives of the intergovernmental Yaoundé Process Convergence Plan. In the letter, COMIFAC calls for further assistance from AfESG in mobilizing the necessary resources to implement the strategy. I will soon be approaching our Central African members, partners and donor agencies to find out how to best collaborate in these efforts.

SOUTHERN AFRICA

The Southern African Elephant Conservation Strategy (SAECS) is still undergoing final review by the range state governments. In the meantime, and thanks largely to efforts by our South African members, the South African government's Department of Environmental Affairs and Tourism has expressed an interest in funding an AfESG Southern African Programme Officer position to be located in my IUCN SSC office at Kirstenbosch in Cape Town. The new Programme Officer would play an important role in providing technical support to the Southern African elephant range states, particularly with regard to implementing SAECS. We are hoping such support will be forthcoming to allow us to provide ready assistance to these range states, which face a wide range of serious challenges in managing and conserving their elephant populations, many of which continue to grow and come into increasing conflict with local communities.

WEST AFRICA

As so many of the key elephant populations in West Africa are transboundary, much recent emphasis in the region has been on developing transfrontier elephant conservation strategies and action plans. The latest of these is the Ziama–Wenegisi transfrontier elephant action plan, which was funded by the Japanese NGO Keidaren Nature Conservation Fund and

acheteurs tiers, apparemment en violation des contrôles domestiques du Zimbabwe. Même si cet incident a conduit à la suspension volontaire des ventes aux enchères d'ivoire au Zimbabwe, le Secrétariat de la CITES reste inquiet de la pertinence de la réponse des autorités. Ceci pourrait affecter négativement toutes les évaluations futures de l'éligibilité du Zimbabwe pour les ventes internationales d'ivoire.

Enfin, les récents rapports de TRAFFIC (<http://www.traffic.org/content/617.pdf/> ; http://www.traffic.org/content/204.pdf) témoignent du fait qu'il est très facile de trouver de l'ivoire, probablement d'origine illégale, sur les marchés angolais et égyptiens. Les missions permanentes des Nations unies dans ces deux pays ont reçu les rapports de TRAFFIC et des copies du Plan d'action pour les éléphants de la CITES. Le Secrétariat de la CITES a aussi proposé son assistance technique aux deux pays pour réglementer ce commerce.

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

Stratégie du Programme WWF pour l'éléphant africain

Cette année, plusieurs membres et personnel du GSEAF ont participé à l'évaluation de la première phase du Programme WWF pour l'éléphant africain, de 2001 à 2006. En se basant sur les recommandations émises lors de cet exercice, le WWF développe maintenant un plan d'action pour les cinq prochaines années. Ce plan définit les priorités institutionnelles du WWF pour l'espèce. Les membres et le personnel du GSEAF ont de nouveau été priés de donner leurs commentaires.

AFRIQUE CENTRALE

J'ai reçu récemment une lettre officielle du Secrétariat de la COMIFAC (Commission des Forêts d'Afrique Centrale) qui approuve la Stratégie de Conservation de l'Eléphant en Afrique Centrale (CAECS) et qui note les synergies qu'elle permet avec les objectifs de la conservation de la biodiversité du Plan de Convergence intergouvernemental du Processus de Yaoundé. Dans cette lettre, la COMIFAC demande une aide supplémentaire au GSEAF pour mobiliser les ressources nécessaires à la mise en place de la stratégie. Je

the German government funding agency Kreditanstalt für Wiederaufbau with technical assistance from the AfESG Secretariat. The Ziama–Wenegisi ecosystem, which is situated on the border of Guinea and Liberia, is an important biodiversity hotspot. It is believed that the civil war in Liberia largely displaced elephants in the Wenegisi Forest Reserve into the adjacent Ziama Forest, which now hosts the largest elephant population in Guinea. However, since the cessation of hostilities in Liberia there is some evidence that elephants may be returning (Sambolah 2005). However, in the interim, the corridor linking the two reserves has become increasingly settled and disturbed by human activity. This human settlement poses major challenges to maintaining connectivity between these two forest fragments and calls for coordinated action on both sides of the border. The Ziama–Wenegisi action plan is available in French and in English on our website <http://iucn.org/afesg/tools>.

Efforts are also continuing to secure the seasonal migration routes elephants use to move between southern Burkina Faso and northern Ghana. Since 2003, when AfESG identified this corridor as one of the six main transfrontier elephant ranges in West Africa, there has been ever closer cross-border collaboration and coordination of conservation efforts. Discussions at a workshop in Tamale, Ghana, in June 2006, which was attended by government agencies, NGOs and local community representatives from both sides of the border, discussed the feasibility of establishing and maintaining a permanent corridor stretching all the way from Nazinga Ranch in Burkina Faso to Mole National Park in Ghana. However, it is clear that trying to establish a viable corridor linking these two areas poses a number of problems. For example, the forest reserves that would function as ‘stepping stones’ in the corridor are small, and much of the remaining habitat between them is already cultivated. Furthermore, the boundaries of this corridor have yet to be defined and there is no detailed information about elephant movements. The elephant migration patterns between Nazinga and Kabore Tambi areas in Burkina Faso and the Red and White Volta ecosystems in northern Ghana are better understood, thanks largely to work by such organizations as Association Amnistié Pour l’Eléphant and the Nature Conservation Research Centre. It is encouraging to note that further stakeholder consultations are now being planned to help properly demarcate and manage this corridor, and to tackle the many threats currently fac-

rencontrerai bientôt nos membres d’Afrique centrale, les partenaires et les organes donateurs pour voir comment collaborer au mieux dans ces efforts.

AFRIQUE DU SUD

Les gouvernements des Etats de l’aire de répartition sont encore occupés à passer en revue la Stratégie sud-africaine de conservation de l’éléphant (SAECS). Entre-temps, et en grande partie grâce aux efforts de nos membres sud-africains, le Département sud-africain des Affaires environnementales et du Tourisme a manifesté son intérêt à financer un poste de responsable de programme en Afrique du Sud qui sera basé dans mon bureau de la CSE/UICN à Kirstenbosch, au Cap. Le nouveau Responsable de programme jouera un rôle important car il fournira un support technique aux états de l’aire de répartition en Afrique australe, spécialement en ce qui concerne l’application de la SAECS. Nous espérons qu’un tel support va nous permettre d’apporter une aide rapide à ces états qui sont confrontés à toute une gamme de défis sérieux dans la gestion et la conservation de leurs populations d’éléphants dont certaines continuent à croître et sont de plus en plus impliquées dans des conflits avec les communautés locales.

AFRIQUE DE L’OUEST

Comme tellement de populations clés d’éléphant ouest africaines sont transfrontalières, on a parti-culièrement insisté récemment sur le développement de stratégies et de plans d’action pour la conservation transfrontalière des éléphants. Le dernier de ceux-ci est le plan d’action transfrontalier pour l’éléphant de Ziama-Wenegisi, financé par l’ONG japonaise *Keidaren Nature Conservation Fund* et par l’agence de financement du gouvernement allemand *Kreditanstalt für Wiederaufbau*, avec une assistance technique du Secrétariat du GSEAf. L’écosystème Ziama–Wenegisi, qui se trouve sur la frontière entre la Guinée et le Liberia, est un haut lieu de la biodiversité. On estime que la guerre civile du Liberia a largement déplacé les éléphants de la *Wenegisi Forest Reserve* vers la forêt de Ziama voisine qui abrite maintenant la plus forte population d’éléphants de Guinée.

Cependant, depuis l’arrêt des hostilités au Liberia, il semblerait que les éléphants soient en train de revenir (Sambolah 2005), mais entre-temps, le corridor qui reliait les deux réserves s’est vu de plus en

ing elephants using it, including illegal killing, habitat loss and human–elephant conflict.

EAST AFRICA

The Kenya Wildlife Service has now hired a consultant to help develop a national elephant conservation strategy for Kenya. The technical advisory committee will be meeting soon to discuss the next steps.

Indianapolis Zoo prize

The first-ever Indianapolis Zoo Prize of USD 100,000 was awarded to Dr George Archibald, Chair of the IUCN SSC Crane Specialist Group and Chief Executive of the International Crane Foundation. It is intended that the award will be given every other year to ‘an individual who has made significant strides in conservation efforts involving an animal species or multiple animal species’. As one of the five ‘runners up’, I was pleased to attend the awards ceremony, which took place at a gala evening in Indianapolis on 30 September 2006, with IUCN SSC’s former Executive Officer, Simon Stuart, and fellow AfESG member, Iain Douglas-Hamilton. We received a warm welcome from our Indianapolis Zoo hosts and spent a great day at the facility meeting keepers (especially the elephant gang), curators and the senior management.

Fundraising through the AfESG website

As a result of our ongoing efforts to develop new and innovative fundraising strategies while cutting down on costs, we have recently introduced a new online tool for making donations to AfESG. Hard copy versions of *Pachyderm* and the African Elephant Status Reports can also be bought through our website. Donations and purchases can be made by anyone with a credit card (for details see <http://www.iucn.org/themes/ssc/sgs/afesg/donate.html>). Proceeds from all sales will go towards producing future issues of *Pachyderm* and the African Elephant Status Reports. Please spread the word and help support our work!

References

Sambolah R. 2005. Report on the rapid faunal surveys of seven Liberian forest areas under investigation for conservation. Fauna & Flora International, Cambridge, UK.

plus occupé et perturbé par des activités humaines. Les installations humaines constituent un défi majeur pour le maintien de la connectivité entre les deux portions de forêts, et cela requiert une action coordonnée des deux côtés de la frontière. Le plan d’action Zياما–Wenegisi est disponible en anglais et en français sur notre site <http://iucn.org/afesg/tools>.

Les efforts se poursuivent pour sécuriser les voies de migrations saisonnières que les éléphants empruntent pour aller du sud du Burkina Faso au nord du Ghana. Depuis 2003, quand le GSEAF a identifié ce corridor comme une des six aires transfrontalières les plus importantes pour les éléphants en Afrique de l’Ouest, la collaboration transfrontalière et les efforts de coordination pour la conservation ont été plus étroits. Lors d’un atelier à Tamale, au Ghana, en juin 2006, qui a réuni des agences gouvernementales, des ONG et des représentants de communautés locales des deux côtés de la frontière, des discussions ont abordé la possibilité d’établir et d’entretenir un corridor permanent qui s’étend du *Nazinga Ranch* au Burkina Faso jusqu’au *Mole National Park*, au Ghana. Cependant, il est évident qu’essayer d’établir un corridor durable qui relie ces deux zones pose un certain nombre de problèmes. Par exemple, les réserves forestières qui feraient fonction de portes d’entrée de ce corridor sont petites, et une grande partie de l’habitat restant entre elles est déjà cultivée. Qui plus est, il faut encore définir les frontières de ce corridor, et il n’y a aucune information détaillée sur le déplacement des éléphants. Les schémas de migration des éléphants entre les régions de Nazinga et Kabore Tambi au Burkina Faso et les écosystèmes des Volta Rouge et Blanche au nord du Ghana sont mieux compris, en grande partie grâce au travail d’organisations comme l’Association Amnistie pour l’Eléphant et le *Nature Conservation Research Centre*. Il est encourageant de noter que d’autres consultations des partenaires sont prévues pour aider à délimiter précisément et à gérer ce corridor et pour répondre aux nombreuses menaces qui pèsent sur les éléphants qui l’empruntent actuellement, y compris les massacres illégaux, la perte d’habitat et les conflits hommes-éléphants.

AFRIQUE DE L’EST

Le *Kenya Wildlife Service* a requis les services d’un consultant pour l’aider à développer une stratégie nationale pour la conservation des éléphants au Kenya. Le comité de conseil technique se réunira bientôt pour discuter les étapes suivantes.

[SRT] Second scientific roundtable on elephants and their impacts in South Africa. 2006, Statement of scientific consensus. Media statement, 22 August 2006.

Prix du Zoo d'Indianapolis

Le premier prix attribué par le Zoo d'Indianapolis, d'une valeur de 100.000 dollars, a été alloué au Dr George Archibald, Président du Groupe Spécialiste des Grues de la CSE/UICN, et Directeur de l'*International Crane Foundation*. Cette récompense devrait être attribuée tous les deux ans à «un individu qui a accompli des pas significatifs dans des efforts de conservation impliquant une espèce animale ou de multiples espèces». Faisant partie des cinq lauréats, j'ai eu le plaisir d'assister à la cérémonie des *Awards* qui a eu lieu lors d'une soirée de gala, le 30 septembre 2006, en compagnie du Directeur exécutif de la CSE/UICN, Simon Stuart, et d'un collègue membre du GSEAf, Iain Douglas-Hamilton. Nous avons été chaleureusement accueillis par nos hôtes du Zoo d'Indianapolis et nous y avons passé une journée mémorable à rencontrer les gardiens (spécialement le «gang» des éléphants), les soigneurs et les cadres de la gestion.

Récolte de fonds sur le site Internet du GSEAf

Suite à nos efforts pour tenter de développer des stratégies novatrices en matière de récolte de fonds tout en réduisant les coûts au maximum, nous avons récemment lancé un nouvel outil en ligne permettant de faire des dons au GSEAf. On peut aussi acheter en ligne les versions papier de *Pachyderm* et des Rapports sur le statut de l'éléphant africain. Les dons et les achats sont possibles pour toute personne qui dispose d'une carte de crédit (pour les détails, voir <http://www.iucn.org/themes/ssc/sgs/afesg/donate.html>). Les sommes provenant des ventes seront investies dans la production des futurs numéros de *Pachyderm* et des Rapports sur le statut des éléphants africains. S'il vous plaît, faites passer l'information et soutenez notre travail.

Références

- Sambolah R. 2005. Report on the rapid faunal surveys of seven Liberian forest areas under investigation for conservation. Fauna & Flora International, Cambridge, UK.
- [SRT] Second scientific roundtable on elephants and their impacts in South Africa. 2006, Statement of scientific consensus. Media statement, 22 August 2006.

African Rhino Specialist Group report

Rapport du Groupe Spécialiste des Rhinos d'Afrique

Martin Brooks, Chair/Président

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

West African black rhino feared extinct

A recent survey within the last known range of the West African black rhino *Diceros bicornis longipes* in northern Cameroon has failed to locate any sign of their continued presence although many signs of poaching activity were recorded. Drs Isabelle and Jean-Francois Lagrot spent four months in early 2006 patrolling 2500 km between Faro National Park and Bouba N'Djida National Park without success. Enquiry among 21 hunting guides also drew a blank. While Paul Bour of Association Symbiose will be in the field until the end of 2006 checking reports from the field, the outlook for this subspecies does not look good.

Northern white rhino in Garamba National Park, Democratic Republic of Congo

Since the last Chair report, an additional two northern white rhino *Ceratotherium simum cottoni* have been located, so the minimum population stands at four (two adult males, one adult female, one subadult of unknown sex). Modelling should give us a realistic assessment of the probability of this remnant population surviving in the long term. This will be an important consideration at the strategic planning workshop that the Institut Congolais pour la Conservation de la Nature (ICCN) and the African Parks Foundation are organizing, to be held in 2007.

Eighth AfRSG meeting

We held our eighth AfRSG meeting from 27 June to 2 July 2006 at Mlilwane Wildlife Sanctuary, Swaziland. Attended by 42 participants from 14 countries, the meeting was opened by King Mswati III, Ngwenyama of Swaziland in the presence of Her Majesty the Queen Mother, other members of the

Le rhino noir d'Afrique de l'ouest est peut-être éteint

Une récente étude au sein du dernier habitat connu du rhinocéros noir d'Afrique de l'Ouest *Diceros bicornis longipes* au nord du Cameroun n'a permis de localiser aucun signe de sa présence bien qu'on ait relevé de nombreux signes de braconnage. Les Dr Isabelle et Jean-François Lagrot ont passé quatre mois au début de 2006 à patrouiller sur 2500 km entre le Parc National de Faro et celui de Bouba N'Djida, sans résultat. Des enquêtes auprès de 21 guides de chasse n'ont rien donné non plus. Paul Bour, de l'association Symbiose, sera sur le terrain fin 2006 et vérifiera tous les rapports de terrain, mais les perspectives pour cette sous-espèce semblent défavorables.

Le rhino blanc du Nord du Parc National de la Garamba, en République Démocratique du Congo

Depuis le dernier rapport du président, on a localisé deux rhinos blancs du Nord *Ceratotherium simum cottoni* de plus, de sorte que la population minimale est d'au moins quatre animaux (deux mâles adultes, une femelle adulte et un sub-adulte de sexe inconnu). La modélisation devrait nous donner une évaluation réaliste des chances que cette population survive à long terme. Ceci sera un élément important lors de l'atelier de planning stratégique que l'Institut Congolais pour la Conservation de la Nature organisera avec African Parks Foundation en 2007.

Huitième réunion du GSRAf

Nous avons tenu notre huitième réunion du GSRAf du 27 juin au 2 juillet 2006 au Sanctuaire de la Faune de Mlilwane, au Swaziland. 42 participants venus de 14 pays ont assisté à cette réunion inaugurée par le roi Mswati III, Ngwenyama du Swaziland, en

royal family, the acting prime minister, councillors, ministers, members of the diplomatic corps and the local community. The focus was on synthesizing information on the status and management of the six African rhino taxa, international initiatives, rhino strategies and new management techniques.

The African rhino range states reported on their progress in terms of their national plans and rhino conservation programmes and provided detailed information on rhino numbers, poaching, illegal trade and horn stockpiles. The rhino figures, which were synthesized to compile the updated statistics detailed in the Rhino Notes on page 100 reflect the overall upward trend of numbers of both black and white rhino species, but also the very critical status of the northern white rhino and the possible extinction of the West African black rhino, as described above.

Overall numbers of rhinos have continued to increase in the wild, reaching 14,540 white and 3725 black by 31 December 2005. This represents an overall population increase of 92.3 % (white) and 54.6 % (black) since 1995—the year that the decline in black rhino numbers bottomed out with numbers at a low of 2410. The net annual increase over the last decade has been 6.6 % white and 4.5 % black. Recent trends, however, vary between subspecies, with the two rarest African rhino species faring badly, as described above, while the trend in numbers of other subspecies is up. By the end of 2005, numbers of the other three black rhino subspecies in the wild had increased to an estimated 1865 south-central (*D.b. minor*), 1220 south-western (*D.b. bicornis*) and 640 eastern (*D.b. michaeli*) black rhino. Southern white rhino numbers continue to increase rapidly, reaching 14,540 by 2005. There are also a further 760 white rhino (750 southern and 10 northern) and 240 black (171 eastern and 69 south-central) in zoos and intensively managed facilities worldwide.

Following a session in which eight rhino support and funding agencies described their activities and priority areas of interest, delegates were advised about the implications for the AfRSG of the Decisions emanating from CITES CoP 13 and the 53rd CITES Standing Committee meeting. The workshop on this later in the meeting agreed, in response to Decision 13.25, that the requested report to CoP 14 on the national and continental status of rhinos and their management should have seven sections dealing with management strategies, population status, legislation, CITES Decisions, illegal killing, stockpiles, trade

présence de Sa Majesté la Reine Mère, d'autres membres de la famille royale, du premier ministre faisant fonction, de conseillers, de ministres, de membres du corps diplomatique et de la communauté locale. Le point central était de synthétiser les informations sur le statut et la gestion des six taxons de rhinos africains, sur les initiatives internationales, sur les stratégies pour les rhinos et sur les nouvelles techniques de gestion.

Les états africains de l'aire de répartition des rhinos ont fait part de leurs progrès en matière de plans nationaux et de programmes de conservation des rhinos et ils ont fourni des informations détaillées sur le nombre de rhinos, le braconnage, le commerce illégal et les stocks de cornes. Les chiffres concernant les rhinos, qui ont été synthétisés pour compiler les statistiques détaillées mises à jour dans les Rhino Notes à la page 100, reflètent la tendance générale à la hausse des rhinos noirs et des blancs, mais aussi le statut très critique du rhino blanc du Nord et la possible extinction du rhino noir d'Afrique de l'Ouest (voir plus haut).

Le nombre global de rhinos a continué à croître dans la nature pour atteindre 14.540 blancs et 3725 noirs, à la date du 31 décembre 2005. Ceci représente une augmentation globale de 92,3% pour les rhinos blancs et de 54,6% pour les rhinos noirs depuis 1995 — l'année où le déclin du nombre de rhinos noirs a atteint son niveau plancher avec 2410 animaux. L'augmentation annuelle nette au cours de la dernière décennie a été de 6,6% pour les rhinos blancs et de 4,5% pour les noirs. Les tendances récentes varient toutefois entre les sous-espèces, et les deux plus rares rhinos africains ont de très mauvais résultats, comme on l'a dit plus haut, alors que le nombre des autres sous-espèces est à la hausse. Fin 2005, les chiffres pour les trois autres sous-espèces de rhinos noirs en liberté ont augmenté pour atteindre 1865 rhinos du Centre-sud (*D.b. minor*), 1220 du Sud-ouest (*D.b. bicornis*) et 640 de l'Est (*D.b. michaeli*). Le nombre de rhinos blancs du Sud continue à croître rapidement — 14.540 en 2005. De plus, il y a encore 760 rhinos blancs (750 du Sud et 10 du Nord) et 240 noirs (171 de l'Est et 69 du Centre-sud) dans les zoos et dans des installations gérées de façon intensive dans le monde entier.

Suite à une session au cours de laquelle huit agences de support et de financement des rhinos avaient décrit leurs activités et leurs domaines d'intérêt prioritaires, les délégués ont été mis au courant des implications, pour le GSRAf, des Décisions émanant de la CoP 13 de la CITES et de la 53^{ème} réunion du Comité perma-

routes and recommendations. With strong support from TRAFFIC, we have reported progress to CITES Standing Committee 54, as well as our view that this approach would be more appropriate than the more complex and expensive Rhino Indicators Process, and indeed would negate the need for it.

Also related to CITES, the implementation of trophy hunting in Namibia and South Africa under quotas approved at CITES CoP 13 was reported on and discussed. Namibia has drafted a policy on tourism and wildlife concessions on state land, and the trophy hunting of black rhino will only proceed once this policy has been approved. South Africa implemented hunting in 2005, when three of the permits were exercised. However, delegates raised some concerns about the programme, and it was agreed that the SADC Rhino Management Group would approach the relevant South African authority and private owners with these concerns.

Delegates were then informed of the conservation strategies being applied in KwaZulu-Natal through the Black Rhino Range Expansion Project, and in Assam for the greater one-horned rhino, of rhino policies in West Bengal and Nepal, and of rhinos in captivity. This was followed by a session on focal populations during which the habitat suitability and proposed re-establishment of black rhinos in the northern Serengeti, the status of the northern white rhino in Garamba National Park in DRC, the survey and possible extinction of the West African black rhino in Cameroon, rhino reintroduction in Uganda and North Luangwa National Park in Zambia, metapopulation management of rhinos in Kenya and Tanzania, the SADC Rhino Management Group's report on black rhino performance and management in Namibia, South Africa and Zimbabwe, and the status of Asian rhinos were reported on and discussed. The third day was devoted to techniques and research. It covered the Kenyan Darwin Initiative, assessing black rhino browse, rhino horn fingerprinting, Wildlife Investigator and RHINO software as management tools, using digital cameras for rhino surveys at waterholes, and law enforcement and monitoring in conserving rhino ecosystems.

Before they attended workshops or meetings of the SADC Rhino Recovery Group and AFRSG members, participants went on a field trip to the Mkhaya Game Reserve during which they saw how both black and white rhinos are being re-established and managed, and they visited ecotourism facilities.

de la CITES. Cet atelier a accepté ensuite, en réponse à la décision 13.25, que le rapport demandé pour la CoP 14 sur le statut national et continental des rhinos et sur leur gestion ait obligatoirement sept sections traitant respectivement des stratégies de gestion, du statut des populations, de la législation, des Décisions de la CITES, des massacres illégaux, des stocks et des routes du commerce et des recommandations. Avec le ferme support de TRAFFIC, nous avons fait part des progrès au 54^{ème} Comité permanent de la CITES et dit que cette approche serait plus appropriée que les Processus Indicateurs des Rhinos, plus complexes et plus coûteux, et qu'elle annulait la nécessité de ceux-ci.

Concernant aussi la CITES, on a aussi discuté de la mise en place de la chasse aux trophées en Namibie et en Afrique du Sud, selon des quotas approuvés par la CoP 13 de la CITES. La Namibie a préparé une politique du tourisme et des concessions de chasse sur des terres de l'Etat, et la chasse aux trophées de rhinos noirs ne commencera que lorsque cette politique aura été approuvée. L'Afrique du Sud a mis en place la chasse en 2005, et trois permis ont été utilisés. Cependant, des délégués ont émis des remarques concernant le programme, et on a décidé que le Groupe de gestion des rhinos de la SADC contacterait les autorités sud-africaines compétentes et les propriétaires privés pour leur faire part de leurs inquiétudes.

Les délégués ont aussi appris quelles étaient les stratégies de conservation appliquées au KwaZulu-Natal par le *Black Rhino Range Expansion Project*, et en Assam, pour le grand rhinocéros unicolore, des politiques en matière de rhinos dans l'Ouest du Bengale et au Népal et des rhinos en captivité. Il y eut ensuite une session sur les populations focales où on a discuté de la pertinence de l'habitat et du projet de réintroduction du rhino noir dans le nord du Serengeti, du statut du rhino blanc du Nord au Parc National de la Garamba en RDC, de l'étude et de l'extinction possible du rhino noir d'Afrique de l'Ouest au Cameroun, de la réintroduction du rhino noir en Ouganda et dans le Parc National de Lwangwa-nord en Zambie, de la gestion de la métapopulation des rhinos au Kenya et en Tanzanie, du rapport du Groupe de gestion des rhinos de la SADC sur les performances et la gestion du rhino noir en Namibie, en Afrique du Sud et au Zimbabwe et du statut des rhinos asiatiques. Le troisième jour fut consacré aux techniques et à la recherche. Cela couvrait la *Kenyan Darwin Initiative*, l'évaluation de l'alimentation des rhinos et de l'empreinte génétique des cornes de rhinos, du *Wildlife Investigator* et du

Workshops were held to 1) develop a framework and terms of reference for the proposed East African Community Rhino Management Group (Kenya, Tanzania, Uganda) which aims primarily to enhance the metapopulation management of the eastern black rhino *D.b. michaeli*, 2) develop a format and process for drafting IUCN SSC Guidelines on Rhino Translocations for Conservation Purposes, 3) agree on the process and content for presenting reports to CITES Standing Committee 54 and CoP 14, and agree on the CITES Indicators Process, 4) explore further the models available for community-based rhino conservation in Africa and Asia, and 5) design a three-year funding strategy for the AfRSG Secretariat, its biennial meetings and *Pachyderm*. Concurrently, meetings were held of the SADC Rhino Recovery Group to determine regional priorities, and of the AfRSG members to discuss organizational strategy and priorities and to assess goal achievement over the past two years.

Appreciation

AfRSG is extremely grateful to UK's Department of Environment and Rural Affairs for providing the core funding that enabled us to hold the meeting; we would also like to acknowledge the support provided to the Secretariat over the past year by WWF-SA, the US Fish and Wildlife Service, the International Rhino Foundation and Save the Rhino International.

Comprehensive confidential proceedings have been compiled and distributed to participants. An abridged version is available for non-participants on request from the AfRSG's Scientific Officer, Dr Richard Emslie, at emslieafrrsg@telkomsa.net.

logiciel Rhino comme outils de gestion, de l'utilisation de caméras digitales pour la surveillance des rhinos aux points d'eau et de l'application et du suivi des lois dans la conservation des écosystèmes des rhinos.

Avant d'assister aux ateliers et aux réunions des membres du *Rhino Recovery Group* de la SADC et du GSRAf, les participants ont fait une visite de terrain à la Réserve de Faune de Mkhaya où ils ont vu comment les rhinos noirs et les blancs se réinstallent et sont gérés, puis ils ont visité les installations pour l'écotourisme.

Les ateliers se sont tenus pour 1) développer un cadre et des termes de référence pour le futur «Groupe de gestion communautaire des rhinos en Afrique de l'Est» (Kenya, Tanzanie, Ouganda) qui vise principalement à améliorer la gestion en métapopulation du rhino noir de l'Est *D.b. michaeli*, 2) développer un format et des processus pour la préparation des Lignes directrices de la CSE/UICN pour la translocation des rhinos à des fins de conservation, 3) se mettre d'accord sur le processus et le contenu des rapports à présenter au 54^{ème} Comité permanent de la CITES et à la CoP 14 et sur les Processus Indicateurs de la CITES, 4) étudier plus profondément les modèles disponibles pour la conservation communautaire des rhinos en Afrique et en Asie et 5) concevoir une stratégie de financement sur trois ans pour le Secrétariat du GSRAf, ses réunions bisannuelles et *Pachyderm*. Dans le même temps, il y avait des réunions du *Rhino Recovery Group* de la SADC pour déterminer les priorités régionales, et des membres du GSRAf pour discuter de la stratégie et des priorités organisationnelles et pour évaluer les résultats des deux dernières années.

Remerciements

Le GSRAf est extrêmement reconnaissant envers le Département britannique de l'Environnement et des Affaires rurales qui lui a assuré les fonds de base nécessaires pour tenir la réunion; nous voudrions aussi remercier le WWF-SA, le *Fish and Wildlife Service* américain, l'*International Rhino Foundation* et *Save the Rhino International* pour le support qu'il ont accordé au Secrétariat au cours de l'année dernière.

Un compte-rendu détaillé et confidentiel a été compilé et distribué aux participants. Une version abrégée est disponible sur demande pour les non-participants auprès du Responsable scientifique du GSRAf, le Dr Richard Emslie, sur emslieafrrsg@telkomsa.net .

Asian Rhino Specialist Group report

Rapport du Groupe Spécialiste des Rhinos d'Asie

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

Kondominium Taman Anggrek 3-23B, Jln. Parman. Slipi, Jakarta 11470, Indonesia;
email: Nico@strien.nl

Tribute

On 23 September the Asian Rhino Specialist Group lost two prominent and long-time members in a helicopter crash in Nepal: Dr Tirtha Man Maskey, AsRSG Co-chair for South Asia, and Mr Narayan Poudel, Director General of the Department of National Parks and Wildlife Conservation, Nepal. (See Tribute on page 107)

Dr Maskey started his co-chairmanship of our group with zeal and enthusiasm. He had quickly organized his office and was engaged with organizing a major rhino workshop in Kaziranga scheduled for 14–16 October. Due to the tragic event the workshop has been postponed to early March 2007.

Mr Poudel was recently promoted to the post of director general, taking over the helm from Dr Maskey. He was faced with the difficult task of restoring security in Nepal's rhino areas, after a spate of poaching caused by the political unrest of the last two years had severely reduced the number of rhinos in Chitwan and Bardia.

Both men had recently started a new stage in their distinguished careers, and they will be missed by all—both personally and professionally.

Andalas moving to the Sumatran Rhino Sanctuary, Way Kambas National Park, Sumatra

Andalas, the young male rhino currently residing in Los Angeles Zoo, will soon move to the Sumatran Rhino Sanctuary (SRS) as recommended by the Global Management and Propagation Board (GMPB) of the Sumatran rhino managed breeding programme. Andalas is the first-born calf of the pair in Cincinnati Zoo, and was the first Sumatran rhino born in captivity in 112 years.

Andalas is now over five years old and shows clear signs of reaching adulthood. In SRS, after a period of

Hommage

Le 23 septembre, le Groupe Spécialiste des Rhinos d'Asie a perdu deux de ses membres les plus anciens et les plus éminents dans un accident d'hélicoptère au Népal: le Dr Man Maskey, co-président du GSRAs pour l'Asie du Sud, et le Dr Narayan Poudel, Directeur général du Département des parcs nationaux et de la Conservation de la Faune au Népal. (Voir l'hommage qui leur est rendu page 107)

Le Dr Maskey a entrepris son travail de co-président de notre groupe avec zèle et enthousiasme. Il avait rapidement organisé son bureau et s'était lancé dans l'organisation d'un atelier important sur les rhinos qui devait se tenir à Kaziranga du 14 au 16 octobre. Suite à ce tragique accident, l'atelier a été reporté au début de mars 2007.

M. Poudel avait été récemment promu au poste de directeur général, reprenant la fonction du Dr Maskey. Il avait la lourde tâche de restaurer la sécurité des zones à rhinos du Népal, après que la recrudescence du braconnage causée par l'instabilité civile eut gravement réduit le nombre de rhinos à Chitwan et à Bardia.

Ces deux hommes avaient récemment entamé une nouvelle étape de leur remarquable carrière et ils nous manqueront à tous, tant sur le plan professionnel que personnel.

Départ d'Andalas vers le Sanctuaire des Rhinos de Sumatra, dans le Parc National de Way Kambas, à Sumatra

Andalas, le jeune rhino mâle qui vit actuellement au Zoo de Los Angeles, va bientôt être transféré au Sanctuaire des Rhinos de Sumatra (SRS), comme l'a recommandé le Conseil pour la gestion mondiale et la propagation (GMPB) du programme de reproduction

quarantine and acclimatization, he will be accompanied by the young female Sumatran rhinos Ratu and Rosa. It is expected that the three will meet for the first time in mid-2007. The SRS staff are readying the facilities and all are excited by this unprecedented act of cooperation within the managed breeding community.

Rosa, the young female from Bukit Barisan Selatan National Park, is apparently not yet fully mature and her reproductive organs have not developed fully. She may take a year or more to reach adulthood and is not at all keen on being together with the resident old male, Torgamba. But she is healthy and has adapted very well.

On the other hand, Ratu, the female rhino rescued from Way Kambas National Park, is somewhat older and has already paired twice with Torgamba. From her behaviour during courtship, it was obvious that she had encountered males before being moved to SRS, but it appears that she had not been pregnant before.

The reproductive cycles of all three females are now being regularly monitored with ultrasonography examinations and hormonal analysis. Torgamba's health is rather unstable. He has periods of anaemia and weight loss, and he only occasionally shows interest in the females.

Though GMPB recommended moving Bina to the USA as soon as possible for a last attempt to attain a pregnancy with Ipuh, the proven breeder in Cincinnati, consensus now is to keep her in SRS so that first she has a chance to interact with Andalas. Bina's reproductive cycle shows more and more irregularities and she may in fact be nearing the end of her reproductive potential. Also the high cost of moving a rhino, especially one with doubtful breeding potential, is an important consideration. The situation will be closely monitored by the reproductive experts and veterinarians and evaluated from time to time.

Application for CITES permits to move both Andalas and Bina is at an advanced stage, and Andalas is expected in the SRS in January or February 2007.

Update on the Indonesian Rhino Conservation Strategy

As a follow-up to the February 2006 workshop on the update of the Indonesian Rhino Conservation Strategy, the director general of Forest Protection and Nature Conservation officially installed a task force

assistée des rhinos de Sumatra. Andalas est le premier descendant du couple du zoo de Cincinnati et c'était le premier rhino de Sumatra né en captivité en 112 ans.

Andalas a maintenant plus de cinq ans et montre les signes évidents du début de l'âge adulte. Au SRS, après une période de quarantaine et d'acclimatation, il recevra la compagnie des deux jeunes rhinos de Sumatra femelles, Ratu et Rosa. Les trois animaux devraient se rencontrer pour la première fois vers la moitié de 2007. Le personnel du SRS prépare les installations et il est très excité par cette coopération sans précédent au sein de la communauté de la reproduction assistée.

Rosa, la jeune femelle du Parc National de Bukit Barisan Selatan, ne semble pas encore tout à fait mature, et ses organes reproducteurs ne sont pas encore complètement développés. Il lui faudra encore un an ou plus pour être adulte, et elle n'a pas la moindre envie de rejoindre le vieux mâle résident, Torgamba. Cependant, elle est en bonne santé et s'est très bien adaptée.

D'autre part, Ratu, la femelle rescapée du Parc National de Way Kambas, est plus âgée et s'est déjà accouplée deux fois avec Torgamba. D'après son comportement pendant la parade, il est certain qu'elle avait déjà rencontré des mâles avant d'être transférée au SRS, mais il semble qu'elle n'a jamais été prégnante.

Les cycles de reproduction des trois femelles sont surveillés régulièrement par ultrasons et analyses hormonales. La santé de Torgamba est plutôt instable. Il passe par des périodes d'anémie et de perte de poids et il ne manifeste que rarement de l'intérêt pour les femelles.

Alors que le GMPB avait recommandé de transférer Bina aux USA dès que possible pour tenter une dernière fois de la faire féconder par Ipuh, le reproducteur avéré de Cincinnati, il y a maintenant un consensus pour la garder au SRS pour qu'elle ait d'abord une chance d'interagir avec Andalas. Le cycle reproducteur de Bina est de plus en plus irrégulier et il se pourrait qu'elle approche, en fait, de la fin de son potentiel reproducteur. Il faut aussi tenir compte du prix élevé du transfert d'un rhino, spécialement lorsque son potentiel reproducteur est incertain. La situation sera suivie de près par les experts en la matière et les vétérinaires, et réévaluée de temps en temps.

La demande de permis CITES pour transférer Andalas et Bina est en bonne voie et Andalas devrait arriver au SRS en janvier ou février 2007.

in June 2006. The task force, with 11 members from government and NGOs, will complete the conservation strategy document and oversee and guide its implementation.

It is expected that the documents will be finalized early in 2007 and that the new Indonesian Rhino Conservation Strategy, the 'Rhino Century Program', will be officially launched later next year. Implementation, especially for the planned range expansion for the Javan rhino, will start soon after.

Training cooperation, Indonesia-Sabah

At the invitation of the Sabah Wildlife Department and SOS Rhino (Borneo), two senior rangers, Mr Arief Rubianto and Mr Miskun, conducted a training programme with field staff in Tabin Wildlife Reserve and adjacent areas in June and July 2006. The two rangers made five trips to Tabin and two to the Kretam area. Twenty-six field staff from SOS Rhino and the Tabin Wildlife Reserve were trained in field techniques and in rhino survey and monitoring. The training was very successful, and a good number of rhino signs were found; on one occasion a rhino was seen and photographed—a first in Sabah.

In July 2006 a group of 21 rangers from WWF Sabah, Sabah Wildlife Department and Yayasan Sabah attended a one-week training course in Way Kambas, Sumatra. After one day of theory on law enforcement, rhino biology and monitoring, participants visited SRS to see rhinos at close range and to work with footprints and other rhino sign. Three days of field training in Way Kambas National Park concluded the course.

The cooperation between the Indonesian and the Sabah Rhino Protection Unit (RPU) programmes has been mutually beneficial, and it is hoped and expected that more exchanges of staff will take place in the future.

The recent survey in key rhino areas has shown that rhinos are present in a wider area, that the previous estimates were probably on the pessimistic side, and that rhinos occur also in a number of smaller forest pockets. Though this is a positive development, it also means that more personnel are needed to protect and monitor the rhino areas. The number of RPUs fielded by SOS Rhino, WWF and the Sabah Wildlife Department needs to be increased to cover all areas in a well-coordinated fashion.

Mise à jour de la Stratégie Indonésienne de Conservation du Rhino

Suite à l'atelier de février 2006 sur la mise à jour de la Stratégie indonésienne de Conservation des rhinos, le directeur général de la Protection des forêts et de la Conservation de la nature a installé officiellement une unité spéciale en juin 2006. Composée de 11 membres venant du gouvernement et d'ONG, elle devra compléter le document de la stratégie de conservation, superviser et orienter son application.

Les documents devraient être prêts au début de 2007, et la nouvelle Stratégie indonésienne de conservation des rhinos, le « *Rhino Century Program* », sera lancée officiellement un peu plus tard. Sa mise en application, et spécialement l'extension prévue de l'aire dévolue au rhinocéros de Java, commencera ensuite rapidement.

Coopération pour la formation, Indonésie-Sabah

A l'invitation du Département de la Faune de Sabah et de SOS-Rhino (Bornéo), deux conservateurs seniors, M. Arief Rubianto et M. Miskun, ont dirigé un programme de formation dans la Réserve de Faune de Tabin et les zones voisines en juin et juillet 2006. Les deux conservateurs sont allés cinq fois à Tabin et deux fois dans la région de Kretam. Vingt-six membres du staff de SOS-Rhino et de la Réserve de Faune de Tabin ont été formés aux techniques de terrain, à la surveillance et au monitoring des rhinos. La formation a été très réussie, et on a trouvé bon nombre de signes de rhinos: on a même vu et photographié un rhino, une première pour Sabah.

En juillet 2006, un groupe de 21 gardes du WWF-Sabah, du *Sabah Wildlife Department* et de *Yayasan Sabah* ont assisté à une formation d'une semaine à Way Kambas, Sumatra. Après un jour de théorie sur l'application des lois, la biologie des rhinos et leur monitoring, les participants ont visité le SRS pour voir les rhinos de près et travailler sur les empreintes des rhinos et les autres indices. Trois jours de formation sur le terrain dans le Parc National de Way Kambas ont clôturé le cours.

La coopération entre les programmes des Unités de protection des rhinos (RPU) d'Indonésie et de Sabah est bénéfique de part et d'autre, et on espère que d'autres échanges de personnel auront lieu à l'avenir.

Rhino campaigns from European and American zoos

The European Association of Zoos and Aquaria (EAZA) rhino campaign, conducted with Save the Rhino International, concluded its one-year rhino campaign at the annual EAZA conference in October 2006. Participating in the campaign in Europe were 128 of the 292 members; they raised more than 515,000 euros, almost 50% above the target of 350,000 euros.

All the projects selected for the campaign and several of those on the waiting list will be funded, including substantial support for RPUs in Indonesia and Sabah, Malaysia, and for the Indian rhino translocations in Assam, India.

On behalf of all the rhino friends in Asia I would like to thank all the European zoos and the many thousands of supporters who made this campaign so successful. The donations are a significant contribution to rhino conservation in Asia. It is sad that the campaign is over, but I hope that some long-term relationships will develop to continue the support from the European zoos for rhino conservation in Asia.

Meanwhile the North American Save the Rhino Campaign is rapidly gaining momentum. The campaign, launched in January 2006 by the International Rhino Foundation in partnership with the Rhino Advisory Group/Species Survival Plans of the American Zoo & Aquarium Association and Ecko Unlimited, focuses on the more than 90 zoos in North America that have rhinos. Already 40 zoos have been recruited for the campaign. Several fundraising events have been organized including a major hip-hop concert in Central Park, New York, organized by Marc Ecko, that has raised USD 150,000 for rhino conservation.

La récente étude des zones clés des rhinos a montré que les rhinos sont présents sur de plus grandes étendues, que les estimations précédentes étaient sans doute trop pessimistes et que l'on trouve aussi des rhinos dans un certain nombre de plus petits îlots forestiers. Si ceci est un développement positif, cela signifie aussi qu'il faut plus de personnel pour protéger et pour surveiller les zones à rhinos. Le nombre de RPU envoyées sur le terrain par SOS-Rhino, par le WWF et par le Département de la Faune de Sabah doit augmenter pour couvrir toutes les zones de façon coordonnée.

Campagnes Rhinos des zoos européens et américains

La campagne rhinos menée par l'Association européenne des zoos et des aquariums (EAZA) et dirigée par *Save the Rhino International* a conclu sa campagne d'un an lors de la conférence annuelle de l'EAZA en octobre 2006. 128 des 292 membres ont participé à la campagne en Europe; ils ont récolté plus de 515.000 euros, près de 50% de plus que l'objectif de la campagne qui était de 350.000 euros.

Tous les projets sélectionnés pour la campagne et plusieurs de ceux qui étaient sur la liste d'attente seront financés, y compris un soutien substantiel pour les RPU d'Indonésie et de Sabah en Malaisie, et pour les transferts de rhinos unicornes en Assam, Inde.

Au nom de tous les amis des rhinos en Asie, je voudrais remercier tous les zoos européens et les milliers de supporters qui ont fait de cette campagne un succès. Les dons sont une contribution significative à la conservation des rhinos en Asie. C'est dommage que la campagne soit terminée, mais j'espère que des relations à long terme vont se nouer pour poursuivre le soutien des zoos européens à la conservation des rhinos en Asie.

D'autre part, la campagne de *Save the Rhino* en Amérique du Nord prend rapidement de l'ampleur. Lancée en janvier 2006 par l'*International Rhino Foundation* en partenariat avec *Rhino Advisory Group/Species Survival Plans* de la *American Zoo & Aquarium Association* et *Ecko Unlimited*, la campagne se concentre sur les zoos nord-américains qui possèdent des rhinos; ils sont plus de 90. Quarante d'entre eux ont déjà été recrutés pour la campagne. Il y a déjà eu plusieurs événements destinés à récolter des fonds, y compris un grand concert hip-hop à Central Park, à New York, organisé par Marc Ecko, qui a récolté 150.000 dollars pour la conservation des rhinos.

RESEARCH

Recensement d'éléphants dans la Réserve Communautaire du Lac Télé, République du Congo

Fortuné C. Iyenguet,¹ Guy-Aimé F. Malanda,¹ Bola Madzoke,¹ Hugo J. Rainey,^{1,*}
Catherine A. Schloeder,² Michael J. Jacobs²

¹ Projet Réserve Communautaire du Lac Télé, Wildlife Conservation Society–Congo, BP 14537, Brazzaville, République de Congo

² Adresse actuelle: PO Box 445, Fortine, Montana 59918, USA

* Auteur avec lequel il faut communiquer : hrainey@wcs.org

Résumé

Nous avons effectué le suivi des éléphants dans la Réserve Communautaire du Lac Télé, d'une superficie de 4400 km², en République du Congo, afin d'estimer le statut et les tendances des populations. L'habitat, à l'intérieur de la réserve, est constitué par les forêts saisonnièrement inondées et marécageuses, faites d'îlots de forêts de terre ferme. A l'aide des méthodes de transect linéaire et d'échantillonnage de DISTANCE, nous avons estimé les densités d'éléphants sur la base du comptage des crottes en saisons des basses et hautes eaux (la saison d'inondation). Selon nos estimations, la réserve présente de faibles densités d'éléphants dans les forêts saisonnièrement inondée et marécageuse. Les éléphants ne sont présents dans la forêt de terre ferme qu'en saison des hautes eaux. En 2004, notre estimation de 316 individus (95% intervalle de confiance 98, 1045) dans la réserve est similaire à celle faite en 2002. Toutefois, la marge d'erreur est haute en raison du nombre insuffisant des tas de crottes. Il est possible que des suivis supplémentaires puissent réduire la marge d'erreur et fournir des informations sur la distribution des éléphants suivant les habitats.

Abstract

We surveyed elephants in the 4400-km² Lac Télé Community Reserve in the Republic of Congo to provide estimates of population status and trends. Habitat in the reserve consists of seasonally flooded and swamp forest with patches of terra firma forest. Using line transects and distance sampling techniques we estimated elephant densities from dung counts in both low- and high-water seasons (flooding seasons). We estimated that the reserve holds low densities of elephants in seasonally flooded and swamp forest. Elephants are present in the terra firma forest in the high-water season only. Our estimate in 2004 of 316 (95% CI 98, 1045) elephants in the reserve is similar to that found in 2002. However, there was a large error in calculating estimates because of the low number of dung piles. Further surveys may help to reduce this error and provide information on elephant distribution between habitats.

Introduction

La Réserve Communautaire du Lac Télé (RCLT) est un des deux sites qui protègent les forêts maréca-

geuses et saisonnièrement inondées en Afrique Centrale et c'est l'unique site en République de Congo. La réserve est déjà connue pour ses grandes populations de grands singes (Poulsen et Clark 2004).

On soupçonne que la population d'éléphants dans et autour du Parc national de Nouabale Ndoki visite saisonnièrement les forêts marécageuses (y compris la forêt inondée) au sud-est du parc et que les éléphants utilisent ou utilisaient la RCLT pendant la saison sèche. Poulsen et Clark (2002) ont trouvé une densité d'éléphants relativement faible (0.07 individus/km²) dans la réserve en 2002.

La réserve est dans une phase de transition: la direction est entrain d'élaborer le plan d'aménagement et une équipe de protection de la réserve est encore en formation. Par la suite, une augmentation de notre connaissance de la répartition et abondance des éléphants pourra aider la gestion à mieux cibler les patrouilles et la sensibilisation des villages proches des zones clés des éléphants. Le suivi des populations des éléphants est aussi important pour la gestion et pour établir si les activités de conservation mises en place dans la réserve sont efficaces. Nous avons envisagé de faire le suivi des éléphants en saison des basses eaux pour le suivi continu des tendances des populations. Aussi, nous avons également réalisé une étude dans la saison des hautes eaux dans la terre ferme pour établir s'il y a une population résidente dans la réserve pendant toute l'année. L'étude'était faite avec une étude sur l'abondance et densité des grands singes dans la réserve (Poulsen et Clark 2004).

Zone d'étude

La Réserve Communautaire du Lac Télé se situe au nord du Congo dans le département de la Likouala et à cheval entre les districts d'Epéna et de Bouanéla. La réserve était créée en 2001 avec le soutien de la population qui a signé un accord pour la création de la réserve. Le Ministère de l'Economie Forestière et de l'Environnement (MEFE) qui gère la réserve est appuyé par la Wildlife Conservation Society et travaille ensemble, à l'élaboration d'un plan d'aménagement qui inclue la gestion communautaire participative. Jusqu'à présent, seules les lois nationales sont applicables dans la réserve. Toutefois, la chasse pour l'autoconsommation est légale mais la chasse commerciale n'est pas légale au Congo. Les éléphants et autres grands mammi-fères sont intégralement ou partiellement protégés. Les objectifs de la conservation dans la RCLT sont la conservation de la biodiversité et la gestion durable des ressources naturelles. Les ressources naturelles principales sont la faune, les poissons et les forêts elles-mêmes dont dépend

la population. La RCLT protège 4,400 km² de forêt et savane. Il existe quatre types de forêt, mais, pour la présente étude, nous incorporons la forêt ripicole dans la forêt saisonnièrement inondée, étant donné le caractère fragmenté de la forêt ripicole (fig. 1, tableau 1). Nous n'avons étudié les éléphants qu'en milieu forestier.

A l'exception de la terre ferme, une bonne portion de la RCLT y compris la savane est inondée en saison des hautes eaux (juillet–novembre). En cette saison, les gens ne se déplacent que par pirogue à travers la réserve et, à moins d'une pirogue, l'entrée en forêt marécageuse et saisonnièrement inondée est limitée par la profondeur des eaux. Une route goudronnée relie Epéna à Impfondo, capitale de la région, située à l'est de celle-ci. En saison des basses eaux (décembre–juin), des pistes relient de nombreux villages et il est possible d'accéder en forêt à pied. Vingt-sept villages se trouvent dans et autour de la réserve, avec une population de plus de 17.000 habitants, pour une densité de 3 habitants par km² (Poulsen et Clark 2002). Les communautés locales dépendent largement des ressources naturelles. Les poissons constituent 91 % du régime alimentaire et la viande de brousse 7 % (Poulsen et Clark 2002). Seuls 2 % des protéines consommées par elles proviennent des animaux domestiques.

Dans la zone, la température varie très peu toute l'année, avec une moyenne de 25.6°C. Mais les périodes et l'intensité des précipitations sont fortement variables. Les précipitations annuelles varient entre 1350 et 1800 mm, tandis que les précipitations mensuelles moyennes oscillent entre 15 et 300 mm. Les précipitations les plus importantes ont généralement lieu d'août à novembre. La saison sèche, avec de faibles précipitations, intervient de décembre à mars. Toutefois, la durée et la date initiale de cette saison changent d'année en année. Il y a également une petite saison des pluies d'avril à juin, puis une petite saison sèche en juillet (Poulsen et Clark 2002).

Tableau 1. Proportion des habitats au niveau de la RCLT

Habitat	Superficie (km ²)	%
Forêt marécageuse	2156	49
Forêt saisonnièrement inondée	1100	25
Forêt terre ferme	440	10
Savane	704	16

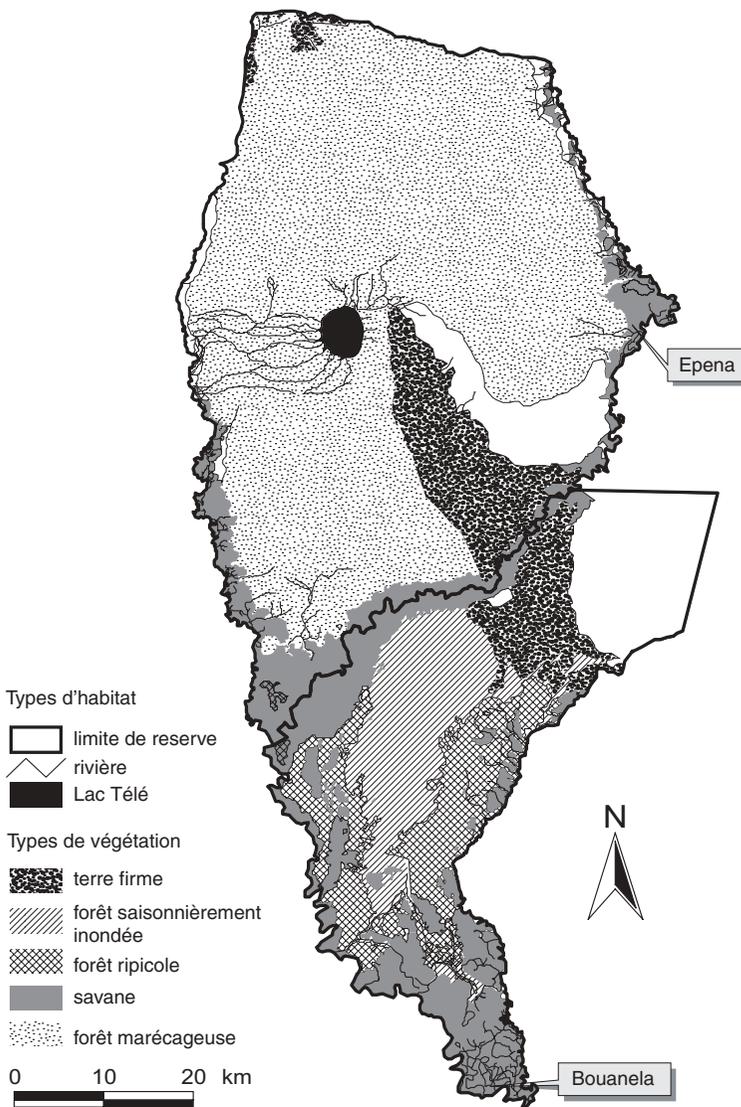


Figure 1. Carte de différents types d'habitats et de végétation.

Méthodologie

Transects

Les éléphants ne peuvent pas être comptés directement dans la forêt, car il est difficile de les observer dans le sous-bois épais (Barnes et Jensen 1987; Barnes et al. 1991 ; Barnes et al. 1993 ; Barnes et Blom 1995). Le présent recensement se fonde donc sur les comptages de crottes, d'ores et déjà expérimentés avec succès dans d'autres régions d'Afrique où la

visibilité est faible (Short 1983; Tutin et Fernandez 1984; Jachman et Bell 1984; Merz 1986).

Les transects ont été parcourus dans la forêt mixte de terre ferme pendant la saison des basses eaux (7–30 novembre 2003) et, à travers la réserve, pendant la saison des hautes eaux (17 mars–23 juillet 2004). Les transects parcourus sont ceux qui ont été utilisés par Poulsen et Clark (2002). Les transects, utilisés pour la première fois sur terre ferme en saison des hautes eaux, ont été une seconde fois suivis en saison des basses eaux. Lors de la période des cinq mois située entre l'échantillonnage initial sur terre ferme et le second, la végétation a repoussé et a refermé les transects. En conséquence, la reprise de l'échantillonnage sur les mêmes transects n'a pas influé sur les résultats.

Dans les forêts marécageuse et saisonnièrement inondée, les transects mesuraient 5 km de long et étaient séparés l'un de l'autre d'une distance de 5 km. Quant aux transects de la terre ferme, ils étaient longs de 2 km et espacés de 3.5 km. Nous avons également parcouru des transects de moins de 5 km et de moins de 2 km. Le caractère court de ces transects s'explique : soit qu'ils finissaient dans un autre type d'habitat, soit qu'ils se poursuivaient hors de la RCLT. Les coordonnées du début et de la fin de chaque transect ont ensuite été déterminées à l'aide

du système d'informations géographiques (SIG). Sur la base de ces informations, et en se servant d'un GPS et d'une boussole, nous avons pu localiser les transects dans la forêt. À l'aide des coordonnées du début et de la fin de chaque transect, nous avons été capable d'ouvrir une ligne droite en suivant le cap 335°. Trois guides parcouraient le transect et ses alentours pour l'identification des indices d'éléphants : pistes, empreintes, crottes, restes de nourriture.

Nous avons repris et parcouru 56 transects linéaires (24 sur la terre ferme et 32 dans les deux autres habitats), représentant une distance de 128 km entre mars et juillet et de 42,7 km en novembre. Nous avons parcouru 82,4 km en forêt inondée de façon saisonnière, 45,9 km sur la terre ferme et 42,7 km dans la forêt marécageuse.

La méthode 'line transect' (Burnham et al. 1980) a été utilisée par Koster et Hart (1988) pour compter des antilopes de forêt, et pour compter les crottes d'éléphants de forêt (Barnes et Jensen 1987). Quand une crotte est découverte, on en mesure la distance par rapport à la ligne centrale. Nous avons collecté les informations ci-après sur la crotte : la date, l'heure, la distance du transect, la distance perpendiculaire, l'indice, et l'âge de l'indice. Nous avons attribué un référentiel à l'âge de l'indice (White et Edwards 2000). Les distances perpendiculaires sont utilisées pour estimer le nombre de crottes au km².

Recces voyages

Entre chaque transect, la voie de moindre résistance était prise par les chercheurs pour atteindre le prochain transect. Les signes humains vus pendant les mouvements entre les transects étaient notés pour étudier la présence de l'homme dans la réserve. Cette méthode est le 'recce voyage' utilisé dans les études de MIKE. Les données collectées étaient utilisées pour calculer un indice sur la présence de l'homme dans la réserve. Les signes humains notés, y compris les suivants, sont détaillés dans White et Edwards (2000): pistes utilisées et abandonnées; coupes faites à la machette ou branches cassées; sentiers utilisés régulièrement; lignes de collets ; cartouches vides; récolte de miel; campements.

La longue des recces voyages, les signes d'éléphants étaient notés aussi pour comparer les données entre l'homme et faune. Bien que cela ne permette pas de calculer les densités de la présence de l'homme ni de monter les cartes, cela permet aux gestionnaires de la réserve de connaître les zones les plus utilisés pour les activités humaines.

Estimation des densités

Nous avons estimé la densité des éléphants sur la base des données collectées sur nos transects en utilisant le logiciel DISTANCE (Buckland et al. 2001 Thomas et al. 2003). Pour améliorer l'estimation du modèle, nous avons exclu les 10 % d'observations les plus éloignées

des lignes de transects. DISTANCE modélise la distance entre le transect et l'observation pour estimer la densité de l'observation dans la zone d'étude. Quatre modèles pour la détection ont été considérés. Le critère d'information d'Akaike (Akaike Information Criterion-AIC), a été calculé pour chaque modèle et le choix du modèle final a été fait sur la base d'un faible AIC ou d'une faible variance.

Barnes et al. (1995) ont proposé la formule suivante pour calculer la densité d'éléphants :

$$D = (YZ) / X$$

où

D = densité des éléphants

Y = densité des crottes (calculée via DISTANCE)

Z = taux journalier de dégradation des crottes

X = taux de défécation par jour et par éléphant

On a conclu que les éléphants produisent une moyenne de 17 à 20 tas de crottes par jour (Coe 1972; Merz 1986; Tchamba 1992). Nous avons utilisé un taux de défécation de 20 tas de crottes par jour dans nos calculs de telle sorte qu'au bas mot, les résultats soient de *X* = 20.

Le taux journalier de dégradation des crottes dépend de la température et des précipitations. Barnes et al. (1997) ont proposé la formule suivante pour le calculer:

$$Z = (-96,498 + (0,063 \times \text{précipitation mensuelle (mm)}) + (4,667 \times \text{température moyenne mensuelle } ^\circ\text{C}) / 1000$$

Le tableau 2 présente les précipitations et la température enregistrées à Epéna (le siège du Projet de la RCLT) pendant la période d'étude.

Tableau 2. Les précipitations et la température moyenne au cours de la période d'étude à Epéna

Mois	Précipitations totale (mm)	Température moyenne (°C)
2003		
Novembre	59,7	26,8
2004		
Mars	155,5	27,6
Avril	136,5	29,5
Mai	231,5	28,6
Juin	314,5	26,7
Juillet	135,0	27,2
Moyenne Mars-juillet	194,6	27,9

Source : données non publiées Wildlife Conservation Society Projet, Réserve Communautaire du Lac Télé

Ainsi donc, le calcul de Z, le taux journalier de dégradation des crottes, a donné 0,03 en novembre 2003 et 0,05 entre mars et juillet 2004.

Résultats

Densité et distribution des éléphants

Le nombre d'observations de crottes a été faible et ne nous a laissé qu'une estimation imprécise de la densité d'éléphants dans la réserve (tableau 3). Les observations de crottes d'éléphants étaient concentrées dans les forêts marécageuse et saisonnièrement inondée, avec des taux d'observations élevés. Pendant la saison des basses eaux (mars à juillet), nous n'avons pas eu de crottes sur la terre ferme. En multipliant les estimations de densité d'éléphants dans les forêts marécageuses et saisonnièrement inondée par la surface de chacun de ces habitats de la réserve, nous estimons que, lors de la saison de basses eaux, la réserve abrite environ 316 (95% CI 98, 1045) éléphants. Nous n'avons pas trouvé une préférence dans l'occupation des habitats, car il n'y a pas une différence significative entre les observations de la forêt marécageuse et celles de la forêt saisonnièrement inondée (t -test, $t = 0.60$, $n = 23,10$, n.s.) (figs. 2 et 3).

Influence humaine sur la distribution des éléphants

La comparaison des observations d'indices d'éléphants et d'indices humains par habitat indique qu'il n'y a pas une corrélation entre les deux indices peut-être parce que la densité des crottes est faible (fig. 4).

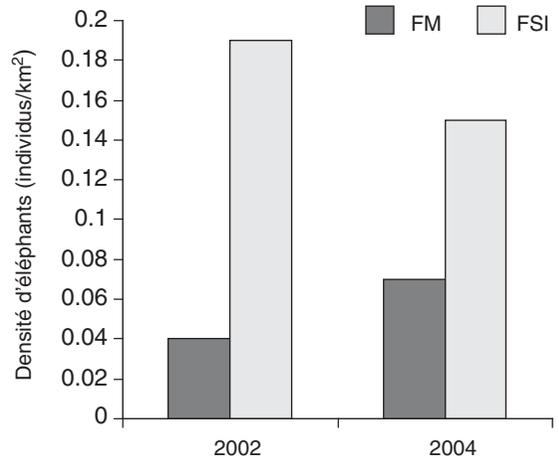


Figure 2. Densités d'éléphants en forêts marécageuse (FM) et saisonnièrement inondée (FSI) en 2002 et 2004.

Indices des signes humains et éléphants

Les indices des signes humains pris le long des reces voyages se trouvent dans tous les habitats (fig. 5). Ils sont communs dans la terre ferme comme dans les autres habitats. De même, dans la terre ferme, les signes humains sont abondants dans les deux saisons. Les signes éléphants notés le long des reces voyages sont moins communs que les signes humains (fig. 5). Aussi sont-ils rares ou absents sur la terre ferme dans toutes les deux saisons.

Tableau 3. Densité d'éléphants dans la Réserve Communautaire du Lac Télé, de mars à juillet 2004

Habitat	Tas de crottes	Tas de crottes/km ²	Densité de crottes/km ²	Densité d'éléphants/km ²	90% CI elephants/km ²	% CV
Forêt marécageuse	9	0,21	27,09 ^a	0,07	[0,02, 0,26]	64,45
Forêt saisonnièrement inondée	37	0,41	59,57 ^b	0,15	[0,05, 0,44]	57,17
Terra ferme (basses eaux) ^c	0	–	–	–	–	–
Terra ferme (hautes eaux)	9	0,18	15,217	0,02	[0,01, 0,07]	0,618

95 % CI équivalent à 95 % d'intervalle de confiance. Le faible nombre de crottes observées a réduit la précision et a augmenté le coefficient de variation (CV)

^a Uniforme simple polynomial (AIC = 24,45); ^b Uniforme simple polynomial (AIC = 97,88)

^c Des crottes d'éléphant n'étaient pas trouvées dans la forêt de terre ferme pendant les basses eaux, alors ce n'était pas possible de calculer une densité.

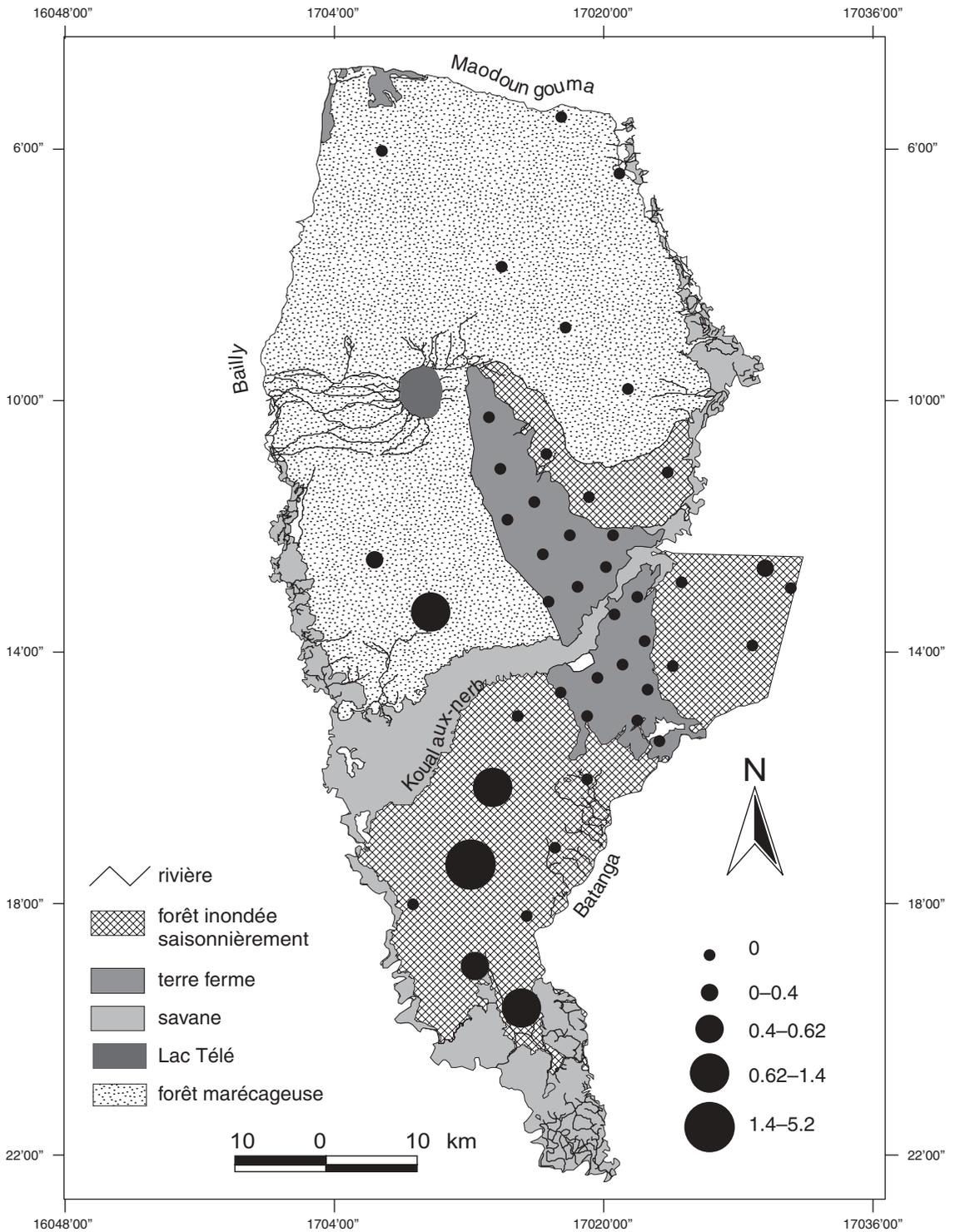


Figure 3. Distribution et taux de rencontre des éléphants en 2004 dans la RCLT. (Source : Wildlife Conservation Society)

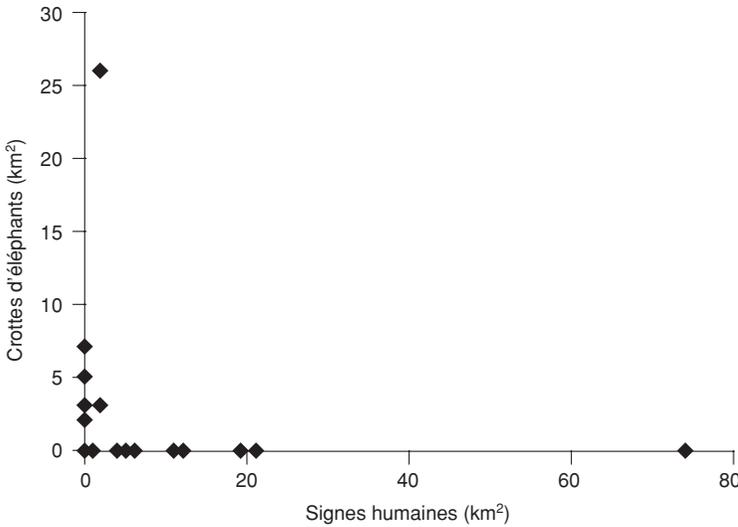


Figure 4. La densité des crottes d'éléphants (km²) relevées et les signes d'activité humaine ne présente aucune corrélation, $r^2 = 0.01$.

Discussion

Le présent suivi confirme la présence d'une population d'éléphants, avec une densité faible, très proche du niveau où Poulsen et Clark (2002) l'ont trouvé (tableau 4). Ces derniers ont estimé à 295 (95 % CI 132, 784) le nombre d'individus d'éléphants dans la RCLT et, en dépit du coefficient de variation (CV) élevé, nos résultats soutiennent ce chiffre et nous estimons, quant à nous, qu'il en existe 316 (95% CI 98, 1045) individus. Même si l'estimation de la population de 2004 est plus grande que celle de 2002, les CI (95 %) de 2002 et 2004 sont si grandes qu'il n'y a pas de différence entre les estimations des deux années. Ce n'est qu'après au

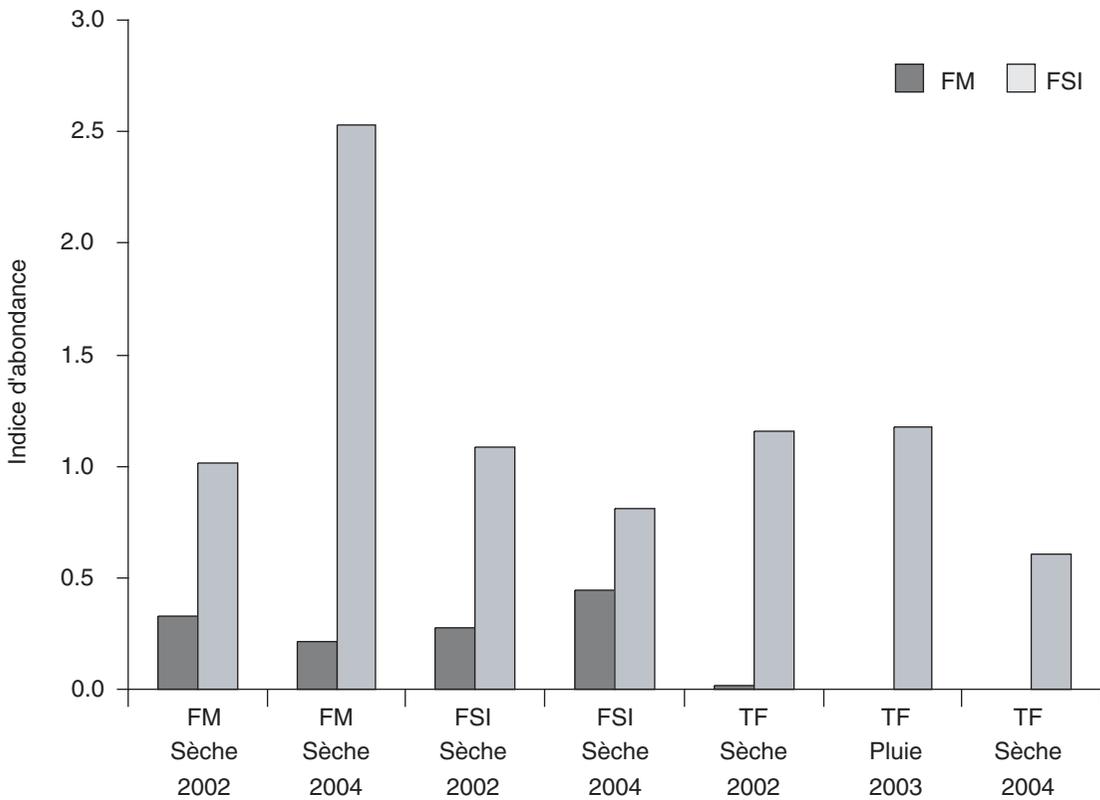


Figure 5. Indices d'abondance des éléphants (colonnes noires) et l'homme (colonnes grises) calculé des signes notés le long des recces voyages. FM-forêt marécageuse, FSI-forêt saisonnièrement inondée, TF-forêt terre ferme. Toutes les données étaient prises en saison sèche, sauf dans la terre ferme en 2003.

Tableau 4. Les estimations de densité d'éléphants (individus/km² avec intervalle de confiance), 2001–2004 au niveau de la RCLT (Poulsen et Clark 2002)

Habitat	Niveau d'eau	2001	2002	2003	2004
Forêt marécageuse	bas	–	0,04 (0,01, 0,18)	–	0,07 (0,02, 0,26)
Forêt saisonnièrement inondée	bas	–	0,19 (0,10, 0,36)	–	0,15 (0,05, 0,44)
Forêt de terre ferme	bas	–	NA	–	NA
Forêt de terre ferme	elevé	NA	NA	0,02 (0,01, 0,07)	–

Le trait (–) indique qu'il n'y a pas eu suivi. Le NA désigne le nombre de tas de crottes trop faibles pour le calcul des estimations de densité.

moins quatre années de suivi que le CV diminuera suffisamment pour estimer avec précision les tendances de la population des éléphants dans la réserve.

Les densités d'éléphants dans les forêts d'Afrique centrale sont en moyenne de l'ordre de 0,29 à 2,1 éléphants/km² (Eggert et al. 2003). Fay et Agnagna (1992) ont estimé la densité d'éléphants dans la réserve à 0,3 éléphants/km², et ont indiqué que la rivière Batanga à l'est et au sud du Lac Mboukou contenait encore d'importantes populations d'éléphants. Il est donc possible que la pression de chasse reste importante dans la réserve. Poulsen et Clark (2002) ont laissé supposer que la faible abondance des éléphants dans la réserve pouvait être attribuée à trois facteurs : 1) les mouvements saisonniers des éléphants hors de la réserve ; 2) la difficulté de localiser les crottes d'éléphants dans les habitats humides ; 3) l'importance de la chasse. Cependant, il se peut également que la population d'éléphants au nord de la réserve, au Parc national Nouabalé Ndoki et sa zone périphérique, ait répondu à la baisse de la pression de chasse en s'approchant des villages après une durée de cinq ans de protection.

Nous avons trouvé très peu de différence dans l'utilisation par l'éléphant de différents types d'habitats. Il est possible que les crottes aient disparu rapidement dans la forêt marécageuse (Barnes et al. 1991) et que, de notre côté, nous ayons sous-estimé la densité dans cet habitat. Barnes et al. (1991) ont noté que le facteur important qui détermine la densité d'éléphant au Gabon n'est pas la végétation, mais les activités humaines. La densité des crottes d'éléphants est toujours faible et c'est peut-être la raison pour laquelle aucune corrélation n'a été établie entre les activités humaines et la densité en éléphant.

On croit que les éléphants visitent saisonnièrement la réserve par rapport à la disponibilité de nourriture

ou à la retraite des eaux. L'absence des éléphants de la terre ferme pendant les hautes eaux peut être expliquée s'ils migraient hors de la réserve en cette saison. Quoique nous ne disposions pas de données sur les couloirs migratoires des éléphants hors de la RCLT, quelques pistes de traversée du bloc sud au bloc nord de la réserve sont à plusieurs reprises observées. Nous avons remarqué que les éléphants se trouvent sur la terre ferme et ce, pendant la saison des basses eaux. Mais, telle ne constitue pas une preuve concluante de la migration saisonnière entre différents types d'habitats. Leurs mouvements saisonniers peuvent être influencés par la distribution des mares dans la saison des basses eaux ; lorsque les eaux basses souvent il n'y a pas d'eau dans la forêt marécageuse et les éléphants doivent boire des mares. Le village d'Edzama, au sein de la réserve, nous a guidé aux mares à 1 km du village. Ici, dans la savane proche de la forêt, des éléphants boivent régulièrement. Aussi, au sud de Bouanéla, une mare est beaucoup fréquentée par des troupeaux d'éléphant malgré la présence des chasseurs.

Nous n'avons noté aucune corrélation entre la densité d'éléphants et l'activité humaine ni, de même, entre la densité et les types de végétation. Cela suggère que la distribution d'éléphants résulte d'un ensemble de variables biologiques dont le type de végétation, la disponibilité de nourriture et le niveau d'eau en forêt (Poulsen et Clark 2002). Il est possible qu'à la longue, les suivis nous permettent de distinguer les facteurs qui influencent la distribution des éléphants. Enfin, il est indispensable de poursuivre l'étude de dégradation des crottes d'éléphants de la RCLT afin de nous aider à améliorer, à l'avenir, nos estimations de densités.

La protection de la faune dans l'étendue des forêts de la RCLT est faite par le conservateur, deux autres

agents du MEFE et sept écogardes. Nous travaillons dans la RCLT (4400 km²) et sa périphérie (c. 6000 km²), alors la densité des agents de l'équipe de la lutte anti-braconnage est un agent par 1000 km². Malgré cela, ils ont eu des réussites impressionnantes: 24 armes militaires et 800 balles saisies en 12 mois en 2005–06 (PRCLT non-publié). La prolifération d'armes de guerre due aux guerres civiles congolaises de 1993, 1997 et 1998 paraît avoir eu un impact négatif sur les populations d'éléphants au nord du Congo et dans la RCLT et ce, de la dernière décennie jusqu'à ce jour. La prolifération d'armes militaire se confirme par certains incidents de braconnage d'éléphants au sud de la réserve (E. Ngouaka comm. pers.). Les gestionnaires de la RCLT veulent augmenter l'effectif pour mieux gérer la faune, mais la finance de la conservation est toujours limitée.

Conclusions

Notre étude nous a permis d'avoir des estimations approximatives de densités d'éléphants dans la RCLT. Ces modestes résultats doivent être considérés comme indicatifs, et peuvent constituer, avec ceux des précédents recensements, la base du suivi continu des populations d'éléphants de la réserve.

Remerciements

Nous remercions le Conservateur de la RCLT, Domingos Dos Santos et le Ministère de l'Economie Forestière et l'Environnement pour la coopération, le conservateur sortant Emile Ngouaka, pour ses données et Nazaire Massamba, pour la traduction des notes du présent rapport en français. Nous remercions le gouvernement de la République de Congo qui est le partenaire du Projet Réserve Communautaire du Lac Télé avec Wildlife Conservation Society. Nous remercions également l'ensemble des pinassiers qui ont conduit, d'un village à l'autre, nos embarcations. Notre reconnaissance s'adresse, en outre, à tous ceux du Projet qui ont contribué à notre ravitaillement. Que les guides de forêt des villages échantillonnés trouvent ici notre sens de gratitude à leur égard. Reconnaissons, nous le sommes à l'endroit de l'African Elephant Specialist Group (AfESG) du Species Survival Commission de l'UICN ainsi qu'à l'endroit de la Commission Européenne, financeur du AfESG Small Grants Program. Nous exprimons enfin notre gratitude à l'USAID-CARPE.

Références bibliographiques

- Barnes RFW, Agnagna M, Alers MPT, Blom A, Doungoube G, Fay M, Masunda T, Ndo Nkoumou JC, Sikubwabo KC, Tchamba M. 1993. Elephants and ivory poaching in the forests of equatorial Africa. *Oryx* 27 : 27–34.
- Barnes RFW, Asamoah-Boateng B, Naada MJ, Agyei-Ohemeng J. 1997. Rainfall and the population dynamics of elephant dung piles in the forests of southern Ghana. *African Journal of Ecology* 35 : 39–52.
- Barnes RFW, Barnes KL, Alers MPT, Blom A. 1991. Man determines the distribution of forest elephants in Gabon. *African Journal of Ecology* 29 : 54–63.
- Barnes RFW, Blom A, Alers MPT, Barnes KL. 1995. An estimate of the numbers of forest elephants in Gabon. *Journal of Tropical Ecology* 11 : 27–37.
- Barnes RFW, Jensen KL. 1987. How to count elephants in forests. *IUCN African Elephant and Rhino Specialist Group Technical Bulletin* 1 : 1–6.
- Buckland ST, Anderson DR, Burnham KP, Laake JL, Borchers DL, Thomas L. 2001. *Introduction to distance sampling: estimating abundance of biological populations*. Oxford University Press, Oxford.
- Burnham KB, Anderson DR, Laake JL. 1980. Estimation of density from line transect sampling of biological populations. *Wildlife Monographs* 72 : 1–202.
- Coe M. 1972. Defecation by African elephants (*Loxodonta africana africana* Blumenbach). *East African Wildlife Journal* 10 : 165–174.
- Eggert LS, Eggert JA, Woodruff DS. 2003. Estimating population sizes for elusive animals: the forest elephants of Kakum National Park, Ghana. *Molecular Ecology* 12 : 1389–1402.
- Fay JM, Agnagna M. 1992. Census of gorillas in northern Republic of Congo. *American Journal of Primatology* 27 : 275–284.
- Jachmann H, Bell RHV. 1984. The use of elephant droppings in assessing numbers, occupancy and age structure: a refinement of method. *African Journal of Ecology* 22 : 127–141.
- Koster SH, Hart JA. 1988. Methods of estimating ungulate populations in tropical forests. *African Journal of Ecology* 26 : 117–126.
- Merz G. 1986. Counting elephants *Loxodonta africana cyclotis* in the tropical rainforests with particular reference to the Taï National Park, Ivory Coast. *Journal français d'écologie* 22 : 61–68.
- Poulsen JR, Clark CJ. 2002. *Rapport d'étude de faisabilité de la Réserve Communautaire du Lac Télé*. Wildlife Conservation Society, New York.

- Poulsen JR, Clark CJ. 2004. Densities, distributions and seasonal movements of gorillas and chimpanzees in swamp forest, northern Congo. *International Journal of Primatology* 25 : 285–306.
- Short JC. 1983. Density and seasonal movements of the forest elephant *Loxodonta africana cyclotis* Matschie in Bia National Park, Ghana. *African Journal of Ecology* 21 : 175–184.
- Tchamba M. 1992. Defecation by the African forest elephants *Loxodonta africana cyclotis* in the Santchou Reserve, Cameroon. *Mammalia* 56: 155–158.
- Thomas L, Laake TL, Strindberg S, Marques FFC, Buckland ST, Borchers DL, Anderson DR, Burnham KP, Hedley SL, Pollard JH, Bishop JRB. 2003. *Distance 4.1. Release 2*. Research Unit for Wildlife Population Assessment, University of St Andrews, UK. <http://www.ruwpa.st-and.ac.uk/distance/>.
- Tutin CEG, Fernandez. M. 1984. Nationwide census of gorilla (*Gorilla g. gorilla*) and chimpanzee (*Pan t. troglodytes*) populations in Gabon. *American Journal of Primatology* 6:313–336.
- White LJT, Edwards A, eds. 2000. *Conservation research in the African rain forests: a technical handbook*. Wildlife Conservation Society, New York.

Human–wildlife conflict in Mochongoi Forest, Baringo, Kenya: a case study of elephants

Dorothy A. Amwata,¹ Patrick Omondi,² Elphas Bitok²

¹ Department of Range Management, University of Nairobi, PO Box 29053, Nairobi, Kenya
email: damwata@yahoo.com

² Kenya Wildlife Service, PO Box 40241, Nairobi 00100, Kenya

Abstract

This study was carried out to assess the influence of human settlement on habitat structure and distribution of elephants in the heavily exploited Mochongoi Forest in Baringo District, Kenya. The distribution of elephants was estimated by dung counts on line transects. Elephant dung density was highest in the intact forest patch, Kimoriot, followed by Kamailel and Mochongoi. The spatial distribution of elephants in the study area was attributed to human influence on the structure of elephant habitat.

Résumé

Cette étude a été réalisée pour évaluer l'influence des installations humaines sur la structure de l'habitat et la distribution des éléphants dans la Forêt de Mochongoi, dans le district de Baringo, au Kenya, qui est très exploitée. La distribution des éléphants a été évaluée par le comptage des crottes sur des transects linéaires. La densité de crottes d'éléphants était maximale dans l'îlot de forêt intacte, Kimoriot, suivie de Kamailel et de Mochongoi. La distribution spatiale des éléphants dans la zone étudiée a été liée à l'influence humaine sur la structure de l'habitat des éléphants.

Introduction

As human populations rapidly increase in Kenya, many elephant ranges are being converted to farmland to meet food requirements for the growing population. In Kenya, the spread of farming to more marginal rangelands has pushed elephants out of their habitat, intensifying human–elephant conflict (HEC). Although some observers blame colonialism for ruining traditional harmonious relations between wildlife and local people (Martyn 1991; Adams and McShane 1992), others believe that HEC is as old as agriculture in Africa (Bell 1987; Naughton-Treves 1999). Conflict between people and elephants today undoubtedly ranks among the main threats to conservation in Kenya, alongside habitat destruction. The scenario has now turned from the number of people killing elephants to the number of people being killed by elephants and damage to property (Mwathie and Waitthaka 1995). Despite these problems, many communities seem tolerant to the elephant menace, hoping for a solution to come one day.

Much of the original Mochongoi Forest has been excised for human settlement, leaving only areas of rugged terrain that are unsuitable for farming. This continuous encroachment has increased the contacts between people and elephants, further intensifying HEC. The forms of HEC in Mochongoi include crop destruction, competition for grazing and water, livestock diseases, and human deaths and injuries. This raises a fundamental question of whether it is reasonable to expect these resource-poor local people to coexist with elephants. Many conservationists argue that coexistence is possible, even desirable, and indeed that if properly managed the presence of elephants presents both an opportunity and an escape route out of poverty. There is the need to put in place measures and policies that will reduce HEC. Without these measures and policies, local people will undoubtedly take action to defend their interests by killing the elephants. Thus, this study was aimed at establishing elephant population, density, movement patterns, distribution, and possible conflict-mitigation measures.

Study area

Mochongoi Forest is situated in Mochongoi Division of Baringo District, Kenya. It covers an area of 390 km² and lies between latitudes 0°36'N and 36°0'E with an altitude of 1800 m. Figure 1 shows the location of the study area in Kenya. The division is influenced by the intertropical convergence zone, giving it a bimodal rainfall pattern, with the 'long' rains from March to July, and the 'short' rains from mid-September to November. Mean annual rainfall is about 600 mm with mean annual temperature ranging between 25°C and 30°C. The topographical features are rivers, valleys and plains. The soils are tertiary volcanic in origin with porous volcanic sandy and clay dominating. These soils rapidly dry and crack during the dry season and become soggy and waterlogged in the wet season. The main vegetation types in the forested area are *Olea africana*, *Croton megalocarpus*, *Juniperus procera*, *Podocarpus gracilior* and *Acacia* species (Kahata 2002). The forest was previously gazetted but following degazettement of some portions cultivation and settlements have encroached upon it. The areas that are still under forest cover are rugged and steep, making them unsuitable for settlement and cultivation.

Materials and methods

The elephant population was established through dung counts using line transects. Line transects totalling 16.64 km were laid in seven sites in the three major forest patches (Kimoriot, Mochongoi and Kamailel). The perpendicular distance (x) of each dung pile from the centre line was measured using a tape measure. The perpendicular distance for all dung piles visible from the centre line was measured and recorded. To calculate the number of

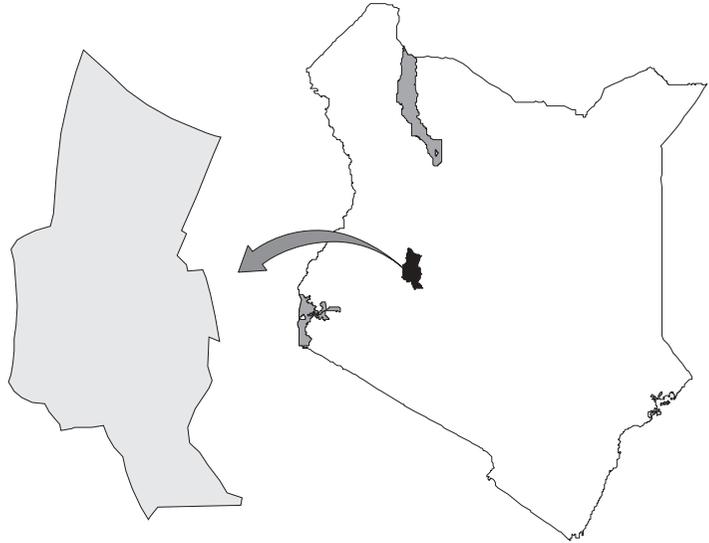


Figure 1. Location of Mochongoi Division in Kenya (from International Livestock Research Institute).

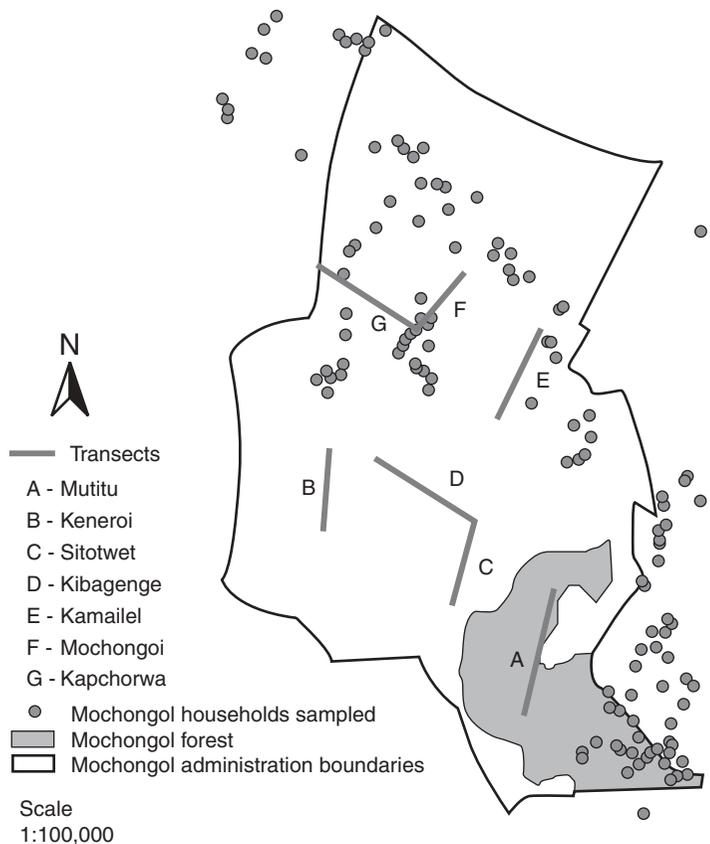


Figure 2. Location of transects, Mochongoi forest and households sampled in Mochongoi Division.

elephants in Mochongoi Forest, a standard method of dung count was adopted (Barnes 1996; Barnes et al. 1997).

Data were collected on vegetation attributes such as density, cover and diversity on the remnant forest patches. A completely randomized design (Steel and Torrie 1980; Gomez and Gomez 1984) was used. Two main transects of one kilometre each were located. From each main transect three perpendicular line transects measuring 500 m each were established at an interval of one kilometre. On each subtransect three plots were used to collect data: 10 x 10 m for trees, 4 x 4 m for shrubs, and 1 x 1 m for herbs. Multistemmed vegetation less than 4 m in height was considered a shrub. Then analysis of variance (ANOVA) was conducted for species cover, relative density and diversity within the forest. The line intercept technique was used for herbaceous vegetation; the percentage of tree and shrub cover was derived as described by Ekaya et al. (2001). In addition to the vegetation analysis, socio-economic data were collected through questionnaires. A questionnaire was administered to 149 randomly chosen respondents to obtain information on socio-economic activities such as household size, age composition, sources of livelihood, incidents of conflict with wild animals, extent of wildlife damage, and possible HEC mitigation measures. These data were analysed using the Statistical Package for Social Science (SPSS) (Norusis 1991).

Results

To estimate the elephant population, methodology by Barnes and Jensen (1987) was adopted. It was assumed that for the three parameters to function, there must be a 'steady state' in the forest—that is, there must be a steady state in elephant numbers in that forest. Thus,

estimated values of dung density is calculated:

$$E = Y \times r/D$$

where E = elephant density, Y = dung density, r = dung decay rate, and D = defecation rate.

The estimates of dung density for the six transects at 95% confident limit and the coefficient of variations are illustrated in table 1. In only one transect, Mutitu, were no dung piles recorded. To estimate the elephant numbers, an estimated dung decay rate of 0.002 and defecation rate of 17 dung piles per elephant per day from Rumuruti Forest (Laikipia) were used, since Mochongoi has similar rainfall and habitat conditions. The mean dung density for Mochongoi Forest was 5017.23 ± 2422 dung piles per km^2 (table 1). Using the above formula, it converts to 0.59 ± 0.31 (or 0.28 to 0.9) elephants per km^2 . The remnant forest is 17.735 km^2 ; this gives the number of elephants in the area as 5 ± 16 . The highest densities were encountered in Kapchorwa and Sitotwet, all in Kimoriot block. Kamailel block transects (Kibagenge, Kamailel) had average densities, and Mochongoi block (Keneroi and Mochongoi) had the lowest.

Land use

Crop production is the main land use in Mochongoi: 59.7% of the respondents practise crop production, 33.56% are involved in small-scale mixed agriculture, and 6.71% burn charcoal for subsistence. Crops grown are maize, beans, sorghum, pyrethrum, vegetables, potato, sugarcane, avocado, citrus fruits, wheat and bananas. There is only one cropping season, April to December, due to the cold weather conditions associated with high altitudes; rain falls between April and June. The calendar of events in the division is shown in table 2.

Table 1. Summary of Mochongoi Forest transect analysis

Transect	Length (km)	Sightings	Density	95%	CV	Var F (0)	F (0)
Kamailel	2.52	16	4548.30	1979.00	32.71	0.064	1.299
Kapchorwa	2.89	20	6286.78	2731.22	19.73	0.003	0.190
Keneroi	1.98	35	2012.35	874.04	21.39	0.005	0.463
Kibagenge	2.68	34	5321.01	2397.31	28.02	0.003	0.245
Mochongoi	1.34	9	1947.44	1019.13	24.61	0.004	0.239
Mutitu	3.10	0	0	0	0	0	0
Sitotwet	2.13	68	9987.52	5534.11	38.87	0.075	1.725
Total	16.64	182	30103.40	14534.80	165.30	0.154	4.160
Mean	2.38	26	5017.23	2422.47	27.55	0.025	0.693

Table 2. Calendar of events for Mochongoi Division

Month	Activity	Elephant interference	Types of conflict
January–March	land preparation	low	store, waterpoint, threats to human life
April–May	planting maize, beans, peas, potatoes	low	crops, threats to human life
May	planting wheat and pyrethrum	low	crops, threats to human life
June–July	first weeding	low	crops, threats to human life
July–August	second weeding of maize, beans, potatoes	medium	crops, threats to human life
August–September	harvesting of beans, peas, potatoes	high	crops, threats to human life
September–October	harvesting of wheat, pyrethrum	high	crops, threats to human life
October–December	harvesting of maize	high	store, crops, threats to human life

Livestock species kept include cattle, sheep, goats, donkeys, chickens, ducks and geese. Only a few households manage the exotic breeds of cows such as Friesian, Ayrshire, and Jersey for commercial and subsistence milk production. The forest has a limited variety of wild mammal species—black-and-white colobus monkey, porcupine, aardvark, bushbuck, dikdik, buffalo, warthog, elephant and hyena.

Mochongoi Forest yields a variety of benefits for the local people. All respondents interviewed appreciate the forest as a source of fuelwood; 94 (63%) noted it as important as a water catchment and for medicine and food; 42 (28%) said it provides timber and poles for construction; 13 (9%) value it for forage for livestock. Opinions about forest ownership varied: 47% said the forest belongs to the government; 24% said it belongs to both community and government; 14% said it was owned by the community; and 15% had no opinion. These responses indicate that it is necessary to make people aware of who owns the forest and its resources.

Deforestation of Mochongoi Forest dates back to 1996 (Kahata 2002), although the government did not degazette it (Divisional Officer, pers. comm. 2003). This contradicts reports by Bitok and Omondi (1999) that portions of the forest were degazetted. Thus settlement in those areas is illegal. The demand for settlement and more agricultural land has resulted in reduced forest cover. This in turn has reduced the elephant range and increased human–elephant conflict in the division. Bitok and Omondi (1999) further approximated the area under forest cover as 20 km². At the time of the study, the area under forest cover was calculated at 17.725 km². If the forest con-

tinues to shrink at the same rate of 0.76 km annually, the forest has a lifespan of only 23.3 years.

Extent of elephant–human conflict

Reported human–wildlife conflict incidents from 1997 to 2003 are analysed in table 3. The decline in the number of incidents reported in 2002 was attributed not to fewer incidents occurring but to the community complaint that neither Kenya Wildlife Service (KWS) nor the government had taken action on previously reported conflicts (fig. 3). Also in discussions with chiefs in 2001, the divisional officer said, ‘You are illegally settled in this forest. You must adjust and live with the elephants.’ As a result, the local people feel sidelined by the government.

Elephant crop raiding in Mochongoi Division has become so intense that farmers spend sleepless nights guarding their farms to reduce crop raiding. They have adopted various mechanisms such as forming groups with farmers guarding farms in shifts. While guarding, they have adopted both passive and active methods. The passive methods include constructing live

Table 3. Analysis of the reported human–elephant conflict incidents, 1997–2003

Year	Kamaillel	Kimoriot	Mochongoi
1997	75	25	–
1998	50	50	–
1999	76.32	13.16	10.52
2000	37.14	41.43	21.43
2001	18.03	40.98	40.98
2002	24.13	51.72	13.79
October 2003	49.01	29.41	21.56

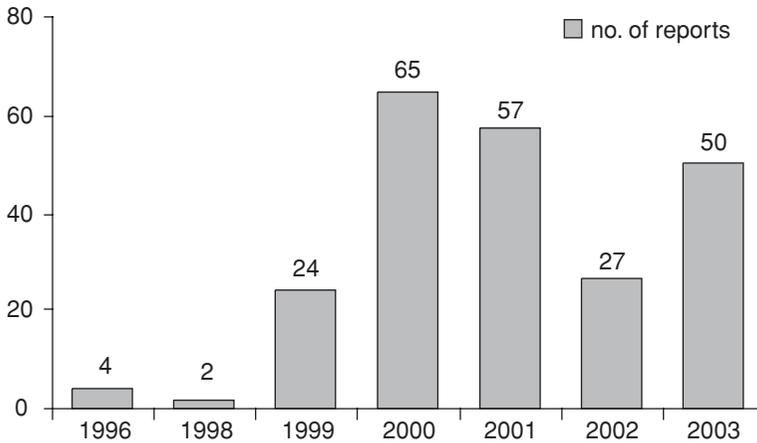


Figure 3. Reported cases of human-wildlife conflict, 1996–2003 (*KWS Occurrence Book, 1996–2003*)

fences around the crop fields and watchtowers, and burning diesel-wrapped cloths; active methods consist of burning fires, making noise, and planting wildlife-resistant crops such as beans, wheat, pepper and pyrethrum.

An increase in settlement in the area has created a demand for more land to increase food production; thus, deforestation has increased. About 88% of the cases reported are elephant related with maize being the most affected. Maize, the staple food in the area, is grown by 92% of the respondents. The major crops reported to be highly susceptible to elephant raids include maize, banana, fruit, millet, cassava, potato, vegetables and sugarcane. Crops such as wheat, pyrethrum, beans, and onion are less susceptible to elephant raids and are only trampled on as the elephants move. The survey shows that 92% of the respondents had had crops destroyed by elephants; only 8% were not affected, and that only because they had been in the area for less than a year.

Vegetation parameters in relation to elephant density

Vegetation analysis was carried out in the three forest patches: Kimoriot, Kamaillel and Mochongoi blocks. The grand mean for absolute density within the three blocks is 5.83 with a standard error of means of 1.10. The mean absolute densities of these different blocks are 10.28 for Kimoriot, 0.90 for Kamaillel, and 6.31 for Mochongoi. The results from analysis of variance show significance at 1% level ($P < 0.001$). Further statistical test shows that the differences be-

tween the three means (7.16, 5.41 and 3.21) are greater than the LSD value (3.104), showing significance. This implies difference in absolute species densities within the three blocks. Kimoriot has the highest absolute density (10.28) because it was intact while Kamaillel block had the lowest due to encroachment. The analysis of variance for species relative density showed that the results are not significantly different at 10% level and below. The grand mean for the three blocks was 2.90 with a standard error of difference of 0.96. The mean relative densities of these dif-

ferent blocks were 3.33 for Kimoriot, 2.08 for Kamaillel and 3.29 for Mochongoi. The results from analysis of variance show insignificance at 10% and below ($P < 0.342$). This shows that the frequencies of different species within the three blocks are not different. It further shows that the difference between the relative density means of the three blocks is smaller than the LSD value (1.908), showing further insignificance. The results show the relative density highest in Kimoriot, next in Mochongoi and lowest in Kamaillel.

The grand mean for percentage of species cover was 0.80. The individual block species cover was 1.09 for Kimoriot, 0.60 for Kamaillel and 0.71 for Mochongoi. Kimoriot block had the highest species cover, next Mochongoi, and lastly Kamaillel. Analysis of variance for percentage species cover was insignificant at 10% and below ($p < 0.202$). This implies that even with the difference in means for percentage species cover the difference is statistically insignificant.

Discussion

Elephant movement patterns within the three patches were undefined due to limited space and resource availability. Frequent elephant movement was noted in Kimoriot block due to plant regeneration providing food for the elephants. Moreover, this block is intact forming a suitable habitat. For Mochongoi and Kamaillel blocks, settlement and encroachment have constricted elephant range, reducing the frequency of elephant sightings, thus few dung piles.

Local people interviewed expressed fear for their lives because of the presence of elephants in the area. Kahata (2002) reported about 100 farms abandoned; this current study recorded an additional 21 parcels of land abandoned. The owners argued that an alternative livelihood was preferable to farming for the elephants. Also, local people reported their lives were at risk because elephants come out of the forest as early as 3 p.m., restricting mobility. A male elephant nicknamed 'John Killer' continually marauds in the three blocks throughout the year.

The current situation contradicts the findings of Kahata (2002) that the frequency of elephant attack was higher during the wet season. This survey reveals that conflict is no longer seasonal. During the wet season elephants trample seedlings; raiding occurs at intermediary and maturity stages of the crops; and after harvesting, elephants raid food stores and houses. However, HEC is more intense in August when elephants from Laikipia Ranch enter Kimoriot block through Marmanet Forest to the north.

The ways forward suggested by the local communities to resolve HEC in Mochongoi Division were as illustrated in table 4.

The questionnaire survey showed that economic loss due to elephants was quite significant. Crop production was the main source of livelihood. These losses in monetary terms ranged from between KES 5000 to 150,000 (USD 75 to 2000), with a mean of KES 30,000 (USD 450) per farmer annually. A survey by Kahata (2002) recommended translocation to minimize conflict in the area. This may not be feasible because elephants act as security for the remnant forest patches, which are important water catchments, in addition to other benefits that accrue from forests. Translocating the elephants will provide argument for excising the remnant forest patches to create more land for agriculture. To avert the trend, farmers within a kilometre from the forest need to be allocated other land and a reforestation programme needs to be initiated immediately.

Conclusion

The study classifies elephants as the problematic wild animal that causes considerable economic loss and

Table 4. Conflict resolutions as suggested by the respondents

Conflict resolution	Number of respondents	Cumulative (%)
Translocation	103 (69.1)	69.1
Electric fence and elephant sanctuary	32 (21.5)	100.0
Moats and more outposts	14 (9.4)	78.5
Total	149 (100.0)	

reduces efficiency of the local people, thus jeopardizing their livelihoods. Collaboration of stakeholders in conservation is essential to reduce the stress of elephants on the local residents through educating them about conservation, natural resources management and compatible alternative livelihood sources.

Acknowledgement

Our thanks go to the Elephant Trust Fund for funding the study. We are also indebted to staff of the Elephant Programme of Kenya Wildlife Service for their support and collaboration. Lastly, we thank the Divisional Officer, Mochongoi, local people and KWS rangers for their participation in making the study a success.

References

- Adams JS, McShane TO. 1992. *The myth of wild Africa*. WW Norton and Co., New York.
- Barnes RFW. 1996. The conflict between humans and elephants in the Central Africa forests. *Mammal Review* 26:67–80.
- Barnes RFW, Beardsley K, Michelmore F, Barnes KL, Alers MPT, Blon A. 1997. Estimating forest elephant numbers with dung counts and geographic information system. *Journal of Wildlife Management* 61:1384–1393.
- Barnes RFW, Jansen KL. 1987. *How to count elephants in forests*. Technical Bulletin No 1. African Elephant and Rhino Specialist Group, Nairobi
- Bell RFV. 1987. Conservation with a human face. In: Anderson R, Groove R, eds., *Conservation in Africa*. Cambridge University Press, Cambridge.
- Bitok EK, Omondi PO. 1999. A survey of Mochongoi Forest elephant population and status of human–elephant conflicts. December progress report. Elephant Programme, Kenya Wildlife Service, Nairobi. Unpublished.
- Ekaya WN, Kinyamario JI, Karue CN. 2001. Abiotic and herbaceous vegetational characteristics of an arid

- rangeland in Kenya. *African Journal of Range and Forage Science* 18:117–124.
- Gomez KA, Gomez AA. 1984. *Statistical procedures for agricultural research*, 2nd ed. Wiley and Sons, New York.
- Kahata MJ. 2002. Elephant pre-translocation survey report: elephant translocation from Mochongoi to Meru National Park. Elephant Programme, Kenya Wildlife Service, Nairobi. Unpublished.
- Martyn R. 1991. People–wildlife conflicts in Africa are there symbiotic alternatives? Wye College, University of London.
- Mwathe MK, Waihtaka JK. 1995. An assessment of the elephant–human conflict situation in Arabuko-Sokoke Forest, Kenya. Elephant Programme, Kenya Wildlife Service, Nairobi.
- Naughton-Treves L. 1999. Whose animals? A history of property rights to wildlife in Toro, western Uganda. In: *Land degradation and development, Uganda*.
- Norusis JM. 1991. *The SPSS guide to data analysis for SPSS/PC+*, 2nd ed. SPSS Inc., Chicago.
- Steel RG, Torrie JH. 1980. *Principles and procedures of statistics*. McGraw-Hill Book Co., New York.

The survival of elephant dung piles in relation to forest canopy and slope in southern Ghana

Richard F.W. Barnes,¹ John Naada Majam,² Bernard Asamoah-Boateng,²
James Agyei-Ohemeng³

¹ Section on Ecology, Behavior and Evolution, Division of Biological Sciences 0116, University of California at San Diego, La Jolla, CA 92093-0116, USA, and Environmental Sciences Research Centre, Anglia Ruskin University, East Road, Cambridge CB1 1PT, UK; email: rfarnes@ucsd.edu

² Wildlife Division, PO Box M239, Accra, Ghana

³ PO Box 91, Wenchi, Brong Ahafo Region, Ghana

Abstract

Dung piles were monitored from deposition to disappearance in three Ghanaian forests. Cox proportional hazard models were fitted to the data to explain the variables that had the greatest influence on dung survival under open canopy and closed forest (< 75% and ≥ 75% canopy cover respectively) after adjusting for rain-fall. For dung piles in closed forest, canopy cover and slope were important predictors of hazard, and one site was markedly different from the other two. The open canopy subsample did not conform to the assumption of the proportional hazards method. Dung decay observations must always be conducted in sites where a dung count survey is done to estimate elephant numbers. The observed dung piles must reflect the occurrence of all vegetation types to avoid bias in the final estimate of elephant abundance.

Résumé

On a surveillé régulièrement des tas de crottes, à partir du moment où ils étaient constitués jusqu'à leur disparition, dans trois forêts ghanéennes. Les modèles à risques proportionnels de Cox ont été adaptés aux données pour expliquer les variables qui avaient la plus grande influence sur la conservation des crottes sous une canopée ouverte ou une forêt très fermée (< 75% et ≥ 75% de couverture respectivement) après avoir ajusté les données aux chutes de pluie. Pour les tas de crottes situés en forêt fermée, la couverture et la pente étaient d'importants indicateurs de risques, et un site était nettement différent des deux autres. Le sous échantillon situé sous la canopée ouverte ne se conformait pas aux suppositions de la méthode des risques proportionnels. Il faut toujours faire des observations de décomposition des crottes dans des endroits où une étude du comptage des crottes sert à évaluer le nombre d'éléphants. Les tas de crottes observés doivent refléter la présence de tous les types de végétation pour éviter tout biais dans l'estimation finale de l'abondance des éléphants.

Introduction

Dung counts can provide estimates of elephant numbers that are just as accurate as other survey methods, and their estimates are more precise (Barnes 2001, 2002). However, they must be conducted scrupulously if they are to provide accurate and precise estimates. The three variables that must be estimated are dung pile density, defaecation rate and dung-disappearance rate. This paper addresses the third variable.

The survival time is inversely proportional to the rate of dung disappearance. It is the time between deposition and the point when the dung pile is judged to have disappeared (stage E of Barnes and Jensen 1987, or stage S4 as defined in Hedges and Lawson 2006). In any given site dung piles show a remarkable variation in their survival times; some disappear rapidly while close neighbours last for weeks. A representative sample of dung piles must be monitored to obtain an unbiased estimate of the decay rate. How-

ever, finding a sample of dung piles is often difficult when elephants are sparse. Sometimes large numbers of fresh dung piles are found in one spot, and tired and frustrated field assistants will be tempted to mark them all. It may be difficult to convince the field teams of the need to search more widely for a representative sample. If we understand the variables that determine the survival time, then field assistants will invest more effort in searching for dung piles.

Rainfall is clearly the most important factor governing dung-decay rates (White 1995; Barnes et al. 1997; Nchanji and Plumptre 2001). Canopy cover and slope vary across every study area, and here we examine their effect on dung survival after adjusting for rainfall. The data come from 1993 and 1994 when we estimated survival times in both wet and dry seasons in three forests in southern Ghana (Barnes et al. 1994, 1997). We fit statistical models that are uncommon in ecology but frequently used in other fields.

Methods

Study sites

This study was conducted in three protected forests in southern Ghana: Ankasa Game Production Reserve, Bia Game Production Reserve and Kakum National Park/Assin Attandanso Game Production Reserve. They were described briefly in Barnes et al. (1997) and in more detail by Barnes et al. (1994).

Field methods

Methods were standardized across sites. At each site a sample of fresh dung piles (< 48 hours since deposition) was marked in the wet and dry seasons and observed at weekly intervals. When the dung pile passed from morphological stage D to stage E (Barnes and Jensen 1987), it was recorded as 'disappeared'.

The angle of slope was measured with a clinometer. A photograph looking vertically upwards was taken by lying down next to the dung pile. Later the area of the photograph covered by foliage was measured with a dot grid to give the percentage of canopy cover over the dung pile.

Rain gauges were established at each site. Three rainfall variables were collected: $RAIN_{10}$ was the rainfall that fell during the first 10 days after deposition of each dung pile, $RAIN_t$ was the rainfall during the

calendar month of deposition while $RAIN_{t+1}$ was the rainfall in the calendar month after the month of deposition. Preliminary analysis showed that only $RAIN_t$ had a strong relationship with dung survival, and the other two were discarded.

Analysis

A total of 427 dung piles were marked and observed in the three forests for 18,217 dung-pile days. Covariates had not been measured for some dung piles, and their elimination reduced the number to 358. Three of these were either lost or had not decayed by the time observations ceased; they were treated in the analysis as *censored* cases (Collett 1994).

The sample spanned a wide range of canopy values, from 0 to 99%. The dung piles with lower canopy values were in clearings, on roads or at the forest edge. They will be more susceptible to wind, sunshine and higher temperatures, and the humidity regime will differ from closed forest. Therefore, the sample was split into two, an outside subsample with canopy values < 75% and a closed forest subsample with canopy values of 75% or more.

The survivor function is the probability that a dung pile survives from the time of deposition to a time beyond t . The hazard function is the probability that a dung pile disappears (i.e. passes to stage E or S4) at time t , conditional upon it having survived to that time. Or put another way, the hazard function represents the instantaneous disappearance rate for a dung pile surviving to time t (Collett 1994).

By fitting a model one can examine the effect of several potential explanatory variables upon the survival of a sample of dung piles. Once one has added a rainfall variable to the model one can then examine the effect of individual variables, such as canopy cover or slope, on the survival function. One may also determine the best combination of variables that influence the hazard function. We fitted a proportional hazards model (Cox 1972; Collett 1994):

$$h_i(t) = \exp(\beta_1 x_{1i} + \beta_2 x_{2i}) h_0(t)$$

which can be re-expressed as:

$\log \{h_i(t) / h_0(t)\} = \beta_1 x_{1i} + \beta_2 x_{2i}$
where $h_i(t)$ is the hazard function for the i th dung pile at time t , and $h_0(t)$ is the hazard function for a dung pile for which the values of all the variables are zero,

for example when there is no rain and the dung pile lies on a flat area. x_1 and x_2 are covariates, such as rainfall and slope, while b_1 and b_2 are regression coefficients. This is therefore a linear model for the log of the hazard ratio. Here only two covariates have been shown, but more can be added.

The proportional hazards model was fitted by maximum likelihood. The change in $-2\log L$ when fitting a new variable was compared with χ^2 for one degree of freedom to evaluate the importance of that variable (Collett 1994).

First we fitted each independent variable by itself. The results indicated the importance of each variable alone. Then we started the model-building process. Since we know from previous work that rainfall is the most important predictor of dung decay (White 1995; Barnes et al. 1997; Nchanji and Plumptre 2001), rainfall was added to the null model. Then the other covariates were added one at a time. We retained the one that produced the greatest reduction in $-2\log L$ (i.e. the one with the highest value of χ^2) when added to the model. The remaining covariates were added one at a time, and again the one causing the greatest reduction in $-2\log L$ was retained. This continued until no further significant reduction of $-2\log L$ resulted.

We applied the test described by Hosmer and Lemeshow (1999) to check that the assumptions of the proportional hazards model were satisfied. After the main-effects model had been derived, another model was fitted using the main-effects model and the interaction of each covariate with $\log(\text{time})$ or $\ln(t)$. Hosmer and Lemeshow (1999) advise centring $\log(\text{time})$ about its mean $[\ln(t) - \overline{\ln(t)}]$ for numerical reasons.

If the hazard function appears to be proportional, one can then proceed to refine the model by examining interactions (Collett 1994). The Akaike Information Criterion (AIC) was used to compare models: the smaller the value of AIC the better the model (Collett 1994).

To adjust for possible differences between sites, indicator variables (Collett 1994) SITE1 and SITE2 were defined (table 1).

Table 1. Indicator variables to distinguish between sites

Study area	SITE1	SITE2
Ankasa	0	0
Bia	1	0
Kakum	0	1

Results

Closed canopy

There were 291 dung piles in the closed forest subsample where canopy cover is $\geq 75\%$. For these dung piles, three variables when added by themselves to the null model produced a significant reduction in $-2\log L$ (table 2). $RAIN_t$ was confirmed to be the best predictor of hazard.

The *SITE2* covariate was also significant, showing that Kakum had a lower hazard than Ankasa and Bia. The third covariate was *CANOPY*: the greater the canopy cover, the slower the rate of dung decay.

Next, having adjusted for $RAIN_t$, the best predictive model was obtained by examining the effect of each of the other covariates. This model included *SLOPE* and *SITE2* as well as $RAIN_t$ (table 3). This means that after adjusting for rainfall, the angle of slope was a very important predictor of hazard. The risk of disappearance increased by about 8% for each 1° increase in slope. Even after taking rainfall and *SLOPE* into consideration, there remained a significant difference between Kakum and the other two sites.

This model was tested for proportional hazards by adding the interaction terms with log time (table 4). There is no evidence to doubt the assumption of proportional hazards because each of the interaction terms was insignificant (Hosmer and Lemeshow 1999).

Interaction terms for $RAIN_t * SLOPE$, $RAIN_t * SITE2$ and $SLOPE * SITE2$ were added to the model. Two out of the three were retained (table 5). Adding these interaction terms reduced the AIC from 2646.58 to 2631.65, and the reduction in $-2\log L$ was significant ($\chi^2 = 18.93$, $P < 0.001$). Note that the coefficient for *SLOPE* was not significant, but it was retained in this model to conform to the hierarchic principle (Collett 1994).

Open canopy

There were 67 dung piles where canopy cover is $< 75\%$. First, a model was fitted to each independent variable alone. As expected, rainfall was a significant predictor of hazard (table 6). However, *CANOPY* was the strongest predictor. Note that increasing canopy was associated with a higher hazard.

Table 2. Closed forest: proportional hazard estimates for each independent variable fitted by itself to the null model

Variable in model	β	s.e. (β)	χ^2	Hazard ratio	95% confidence limits for hazard ratio
SITE1	0.221	0.125	3.12	1.247	0.976–1.592
SITE2	-0.299	0.119	6.29*	0.742	0.587–0.937
CANOPY	-0.019	0.009	4.05*	0.982	0.964–1.000
SLOPE	0.009	0.014	0.36	1.009	0.981–1.038
RAIN _t	0.006	0.001	57.14****	1.006	1.005–1.008

* $P < 0.05$; **** $P < 0.0001$

Table 3. Closed forest: the best combination of variables in the proportional hazards model (AIC = 2646.58)

Variable in model	β	s.e. (β)	χ^2	Hazard ratio	95% confidence limits for hazard ratio
RAIN _t	0.007	0.001	61.76****	1.007	1.006–1.009
SLOPE	0.078	0.017	20.49****	1.082	1.045–1.119
SITE2	-0.451	0.144	9.80**	0.637	0.480–0.845

** $P < 0.01$; **** $P < 0.0001$

Table 4. Closed forest: test for proportionality (AIC = 2650.04)

Variable in model	β	s.e. (β)	χ^2	Hazard ratio	95% confidence limits for hazard ratio
RAIN _t	0.007	0.001	62.77****	1.007	1.006–1.009
SLOPE	0.081	0.018	21.27****	1.084	1.048–1.122
SITE2	-0.464	0.145	10.22**	0.629	0.473–0.836
RAIN _t *ln(<i>t</i>)	-0.001	0.001	0.28	0.999	0.997–1.002
SLOPE*ln(<i>t</i>)	-0.042	0.034	1.58	0.959	0.898–1.024
SITE2*ln(<i>t</i>)	0.160	0.287	0.31	1.173	0.668–2.059

** $P < 0.01$; **** $P < 0.0001$

Table 5. Closed forest: the final proportional hazards model that includes main effects and interaction effects (AIC = 2631.65)

Variable in model	β	s.e. (β)	χ^2	Hazard ratio	95% confidence limits for hazard ratio
RAIN _t	0.005	0.001	28.07****	1.005	1.003–1.007
SLOPE	-0.044	0.037	1.45	0.956	0.890–1.028
SITE2	-0.980	0.214	20.97****	0.375	0.247–0.571
RAIN _t *SLOPE	0.001	0.000	13.54***	1.001	1.000–1.002
SLOPE*SITE2	0.105	0.037	7.95**	1.111	1.033–1.195

** $P < 0.01$; *** $P < 0.001$; **** $P < 0.0001$

Table 6. Dung piles under open canopy (canopy cover < 75%): proportional hazard estimates for models fitted to each independent variable alone

Variable in model	β	s.e. (β)	χ^2	Hazard ratio	95% confidence limits for hazard ratio
SITE1	-0.119	0.261	0.21	0.887	0.532–1.481
SITE2	-0.063	0.252	0.06	0.939	0.573–1.540
CANOPY	0.014	0.006	6.26*	1.014	1.003–1.026
SLOPE	0.023	0.030	0.60	1.023	0.965–1.084
RAIN _t	0.003	0.002	3.88*	1.003	1.000–1.006

* $P < 0.05$

In the next step, we obtained the best predictive model for open canopy by first fitting $RAIN_t$ and then adding each of the other variables in turn. The model that produced the greatest reduction in $-2\log L$ ($\chi^2 = 9.52$, $df = 2$, $P < 0.01$) included only $RAIN_t$ and $CANOPY$ (table 7). But note that in this model the coefficient for $RAIN_t$ was not significant.

Both interaction terms with $\ln(t)$ were large and significant (table 8). When $RAIN_t$ alone was tested with $RAIN_t * \ln(t)$, the interaction term was significant at $P < 0.0001$, and the same was true for $CANOPY$ and $CANOPY * \ln(t)$. These tests show that the proportional hazard assumption is violated for this subsample.

Discussion

Methodology

The proportional hazards method assumes that the difference in hazard due to a particular covariate remains constant. For example, Kakum's hazard is 26% less than hazard in the other two sites (table 2), and that difference should hold throughout the process of decay. If it changes as a dung pile gets older, then the method of proportional hazards is no longer valid. We cannot explain why the assumption appears to hold for the closed forest subsample but not for the open subsample. It may be a consequence of an inadequate sample size for the open canopy—only 67 dung piles compared with 291. Where proportional

hazards are inappropriate, the non-parametric Kaplan-Meier method may be used to estimate the hazard function (M. Sivarani, pers. comm.). The advantage of the Cox proportional hazards method is that it allows one to evaluate the influence of several covariates.

In the present study dung piles were monitored from the time of deposition until they disappeared. Thus the exact survival time of each dung pile was known and a survival model could be fitted. However the data-collection phase was very time consuming as each dung pile had to be visited at regular intervals. In the future, dung-disappearance rates and the effect of covariates will be estimated more efficiently by Laing et al.'s (2003) method that requires that each dung pile be seen only twice.

Closed forest

Under a dense forest canopy the probability of disappearance (i.e. passing from stage D to E or from stage S3 to S4) for a dung pile depended upon three variables. Rainfall was confirmed to have the greatest influence upon survival or dung-decay rate, as others have shown (White 1995; Barnes et al. 1997; Nchanji and Plumtre 2001). An increase of 1 mm of rainfall would increase the hazard by 1.006 (table 2). For example, if month B had 100 mm more rainfall than month A, the hazard would be $1.006^{100} = 1.82$ times greater in month B.

Slope and rainfall together were significant ($P < 0.001$) but the effect was small (hazard ratio = 1.001;

Table 7. Dung piles under open canopy (canopy cover < 75%): estimates for the variables included in the best proportional hazards model (AIC = 432.64)

Variable in model	β	s.e. (β)	χ^2	Hazard ratio	95% confidence limits for hazard ratio
$RAIN_t$	0.002	0.002	2.37	1.002	0.999–1.005
$CANOPY$	0.013	0.006	5.04*	1.013	1.002–1.025

* $P < 0.05$

Table 8. Dung piles under open canopy (canopy cover < 75%): test for the assumption of proportional hazards (AIC = 289.44)

Variable in model	β	s.e. (β)	χ^2	Hazard ratio	95% confidence limits for hazard ratio
$RAIN_t$	0.003	0.002	1.54	1.003	0.998–1.007
$CANOPY$	0.047	0.010	21.49*	1.048	1.028–1.069
$RAIN_t * \ln(t)$	-0.016	0.005	9.31**	0.984	0.974–0.994
$CANOPY * \ln(t)$	-0.133	0.022	37.16****	0.876	0.839–0.914

* $P < 0.05$; ** $P < 0.01$; **** $P < 0.0001$

table 5). On the other hand, this was in addition to the effect of rainfall (hazard ratio = 1.005; table 5). The effect of slope was particularly marked at Kakum, as revealed by the *SLOPE***SITE2* interaction.

After allowing for rainfall and slope, there was a major difference in hazard between Kakum on the one hand and Bia and Ankasa on the other (table 5). This could be due to differences between the field teams, for example in judging when a dung pile had 'disappeared'. However, the teams were trained carefully to avoid this sort of problem. The difference is probably due to covariates that were not included in the model, such as soil type or the presence of animals or birds that rummage through dung piles in search of seeds. This emphasizes the point that dung-decay observations must be conducted at every site where a dung count is conducted.

When considered by itself, canopy cover reduced the hazard (table 2): dung piles lasted longer under the densest canopy. However this effect did not appear in the final model after accounting for *RAIN_t*, *SLOPE* and *SITE2* (tables 3 and 5).

Open forest

Interpretation of the results from open forest must be limited because the proportional hazard assumption did not hold. We make just two comments. First, the hazard appeared to increase with canopy cover (table 7). In other words, dung piles lasted longer in more open areas, probably because they dried out soon after deposition (White 1995). This is in contrast to closed forest (table 2), where dung piles lasted longer under completely closed canopy but is consistent with the observations of Nchanji and Plumpton (2001), who had a range of canopy from 51% to 77%. Second, in contrast to closed forest, after adjusting for rainfall there was no evidence that slope was important in these open places.

Conclusion

The marked difference between sites—especially after adjusting for slope, canopy and rainfall—illustrate the necessity for estimating dung-decay rates at the site where an elephant dung census is to be conducted. One can no longer justify using dung-decay estimates from similar sites.

Canopy was a significant predictor in the absence of the other covariates in this closed forest subsample. It may also be important in more open habitats. Slope

was also an important predictor. This means that when planning a dung-count survey, the monitored dung piles must be distributed so as to cover the range of canopy and slope values that will be included in the line transects. One cannot choose a convenient sample of dung piles in a flat area near camp, for that will give a biased estimate of the rate of disappearance. Therefore, as much importance must be given to the selection of dung piles for estimating decay rates as to the placement of line transects. In other words, habitat types must be represented in proportion to their occurrence, for example, by searching for dung piles along randomly or systematically placed transects (Buckland et al. 2001; Laing et al. 2003).

Acknowledgements

This project was supported by the European Commission's African Elephant Conservation Programme, funded by the Ecology in Developing Countries Programme of DGVIII, and was managed by Stephen Cobb and Helen de Jode at the Environment & Development Group in Oxford, UK. We thank Mr GA Punguse, the Chief Game and Wildlife Officer, for his enthusiastic support. Our assistants in the field were John Nyame, Emmanuel Peasah, Augustine Bayuo, Coleman Antwi, Jimah Telli and Prince John Kofie. The work at Kakum was greatly facilitated by Malcolm Stark. We thank two anonymous referees for their comments on an earlier version.

References

- Barnes RFW. 2001. How reliable are dung counts for estimating elephant numbers? *African Journal of Ecology* 39:1–9.
- Barnes RFW. 2002. The problem of precision and trend detection posed by small elephant populations in West Africa. *African Journal of Ecology* 40:179–185.
- Barnes RFW, Asamoah-Boateng B, Naada Majam J, Agyei-Ohemeng J, Tchamba MN, Ekobo A, Nchanji A. 1994. Improving the accuracy of forest elephant census methods: studies of dung-decay rates in Ghana and Cameroon. In *African Elephant Conservation Programme final report*, vol. 5. The Environment & Development Group, Oxford.
- Barnes RFW, Asamoah-Boateng B, Naada Majam J, Agyei-Ohemeng J. 1997. Rainfall and the population dynamics of elephant dung piles in the forests of southern Ghana. *African Journal of Ecology* 35:39–52.

- Barnes RFW, Jensen KL. 1987. How to count elephants in forests. *IUCN African Elephant and Rhino Specialist Group Technical Bulletin* 1:1–6.
- Buckland ST, Andersen DR, Burnham KP, Laake JL, Borchers DL, Thomas L. 2001 *Introduction to distance sampling: estimating abundance of biological populations*. Oxford University Press, Oxford.
- Collett D. 1994. *Modelling survival data in medical research*. Chapman & Hall, London.
- Cox DR. 1972. Regression models and life tables (with discussion). *Journal of the Royal Statistical Society B* 74:187–220.
- Hedges S, Lawson D. 2006. *Dung survey standards for the MIKE Programme*. CITES MIKE Programme, Nairobi, Kenya.
- Hosmer DW, Lemeshow S. 1999. *Applied survival analysis: regression modeling of time to event data*. John Wiley & Sons, New York.
- Laing SE, Buckland ST, Burn RW, Lambie D, Amphlett A. 2003. Dung and nest surveys: estimating decay rates. *Journal of Applied Ecology* 40:1102–1111.
- Nchanji AC, Plumptre AJ. 2001. Seasonality in elephant dung decay and implications for censusing and population monitoring in south-western Cameroon. *African Journal of Ecology* 39:24–32.
- White LJT. 1995. Factors affecting the duration of elephant dung piles in rain forest in the Lope Reserve, Gabon. *African Journal of Ecology* 33:142–150.

Première estimation de la densité d'éléphants dans le Parc National de Monte Alen, Guinée Equatoriale

Marielle Puit,¹ Andrea Ghiurghi^{2,*}

¹ Rue du Bois des Haies, 6a, 4217, Héron, Belgique; email : puitmarielle@yahoo.fr

² Piazza del Sole 63, 00144, Rome, Italie; email : aghiurghi@libero.it

* auteur correspondant

Résumé

Pour la première fois en Guinée Equatoriale, la densité d'éléphants a été évaluée grâce à un inventaire sur transects linéaires mené entre octobre 2003 et février 2004 dans la récente extension sud du Parc National de Monte Alen (secteur Mont Mitra). La densité d'éléphants a été estimée à 0,55 individus/km² (IC 95% : entre 0,31 et 0,79). En intégrant les données récoltées sur des *recces* parallèles aux transects, la densité d'éléphants a été précisée à 0,58 individus/km². La partie sud du parc s'étendant sur 1200 km², on estime à environ 700 le nombre d'éléphants utilisant cette zone comme partie de leur domaine vital. Malgré la pression cynégétique passée et présente exercée dans le parc, cette densité d'éléphants est proche de celle obtenue dans des zones peu perturbées d'Afrique centrale ce qui confirme ainsi l'importance du Parc National de Monte Alen en tant que site de conservation d'une population viable d'éléphants.

Abstract

For the first time in Equatorial Guinea, the absolute density of elephants was determined following a survey on line transects carried out between October 2003 and February 2004 in the recently extended southern part of Monte Alen National Park (1200 km²). Elephant density was estimated at 0.55 animals/km² (CI 95%: between 0.31 and 0.79). By integrating data collected on reconnaissance surveys parallel to transects, elephant density was corrected to 0.58 animals/km². It is estimated that about 700 elephants use the southern 1200 km² of the park as part of their range. Despite past and present hunting pressure, this elephant density is close to figures obtained in little-disturbed areas of Central Africa, and it confirms the importance of Monte Alen National Park as a conservation area with a viable elephant population.

Introduction

Jusqu'à présent, l'état des populations d'éléphants de forêt, *Loxodonta africana cyclotis*, en Guinée Equatoriale était très peu documenté. En effet, hormis pour le secteur nord du Parc National de Monte Alen (PNMA) et pour la Réserve de Rio Campo à l'extrémité Nord-est du pays, où la présence de l'espèce est confirmée, aucune donnée scientifique récente n'est disponible pour le reste du pays, comme le confirme le Groupe Spécialiste des Eléphants africain (AfESG 2005). A partir des années 70, plusieurs enquêtes ont permis de souligner la présence des densités importantes d'éléphants dans la partie continentale de la Guinée Equatoriale mais aucune estimation ni description

précise de l'aire de répartition de l'espèce dans le pays n'a été effectuée. Bien que des études quantitatives n'aient pas été entreprises, selon une conjecture environ 300 éléphants utilisent la partie nord du PNMA comme une portion de leur aire de distribution (Blanc et al. 2003). Une telle déficience d'information concernant la distribution et le nombre d'éléphants en Guinée Equatoriale constitue un fait unique pour un pays d'Afrique centrale.

Pourtant, les informations relatives à l'abondance, à la répartition de la faune ainsi qu'aux interactions homme-faune sont primordiales pour développer des politiques de gestion efficace des aires protégées et apporter des éléments de comparaison à l'échelle régionale, voire internationale.

Dans le cadre du Programme ECOFAC (Programme de Conservation et d'Utilisation Rationnelle des Ecosystèmes d'Afrique centrale) financé par le Fonds Européen de Développement, une étude préliminaire destinée à évaluer l'abondance des grands mammifères et l'intensité des activités anthropiques (notamment la présence des braconniers) dans le PNMA a été lancée entre octobre 2003 et février 2004. En effet, la plupart des données tant environnementales que socio-économiques concernaient jusqu'en 2003 seulement les 800 km² initiaux du parc alors que sa superficie s'est accrue jusqu'à 2000 km² en 1998.

Dans cet article nous présentons les résultats relatifs à l'estimation de la densité des éléphants dans le secteur sud du PNMA, le secteur « Mont Mitra ».

Site d'étude

Le Parc National de Monte Alen (PNMA) est situé au Centre-ouest de la région continentale de Rio Muni en Guinée Equatoriale. Il est situé dans la cordillère de Niefang, dont l'altitude varie entre 400 et 1350 m d'altitude. Créé en 1992 durant la première phase du Programme ECOFAC, le PNMA était d'une superficie initiale de 800 km², mais à partir de 1998 sa superficie s'est accrue jusqu'à 2000 km² après l'inclusion dans les limites du parc de la vaste forêt au sud de la rivière Laña (fig. 1).

Le climat, de type équatorial, est caractérisé par deux saisons sèches: de juin à mi-septembre et de décembre à mi-février. La température moyenne annuelle est de 25°C. Les précipitations moyennes s'élèvent à environ 2500 mm/an avec un taux d'humidité variant de 80 à 90 % toute l'année (Lejoly et Senterre 2001). La forêt du Rio Muni fait partie du centre d'endémisme guinéo-congolais et du domaine bas-guinéen atlantique (Lejoly 1996). L'écosystème forestier principal présent sur la cordillère de Niefang est une forêt primaire dense sub-montagnarde riche en *Burseraceae* et *Caesalpinaceae*. Cette forêt possède une diversité exceptionnelle en ligneux qui s'explique par le relief particulièrement accidenté de la région mais également par le fait que cette région aurait constitué un refuge forestier durant la période sèche du Pleistocène (Lejoly et Senterre 2001). L'abondance en espèces végétales commerciales telles *Aucoumea klaineana* a suscité depuis l'époque coloniale l'intérêt de plusieurs sociétés d'exploitation forestière. Aujourd'hui, ces sociétés ne sont plus présentes aux alentours du parc, la dernière compagnie

s'étant retirée en 2000 (Garcia Esteban et Martinez Pena 2000).

La faune sauvage du parc comporte 233 espèces d'oiseaux, 65 espèces de reptiles, 57 espèces d'amphibiens, 62 espèces de poissons et 109 espèces de mammifères sur les 111 qu'abrite le Rio Muni. Parmi ces derniers, 16 espèces de primates sont présentes dans le parc, notamment les gorilles *Gorilla gorilla gorilla* et les chimpanzés *Pan troglodytes*. Les autres grands mammifères emblématiques du parc sont notamment le buffle *Syncerus caffer nanus*, le pangolin géant *Manis gigantea*, le sitatunga *Tragelaphus spekei*, la panthère *Panthera pardus* et l'éléphant de forêt *Loxodonta africana cyclotis* (Lasso Alcalá 1995).

La population humaine vivant en périphérie du parc est estimée à environ 1500 habitants répartis dans huit villages situés du côté ouest et sud de l'extension sud du parc. Cette population dépend étroitement des ressources cynégétiques comme l'ont montré plusieurs études aux pourtours du parc (Fa et Garcia Yuste 2001).

La zone d'étude, correspondant au secteur sud du parc (le secteur Mont Mitra), est d'une superficie de 1200 km². L'étude s'est déroulée durant la fin de la seconde saison sèche et la première saison des pluies entre octobre 2003 et février 2004.

Méthodologie

Pour cette étude, la méthodologie de comptage direct et indirect sur une combinaison de transects linéaires et de *recces* a été utilisée (Walsh et White 1999). Puisque aucune observation directe d'éléphant n'a été faite, leur densité a été estimée à partir du comptage des crottes. Les traces humaines ont également été comptabilisées au cours de cet inventaire.

Pour chacune de ces zones, trois transects de 4 km de long ont été choisis au hasard sur la carte en respectant cependant une direction perpendiculaire aux cours d'eau et chemins afin d'obtenir un échantillon représentatif des différents types de végétation.

Suite à la présence d'obstacles rocheux, de nombreux transects n'ont pu atteindre la longueur de 4 km initialement prévue. De ce fait, afin d'obtenir une surface d'échantillonnage suffisante, 8 nouveaux transects totalisant 19,6 km de long ont été ouverts et inventoriés directement lors des missions d'inventaire. Finalement, un total de 68,3 km ont été ouverts en forêt, comptabilisant 28 transects d'une largeur d'environ 80 cm et mesurant entre 0,5 km et 4,3 km (fig. 1).

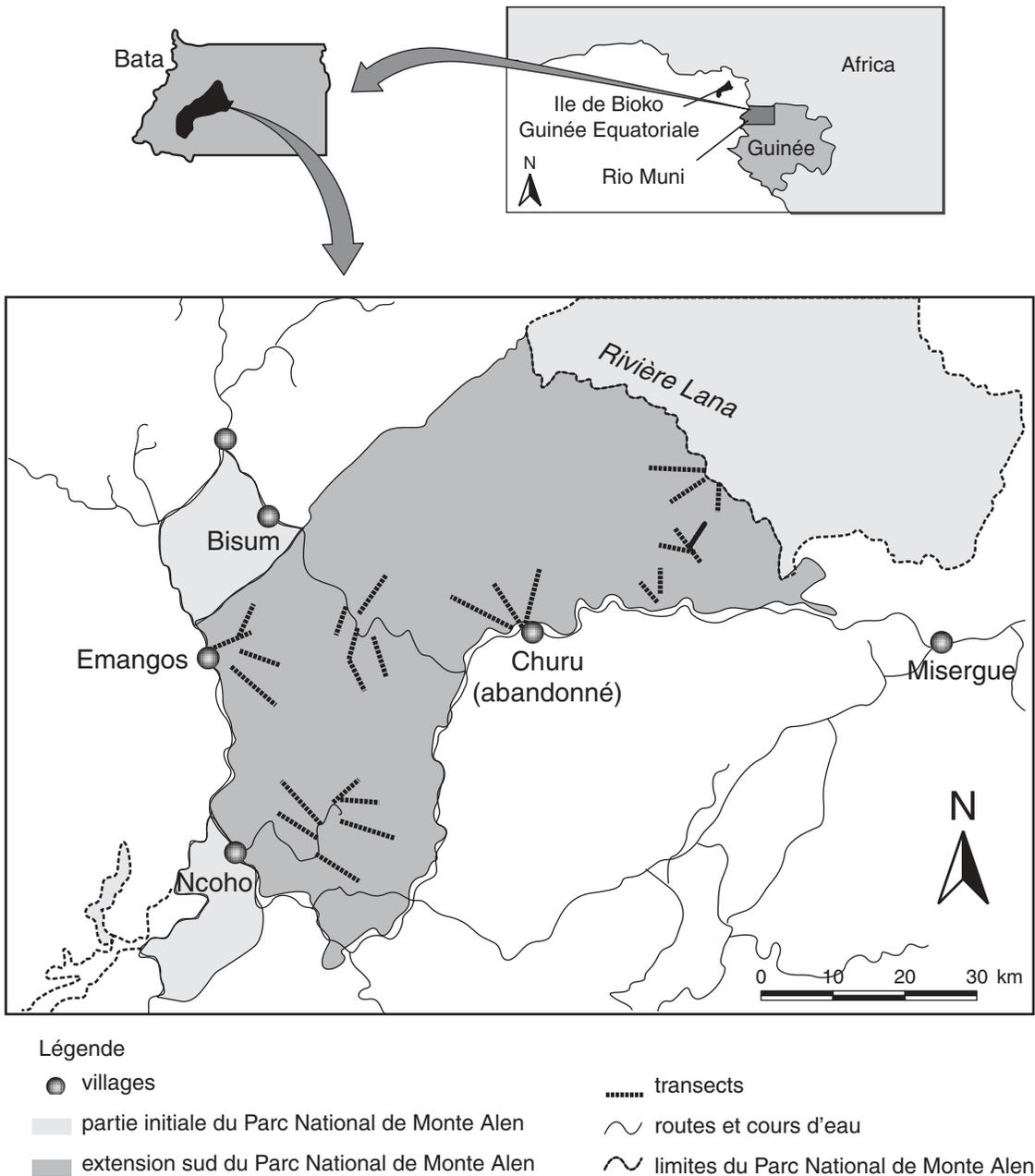


Figure 1. Carte du secteur Sud du Parc National de Monte Alen.

Chaque jour, les comptages commençaient entre 7000 et 8000. La vitesse d'avancement de l'équipe d'inventaire variait entre 0,5 km/h et 0,75 km/h suivant la topographie et le nombre d'observations. Pour chaque crotte d'éléphant observée sur ces transects, la distance perpendiculaire au layon ainsi

que l'âge étaient relevés suivant le protocole et la classification proposés par White et Edwards (2000). Les traces humaines telles que les pièges, les pistes humaines, les cartouches, les campements de pêche ou de chasse et les sites d'anciens villages ont également été dénombrés lors de cet inventaire.

Pour chacun des transects le retour consistait en une marche *recce* débutant à 50–100 m de la fin du transect et réalisée sur un chemin de moindre résistance approximativement parallèle au transect. Le nombre de tas de crottes d'éléphant observés le long de chaque *recce* était enregistré, sans mesurer les distances perpendiculaires.

Méthodes d'analyse des données

La densité des crottes d'éléphant dans la zone d'étude (crottes/km²) a été calculée à l'aide du logiciel Distance 3.5 (Thomas et al. 1998) testant les quatre modèles standards pour la fonction de détection proposée par le logiciel.

Afin d'augmenter la précision des estimations de la densité des tas de crottes d'éléphant, le taux de rencontre des crottes le long des *recces* a été calculé (nombre de crottes observées par km). L'équation permettant de combiner les données sur transect et sur *recce* est la suivante (White et Edwards 2000):

$$D = (N_t + \mu N_r) / 2(L_t + L_r) WP$$

où D = densité de crottes; $\mu = (N_t / \text{km}) / (N_r / \text{km})$; N_t = nombre de crottes sur le transect; N_r = nombre de crottes sur les *recce*; L_t = longueur du transect; L_r = longueur du *recce*; W = largeur du transect; P = probabilité de détection sur le transect.

La densité des éléphants (E) est calculée à partir de la densité des crottes en utilisant la formule de Barnes et Jensen (1987) qui intègre les taux d'apparition et de disparition de ces crottes:

$$E = D(r/d)$$

où E = nombre d'éléphants par km²; D = nombre de crottes par km²; r = taux de décomposition des crottes; d = taux journalier de défécation par éléphant.

Le temps limité de l'étude n'a pas permis d'effectuer un suivi de la dynamique de la disparition des crottes dans le PNMA. En conséquence, nous avons utilisé les taux journaliers de décomposition des crottes (r) calculés par White (1995) et Barnes et Barnes (1992), et les taux de défécation (d) calculés par Plumptre (2000), Tchamba (1992) et Beyers et al. (2001).

Puisque la dynamique de la disparition des crottes dans le PNMA n'a jamais été étudiée, on assume ici un *steady state*, c'est-à-dire que le nombre de crottes produites équivaut au nombre de crottes disparues chaque jour.

Résultats

Estimation de la densité de crottes d'éléphants

Le long des 68,3 km de transects inventoriés, 101 tas de crottes d'éléphant ont été enregistrés. Les données recueillies dans les différentes zones parcourues ont été regroupées et traitées ensemble afin de déterminer la fonction de détection des crottes. Pour l'analyse des données, les mesures de distance perpendiculaire supérieure à 512 cm ont été éliminées, soit 5 % des observations (Buckland et al. 2001). Parmi les 4 modèles mathématiques testés pour la fonction de détection, c'est le modèle Hazard-rate avec 2 « *cosine adjustment terms* » qui a été choisi sur la base du minimum de l'Akaike's Information Criterion (AIC) (fig. 2). L'estimation ponctuelle de la densité des crottes dans l'aire d'étude est de 471 crottes/km² (entre 317,27 et 699,21, intervalle de confiance 95 %), avec un coefficient de variation égal à 20,1 % (tableau 1).

Estimation de la densité d'éléphants

La densité moyenne d'éléphants dans l'extension sud du parc au moment de l'étude a pu être estimée entre 0,43 à 0,83 éléphants par km² (valeurs ponctuelles) suivant les valeurs de r et d utilisées (tableau 2). Parmi les différentes valeurs de d , c'est celle de Tchamba (1992) qui, basée sur 16 périodes prolongées d'observations, semble la plus précise (SE = 0,23). D'autre part, la valeur de $r = 0,023$ (Barnes et Barnes 1992; SE = 21748 x 10⁻³), calculée en saison des pluies, serait la plus proche de la réalité puisqu'une grande partie de l'étude dans le PNMA s'est déroulée durant cette période. En tenant compte de ces valeurs, l'estimation de la densité des éléphants au moment de l'étude est de 0,55 ind/km². La précision de l'estimation de la densité (E) des éléphants est liée à la précision de trois composantes de l'équation suivante (Barnes 1993): $CV^2(E) = CV^2(D) + CV^2(r) + CV^2(d)$ (D est la densité des crottes estimée par cette étude). Le $CV(E)$ ainsi calculé est égale à 0,2224, l'Intervalle de Confiance à 95% étant entre 0,31 et 0,79.

Calcul de la densité des éléphants après intégration des données récoltées sur les recces

Un total de 135 crottes ont été comptabilisées le long des 69,9 km de *recces* parcourus. La figure 3 montre la relation existant entre le nombre de crottes

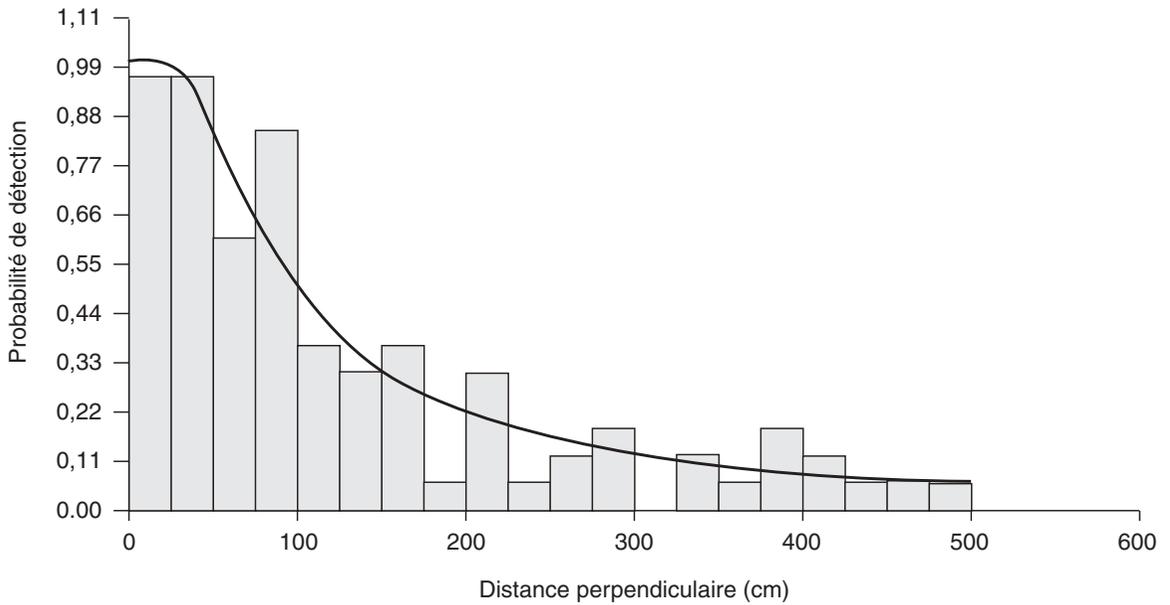


Figure 2. Histogramme de fréquence et courbe de détection (modèle *hazard rate/cosine*) des crottes d'éléphants observées durant cette étude. GoF : $\chi^2 = 12,642$; degrés de liberté = 17 ; $P = 0,759$.

Tableau 1. Densité des crottes d'éléphant dans l'extension sud du Parc National de Monte Alen

Paramètre	Estimation ponctuelle	Erreur standard	Coefficient de variation (%)	Intervalle de confiance à 95%	
<i>P</i>	0,291	0,050	17,31	0,207	0,410
<i>LET</i> (cm)	149,210	25,834	17,31	106,070	209,890
<i>n</i> / <i>L</i>	1,406	0,143	10,21	1,151	1,716
<i>D</i>	471,000	94,659	20,10	317,270	699,210

P = probabilité d'observer une crotte ; *LET* = largeur effective du transect (= $L \cdot P$) ; *n* = nombre de crottes détectées (=96) ; *L* = longueur totale des transects (= 68,3 km) ; *D* = densité estimée des crottes (crottes/km²) ; largeur du transect *W* = 512 cm ; modèle choisi : hazard rate/cosine

Tableau 2. Estimation de la densité des éléphants *E* (ind./km²) en considérant différentes valeurs de *r* et *d*

Valeurs de <i>r</i> et <i>d</i> utilisées pour l'estimation	Références	<i>D</i> (ind./km ²)
<i>r</i> = 0,018 ; <i>d</i> = 19,7	(White 1995 ; Tchamba 1992)	0,43
<i>r</i> = 0,023 ; <i>d</i> = 19,7	(Barnes et Barnes 1992 ; Tchamba 1992)	0,55
		(IC 95% : 0,31–0,79)
<i>r</i> = 0,018 ; <i>d</i> = 16,2	(White 1995 ; Plumptre 1991)	0,52
<i>r</i> = 0,023 ; <i>d</i> = 16,2	(Barnes et Barnes 1992 ; Plumptre 1991)	0,67
<i>r</i> = 0,018 ; <i>d</i> = 13	(White 1995 ; Beyers et al. 2001)	0,65
<i>r</i> = 0,023 ; <i>d</i> = 13	(Barnes et Barnes 1992 ; Beyers et al. 2001)	0,83

observées par km sur chaque couple *recce*-transect. Le coefficient de corrélation de Spearman entre les deux séries de données est : $r_s = 0,793$ ($P < 0,01$).

La corrélation étant significative, les données relevées sur les *recce*s peuvent être utilisées pour calculer la densité de crottes :

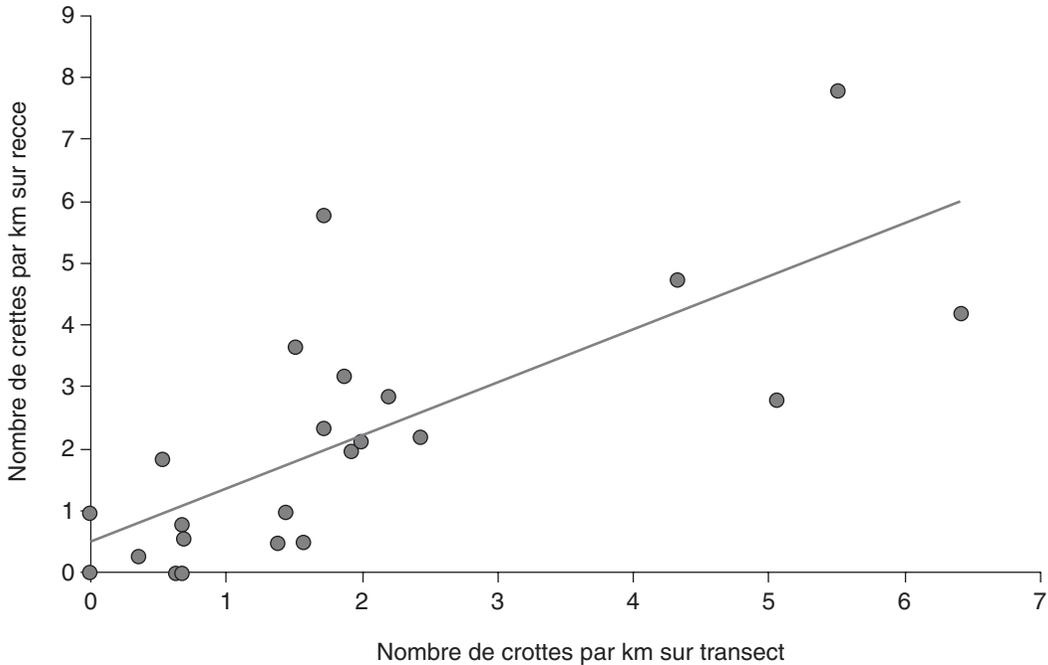


Figure 3. Relation entre les taux de rencontre des crottes observées sur les transects et les recce dans l'extension sud du PNMA [$r_s = 0,793$; $P < 0,01$].

$$D = (101 + \mu 135) / 2 (68,3 + 69,9) (0,0014921) = 495,92 \text{ crottes/km}^2$$

Cette valeur est un peu plus élevée que celle obtenue en utilisant les seules observations sur transect. En utilisant les mêmes valeurs de $r = 0,023$ (Barnes et Barnes 1992) et $d = 19,7$ (Tchamba 1992), on obtient une estimation de la densité des éléphants de 0,58 individus/km².

Présence humaine et braconnage

Des traces d'activité cynégétique (cartouches, pièges, pistes) ont été observées le long des transects et des *recce* dans l'extension sud du parc, mais aucune carcasse d'éléphant n'a été observée. Plusieurs camps de chasse en activité ont été dénombrés dans la zone d'étude mais aucun n'était présent le long des transects et *recce*: ils se situaient le long des chemins et des anciennes pistes forestières bordant les limites du parc. Aucun signe particulier dans ces camps telle la présence de viande d'éléphant ou de carabines n'a permis de déterminer avec certitude si ces campements hébergeaient des braconniers combinant la chasse des espèces de petite et moyenne taille avec celle de l'éléphant.

Discussion

Avec une estimation moyenne de densité d'éléphants de 0,58 individus/km², environ 700 éléphants utiliseraient l'extension sud du PNMA comme partie de leur domaine vital. En effet, même si la zone d'étude est assez étendue avec 1200 km², il est peu probable que les éléphants résident dans cette zone toute l'année. Cette estimation d'éléphants dans le PNMA est bien supérieure à celle suggérée jusqu'à présent dans la littérature puisque le dernier rapport de l'UICN sur le statut de l'éléphant d'Afrique rapporte à plus ou moins 300 le nombre d'éléphants susceptibles d'utiliser le parc (Blanc et al. 2003).

Par comparaison avec différents sites d'étude (réserves naturelles, exploitations forestières, ...), l'estimation de la densité d'éléphants dans l'extension sud du PNMA est proche de la valeur obtenue dans des zones peu perturbées de l'Afrique centrale. Elle est toutefois plus faible que les densités enregistrées dans d'autres aires protégées, telles le Parc National d'Odzala (Congo), la Réserve Okapi (République Démocratique du Congo, RDC), le Parc National de la Lopé (Gabon) et la partie centrale du Parc Kahuzi-Biega (RDC) où les densités ont également été

estimées à partir d'une combinaison de *recces* et de transects linéaires (tableau 3).

Cette estimation est cependant à considérer avec précaution puisqu'elle est basée sur des valeurs de taux de disparition des crottes et de taux de défécation calculés pour d'autres sites que le PNMA. En outre, puisque la dynamique de la disparition des crottes dans le PNMA n'a jamais été étudiée, on assume ici un *steady state* (c'est-à-dire que le nombre de crottes produites équivaut au nombre de crottes disparues chaque jour), bien que cette hypothèse puisse engendrer des biais parfois non négligeables. En effet, plusieurs études menées ailleurs en Afrique (Barnes et al. 1997; Nchanji et Plumptre 2001; Laing et al. 2003) ont montré qu'une population de crottes est rarement dans un *steady state* suite notamment à la variation des précipitations et aux mouvements migratoires des animaux dans l'aire d'étude.

Les variations de densité d'éléphants en fonction des saisons et de la pression anthropique (Barnes et al. 1991; Hall et al. 1997) n'ont pu être évaluées faute de temps, de sorte que seule une densité moyenne a été obtenue pour l'ensemble de l'aire d'étude durant la période couvrant la seconde saison des pluies et une partie de la première saison sèche de l'année.

L'ouverture prévue des 84 km de transect dans l'extension sud du PNMA n'a pas été atteinte. La topographie très accidentée de la zone combinée au manque de données relatives au milieu physique explique en partie ce résultat. En effet, l'ouverture de plusieurs transects n'a pu être complétée à cause de la présence d'obstacles infranchissables tels que des parois rocheuses ou des gorges profondes.

En outre, seules les données topographiques de la zone initiale du parc ainsi que celle de la partie nord de l'extension sud du parc étaient disponibles au

Tableau 3. Estimation de la densité des éléphants dans différentes forêts de l'Afrique centrale. Les densités ont été estimées à partir des densités des crottes (excepté « * ») Pour toutes les études, les valeurs $d = 19,7$ (Tchamba 1992) et $r = 0,023$ (Barnes et Barnes 1992) ont été considérées sauf pour «^a» où $d = 13$ et $r = 0,018$ et pour «^c» où $r = 0,0232$ (Hall et Bengana 1996)

Zone d'étude	Densité des crottes (crottes/km ²)	Densité d'éléphants (individus/km ²)
Odzala, Congo ^a	2450	3,4
Réserve Okapi, RD Congo ^a	1230	1,7
Lopé, Gabon ^a	620	0,9
Gabon ^b :		
Moyenne nationale, exclue Libreville	—	0,28
Stratum 1 (nord-est)	311	0,36
Stratum 2 («Mountains»)	464	0,55
Stratum 3 (ouest)	395	0,46
Stratum 4 (haute densité humaine)	83	0,09
Gabon, Réserve de la Lopé (5 sites)*	—	0,3–3,0*
Kahuzi-Biega, RD Congo ^c :		
Zone habitée	36	0,04
Forêt peu perturbée	476	0,55
Forêt, zone centrale	1337	1,55
Permis forestier Leroy, Gabon ^d :		
Lot 28	330	0,30 / 0,39
Lot 30	408	0,53 / 0,69
Lot 32	587	0,37 / 0,47
Extension sud du Parc National de Monte Alen (présente étude)	496	0,58

^a Beyes et al. (2001) ; ^b Barnes et al. 1995 ; ^c Hall et al. 1997 ; ^d Ghiurghi (2002);

* White 1994. Estimations basées sur des observations directes.

moment de l'étude. Enfin, de nombreuses zones de la partie sud du parc ne sont pas encore suffisamment bien connues par les écogardes, notamment les pistes ou chemins permettant une accessibilité facile dans les zones centrales du parc. Cette conjoncture explique les difficultés rencontrées pour réaliser un inventaire sur transects dans le PNMA.

Cependant, l'utilisation de la méthode *recce*-transect s'est confirmée intéressante dans ce contexte topographique et logistique, nous permettant de parcourir une plus grande distance dans la zone d'étude et ainsi d'augmenter le nombre d'observations.

Parmi les mesures actuelles de protection concrète des éléphants, aucune ne concerne les pourtours du parc. A titre d'exemple, l'abattage d'un éléphant dans un village en périphérie du PNMA au mois de novembre 2003 a été organisé légalement consécutivement à la destruction de plantations villageoises sans que le gestionnaire du PNMA n'en soit averti. Hormis l'abattage de cet éléphant en périphérie du parc, aucun éléphant mort ni carcasse n'ont été retrouvés durant l'étude, malgré la présence de nombreux braconniers opérant dans le parc. Toutefois, sachant que le parc constitue un réservoir de faune pour la région continentale et que de la viande d'éléphant est régulièrement vendue sur le plus grand marché de Bata, la ville principale du Rio Muni (trois relevés de viande en 54 jours entre avril et mai 2003 (Puit 2004), l'abattage d'éléphants dans cette région est plus que probable.

Conclusion

Ce travail doit être considéré comme une étude préliminaire des éléphants du PNMA, d'autres études plus approfondies devant être planifiées sur le long terme afin, d'une part, de préciser la densité et la distribution des éléphants dans le parc et, d'autre part, de démarrer un programme de monitoring à long terme sur l'ensemble des grands mammifères.

En conclusion, cet inventaire constitue la première étape pour la mise en place d'un plan de gestion concret de la faune du PNMA. Néanmoins, il permet d'affirmer l'importance du PNMA comme site de conservation des éléphants et de mettre en évidence les principales menaces anthropiques auxquelles doivent faire face les gestionnaires du parc. Le recueil de données d'inventaire plus précises sera nécessaire pour mieux planifier la gestion des éléphants du parc dans le futur. De nombreuses études ultérieures

portant notamment sur les mouvements des éléphants et sur les facteurs influençant ces migrations seraient également à développer afin de garantir à long terme des mesures de conservation adéquates.

Remerciements

Cette étude a été réalisée dans le cadre du programme ECOFAC à travers l'appui de l'assistance technique fournie par le groupement AGRECO-SECA-CIRAD Forêt en association avec Fauna & Flora International. Nous remercions les bureaux d'étude AGRER et AGRICONSULTING à travers Frank Feys et Barbara Giannuzzi Savelli, l'ensemble du personnel ECOFAC résidant à Monte Alen, en particulier le chef de composante ECOFAC Guinée Equatoriale, Philippe Mortier, les écogardes Restituto Nguema, Felipe Esono et Amancio Mbà lors du travail de terrain, les porteurs, les guides et les pisteurs.

Bibliographie

- [AFESG] African Elephant Specialist Group. 2005. Stratégie régionale pour la conservation des éléphants en Afrique centrale.
- Barnes RFW 1993. Indirect methods for counting elephants in forest. *Pachyderm* 16: 24–30.
- Barnes RFW, Barnes KL. 1992. Estimating decay rates of elephant dung piles in forest. *African Journal of Ecology* 30 : 316–321.
- Barnes RFW, Barnes KL, Alers MPT, Blom A. 1991. Man determines the distribution of elephants in the rain forests of north-eastern Gabon. *African Journal of Ecology* 29 : 54–63.
- Barnes RFW, Blom A, Alers MPT, Barnes KL. 1995. An estimate of the number of forest elephants in Gabon. *Journal of Tropical Ecology* 11 : 27–37.
- Barnes RFW, Jensen KL. 1987. How to count elephants in the forests. *IUCN African Elephant and Rhino Specialist Group Technical Bulletin* 1 : 1–6.
- Barnes RFW, Asamoah-Boateng B, Naada Majam, J, Agyei-Ohemeng J. 1997. Rainfall and the population dynamics of elephant dungpiles in the forests of southern Ghana. *African Journal of Ecology* 35 : 39–52.
- Beyers R, Thomas L, Hart J, Buckland S. 2001. *Recommendations for ground-based survey methods for elephants in the Central African forest region*. Technical report No. 2. MIKE, Central Africa Pilot Project. http://www.cites.org/eng/prog/MIKE/pilot/tech_rep2.shtml_Toc523110308

- Blanc JJ, Thouless CR, Hart JA, Dublin HT, Douglas-Hamilton I, Craig CG, Barnes RFW. 2003. *African elephant status report 2002*. An update from the African Elephant Database. Occasional Paper of the IUCN Species Survival Commission 29 : 59–64.
- Buckland ST, Anderson DR, Burnham KP, Laake JL, Borchers DL, Thomas L. 2001. *Introduction to distance sampling: estimating abundance of biological populations*. Oxford University Press, Oxford.
- Fa JE, Garcia Yuste JE. 2001. Commercial bushmeat hunting in the Monte Mitra forests, Equatorial Guinea: extent and impact. *Animal Biodiversity and Conservation* 24 : 31–52.
- García Estebán, Martínez Pena. 2000. Ayer y hoy de Guinea Ecuatorial. *Bois et forêts des tropiques* 54/266 : 71–78.
- Ghiurghi A. 2002. Inventaire faune dans les lots 28, 30 et 32 de l'UFA 1 de Leroy Gabon. Rapport technique. Projet ECOFAC (Conservation et utilisation rationnelle des Ecosystèmes Forestiers d'Afrique Centrale). Agreco (Groupement Européen d'Intérêt Economique), Bruxelles, Belgique.
- Hall JS, Inogwabini B-I, Williamson EA, Omari I, Sikubwabo C, White LJT 1997. A survey of elephants in the Kahuzi-Biega National Park lowland sector and adjacent forest in Eastern Zaire. *African Journal of Ecology* 35 : 213–223.
- Hart JA, Bengana F. 1996. *Elephant dung decomposition rates in the Ituri Forest*. Typescript Wildlife Conservation Society, New York. Dans: Hall JS, Inogwabini B-I, Williamson EA, Omari I, Sikubwabo C, White LJT 1997. A survey of elephants in the Kahuzi-Biega National Park lowland sector and adjacent forest in Eastern Zaire. *African Journal of Ecology* 35 : 213–223.
- Lasso Alcalá CA. 1995. Biodiversidad animal del Parque Nacional de Monte Alén. Proyecto ECOFAC: Componente Guinea Ecuatorial/Asociación Amigos de Coto Donana. AGRECO-CTFT, Bruxelles, Belgique.
- Laing SE, Buckland ST, Burn RW, Lambie D, Amphlett A. 2003. Dung and nest surveys: estimating decay rates. *Journal of Applied Ecology* 40 : 1102–1111.
- Lejoly J. 1996. Synthèse régionale sur la biodiversité végétale des ligneux dans les 6 sites du projet ECOFAC en Afrique Centrale. AGRECO-CTFT, Bruxelles, Belgique. 81 p.
- Lejoly J, Senterre B. 2001. Los grandes tipos de habitat forestales de Rio Muni. Dans: Aedo C, Morales R, Telleria MT, Velayos M. 2001. Bot-nica y bot-nicos en Guinea Ecuatorial. Real jardin bot-nico–Agencia Española de Cooperación Internacional, Madrid. p. 171–199.
- Nchanji AC, Plumptre AJ. 2001. Seasonality in elephant dung decay and implications for censuring and population monitoring in south-western Cameroon. *African Journal of Ecology* 39 : 24–32.
- Plumptre AJ. 1991. Plant–herbivore dynamics in the Virungas. Thèse de doctorat, Université de Bristol, Angleterre. Non publié.
- Plumptre AJ. 2000. Monitoring mammal populations with line transects techniques in African forests. *Journal of Applied Ecology* 37 : 356–368.
- Puit M. 2004. Dynamique de la filière viande de brousse dans la partie continentale du Rio Muni en Guinée Equatoriale. *Tropicultura* 22 (4) : 204–210.
- Tchamba, M. 1992. Defecation by the African forest elephant *Loxodonta africana cyclotis* in the Santchou Reserve, Cameroon. *Mammalia* 56 : 155–158.
- Thomas L, Beyer R, Hart J, Buckland S. 2001. Recommendations of a survey design for the Central African forest region. Technical report no 1. Monitoring Illegal Killing of Elephants (MIKE), Central African Pilot Project.
- Thomas L, Laake J, Derry J. 1998. *Distance version 3.5, release 5*. Research Unit for Wildlife Population Assessment, University of St. Andrews.
- Walsh PD, White LJT. 1999. What it will take to monitor forest elephant populations. *Conservation Biology* 13(5) : 1194–1202.
- White LJT. 1994. Biomass of rain forest mammals in the Lopé Reserve, Gabon. *Journal of Animal Ecology* 63 : 499–512.
- White LJT. 1995. Factors affecting the duration of elephant dung piles in rain forest in the Lopé Reserve, Gabon. *African Journal of Ecology* 33 : 142–150.
- White L, Edwards A. 2000. *Conservation research in the African rain forests, a technical handbook*. The Wildlife Conservation Society, New York. 456 p.

Human–elephant conflict outlook in the Tsavo–Amboseli ecosystem, Kenya

John Kioko,¹ John Kiringe,¹ Patrick Omondi²

¹ School for Field Studies, Center for Wildlife Management Studies, PO Box 27743, Nairobi, Kenya; email: kiokostar@yahoo.com; jkiringe@fieldstudies.org

² Kenya Wildlife Service, Species Programme, PO Box 40241, Nairobi 00100, Kenya; email: pomondi@kws.org

Abstract

We examined the extent of human–elephant conflict in the area between Amboseli, Chyulu Hills and Tsavo West National Parks in south-western Kenya. Standardized questionnaire interviews administered to 880 residents showed that crop farming has intensified in the last 3 to 10 years, with many Maasai people practising crop farming, a departure from their traditional pastoral lifestyle. Incidents of crop damage by wildlife were common and elephants were reported as the most problematic animal. Incidents of elephant crop raiding were high in the dry season and at night, linked to the wetlands, with bull groups being the dominant crop raiders. Incidence of elephant crop raiding in areas under electric fences was significantly low. Elephants preferred maize (*Zea mays*), a crop farmers consider the most important for their livelihood. Elephants caused few livestock deaths and injuries. Among the households interviewed, 6% had had a family member killed or injured by elephants between 1999 and 2004, and elephants had caused more deaths and injuries than other wildlife species. Residents' perceptions on the importance of having elephants within the area were highly negative. The patterns of attitude towards elephants were associated with the residents' ethnic background, gender, form of land use, benefits accrued from wildlife, level of elephant crop damage, and response of the wildlife authority to problem–elephant reports.

Additional key words: crop raiding, electric fencing

Résumé

Nous avons examiné l'importance des conflits hommes-éléphants dans la région comprise entre les Parcs Nationaux d'Amboseli, de Chyulu et de Tsavo-ouest, dans le sud-ouest du Kenya. Des questionnaires standardisés proposés à 880 résidents ont révélé que les cultures se sont intensifiées au cours des 10 dernières années et que de nombreux Massais pratiquent l'agriculture, en rupture avec leur mode de vie pastoral traditionnel. Les dégâts aux cultures sont fréquents, et les éléphants sont les animaux qui causent le plus de problèmes. Les incidents causés par les éléphants sont nombreux en saison sèche et de nuit, liés aux zones humides, et les groupes de mâles sont les principaux ravageurs. Les raids des éléphants dans les plantations entourées de clôtures électriques étaient significativement moins nombreux. Les éléphants préfèrent le maïs (*Zea mays*), la culture que les fermiers considèrent comme la plus importante pour leur subsistance. Les éléphants ont causé la mort et des blessures à quelques animaux domestiques. Dans les foyers interrogés, 6% avaient eu un membre de la famille tué ou blessé par des éléphants entre 1999 et 2004, et les éléphants avaient causé plus de morts et de blessures que les autres animaux sauvages. Les impressions des résidents quant à l'importance d'avoir des éléphants dans la région étaient très négatives, et le schéma des attitudes envers les éléphants était associé au background ethnique des résidents, à leur sexe, à la façon dont ils utilisaient les terres, aux bénéfices accrus retirés de la faune sauvage, au niveau des dommages causés par les éléphants et à la réponse des autorités de la faune sauvage aux rapports des problèmes des éléphants.

Introduction

Coexistence between elephants (*Loxodonta africana*) and humans in Africa is facing a serious challenge (Leaky and Lewin 1996). Conflict between local people and wildlife is a serious problem in areas adjacent to protected areas (Newmark et al. 1994). The form of land use is usually an important component of the relationship between elephants, humans and other wildlife species (Kangwana 1993). In most rural areas human population largely depends on agriculture for survival (Fratkin 1994). The increase in human population and associated expansion of land under cultivation poses a major threat to the conservation of elephants (Tchamba 1996). In Kajiado District, land under crop cultivation has gradually increased, doubling from 40,000 ha in 1989 to 90,000 ha in 1994 (Awere-Gyekye 1996). Although human-wildlife conflict is not with elephants alone, elephant crop damage has overshadowed that by other wildlife species (Hill 1998). Although elephants cause catastrophic damage to crop farms, their forays are rare, localized and seasonal (de Boer and Ntumi 2001; Parker and Osborn 2001). In the Tsavo–Amboseli ecosystem, land use has progressively shifted from pastoralism to crop farming (Campbell et al. 2000; Kioko 2005). We examine the scale and characteristics of human–elephant conflict in view of the evolving socio-economic dimensions in the area.

Tsavo–Amboseli ecosystem

The Tsavo–Amboseli ecosystem is an area of approximately 5000 km² (Western 1982) and includes about 2000 km² covered by Kimana and Kuku Group Ranches and their environs. These two group ranches lie directly between Amboseli, Chyulu Hills and Tsavo West National Parks (fig. 1). This arid to semi-arid area receives 300–900 mm of rainfall annually (Berger 1993). A ‘short’ rains season occurs between November and December and the ‘long’ rains from March to May. The geology and hydrology are strongly influenced by Mt Kilimanjaro to the south. Highly permeable volcanic rock forms regionally distributed aquifers that are important sources of water in the area (Omenga and Okello 1992; Smith 1997). Maasai pastoralists, who have for centuries occupied the area, used the swamps and slopes of Mt Kilimanjaro as dry-season pasture grounds for their livestock. Wildlife including elephants also use this area. The land

has been administered as communal property under the Group Ranch Act. In the recent past, some of the group ranches have been subdivided and regrettably, critical elephant habitats like the swamps and Kilimanjaro slopes have now been apportioned for crop cultivation. Agriculturists have occupied the slopes of Mt Kilimanjaro since the 1960s with a notable influx of immigrants into the area in the 1980s. Additional crop cultivation has started in the wetlands within the group ranches (fig. 1). Kimana and Namelok fences, 38 km and 24 km long respectively, enclose 42 km² of irrigated farmlands south-east of Amboseli National Park. The two electric fences established to minimize elephant crop damage were completed in 2000 and are managed by the farmers through fence committees.

Methods

We mapped the farming clusters using a geographical positioning system (GPS), and determined areas occupied by the crop fields using ArcView GIS. To assess opinions on human–elephant interactions, we randomly conducted 880 interviews to residents within Kuku and Kimana Group Ranches and environs. Three field assistants fluent in Maasai, Swahili and English were trained in interviewing techniques, and together with the authors interviewed 291 crop farmers, 426 mixed farmers and 163 pastoralists. There were 518 (58.86%) males and 352 (41.14%) females interviewed.

Inside the Namelok fence, 66 farmers were interviewed and 154 farmers inside the Kimana fence. One interview was conducted per Maasai household ‘boma’ among the pastoralists, and the farm owner was interviewed among the farmers. Data on daily elephant crop raiding, extent of crop damage and stage of crop growth when damage occurred were gathered as described by Hoare (1999). The levels of elephant crop damage were calculated following Hoare (1999, 2001), where damage score (< 5 = low, 6–8 = medium, > 9 = high) is the sum of age value, quality value and damage value for all the crops. Age value is classified as 1 = seedling, 2 = intermediate, and 3 = mature; quality value as 1 = poor, 2 = medium and 3 = good; and damage value as 1 = < 5%, 2 = 6–10%, 3 = 11–20%, 4 = 21–50%, 5 = 51–80%, and 6 = > 80%.

We monitored incidents of elephant entry into farms inside Kimana and Namelok electric fences and in farms nearby but outside the fences. We noted the

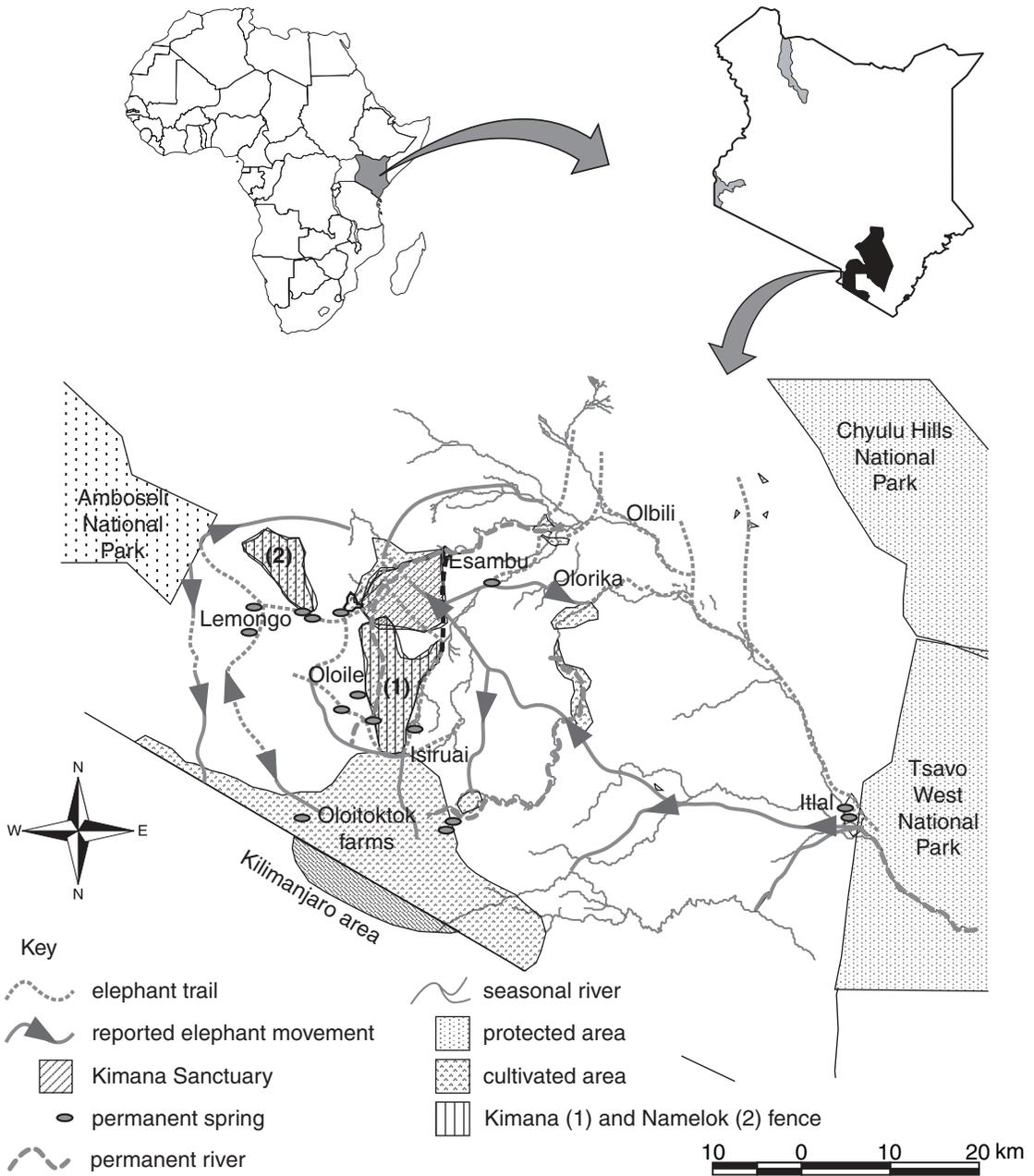


Figure 1. Location of crop farming, Kimana and Namelok fences, and Kimana and Kuku group ranches within Tsavo–Amboseli ecosystem.

number of days it took to repair the fences after elephants broke through as a measure of the fence repair regime. To determine the crop-raiding group types, the first author drove at night with the Kenya Wildlife Service (KWS) Problem Animal Control team and using a powerful spotlight identified

elephant group types. Elephant group type was defined as bull(s) or mixed (bull(s) and female(s)) (McKnight 2004). Information on reported incidents of wildlife-caused livestock injury and death was analysed from occurrence books managed by KWS at various outposts. Data on elephant spearing for the period

1987–2004 were acquired from the Amboseli Elephant Research Project that has kept a long-term database on human–elephant conflict in the Amboseli area.

Results

Level of crop farming

While the Maasai are still predominantly livestock keepers, most have also now taken up crop farming. Farming is dominated by immigrant tribesmen from other parts of Kenya and Tanzania (table 1). A notable influx of immigrants occurred in the 1980s after Kenyan farmers left Tanzania following the collapse of the East African Community in 1977. Most farmers (53%, $n = 390$) have been cultivating in the area for the last 3–10 years; newcomers lease, buy or cooperate in farming with the Maasai owning the land (crop sharing). Irrigated agriculture occupies about 7% (95.8 km²) of two Maasai group ranches (Kuku and Kimana) that directly connect Tsavo West, Chyulu Hills and Amboseli National Parks; 5% of this land (42 km²) was enclosed by electric fences (Kimana and Namelok). On the slopes of Mt Kilimanjaro (Oloitokitok farms) about 200 km² was under rainfed agriculture. Most farmers (70.9%, $n = 521$) cultivated 1–4 acres (0.4–1.6 ha) ($\chi^2 = 479.45$, $df = 2$, $P < 0.001$) and 62.0% ($n = 449$) grew crops both for consumption at home and for sale. The common crops grown were maize 57% ($n = 227$), onion (*Allium cepa*) 25% ($n = 120$), tomato (*Lycopersicon esculentum*) 11% ($n = 52.8$), and beans (*Vigna faba*) 7% ($n = 33.6$). Farmers considered maize, a food and cash crop, as most important for their livelihood ($\chi^2 = 294$, $df = 3$, $P = 0.001$).

Level of elephant crop damage

Most farmers 98.3% ($n = 691$) reported that wildlife damaged crops on their farms. The elephant was

regarded by most farmers 75.7% ($n = 496$) as the most destructive wildlife species and was reported by 76.6% ($n = 418$) to prefer maize ($\chi^2 = 780.74$, $df = 3$, $P < 0.001$). Elephants did not eat chillies (*Capsicum annum*) or tobacco (*Tabacum* sp.). Elephant crop damage per single raid was medium 69.1% ($n = 249$), high 20.5% ($n = 74$) and low 10.5% ($n = 38$) ($\chi^2 = 211.75$, $df = 2$, $P < 0.001$). In most raids (40.1%, $n = 144$) < 5% of an acre (0.4 ha) was destroyed; in a few raids (7.8%, $n = 11$) elephant damage was more than half an acre (0.2 ha). Elephants mainly destroyed mature crops (64%, $n = 233$) rather than crops that were young or at the middle stage of maturity ($\chi^2 = 207.31$, $df = 2$, $P < 0.001$). Most farmers (81.5%, $n = 401$) reported that elephant crop destruction was common in the dry season ($\chi^2 = 15.81$, $P < 0.001$) and 89.3% ($n = 461$) said destruction occurred at night. The raids were, however, insignificantly related to monthly rainfall ($r = 0.48$, $P = 0.1$).

Crop-raiding elephant group size and types

The group size of elephants that invaded different farms differed in dry (Kruskall Wallis, $t = 213.77$, $P < 0.001$) and wet season (Kruskall Wallis, $t = 232.83$, $P < 0.001$). The mean group size ranged from 1.07 ± 0.06 SE to 7.8 ± 1.34 SE. The mean group size of elephants was larger in farms farthest away from protected areas ($r^2 = 0.674$, $P = 0.01$) (fig. 2). The groups ($n = 137$) that the Problem Animal Control team pursued from farms were entirely bull groups.

Livestock deaths and injuries by elephants compared with other wildlife species

Most of the residents (62%, $n = 406$) had experienced livestock injury or death associated with elephants in the period 2002–2003 ($\chi^2 = 38.17$, $P < 0.001$). The aggregate number of sheep and goats killed by wild-

Table 1. Main economic activities among residents within Tsavo–Amboseli ecosystem

Ethnic group	Composition of households interviewed (%)	Involvement in various livelihoods (%)		
		Semi-pastoralists	Crop farming alone	Both farming and semi-pastoralism
Maasai	55.4 ($n = 486$)	98.1	5.6	72.3
Kikuyu	11.2 ($n = 98$)	1.9	41.1	19.0
Kamba	1.8 ($n = 16$)	0	25.4	7.0
Tanzanians	7.3 ($n = 64$)	0	24.0	1.3

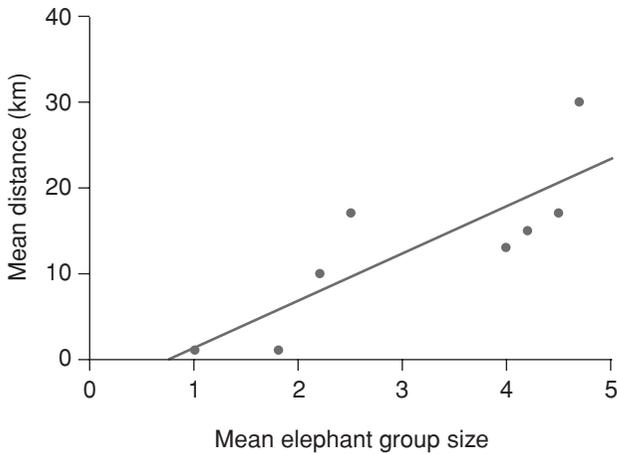


Figure 2. Relationship between mean elephant group size and location of the farms raided by elephants from the nearest protected area.

life among the respondents was (mean = 6.01 ± 0.53 SE, median = 3.00, mode = 1) and cattle (3.16 ± 0.36 SE, median = 2, mode = 1). Elephant-caused livestock deaths and injuries (6%, $n = 6$) were fewer than those caused by hyena 8% ($n = 7$), leopard 10% ($n = 9$) or lion 62% ($n = 57$). Data from the Amboseli Elephant Research Project showed that more cattle (77.4%, $n = 48$) than goats and sheep (22.6%, $n = 16$) were killed by elephants from 1997 to 2003 ($\chi^2 = 18.64$, $P < 0.001$). While there was a positive correlation between reported incidents of carnivore-caused livestock deaths and the amount of rainfall ($r = 0.424$, $P = 0.169$), most incidents associated with elephants occurred in the dry season.

Direct human–elephant interactions and attitudes towards elephants

The number of people who had experienced wildlife-caused deaths and injuries (7.6%, $n = 57$) for the period 1999–2003 was significantly low ($\chi^2 = 543.2$, $P < 0.001$). Information from KWS outposts showed that

elephants had caused the highest number of human deaths and injuries in the period 1994–2004 (fig. 3). There were 75% ($n = 15$) human deaths and 53.3% ($n = 24$) human injuries associated with elephants. Buffaloes had caused 23.8% ($n = 6$) human deaths and 26.7% ($n = 12$) human injuries. A lion caused one human death and a hyena an injury.

Incidents of speared elephants were high in the dry season (63.6%, $n = 28$) compared with those in the wet season (36.4%, $n = 16$). There was no significant difference between the number of female (55.1%, $n = 27$) and male elephants (44.9%, $n = 22$) speared between 1993 and March 2004 in Amboseli National Park and adjacent areas ($\chi^2 = 0.51$, $P < 0.47$).

While many residents (46.6%, $n = 301$) said that they did not harm elephants that came in the vicinity of their homestead, 31.6% ($n = 204$) scared them away and 21.8% ($n = 141$) sought cover in fear ($\chi^2 = 60.33$, $df = 2$, $P < 0.001$). Most residents (66.7%, $n = 455$) were of the opinion that having elephants within the group ranches was not important ($\chi^2 = 75.33$, $P < 0.001$). The semi-pastoral Maasai (37.3%, $n = 163$) were more likely to concur that having elephants in the area was important than were the agriculturalists ($\chi^2 = 24.03$, $df = 2$, $P < 0.001$). More residents who kept livestock (52.6%, $n = 301$)

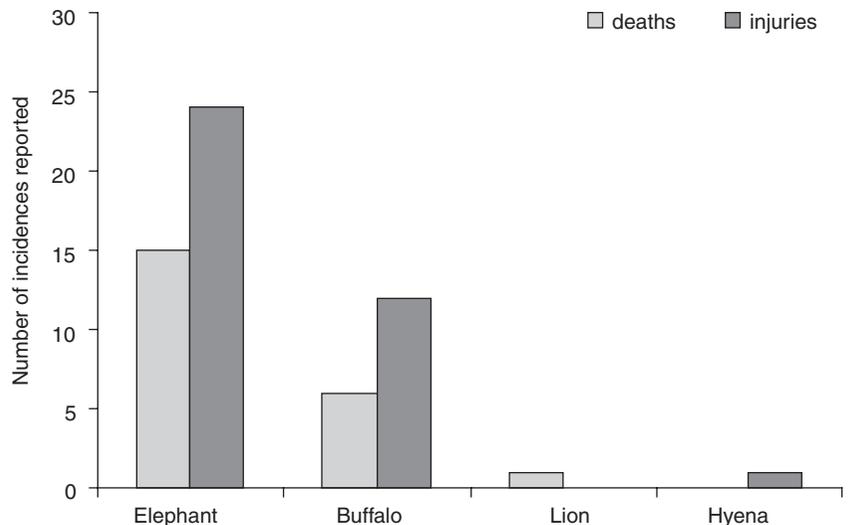


Figure 3. Relationship between elephant- and other wildlife-related human deaths and injuries reported between 1994 and April 2004.

= 81) felt that ‘having elephants was important’ than those who practised crop cultivation alone (28.8%, $n = 51$) ($\chi^2 = 30.20$, $df = 2$, $P < 0.001$) (table 2).

Most of those whose crops had been damaged by elephants did not sustain the view that having elephants in the ecosystem was important. Only 19.2% ($n = 147$) of those who had experienced elephant crop damage felt that having elephants was important ($\chi^2 = 98.00$, $P < 0.001$). Most farmers (74.5%, $n = 149$) who had not been satisfied with the Problem Animal Control team’s response to problem elephant reports did not consider that having elephants was important ($\chi^2 = 3.11$, $P = 0.078$).

There were 36.7% ($n = 212$) who said that they received wildlife benefits. The benefits were considered education bursaries for group ranch members, employment through tourism-related activities, and profits from the sale of curios to tourists. Most of those who had received wildlife benefits (70.3%, $n = 149$) felt that having wildlife in the ecosystem was important compared with 12.3% ($n = 45$) who did not receive benefits ($\chi^2 = 202.43$, $P < 0.001$). The level of education did not appear to influence the respondent’s perception of whether having elephants in the group ranches was important ($\chi^2 = 0.469$, $df = 2$, $P = 0.79$). A higher percentage of females 74.6% ($n = 208$) than males 59.8% ($n = 244$) felt that having elephants was *not* important ($\chi^2 = 16.01$, $P < 0.001$).

Effect of electric fencing in mitigating human–elephant conflict

Farms not enclosed by an electric fence had their crops raided by elephants more frequently than those inside the fences ($F_3 = 39.67$, $P \leq 0.001$). In the fenced areas elephants raided the crops of 42% of the farmers ($n = 93$); the crops of all those ($n = 294$) cultivating in the adjacent unfenced areas were raided. Most (93%) farmers in the fenced areas felt that the level

of elephant crop raids on their farms had declined since the electric fences were established ($\chi^2 = 163.53$, $P \leq 0.001$). Farmers in fenced farms perceived that they have lost USD 24.7 ± 4.84 SE per hectare per season worth of maize crop yield to elephants compared with USD 105.7 ± 23.42 SE by those in the unfenced area. The fences were poorly maintained and frequently vandalized and some fence parts were stolen. Once broken by elephants, it took fence attendants 7 ± 1.5 days to repair Kimana fence.

Discussion

Human–elephant conflict in the Tsavo–Amboseli ecosystem largely manifests itself in the forms of crop damage and of livestock and human death and injury. The conflict is commonly linked to elephant movements during the dry season. The advent of crop farming in what formerly was a predominantly pastoralism area is posing a foremost threat to elephant conservation in the dispersal area. The ease in acquiring land for cultivation has led to an influx of farming immigrants from other parts of Kenya and Tanzania over the last 10 years. In the semi-arid environment, crop farming is confined to the few wetlands and high-potential areas on Mt Kilimanjaro slopes—areas key to elephants, other wildlife and Maasai livestock dispersion in the dry season and during drought periods.

While crop raiding is not limited to elephants, they are an important crop pest. Maize, the most important staple crop, was the crop elephants most preferred. They persistently invaded maize fields after the cobs had formed but before the crop was ready for harvesting. At maturity crops are likely to be more nutritious and palatable (Sukumar 1994). Such elephant foraging behaviour was evident in other crops; for instance, they fed on onion bulbs but left the leafy upper part, dug sweet potato and cassava

Table 2. Relationship between land use and resident’s perception that ‘having elephants in the Kimana and Kuku group ranches is important’

Perception	Livestock keepers (22.16%, $n = 154$)	Crop farming alone (25.47%, $n = 117$)	Mixed crop farming and livestock keeping (52.37%, $n = 364$)
Having elephants ‘is important’	52.6% ($n = 81$)	28.8% ($n = 51$)	28.3% ($n = 103$)
Having elephants ‘is not important’	47.4% ($n = 73$)	71.2% ($n = 126$)	71.7% ($n = 261$)

(*Manihot esculenta*) roots, and sought pumpkin (*Cucurbita maxima*), watermelon (*Citrullus lanatus*), bananas (*Musa* sp.), fruits and sugarcane (*Saccharum officinarum*). Elephants progressively moved along an altitudinal gradient as the dry season progressed in search of green crops and trees up on the slopes of Mt Kilimanjaro. In the irrigated areas, crops were grown throughout the year and provided a constant supply of forage for the invading elephants in the dry season. These findings are consistent with Chiyo et al. (2005), who found that the large fluctuations in forage in the savannas largely determine temporal variations in elephant crop-raiding patterns.

Elephant groups with young were not observed to invade farms far away from the protected areas, probably due to the long distances and the risks it would pose their young ones. The crop raiding was nocturnal. Elephants avoid humans by invading settlements and other areas with high human activity at night (Kangwana 1993). Even where the farms were guarded, it is likely elephants had learned that by raiding the farms at night they increased their chance of evading the farmers.

Though elephants caused more human deaths and injuries than other wildlife species, the incidents were relatively few and were common near or within settlements, farmlands and wetlands. Elephants' antagonistic behaviour toward humans may have risen after persistent harassment (Sukumar 1994) and increased contact with humans. The changes in land use from keeping livestock to farming crops present the elephants with a hostile environment. In the dry season, the wetlands become important watering and foraging grounds for livestock, elephants and migratory wildlife species. The growing human settlement is not only a physical barrier to elephant movement but also creates a potential for elephant harassment.

Culturally, the Maasai viewed elephants in some ways as similar to humans and gave them a respectful distance (Kioko 2005). The young warriors, however, occasionally killed elephants to prove their manhood. The minimal show of hostility towards elephants combined with the fact that livestock keeping does not involve direct conversion of vital habitats such as wetlands is a chance for managers to integrate livestock keeping with elephant conservation.

Although the Maasai are for the most part livestock keepers, they are gradually embracing crop cultivation. The change in land use is worrying. Given the fact that farmers were less willing to accept the

presence of elephants within the group ranches, there is the possibility that crop farming may permanently displace elephants.

The local people's attitude towards conserving elephants is important considering the changing cultural and socio-economic situation within local communities. There is a strong argument (Emerton 2001) that wildlife costs people their livelihoods. The existing land-use policy helps to explain the loss of wildlife in rural areas. In this study, the attitude of a resident in the Amboseli region towards wildlife conservation depended on cultural background, gender, land use, and the costs and benefits associated with interaction with elephants. Negative interaction was mostly due to crop damage. The minimal benefits households received from wildlife apparently created the highly negative perceptions of the importance of elephants to the group ranches. Maasai livelihood strategy, largely dominated by livestock, is less in conflict with elephant presence in the area. Elephants caused only a limited amount of injuries and deaths to humans and livestock.

Recommendations

While the immediate benefits of electric fencing have been realized through reduced crop damage, the future of the fencing project as an elephant barrier is uncertain judging by the extent of vandalism and the poor maintenance regime by the local community. While farmers are the key beneficiaries, other stakeholders (such as agriculture-dependent businessmen, conservation agencies, tourism investors) have a major interest in elephant conservation and thus should provide material and technical support towards managing the fences.

More effective response to human–elephant conflict situations, specifically elephant crop raiding, is required. This will entail additional Problem Animal Control workforce and enlisting the support of local people. Farmers should be empowered with appropriate mitigation tools and training so that they can deal with elephant crop raiding on their own.

In the long term an elephant management strategy is needed that aims to reconcile the needs of humans and of elephants, in particular seeking ways to increase acceptance of elephants by most inhabitants in the ecosystem and community-based approaches to conserve the critical but dwindling elephant habitats.

Acknowledgements

We thank Kenya Wildlife Service's Elephant Research Trust Fund and the Center for Wildlife Management Studies for financially and logistically supporting our work. We are deeply grateful to Timothy Saigilu, who greatly assisted us during data collection.

References

- Awere-Gyekye K. 1996. *Land-use planning and coordination study*. Kenya Wildlife Service, Nairobi, Kenya.
- Berger DJ. 1993. *Wildlife extension: participatory conservation by the Maasai of Kenya*. African Centre for Technology Studies, Nairobi.
- Campbell D, Gichohi HW, Mwangi A, Chege L. 2000. Land-use conflict in Kajiado District, Kenya. *Land-Use Policy* 13:337–348.
- Chiyo PI, Cochrane EP, Naughton L, Basuta GI. 2005. Patterns of crop raiding by elephants: a response to changes in forage quality or crop availability. *African Journal of Ecology* 43:48–55.
- de Boer F, Ntumi C. 2001. Elephant crop damage and electric fence construction in Elephant Reserve, Mozambique. *Pachyderm* 30:57–64.
- Emerton L. 2001. The nature of benefits and the benefits of nature: why conservation has not economically benefited conservation in Africa. In: Humle D, Murphree M, eds., *African wildlife and livelihoods: the promise and performance of community conservation*. James Currey Ltd, UK.
- Fratkin E. 1994. Pastoral land tenure in Kenya: Maasai, Samburu, Boran and Rendille experience, 1950–1990. *Nomadic People* 34/35:55–68.
- Hill CM. 1998. Conflicting attitude towards elephants around the Budongo Forest Reserve, Uganda. *Environmental Conservation* 25:244–250.
- Hoare ER. 1999. *Data collection and analysis protocol for human–elephant conflict situation in Africa*. IUCN/SSC African Elephant Specialist Group, Nairobi, Kenya.
- Hoare RE. 2001. *A decision-support system for managing human–elephant conflict situations in Africa*. IUCN/SSC African Elephant Specialist Group, Nairobi.
- Kangwana FK. 1993. Elephants and Maasai: conflict and conservation in Amboseli, Kenya. PhD thesis. University of Cambridge, UK. Unpublished.
- Kioko J. 2005. Spatial-temporal distribution of African elephants (*Loxodonta africana africana*, Blumenbach) and their interactions with humans in the Kuku–Kimana area of Tsavo–Amboseli ecosystem, Kenya. MSc thesis. University of Greenwich, UK. Unpublished.
- McKnight BL. 2004. Elephant numbers, group structure and movements on privately owned land adjacent to Tsavo East National Park. *Pachyderm* 36:44–51.
- Leakey R, Lewin R. 1996. *The sixth extinction: biodiversity and its survival*. Weidenfeld and Nicholson Publishers, London.
- Newmark WD, Manyaza DN, Gamassa DM, Sariko HI. 1994. The conflict between wildlife and local people living adjacent to protected areas in Tanzania: human density as a predictor. *Conservation Biology* 8:249–255.
- Omenge MJ, Okello ER. 1992. *Geology of the Chyulu–Oloitokitok area*. Mine and Geology Department, Ministry of Environment and Natural Resources, Republic of Kenya.
- Parker GE, Osborn FV. 2001. Dual-season crop damage by elephants in Zimbabwe. *Pachyderm* 30:49–56.
- Western D. 1982. Amboseli National Park. Enlisting landowners to conserve migratory wildlife. *Ambio* 11(5): 302–308.
- Smith LD. 1997. *Amboseli, nothing short of a miracle*. Kenway Publications, Nairobi.
- Sukumar R. 1994. *Elephant days and nights: ten years with the Indian elephant*. Oxford University Press, Bombay.
- Tchamba NM. 1996. History and present in the Waza–Logon Region, Cameroon, West Africa. *Biological Conservation* 75:35–41.

Erratum

In an article entitled Elephant numbers and distribution in the Tsavo–Amboseli ecosystem, south-western Kenya by John Kioko et al. (*Pachyderm* 40: 62–67), all the game reserves mentioned in figure 1 are actually game ranches.

Insurgency and poverty: recipe for rhino poaching in Nepal

Esmond Bradley Martin, Chryssee Martin

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

Abstract

With at least 108 rhinos known to have been poached from 2001 to 2005, Nepal probably had the worst rhino poaching of any country in the world. The Maoist rebel activity drew Army personnel away from the guard posts in Royal Chitwan and Royal Bardia National Parks, leaving the way open for poachers to enter more freely. Neither was their passage through the buffer zones much hindered by the people living there. Parks and non-government organizations have put large sums of money into the buffer zones to give financial support to local communities to improve their living conditions and to win their support for conservation. However, some local people who do not benefit enough from the buffer zone programme have even joined rhino-poaching gangs to act as guides. This report offers suggestions on how rhino poaching can be reduced in Nepal.

Résumé

Avec au moins 108 rhinos braconnés entre 2001 et 2005, le Népal connaît probablement le pire braconnage de rhinos du monde. L'activité des rebelles maoïstes a causé le retrait du personnel de l'Armée des postes de gardes des Parcs Nationaux de *Royal Chitwan* et de *Royal Bardia*, laissant le champ libre aux braconniers. Leur passage par les zones tampons ne fut pas non plus fort entravé par les personnes qui y vivent. Les Parcs et les organisations non gouvernementales ont investi de fortes sommes d'argent dans les zones tampons pour donner un support financier aux communautés locales afin qu'elles améliorent leurs conditions de vie et pour gagner leur soutien à la conservation. Pourtant, certaines personnes qui ne bénéficient pas suffisamment du programme de la zone tampon ont même rejoint les gangs de braconniers pour leur servir de guides. Ce rapport fournit quelques suggestions pour des moyens de réduire le braconnage des rhinos au Népal.

Introduction

In 2000 there were 612 rhinos in Nepal of which 544 were in and around Royal Chitwan National Park, 67 in and around Royal Bardia National Park and one in Royal Suklaphanta Wildlife Reserve. The population had increased at an annual rate of 3.88% per year from 1994 to 2000 (DNPWC 2000). From 2001 to 2005, however, more rhinos were illegally killed in Nepal than anywhere else in Asia and perhaps in the world. Numbers of rhinos poached peaked in 2002 to at least 38, declined in 2003 and 2004, then rose once again in 2005. This report considers the reasons for the trends in rhino poaching from 2003 to 2005 and explains why people living in buffer zones around the parks are allowing poachers to operate, especially in Chitwan Park. One of the main purposes for the Department of National Parks and Wildlife Conser-

vation (DNPWC) and other organizations to invest relatively large sums of money into the buffer zones was to discourage support for rhino poachers.

We suggest ways that could mitigate the poaching problem, though the worsening political instability and economic situation, due to the Maoist insurgency, are likely to hamper efforts.

Methods

We carried out fieldwork in Nepal for three weeks, starting in mid-December 2005, mainly in Chitwan and Bardia Parks. We interviewed staff of the Department of National Parks and Wildlife Conservation in Kathmandu, forest officers in Chitwan District and in Kathmandu, and many NGO staff of the King Mahendra Trust for Nature Conservation, Wildlife Conservation Nepal, Wildlife Watch and WWF-Ne-



The rhinoceros is a special animal for the majority of the Hindu population of Nepal and is often depicted in art. It plays a role in religious practices, and many parts of its body are used medicinally as well. This pair of statues is on the steps to the temple of Batsala Devi in Bhaktapur.

pal, based in and around the parks and in Kathmandu. We also interviewed senior officers of the Royal Nepali Army who are based inside the parks and discussed with lodge managers in and around the parks the repercussions of the decline in tourism. We examined reports, mostly unpublished, prepared by the Department of National Parks and Wildlife Conservation, and obtained the latest economic and political data from the Asian Development Bank.

NGOs and government officers have accumulated many figures on what poachers are paid for killing rhinos. These figures vary widely. We were fortunate to ascertain more likely prices for rhino horn when we were able to interview recently arrested poachers while we were in Chitwan Park. Not only did they give us information on the amount of money they had received in the past for horn but also what had been promised to them had they not failed in this attempt to poach a rhino. We learned about their background and how they were enticed into this illegal activity.

Recent political and economic events in Nepal that affect wildlife conservation

Maoists in Nepal have been agitating for a socialist government for many years. Serious hostilities began in 1996, and the conflict between the Maoists and government authorities had resulted in the deaths of 13,000 people by the end of 2005 (Haviland 2006). The Maoists have destroyed thousands of public buildings, including telecommunication towers, police posts, post offices, and even guard posts within the parks. These offensive actions made the Army increase its attention to the people's security and concentrate its forces in fewer park posts. About 500,000 people have left on a long-term basis to India (Friedman 2005), and another 2 to 2.5 million are working abroad on a seasonal basis (Asian Development Bank 2004). The human rights abuses the Maoists and government authorities are inflicting are appalling.

The conflict has had serious ramifications on the country's economy. It has slowed to an average of 1.9% annual growth (below the human population increase in the country of 2.3%) from 2002 to 2004, compared with 5% from 1993 to 2001 (Asian Development Bank 2005). Arrivals of foreign tourists declined from a peak of 491,504 in 1999 to 277,129 in 2005 (Nepal, Government 2003; Anon. 2006), which greatly reduced the revenue the parks earned and thereby payments to people in the buffer zones. The military and security costs from 1997 to 2004 almost doubled (Asian Development Bank 2004). The violence, poor security and chaos in the country have also curtailed many foreign-funded projects.

According to the Asian Development Bank (2004), a lasting solution to Nepal's problems will take place only when the root causes are tackled. These are social exclusion of certain castes and ethnic groups, huge economic inequalities, lack of opportunity, poor governance and corruption.

Results

Royal Chitwan National Park

RHINO POACHING AND TRADE IN THE HORN FROM 2003 TO 2005

Park staff carry out a rhino census of Chitwan Valley about every five years. In the 2005 count there were 372, a decline of 32% from 2000, due mostly to poaching but also to natural deaths and because 31 were translocated to Bardia Park, 4 to Suklaphanta Reserve and 2 to Japan (DNPWC 2005). The Department of National Parks and Wildlife Conservation has several sets of official figures on poaching incidents in Chitwan Valley from 2001 to 2005. One set is from unpublished statistics on file in the park headquarters in Kathmandu, which gives the rhino's sex, date and place of poaching, cause of death, and what products, if any, were removed illicitly from the carcass. The second set, also unpublished, lists numbers without details and is from the assistant warden of Chitwan Park in charge of anti-poaching, who is resident at Kasara, the Chitwan Park headquarters. Some of the department annual reports (Subba 2001, 2002, 2003) give a third set of figures and poaching details, but these are not up to date and are for the Nepali financial year, not for the Western calendar, so are not used here. (Financial year statistics, when used in this re-

port, refer from mid-July to mid-July and are written, for example, 2002/03.)

The first set records 94 rhinos known to have been poached over this recent five-year period, while the second set records 101 (see table 1). Usually figures collated in the field are more accurate than those noted in the capital city. We use here the second set of numbers of rhinos poached with the details from the Kathmandu statistics.

Table 1. Known rhino poaching and total mortality from all causes in and around Royal Chitwan National Park from January 2001 to December 2005

Year	Known poached (no.) ^a	Known poached (no.) ^b	Total deaths from all causes ^a
2001	16	15	27
2002	35	38	53
2003	19	22	36
2004	9	11	26
2005	15	15	—
Total	94	101	—

Sources: ^a Department of National Parks and Wildlife Conservation Headquarters, Kathmandu, unpublished
^b K. Kunwar, Assistant Warden and Coordinator of Anti-Poaching, Chitwan Park, unpublished

Both sets of figures show that 2002 was the worst year for rhino poaching in Chitwan Valley—at least 38 animals—since the park was established in 1973. Reasons for this have been published elsewhere (Martin 2004). But the most important cause was the transfer of Royal Nepali Army personnel from 32 guard posts to only 8. In 2003, with the introduction of a new strategy to combat poaching (Martin 2004), the number killed declined to 22. Records state that of these, 16 were shot and 1 was electrocuted. In 2004 11 rhinos were poached, of which 6 are known to have been shot. In 2005 when 15 were poached, 11 were shot and 1 was electrocuted. Most of the rhinos killed illegally during these five years were inside the park.

Maoists are rarely involved in rhino poaching or trade in horn. They claim they want to protect the natural environment and furthermore do not possess the expertise of the poachers and traders. Most of the poachers come from just outside the buffer zone in gangs of four to eight that sometimes include a person from the buffer zone who is familiar with the area.

In January 2006 we met five gang members in confinement in the park at Kasara and interviewed three of them. They had been arrested a few weeks earlier near Sauraha, a village on the northern park boundary, while attempting a poaching operation. All the gang members belonged to the Tamang and Kumal ethnic groups, who live north of the park and are extremely poor. Krishna, 43 years old, said he was a farmer with four children. He admitted killing three rhinos in 2002 and 2003 but said he had been inactive in 2004 because members of his gang had been arrested. Ram, aged 45, had been in a gang that shot a rhino in 2004 and seemed to be the worst off; 7 of the 15 children his wife had borne had died. Surya, aged 20, was the illiterate son of a woodcutter, and this had been his first poaching attempt.

Krishna had organized this gang and was the leader and shooter. Ram said he had been talked into joining to carry the rations. Surya, who said he had been forced to join by Ram, had sold some firewood to obtain the 200 rupees (USD 3) needed to buy rice and vegetables

for the hunt. The gang had some cooking pots, home-made bullets and an axe. Their home-made gun was already hidden inside the park. They were arrested while attempting to enter the park in December 2005.

Poaching gangs usually have one or two guns, almost all home made, as they do not like modern weapons and are unfamiliar with them. They usually enter the park in the evening, intending to stay for several days looking for rhinos. They hunt mostly in the late afternoons then hide during the night to avoid capture by patrols.

When they kill a rhino, the poachers' primary objective is to take the horn, but sometimes they are disturbed or lose the animal. In 2003, of the 19 rhinos poached, 16 had their horns removed and 3 their hooves. In 2004 all 9 had their horns taken, and 2 had hooves missing. In 2005, 12 of the 15 rhinos poached had their horns taken and one had had its tail cut off (DNPWC, unpublished statistics).

The shooter, who is usually the gang leader, obtains around 20,000 rupees (USD 277), and each of

Esmund Martin



The Marxists and Maoists, seen here waving their red flags and marching in Bhaktapur in December 2005, are indirectly responsible for the deaths of many rhinos in Nepal, due to the decline in law and order.

the other members 10,000 to 15,000 rupees for an average horn weighing around 700 g. When we interviewed Krishna, he said in 2002 he received 22,000 rupees (USD 287) while the others in the gang got 10,000 rupees (USD 130) each for a horn. In 2003, when Krishna was just a gang member, he was paid 10,000 rupees (USD 128) for a horn. In mid-2004 Ram received the same. In 2005 Surya was promised 10,000–20,000 rupees (USD 138–277) if the gang succeeded.

The poachers sell their rhino horns to middlemen in towns such as Narayanghat (where Krishna sold his horns), Pokhara and Hetuada. The horns usually end up with wealthy traders in Kathmandu. One of these traders, Pemba Lama, was arrested in the Chitwan Valley in June 2005 and was in prison awaiting trial during our visit. He gave useful information to the authorities. He is a Nepalese citizen of Tibetan origin and had been buying rhino horns since about 1998. The Department of National Parks and Wildlife Conservation staff think he has sold about 50 horns, but he admitted to only 20. Most of these came from Chitwan Valley, but also some from Bardia Park, and one or two from India (Kamal Kunwar, Assistant Warden, Co-ordinator for Anti-Poaching, Chitwan Park, pers. comm. January 2006). Lama also traded in medicinal plants and had made a lot of money. By the time he was 40 in 2005 he had accumulated at least one large house in Kathmandu, other properties and several cars. In June 2005 he went to Nawalparasi District (as he had done before, along with visits to Narayanghat) to buy horn from one of his middlemen. Park officials arrested him carrying a horn. He was about to give a middleman 446,000 rupees (USD 6169) for another horn weighing 700 g. Lama told the officials he usually bought horns for the equivalent of USD 4250 to USD 5700. He sold them to Tibetans in Kathmandu, who sent them to Tibet (Anon. 2005; Thapaliya 2005; Yonzon 2005; Kunwar, pers. comm. December 2005; Shiva Raj Bhatta, Chief Warden, Chitwan Park, pers. comm. January 2006).

WHY DID POACHING DECLINE IN 2003 AND 2004?

In early 2003, to combat the escalating rhino poaching the parks department introduced new anti-poaching measures. The main ones were: 1) so-called sweeping operations, with large groups of park and Army personnel intensively patrolling; 2) greater incentives for patrollers; 3) joint patrols of Army and

park staff together; 4) Army and park staff being authorized to make arrests outside the park; and 5) more efficient use of informers and more reward money (Martin 2004). Rhino poaching declined as a result, but not enough; thus further measures had to be taken in 2004 and 2005.

Most significantly, the park increased the number of its informers from 7 in 2003 to 20 by 2005, and helped them improve their ways of collecting information on potential rhino poachers and traders. The performance of the informers steadily improved. In 2002 they were terrified of the Maoists, but with reassurance from the park staff they overcame their fear and have done a better job (Bhatta, pers. comm. December 2005). Three NGOs (International Trust for Nature Conservation, King Mahendra Trust for Nature Conservation and WWF-Nepal) provided 61,000 rupees (USD 783) each month in 2003 for the informers and raised this to 81,000 rupees (USD 1120) by 2005. The Army also provided some money for its own informers. An intelligence-gathering system is recognized as the most effective anti-poaching measure, and its cost is extremely low, less than 1% of the total park and Army budgets for Chitwan Park.

As a result of the expanded and improved intelligence system, various government authorities caught more poachers in Chitwan Valley, which was the main reason why the number of rhinos illegally killed fell. From 2002 to 2003 authorities arrested 26 rhino poachers (Martin 2004). From July to December 2004 they caught 16 rhino poachers (Kunwar, pers. comm. December 2005). From January to November 2005 authorities arrested 46 rhino poachers, middlemen and traders. In addition, during 2005, 11 tiger and leopard poachers and skin traders, 16 timber smugglers, and 106 others dealing in illegal firewood and other products were arrested (Manandhar and Subba 2004; Thapaliya 2005). With the help of informers the Army arrested two traders and confiscated four rhino horns in Chitwan Valley, bringing the traders and the horns to the Kathmandu District Forest Office (Kamal Shrestha, District Forest Officer Kathmandu, pers. comm. December 2005).

The Army changed its strategy to allow the men stationed in the parks to go on patrol to more of the surrounding areas rather than keeping so many men on post. This made it more difficult for the poachers to evade the soldiers (Lt Col. Ajit Thapa, Battalion Commander, Chitwan Park, pers. comm. January 2006).



This poaching gang was arrested in December 2005 while attempting to enter Royal Chitwan National Park to hunt rhinos.

WHY WAS THERE A RISE IN POACHING IN 2005 COMPARED WITH THE YEAR BEFORE?

The new anti-poaching efforts worked especially well in late 2003 and 2004. However, according to Bhatta, there was a gradual breakdown in communications from mid-2004 onwards. There was a drop in the morale of park staff when five staff from the adjacent Parsa Wildlife Reserve were killed in a mine blast laid by Maoists. One of only four vehicles used for patrolling Chitwan was destroyed in this attack, reducing staff mobility (Bhatta, pers. comm. January 2006). Another park vehicle in Royal Suklaphanta Wildlife Reserve (in western Nepal) with 3 park staff and 10 illegal timber traders was also blown up in a Maoist mine blast (Tirtha Maskey, director general until January 2006 of DNPWC, pers. comm. August 2006). Narayan Poudel, the deputy director general of DNPWC based in Kathmandu, further believed that the poachers found gaps in Chitwan Park's anti-poaching strategy and that the staff had become somewhat inactive and complacent (pers. comm. January 2006).

Kunwar agreed with this remark, adding that park staff became overconfident in early 2005 because they had been so successful in reducing rhino poaching in 2004 (pers. comm. January 2006).

CHITWAN'S BUFFER ZONE AND IT ROLE IN RHINO CONSERVATION—A DOUBLE-EDGED SWORD

Many of the 250,000 people living in the 750 km² Chitwan Park's buffer zone are still extremely poor and have started to complain vociferously that rhinos cause destruction and that they are not receiving enough compensation or adequate benefits. Some are so disillusioned they are even assisting rhino poachers.

The buffer zone concept was promulgated for Nepal's protected areas in 1993 by an amendment to the National Parks and Wildlife Conservation Act of 1973 to help make the local community rely on buffer zone products rather than park resources and to win their support for conservation. The buffer zones were to be mostly funded by 30–50% of the revenue raised

by each park. For Chitwan Park, the buffer zone was created in 1996, and following discussions with the Buffer Zone Management Committee, 50% of the park's revenue was to go to the local communities (Upadhyay c. 2002; Manandhar and Subba 2004). From 1999 to 2004 the park provided to the Buffer Zone Management Committee approximately USD 2,200,000, but it has spent only about half, holding on to the rest for projects not yet started (Adhikari et al. 2005). The buffer zone has also received relatively large sums of money from the United Nations (under the Participating Conservation Programme of the United Nations Development Programme), the King Mahendra Trust for Nature Conservation, WWF-Nepal and other NGOs.

The money is earmarked to help communities living in the buffer zone develop projects to improve their livelihoods, but unfortunately not enough is actually provided, leading to some disillusioned locals. Locals are also asked not to permit rhino poachers to pass through to the park nor assist them. It is in the local people's interest to keep poachers out of the park, especially rhino poachers: if the park's large animals are killed, fewer tourists will come—a disaster for local people, who get half the park's revenue, almost all based on tourism. Unfortunately, many local people do not understand this link, partly as they are not getting enough of the funds (Maskey, pers. comm. August 2006). Park staff and local leaders have all agreed that this is a problem. For example, Ganga Thapa, Executive Officer, King Mahendra Trust for Nature Conservation, said that not enough emphasis goes into educating local people about the benefits they can accrue by protecting the park. Chandra Gurung, Country Representative of WWF Nepal Program, concurs, 'We have a good policy of buffer zones, but we have had difficulties in convincing the buffer zone communities how important conservation is to them' (pers. comm. January 2006). Kunwar laments that the buffer zone people are indifferent about helping him in his anti-poaching strategy and rarely give him information on potential poachers (pers. comm. January 2006). Ashok Bhandari, the ranger for the eastern part of Chitwan Park, admits that his staff have been unable to convince many local people that they benefit by protecting the biodiversity of the park.

There are several further explanations why people are not interested in conservation: 1) The Buffer Zone Management Committee receives half the an-

nual park revenue whether or not the people protect the park from poachers, so local people have little incentive to stop poachers. 2) The amount of money given to the buffer zone has declined as Chitwan Park's revenue has fallen. Revenue decreased by 63% from 2000/01 to 2004/05 in US dollars equivalent excluding any inflation factor (see table 2). This was mostly due to the collapse in tourism from 117,512 visitors in 1999/2000 (the highest recorded) to only 42,654 in 2004/05, a 64% reduction (statistics from Royal Chitwan National Park, unpublished). The reason for this is the Maoist insurgency, not a lack of biodiversity nor because of rhino and tiger poaching. It is in the interest of the local people to protect the wildlife and to keep the habitat intact so that tourists will return when the country becomes stable. But waiting in anticipation of a future benefit is difficult for poor and hungry people. Researchers Mark Murphy, Krishna Oli and Steve Gorzula have written, 'The primary problem with the buffer zone system in Nepal is that it has not lived up to ... expectations. The benefits have been limited, and therefore the expected behaviour change which would reduce pressure and enhance the conservation of biological diversity has not happened as envisioned' (Murphy et al. 2005).

Table 2. Revenue earned by Royal Chitwan National Park, 2000/01 to 2004/05

Year	Nepalese rupees	US dollars
2000/01	74,302,801	1,041,385
2001/02	38,887,119	517,116
2002/03	30,831,199	398,885
2003/04	40,060,770	528,158
2004/05	28,137,909	385,187

Sources: Manandhar and Subba 2004; Department of National Parks and Wildlife Conservation Headquarters, Kathmandu, unpublished

There is also a problem as to how the Buffer Zone Management Committee and the user committees decide who receives the money from the park. Mainly two sorts of people live in the buffer zone: so-called non-farmers who are mostly landless and marginalized peoples, and farmers who are not so poor and have some land. There are also some professional workers, such as teachers and nurses, but they are a small minority. The first group consists of Chepangs,

Bote and Majhi peoples. According to 444 interviews carried out in late 2003 and early 2004 by Adhikari et al. (2005), these people belong to the lower castes of Hindu society, 86% to the Baisya caste. In Adhikari's survey, not one landless family belonged to the upper castes, the Brahmins and Chhetris. On average, the unemployed non-farmers had only 1.7 years of formal education compared with 4.4 years for the farmers. The marginalized people formerly lived along the rivers and in the forests, and were hunter-gatherers. When the park was created in 1973 they were only allowed to fish using traditional cast nets and to collect thatch grass only once a year in the park. Now they are very poor, and they have few alternative sources of income, so they are tempted to poach in the park's forests. As their resentment builds, these people are becoming more sympathetic to the goals of the Maoists (Adhikari et al. 2005; Chitwan Park staff, pers. comm. January 2006).

Several people said the Buffer Zone Management Committee and the many user committees are run by the higher castes. They ensure that they receive a

higher proportion of the resources than the poorest of the poor, who do not receive a fair sum. Consequently, many of the very poor remain without jobs and education.

Poudel also believes that the poorest people in the buffer zone do not receive a fair share of the park's money, and more poverty alleviation projects are needed. The Adhikari report of 2005 concluded 'the community development programmes do not reach the poor and marginalized communities at individual household levels. ... Local people, particularly poor and indigenous communities, do not have access to decision-making for benefit sharing.'

Adhikari's survey showed that the farmers can be divided into three economic groups: poor, moderate, higher income. The poor farmers are mostly from the lower castes (53% from the Baisya group), while the higher income families are from the higher castes. His survey also showed that the damage to crops by rhinos amounted to 3320 rupees (USD 42) per family each year for both the moderate and the higher income families. They have to put up with the loss



Esmond Martin

The best way to observe rhinos in Nepal is from the back of an elephant, which can approach them closely.

and spend money erecting barriers as a deterrent. The government does not have a formal scheme to pay compensation for damage to crops or buildings. The government pays automatically only for human deaths caused by wild animals, and that is just 25,000 rupees (USD 352) per fatality. From 2001 to 2005 rhinos killed 16 people in Chitwan Valley, 5 in 2005 alone. Damage to crops and houses and frequent casualties have antagonized the farmers, some of whom get annoyed and turn to assisting rhino poachers.

All these issues need to be resolved to improve the attitudes of the people in the buffer zone. In addition, some of the money from park revenue that is allocated to the buffer zone should be spent on employing local people full-time to patrol it especially along the park boundary. This has been done successfully by communities living around West Bengal's Gorumara National Park where rhinos are flourishing (Martin 2006) and in some of the buffer zone areas in Nepal's Bardia National Park. The Buffer Zone Management Committee should set up in cooperation with park management an intelligence network of paid informers and should offer reward money.

Royal Bardia National Park

RHINO POACHING AND TRADE IN HORN FROM 2003 TO 2005

Maoists living inside the park have prevented a rhino census since 2000. Between 1986 and 2003 park staff, with the assistance of WWF-Nepal and the King Mahendra Trust for Nature Conservation, translocated 83 rhinos from Chitwan to Bardia; but most people believe, despite breeding, that the number in the park is now much less than this.

The two main locations for rhinos in the park are the Karnali Flood Plain in the west and the Babai Valley in the south-east. The floodplain population estimate is 30 to 33 plus 7 that have moved outside the park. The number of rhinos in the Babai Valley is unknown as the Maoist presence deters the Army, park staff and tourists from going there. Puran Shrestha, the chief park warden, hopes there may be as many as 37 to 47 (pers. comm. January 2006). Others, including Poudel, believe the number is much lower. WWF-Nepal staff counted 15 rhinos in 2004 but they could not finish their survey because Maoists stopped them and took their equipment (Anil Manandhar, WWF Nepal Program, pers. comm. January 2006).

The year 2003 was the worst for rhino poaching in Bardia Park. Poachers killed at least nine rhinos, all in the Babai Valley. Six of these are known to have been shot. The poachers took all the horns and removed hooves from four of them. One carcass had some of the skin missing and from another the head had been taken.

In 2004 poachers are known to have killed two rhinos by poisoning in the Babai Valley. One had its horn and hooves removed but the other did not. Information from the Babai Valley is sparse but so far as is known no rhinos were poached in 2005 (see table 3) (DNPWC unpublished).

Table 3. Known rhino poaching and total mortality from all causes in and around Royal Bardia National Park, 2001–2005

Year	Number known poached	Total deaths from all causes
2001	0	0
2002	3	5
2003	9	10
2004	2	3
2005 (to mid-Dec)	0	—

Source: Department of National Parks and Wildlife Conservation Headquarters, Kathmandu, unpublished

The poachers come from beyond the park buffer zone. Most are from the Taratal area near the Indian border or from the Surkhet area north of the park. Taratel poachers are familiar with the Babai Valley as their families lived there before the government moved them out in the early 1980s (DNPWC 2001). They use mostly homemade rifles and bullets to kill the rhinos. A gang of three or four rhino poachers in 2003 received between 40,000 and 50,000 rupees (USD 513–642) for a rhino horn from traders who live just outside the buffer zone, according to Ramesh Thapa (pers. comm. December 2005), a ranger who has worked in Bardia Park since 1990 and who has interrogated many poachers. The traders sell it for 100,000 to 200,000 rupees (USD 1284–2567) to other traders in Nepalgunj and Pokhara who come from the hilly areas of the country, especially from the Humla District near Tibet. They also buy other wildlife products, such as tiger bones and skins, and arrange for the wildlife products to get to Kathmandu for export to Tibet.



A poacher sees money, the government sees revenue, and the tourist sees an endangered animal.

REASONS FOR PRESUMED DECLINE IN RHINO POACHING IN BARDIA PARK, 2004 AND 2005

The main reason for the improved protection of Bardia's rhinos was that the Army reoccupied a seventh post in 2004, providing more security in the park (Lt Col. Ashok Sigdel, Battalion Commander, Bardia Park, pers. comm. December 2005). Patrolling also expanded in the buffer zone, an area of 328 km² where about 130,000 people live. In 2004 the Buffer Zone User Groups set up some anti-poaching teams organized by the Terai Arc Landscape Program of WWF-Nepal. Each consists of three or four people from the buffer zone and concentrates on patrolling the park and buffer zone boundaries, often with District Forest Office staff (Bidya Shrestha, Business Development Officer, Terai Arc Landscape Program of WWF-Nepal, Thakurdwara, Bardia Park; Sigdel and P. Shrestha, pers. comm. December 2005). In addition, about 30 members of the Nature Guide Association of Nepal patrol the park boundaries, especially along the rivers (Thapa and Naresh Subedi, the King Mahendra Trust for Nature Conservation Bardia Conservation Programme, pers. comm. December 2005).

In 2004 the Buffer Zone User Groups set up committees to gather information on poaching and trading wildlife products, and by the end of 2005 there were 15 such committees consisting of students, teachers, social workers and others. They collect important information to give to the park staff and Army. This has helped scare away potential rhino poachers (Thapa and P. Shrestha, pers. comm. December 2005).

Bardia Park has its own information system for which three informers receive a monthly stipend of 2000 rupees (USD 28) from the Terai Arc Landscape Program of WWF-Nepal. The park also has reward money supplied by the government; in 2004, 50,000 rupees (USD 678) were paid to 15 people who supplied information on rhino poachers. Information gathering in Bardia became more efficient in 2004 and 2005. As a result, in 2004/05 park staff were involved in the arrest of, among others, 38 animal poachers, 61 illegal grass cutters, 104 firewood collectors, 78 woodcutters, and 46 people illegally collecting plants (Bardia Park, unpublished statistics).

In October 2005, rhino poachers were discouraged even further from entering Bardia when the Army increased its strength from around 500 to 870

men, from 4 to 6 companies. By December 2005 they had reoccupied 2 more of the original 14 posts, Bhurigaun and Ramuwapur, both on the edge of the Babai Valley, making a total of 9 Army posts scattered through the park (Sigdel, pers. comm. December 2005).

DROP IN BARDIA PARK REVENUE

In 2000/01, revenue earned by Bardia Park declined with the fall in tourism. As in Chitwan, the buffer zone receives half this revenue so the fall in tourism has had an adverse effect on communities living around the park. From 2000/01 to 2003/04 park revenue declined by 64.5% in US dollars (see table 4). From 2000/01 to 2004/05 the number of tourists dropped from 9940 (6715 foreigners, who pay the highest fees) to 1173 (661 foreigners), over a 90% decline in foreigners (Bardia Park, unpublished statistics). In December 2005 we surveyed 20 tourist lodges and tented camps around Bardia, of which 8 were closed due to the shortage of tourists. For the 210 beds available on one day there were only 18 guests. In 2000 these camps and lodges employed 300 staff, but had only 75 at the end of 2005. The Maoist rebellion is responsible for the decline in tourism. Most people drive to Bardia, but there are so many roadblocks that it takes at least 2 days to get from Kathmandu to the park, a distance of 600 km. This journey takes even longer when the Maoists declare a strike, preventing the movement of cars, buses and trucks on the highway. Negative reports in the media, and travel agents (who advise the few tourists who are planning visits to Nepal to go to Chitwan instead of Bardia) have practically ruined tourism in this park.

Because rhinos do not cause much damage outside the park there is very little animosity towards them. In 2004/05, for example, only one house was reported damaged by a rhino, and park staff paid 1000

rupees (USD 14) for this damage. Only three people were reported injured by rhinos and they received in total 13,500 rupees (USD 185); there were no deaths (unpublished statistics, Bardia Park). As such incidents have been few and people are compensated, they are less likely to collude with rhino poachers. This has allowed the rhinos we know of, especially in the Karnali Flood Plain near the park boundary, to remain relatively safe.

Chitwan and Bardia Park budgets and workforce

All parks in Nepal get a regular subvention for their development and management. The parks also earn revenue, nearly all from tourism, half going to the government and half to the buffer zone committees. The total budget allocations and Army funds given to Chitwan and Bardia Parks are high compared with most other protected areas with rhinos in Asia. It is not possible to obtain a precise figure for each park because the Army budgets are classified. We can, however, estimate them. We can calculate an average cost of each park employee by dividing the budget of the park (including the main NGO contributions to the buffer zone and intelligence fund) by the number of park employees. We multiply this figure by the number of park employees and Army personnel stationed in the park to estimate the complete budget for the park.

In 2004/05 the complete budget for Chitwan Park (park plus Army), including some money for the buffer zone, was approximately 120,000,000 rupees (USD 1,650,000). If this amount is divided by the 932-km² size of the park, the result is USD 1760/km². If we consider only the government money and exclude the NGO contribution, the figure is not much less—USD 160/km². The 2004/05 complete budget (park plus Army) for the 968-km² Bardia Park, including funds from Care International (SAGUN money) and intelligence money, was 117,000,000 rupees (USD 1,600,000). As before, this is USD 1660/km², reduced by USD 120/km² if NGO funds are ignored.

Besides the high budgets for these two parks, there are many employees: over one man per km². Chitwan Park has about 1105 full-time staff, including Army personnel, and there are 997 people in Bardia, also including the Army. Almost all are involved in patrolling at some time. This is one of the highest ratios

Table 4. Revenue earned by Royal Bardia National Park, 2000/01 to 2003/04

Year	Nepalese rupees	US dollars
2000/01	9,821,784	137,656
2001/02	4,376,583	58,199
2002/03	2,777,655	35,933
2003/04	3,710,146	48,914

Source: Manandhar and Subba 2004

in the world of people per square kilometre for government-managed large wildlife areas.

Recommendations

The budgets and the number of people working in Chitwan and Bardia Parks are sufficient to reduce rhino poaching if certain changes are made.

- The Army must spread out and reoccupy more of their old posts.
- The Army and the parks must improve all aspects of their anti-poaching patrols. Recent studies in Chitwan Park have concluded that anti-poaching strategies are crucial for the protection of the rhino (Poudyal et al. 2005; Poudyal and Knowler 2005; Knowler and Poudyal 2005). Simulation models by Knowler and Poudyal (2005) “indicate that ... a conventional conservation strategy, emphasizing the role of anti-poaching units (APUs), is likely to increase the rhino population to a greater extent than the other strategies ...”.
- NGOs, the parks and Army must provide more money and workforce for the intelligence-gathering networks.
- Strategies against poachers must be continually updated so that the poachers do not get familiar with the tactics employed. Army officers in the parks said that being one step ahead of the poachers and being able to surprise them, and intelligence networks, are the main aids to defeating poachers.
- The Buffer Zone Management Committees need to spend more money on conservation issues.
- The Buffer Zone Management Committees need to spend more money on teaching local people the advantages to them of conserving rhinos because they receive half the parks’ revenues.
- The Buffer Zone Management Committees must allocate more of their funds to the poorest people.
- Since crop damage causes the most antagonism, the Buffer Zone Management Committees should consider paying compensation for crop loss around Chitwan.

Strong anti-poaching strategies within Chitwan and Bardia Parks, based on patrolling and intelligence networks, combined with support from the communities living around the parks, will ensure successful rhino conservation in Nepal.

Acknowledgements

The Columbus Zoo and Aquarium Conservation Fund, the John Aspinall Foundation, the International Rhino Foundation and the Brevard Zoo in Florida financed the fieldwork in Nepal, for which we are most grateful. We wish also to thank Shiv Bhatta, Barry Goode, Chandra Gurung, Tirtha Maskey, and especially Lucy Vigne for all their help with the manuscript.

References

- Adhikari B, Haider W, Gurung O, Poudyal M, Beadmore B, Knowler D, Van Beukering P. 2005. Economic incentives and poaching of the one-horned Indian rhinoceros in Nepal. Poverty Reduction and Environmental Management (PREM) Working Paper 05/12. Vrije University, Amsterdam. Unpublished report.
- Anon. 2005. Rhino poachers caught in Nepal. *Focus* (WWF US) 27(6):3, November/December.
- Anon. 2006. Tourist arrivals dip by 3.9 pc. *Kathmandu Post* 2 January, Kathmandu.
- Asian Development Bank. 2004. *Country strategy and program 2005–2009, Nepal*. ADB, Manila.
- Asian Development Bank. 2005. *Quarterly economic update Nepal*. ADB, Kathmandu.
- [DNPWC] Nepal Department of National Parks and Wildlife Conservation. 2000. Count rhino Nepal 2000. Kathmandu. Unpublished report.
- [DNPWC] Nepal Department of National Parks and Wildlife Conservation. 2001. *Royal Bardia National Park management plan 2001–2005*. DNPWC, Kathmandu.
- [DNPWC] Nepal Department of National Parks and Wildlife Conservation. 2005. Rhino count 2005 in and around Royal Chitwan National Park. DNPWC, Kathmandu. Unpublished report.
- Friedman L. 2005. *The conflict in Nepal: a simplified account*. Shrii Shakti, Kathmandu.
- Haviland C. 2006. A divided kingdom. *The Spectator* 25 February.
- Knowler D, Poudyal M. 2005. Economic incentives and poaching of the one-horned Indian rhinoceros in Nepal. Simulation modelling of policies to combat the poaching of rhino in Royal Chitwan National Park. PREM Working Paper. Institute of Environmental Studies, Vrije University, Amsterdam. Unpublished report.
- Manandhar L, Subba B, eds. 2004. *Department of National Parks and Wildlife Conservation annual report 2003–*

- 2004 (*Shrawan 2060–Asadh 2061*). DNPWC, Kathmandu.
- Martin E. 2004. Rhino poaching in Nepal during an insurgency. *Pachyderm* 36:87–98.
- Martin E. 2006. Policies that work for rhino conservation in West Bengal. *Pachyderm* 41:74–84.
- Murphy M, Oli K, Gorzula S. 2005. Conservation in conflict: the impact of the Maoist-government conflict on conservation and biodiversity in Nepal. International Institute for Sustainable Development, Winnipeg, Canada. Unpublished report.
- Nepal, Government of. 2003. *Statistical yearbook of Nepal 2003*. Central Bureau Statistics, Kathmandu.
- Poudyal M, Knowler D. 2005. Economic incentives and poaching of the one-horned Indian rhinoceros in Nepal. Poaching of the one-horned Indian rhinoceros in the Chitwan Valley, Nepal. A retrospective econometric analysis. PREM Working Paper 05/07. Institute of Environmental Studies, Vrije University, Amsterdam. Unpublished report.
- Poudyal M, Rothley K, Knowler D. 2005. Ecological and economic analysis of poaching of the greater one-horned rhinoceros (*Rhinoceros unicornis*) in Nepal. School of Resource and Environmental Management, Simon Fraser University, British Columbia, Canada. Unpublished report.
- Subba B, ed. 2001. *Department of National Parks and Wildlife Conservation annual report 2000–2001*(*Shrawan 2057–Asadh 2058*). DNPWC, Kathmandu.
- Subba B, ed. 2002. *Department of National Parks and Wildlife Conservation annual report 2001–2002* (*Shrawan 2058–Asadh 2059*). DNPWC, Kathmandu.
- Subba B, ed. 2003. *Department of National Parks and Wildlife Conservation annual report 2002–2003* (*Shrawan 2059–Asadh 2060*). DNPWC, Kathmandu.
- Thapaliya B. 2005. Anti-poaching operations. Royal Chitwan National Park. Unpublished report.
- Upadhyay G. c. 2002. *Royal Chitwan National Park and buffer zone management plan (2001–2005)*. DNPWC, Kathmandu.
- Yonzon P. 2005. Arresting illicit trade on wildlife. *WCN (Wildlife Conservation Nepal) Newsletter* 3(3):5.

Policies that work for rhino conservation in West Bengal

Esmond Bradley Martin

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

Abstract

The number of rhinos in West Bengal, India, has been increasing greatly since 1994. Gorumara National Park has seen numbers rise from 15 in 1994 to 28 in 2005, and Jaldapara Wildlife Sanctuary from 35 to just over 100, according to official statistics. Today, Jaldapara has the third largest rhino population in Asia. No rhino poaching has been reported in either protected area since 1996.

This paper examines why the Forest Department of West Bengal has been so successful in rhino conservation. The main reason is that the central and state governments have allocated considerable sums of money to the budgets of these two rhino areas. This has allowed the employment of many people who patrol intensively and has made it possible for the Forest Department to donate generously to projects for the poor people living around Jaldapara and Gorumara. There is thus a close relationship between the department and the local people who act together to deter poaching of rhinos.

Résumé

Le nombre de rhinos du Bengale occidental, Inde, a beaucoup augmenté depuis 1994. Le Parc National de Gorumara a vu sa population passer de 15 en 1994 à 28 en 2005, et le Sanctuaire de la Faune de Jaldapara est passé de 35 à plus de 100 d'après les statistiques officielles. On ne signale aucun braconnage dans ces deux aires protégées depuis 1996.

Cet article étudie pourquoi le *Forest Department of West Bengal* réussit si bien dans la conservation des rhinos. La raison principale est que les gouvernements central et de l'Etat ont alloué des sommes considérables au budget de ces deux zones à rhinos. Ceci a permis d'employer de nombreuses personnes qui patrouillent intensément, et le Département des Forêts a pu donner généreusement à des projets pour les personnes pauvres qui vivent autour de Jaldapara et de Gorumara. Il y donc une relation étroite entre le département et les personnes pauvres qui agissent ensemble pour décourager le braconnage des rhinos.

Introduction

The rhinos in the state of West Bengal, India, are the least known of the main rhino populations of Asia. Conservationists find this surprising, because from the late 1980s rhinos in Gorumara National Park and Jaldapara Wildlife Sanctuary (both in Jalpaiguri District) have increased notably with little poaching. There are now more rhinos in Jaldapara than in any other protected area in Asia except in Kaziranga and Royal Chitwan National Parks. Jaldapara holds the third largest population in all of Asia—around 90–100 animals.

In 1978, according to the West Bengal Forest Department, about 19 rhinos remained in Jaldapara, compared with 75 in the late 1960s, mainly due to severe poaching for their horns. These 19 animals reportedly increased to 96 in 2004, according to an

official census—one of the fastest increases for any rhino population worldwide. A similar situation prevails in the much smaller Gorumara National Park, where during the same period (1978–2004) its rhino population expanded from 8 to 25.

This paper examines the reasons why the West Bengal Forest Department has been so successful in increasing its rhino numbers and in almost completely eliminating poaching.

Only two places in West Bengal still have rhinos—Gorumara covering 80 km² and Jaldapara, 216.5 km². They are located in the north, near the border with Bhutan. I visited both protected areas in December 2005 and interviewed personnel, mainly from the West Bengal Forest Department located throughout the state. I also met conservationists in New Delhi, but most were not so familiar with West Bengal's rhinos.

Results

Gorumara National Park

RHINO NUMBERS AND POACHING INCIDENTS

In 1895 Gorumara was made a forest reserve. In 1949 the reserve, then covering only 8.5 km², became a wildlife sanctuary. In 1994, the sanctuary was expanded to 79.99 km² and turned into a national park (Singhal and Gupta 1998).

One of the earliest estimates of rhino numbers was in the mid-1930s, when there were around 4–5, rising to about 12 by 1940. In the mid-1950s, the population probably reached an all time low for the 20th century, at just 3 animals. From then until 1993 the number rose to about 15 with at least 9 others known to have been poached (Martin 1996a). Details of the poachers, middlemen and markets for horn for Gorumara and Jaldapara's rhinos for the 1960s to 1997 are well recorded (Bist 1994; Martin 1996a,b, 1999).

From 1994 to 2005 the rhino population in Gorumara grew from 15 to about 25 (see table 1). Only one animal was brought into Gorumara over

this period, a male in 1995 from Assam (Raha 1996), which remained in the park until 2004 and was then taken to the Calcutta Zoo. Various censuses showed there were 19 rhinos in 1998, 22 in 2002, and 25 in 2004.

Table 1. Official estimates of West Bengal's rhino population, 1994–2005

Year	Rhinos in Gorumara National Park (no.)	Rhinos in Jaldapara Wildlife Sanctuary (no.)
1994	15	35
1995	16	35
1996	18	42
1997	?	44
1998	19 (census)	55 (census)
1999	19	55
2002	22 (census)	85 (census)
2004	25 (census)	96 (census)
2005	28	105

Sources: Thapliyal c. 2003; Singhal and Gupta 1998; West Bengal Government 2004; unpublished statistics from the West Bengal Forest Department



Esmund Martin

An amusing rhino statue stands at the entrance to Gorumara National Park.

The last rhino known to have been poached was in June 1992. This rhino had strayed out of Gorumara into the nearby Apalchand forests and was killed. The local Mech people took some of the skin, nails and intestines for medicine but left the meat. The Forest Department later recovered the various body parts (MK Nandi, Conservator of Forests, West Bengal, pers. comm. 1993; Bist 1994).

GORUMARA BUDGETS

What factors led to this great success in rhino population growth in Gorumara? First, the staff are honest, competent, motivated and hard working. Second and of notable importance, the state and central governments allocate a high budget to the park (which is part of the Jalpaiguri Forest Division). The budget for Gorumara is combined with that for Neora Valley National Park and expenses for forest staff elsewhere in the division. Thus, while the central government figures are available solely for Gorumara, the state government ones can be estimated based upon the number of employees in Gorumara (47%) versus the total number in the division.

Three main categories make up Gorumara's budget: the state plan is largely for capital expenditures; the non plan, also money from the state, is mostly for recurrent expenses such as salaries, medical costs, electricity and vehicle maintenance; and the central sponsored scheme (CSS), which is money from the central government, is for increasing the grass habitat as preferred by rhinos, constructing wallows, and making other such improvements. Funds in this third category have increased massively (see table 2), with a seven-fold increase in US dollars from 2000/01 to 2004/05.

In 2005 the Jalpaiguri Forest Division had 134 permanent employees, 63 in Gorumara. Thus if we

Table 2. Budget for central sponsored scheme for Gorumara National Park, 2000/01 to 2004/05

Financial year	Rupees	US dollar equivalent
2000/01	1,000,000	21,739
2001/02	1,500,000	31,120
2002/03	8,016,100	167,002
2003/04	5,631,700	125,149
2004/05	6,507,500	148,913

Source: West Bengal Forest Department, Jalpaiguri, unpublished

use 47% of the budget for the state plan and the non plan for Gorumara and 100% for CSS, we obtain a figure of USD 344,387 for the average annual budget for Gorumara for the three-year period of 2002/03, 2003/04 and 2004/05 (see table 3). This approximate figure is no doubt an underestimate as there are at least 30 casual workers stationed in Gorumara who are not included.

Table 3. Estimated annual budget for Gorumara National Park, 2002/03 to 2004/05

Financial year	Rupees	US dollar equivalent
2002/03	17,574,046	366,126
2003/04	14,649,548	325,546
2004/05	14,923,076	341,489

Source: Calculated from statistics supplied by the West Bengal Forest Department, Jalpaiguri, unpublished

In 2003/04 and 2004/05, two more funding sources were initiated to aid local people and the habitat in North Bengal (referring to the northern part of the state of West Bengal). The first, The North Bengal Project, is a fund from the state government to uplift the social and economic conditions of the poor and minority people of North Bengal. The starting budget for Jalpaiguri Forest Division was 490,000 rupees (USD 10,900) and the following financial year it was increased four-fold to 1,949,602 rupees (USD 44,600) with some of this money going to the people around Gorumara. The second source of funds, called the Rehabilitation of Degraded Forests, is from the National Agriculture and Rural Development Bank based in Bombay. The initial funding was 1,317,512 rupees (USD 30,149). This is helping to alleviate pressure on the forests within the park by, among other activities, planting trees in the forest areas around the park.

The recent budgets for Gorumara translate into one of the highest per square kilometre for any government-protected area for large animals in the world—USD 4305/km² per year on average (2002/03 to 2004/05) for the 80-km² park. Known recent budgets for other protected areas are few, but as a comparison Kibale National Park (766 km²) in Uganda (which has an elephant population) spent USD 179/km² in 2000 (Struhsaker et al. 2005). In Nepal's Royal Chitwan National Park, the budget in 1997/98 for the 932 km² was about USD 1000/km² (excluding non-government organization (NGO) as-



Tourists to Gorumara National Park can spend the night there only when the small, 2-suite Forest Guest House is not being used by government officials.

sistance), and for Royal Bardia National Park's 968 km² it was about USD 700/km² (also excluding NGO assistance), based on Martin (1998).

Thus, the budget for Gorumara grew considerably from the 1990s allowing a higher concentration of manpower, which in turn has prevented any rhino poaching recently. In 2005, there were 63 permanent staff plus 30–35 casual labourers. This works out at over one person per square kilometre. For comparison, in Garamba National Park in the Democratic Republic of Congo, where there is the last known population of northern white rhinos, there are about 250 park staff for 4900 km² or one person per 20 km² (Kes Hillman Smith, rhino conservationist formerly in Garamba National Park, pers. comm. March 2006).

IMPROVEMENTS IN CONSERVATION POLICY FOR GORUMARA

The large budget for Gorumara has allowed staff to improve their management strategy in several ways. Patrolling in the park is now better, community help has

increased, and compensation to the villagers for wildlife damage is better managed. Staff are now working with villagers in gathering intelligence and are collaborating with them in patrolling outside the park.

Inside Gorumara, the Forest Department has improved its patrolling camps and modernized the radio network. Patrolling, although still quite traditional, is effective. In the grasslands, where most of the rhinos congregate, domesticated elephants are used; in the forest area, where staff can hide themselves, foot patrolling is more common. The large number of staff has permitted intensive patrolling during both day and night. This is one main reason why there has been no rhino poaching in the park for years. However, illegal hunters still pursue other mammals. For instance, in May 2005 four tribal poachers (members of tribal communities) were arrested on the park boundary for killing a wild boar with a bow and arrow (Bimal Debnath, range officer, Gorumara National Park, pers. comm. 2005). In December 2005 several people with fresh deer meat were arrested outside the park (D Bera, range officer, Gorumara South, pers. comm.

2005). In 2005, staff shot dead an illegal tree cutter who was part of a gang in the park. Illegal tree felling and firewood collecting are common problems. Some tribal women are paid 100 rupees (USD 2.22) a day to illegally collect twigs and branches. Sometimes a group of up to 100 such women enter the park illegally to collect forest products. Patrol work is thus important to prevent poaching inside the park.

Another factor that has hugely assisted rhino conservation is that park officials have a large budget to spend on items that people living around the park need. Thousands of very poor people live scattered around Gorumara—farmers, scheduled castes “untouchables” and tribals. The farmers are very traditional and do not have irrigated fields, relying instead on rainfall for growing rice; some have low-grade cattle. Most of these marginal farmers along with landless labourers are based in small villages fringing the park (Singhal and Gupta 1998). Most have organized themselves into eco-development committees. In 2005 there were 11 such committees with 1601 members representing about 6500 individuals. These committees advise the Forest Department on specific local needs. In turn, the Forest Department provides projects and assists people, particularly the poorest, with basic amenities irrespective of their class, religion or caste. Aid includes water pumps, paths, roads, electricity, and books for students. The Forest Department also helps set up fish ponds, piggeries, chicken hatcheries and wilderness camps for Indian tourists. They teach women how to make handicrafts, they employ and train guides to teach school children how to entertain tourists with cultural dances and songs, and they employ local people to repair roads and clear fire lines within the park for a minimum daily wage (in 2005, 67.34 rupees or USD 1.50), which is slightly higher than what they would earn from local government authorities as labourers (Koushik Sarkar, Assistant Divisional Forest Officer (Wildlife), Jalpaiguri, pers. comm. 2005). At local request, the Forest Department has also put up electric fences to prevent rhinos and elephants from wandering out of the park, thus protecting people and their crops. The Forest Department started this assistance in the mid-1990s, and early in the present decade large amounts of money were allocated for this purpose. The department is careful to spread the benefits fairly through the eco-development committees for their communities and avoids giving any one family more than one form of assistance in a year.

The department compensates these 6500 individuals and also others outside the park boundary and beyond for conflict with wildlife: crop damage, damage to property, livestock death, and most importantly, death and injury to people. Any crop damage (such as by elephants, wild boars and peacocks) is compensated by up to 2500 rupees (USD 56) a hectare. Owners of huts destroyed by elephants, for example, are given a maximum of 1500 rupees (USD 33), while the Forest Department also pays up to 450 rupees (USD 10) for a cow, goat or pig killed by a wild animal. Families outside the park who have lost a member to a wild animal receive 30,000 rupees (USD 667) and those wounded receive medical care paid for by the department (Debnath and Sarkar, pers. comm. 2005). In 2004, the worst case of death around Gorumara occurred when five villagers brought back to their house a harvested crop, and an elephant followed them and killed them all inside the house to eat the crop (Bera, pers. comm. 2005).

All these funding schemes to help the poor around Gorumara have resulted in strong cooperation between the villagers and the Forest Department, which has further reduced illegal activities. Their relationship is so good that since 1999, villagers have been organizing units themselves to patrol areas along the park boundary voluntarily. They also patrol jointly with the Forest Department staff: the village volunteers just outside the boundary and park staff just on the inside. Many local people guard against poachers.

Formal and informal intelligence-gathering activities have recently been very effective—another reason for the absence of rhino poaching in Gorumara. In 2000 or 2001 the Forest Department set up a control cell against illegal trade to investigate illegal activities and to make arrests. Two operations were carried out in the first five months. Two people were arrested in Siliguri who were said to have possessed tiger skins, and one person who had obtained an elephant tusk was arrested at Birpara (north-west of Jaldapara). A month later the cell collapsed due to overall poor management (Debnath, pers. comm. 2005). In 2005 an informal intelligence-gathering network was started instead, mostly based on information supplied by people living on the park boundary who sympathized with the park officials. It works very well. Not much money is allocated to this (Debnath, pers. comm. 2005) as the Forest Department believes it is not necessary because local people around the park appreciate the department’s activities for the community and

will thus report potential rhino poachers entering Gorumara (Sarkar, pers. comm. 2005). If traders or poachers try to organize their activities in these fringe villages, local people will likely report them to park authorities of their own accord without money changing hands for information, as usually occurs elsewhere. As one range officer said, 'We now have thousands of pairs of eyes preventing poachers instead of the 63 pairs belonging to our staff,' (Debnath, pers. comm. 2005).

Jaldapara Wildlife Sanctuary

RHINO NUMBERS AND POACHING INCIDENTS

In 1932 the Bengal Rhinoceros Preservation Act was promulgated specifically to help the greater one-horned rhino. Nine years later, Jaldapara encompassing 99.51 km², was set aside as a game sanctuary to conserve rhinos. In 1976 it was expanded to 115.53 km² and the name changed to Jaldapara Wildlife Sanctuary. In 1990 the sanctuary was almost doubled to its present size of 216.5 km², making it more than 2.5 times larger than

Gorumara National Park (Pandit 1997). Gorumara is located in Jalpaiguri Forest Division; Jaldapara is in neighbouring Cooch Behar Division.

In the early 1930s there were an estimated 45 rhinos in Jaldapara and numbers increased to a maximum of 75 in the middle and late 1960s. Due to severe poaching, which killed at least 28 animals from 1968 to 1972 and another 18 from 1972/73 to 1985, their numbers declined to a low of about 20 (Martin 1996a). In 1988 the official estimate was 24 and a year later 27. It must be noted that although the official figure given for 1986 is 14, officials believe it should have been 24 to fit with the other statistics, and must have been a typographical error (S.C. Dey, the then Conservator of Wildlife for West Bengal, and P.T. Bhutia, Conservator of Forests Wildlife Circle (North), Jalpaiguri, pers. comm. 2005). Alternatively this low figure could be due to a miscount that year (MC Biswas, District Forest Officer, Cooch Behar Division, pers. comm. 2005).

The rhino population of Jaldapara increased from around 30 in 1990 to a census figure of 55 in 1998.

Esmond Martin



Paintings on the outside of the Hollong Forest Lodge publicize wildlife conservation. Built in 1972–1973, the lodge has seven bedrooms.

By 2002 the census estimate was 85 rhinos and in the 2004 census, 96. There is a discrepancy in these figures as well as they jump too high from 1988 to 2002 (and only one rhino was brought into the sanctuary in 1995). Either the first set of figures (from 1986 to 1998) is too low from undercounting or the second set (from 2002 onwards) is too high. S.C. Dey believes the latter is probably the case but that today they number at least in the high 80s. The staff at Jaldapara believe their latest census figures are correct and the earlier ones are underestimates.

In 1996 the last known Jaldapara rhino was poached after it wandered out of the sanctuary. A gang of three or four people followed the rhino and shot it with a country-made muzzle loader. They were later arrested and the Forest Department recovered the horn. In 2000 the horn was stolen from a rhino that had died naturally in the Torso River. Forest staff investigated the case and arrested a local Bengali, recovering the horn also (Anjan Guha, Assistant Wildlife Warden, Jaldapara Wildlife Sanctuary, pers. comm. 2005).

Since 1996 some poaching of other wild animals has continued in and around Jaldapara but in low numbers; deer poaching has almost stopped. Although there is still demand for products from elephants, leopards and wild boar, poaching is only occasional.

JALDAPARA BUDGETS

The great reduction in poaching, especially for rhinos, has been made possible, as for Gorumara, by the high budget for the sanctuary. Similar to Gorumara, most funds come from the central government (called CSS) and from the state government (state plan and non plan). Again there is no specific budget available for the state funds for Jaldapara, but the figures can roughly be calculated from statistics for the entire Cooch Behar Division. The permanent staff for Jaldapara number 187, which is 41.6% of the total for the division. Thus by using 41.6% of the division's total funds, Jaldapara's figures can be established for these state budget sectors. There are two CSS funds, one entirely for the sanctuary and the other fund known as Project Elephant that gives about 80% to Jaldapara.

Three additional funds to Jaldapara are Swarnajayanti Gramin Rojgar Yojna, Forest Development Agency, and Grants in Aid for Zilla Parishad (part of the local self-government). These cover the

Cooch Behar Division and are also calculated for Jaldapara using 41.6% of the total figures.

The figure for the state plan plus the three additional funds for Jaldapara for 2003/04 was 4,322,612 rupees (USD 96,058), and for non plan was 19,932,081 rupees (USD 442,935). The CSS figures for Jaldapara Wildlife Sanctuary were 6,964,648 rupees (USD 154,770), and for Project Elephant 1,178,719 rupees (USD 26,194). The grand total thus was 32,398,060 rupees (USD 719,957) for 2003/04, the last published financial year. This figure is an estimate based mostly on statistics from the West Bengal government (2004). The total budget for 2004/05 is not yet known but has been estimated by the Conservator of Forests of the Wildlife Circle (North) at around 30,000,000 rupees (Bhutia, pers. comm. 2005), very close to my estimate calculated for the previous financial year. This 2004/05 figure works out at USD 3171 per km² for the 216.5-km² sanctuary.

This sizeable budget has permitted the Jaldapara authorities to employ a large number of people. Besides the permanent staff of 187, there were about 100 casuals, many of whom are involved in protection duties. Thus, there is over one person per square kilometre in Jaldapara, similar to Gorumara. Although not all are involved directly in anti-poaching activities, simply their presence in the park serves as a deterrent.

CONSERVATION POLICY IMPROVEMENTS FOR JALDAPARA

The high budget for Jaldapara, as compared with most such protected areas, has allowed increased expenditure in four main categories: patrol, intelligence gathering, community help, and compensation. The latter two areas of improved support have in turn enabled park staff to win the support of the local people, further reducing poaching.

Senior staff in the sanctuary implement an intensive protection strategy. A typical day's activities include the following. From 5 a.m. to 9 a.m. the sanctuary is patrolled and 'screened' (careful examination of the area) for elephants. From 9 a.m. to 3 p.m. the staff change over to foot patrols, and from 3 p.m. to 7 p.m. they patrol once more for elephants. Staff use vehicles from 7 p.m. to 10 p.m. to patrol around the sanctuary. From 10 p.m. to 5 a.m. the night staff operate from 12 anti-poaching camps with three people in each, often using elephants during the rainy season, but in the dry months on foot and by vehicle. These camps are scat-

tered throughout the park, allowing 36 patrollers per night. They are all supplied with firearms (12 bore and .315 rifles), searchlights and a radio system. Thus, for 24 hours a day the sanctuary is intensively patrolled (Guha, pers. comm. 2005).

Intelligence gathering also plays a key role in protecting rhinos within Jaldapara. Different from Gorumara, it has established an intelligence network with 25 to 30 informers, called 'source' people who are paid, but only after they provide credible information that leads to a successful operation. Up to 10,000 rupees per case can be given to an informer. From 2003 to 2005 an annual average of 100,000 rupees (USD 2220) was paid to these source people (Biswas, pers. comm. 2005). Businessmen sometimes use the Jaldapara area as a corridor to move all types of illegal wildlife products through India, such as tiger parts, ivory, leopard skins and musk, as it is geographically close to Bhutan, China and Nepal (Martin

1999). Consequently the intelligence network also contributes to the arrest of these wildlife traders.

Huge sums of money (from CSS, the State Forest Department, and the rural development budget of the state government) have been invested in the local communities around Jaldapara to discourage them from illegally exploiting the forests and instead to support the sanctuary. The Forest Department, with the cooperation of the eco-development committees (as for Gorumara), has set up alternative income-generating activities, such as mushroom farms, piggeries, irrigation agriculture and poultry farms. Education facilities have also been improved.

Human-wildlife conflict is a serious problem in the region. In 2004, elephants killed 25–30 people in the northern part of West Bengal, including 6–8 people around Jaldapara (Guha, pers. comm. 2005). The Forest Department compensates for all deaths from wildlife. People near Jaldapara, as for Gorumara, receive benefits for other wildlife damage as well. This has greatly contributed to the well-being of these poor people. As a result, they often freely give the Forest Department information on 'potential' poachers.

Human-wildlife conflict is also a serious risk for the sanctuary staff. In 2004 rhinos injured four members of the Forest Department, two of whom died; two more staff were killed by rhinos in 2005. Wild elephants killed three staff in 2005. Because of the high danger, as an incentive to work in the sanctuary, the family of a member of staff killed receives at least 200,000 rupees (USD 2778) in total, half from the Forest Department and half from an insurance scheme set up by the Wildlife Trust of India (Guha, pers. comm. 2005, 2006).

All these activities carried out by the Forest Department in and around Jaldapara have reduced poaching, especially of rhinos. It has taken a large amount of public money to achieve this success.

Discussion

Compared with other government-protected areas with rhinos in Asia and Africa, one may well ask, why does the Forest Department in West Bengal put so much more money into rhino protection—more than almost any other place—with so little economic return, such as from tourism? The amount of money allocated from the West Bengal and central governments to wildlife and its habitat development for the entire state has increased eight-fold in rupees (almost



Esmond Martin

Watchtowers inside Jaldapara Wildlife Sanctuary serve the dual purpose of allowing visitors to view the wildlife and sanctuary staff to keep an eye out for poachers.



Bhutanese oranges come south to the town of Jaigaon, and wildlife products, including rhino horn, pass through here on their way to Phuntsholing in Bhutan.

three-fold in US dollars) from 1989/1990 to 1999/2000 (see table 4). This certainly is not due to revenue collected from tourists, although this has risen. In the financial year 2004/05, 16,294 (including only 118 foreigners) visited Gorumara and 2778 (including only 98 foreigners) visited Jaldapara. An Indian adult pays only 25 rupees (USD 0.57) to enter Jaldapara and 40 rupees (USD 0.92) for Gorumara. So there is very little profit when you consider the overheads incurred from collecting it. There are extremely few beds in either park to earn revenue. In

1958 and 1973 two very small lodges opened in Jaldapara providing 10 double rooms, and later another in Gorumara with three rooms. There are only a few places to stay outside. Around Gorumara there are nine lodges with about 232 beds and around Jaldapara only three lodges with 102 beds; most operate at low occupancy rates. All but one of these was built between 1998 and 2005. None is of a high standard so they have not attracted many foreigners, who usually spend more money than Indians. These lodges employ only a few people. In late 2005 (the tourist

Table 4. Budget in US dollars for wildlife and habitat development for the state of West Bengal, 1989/90 to 1999/2000

Year	Non plan and 7th/8th plan	State plan	Central sponsored scheme	Total
1989/90	1,664,967	321,987	267,417	2,254,371
1991/92	1,630,426	275,969	460,543	2,366,938
1993/94	2,143,065	463,226	741,548	3,347,839
1995/96	2,599,912	960,500	819,500	4,379,912
1997/98	4,056,447	681,158	981,105	5,718,710
1999/2000	5,022,989	611,122	814,575	6,448,686

Source: Thapliyal c. 2003, calculated from rupees to US dollars

and dry season) those around Gorumara had 50 employees and around Jaldapara only 40 employees.

The main reason the West Bengal government has put in large amounts of resources to protect Gorumara and Jaldapara is because the officials (who are mostly from the state) believe that these areas are part of their state's natural heritage, of which they are intensely proud. Jaldapara is shaped like a pair of trousers, so it has long boundaries that need extra protection. The central government also has been increasing its support because the money has been well spent and rhino conservation has been such a success. Government departments in West Bengal are especially noted for being less corrupt than some others in India. This is partly because there is a very active press that exposes corruption and mismanagement; there is a large literate population that complains about corruption; and there is also a local form of self-government called a *panchayat*, which is vigilant. There is hardly any political victimization in posting and deploying staff so officials are not discriminated against and instead are chosen on merit. The West Bengal government is noted for hiring staff who are honest, have personal acumen, are experts, and are committed to their job. The Forest Department has a policy of keeping a qualified person in wildlife conservation in a specific position for as long as that person is productive; it does not move staff after a year or so as can happen elsewhere (Dey and Guha, pers. comm. 2005). In addition, the Forest Department has an ideology and a sense of purpose. These attributes have helped it to obtain support from other departments such as the civil administration, police and judiciary (Dey and Biswas, pers. comm. 2005).

As the Forest Department in West Bengal is so committed, it attracts competent government staff. Salaries are not high; a guard or a mahout earns only 2700 to 4400 rupees (USD 62–101) a month, while a forest ranger (a senior position) earns 4500 to 9700 rupees (USD 103–226). They certainly do not join the department for good salaries. Instead, they join to support the department because it is extremely effective in wildlife conservation and management. Many officers wish to play a part in this successful work as they believe, far more so than conservationists in many parts of the world, that wild animals have a right to survive, despite the burgeoning human population, and must be helped to do so, even at high expense with few economic returns. They do not support the view that 'wildlife must pay its way'; they are

dedicated to protecting wildlife as a vital resource in a country where so little wild habitat is left.

Some improvements are still needed, however, in managing Gorumara and Jaldapara. Some of the senior staff members believe that both areas have nearly reached their carrying capacity for rhinos as only a small part of the habitat is suitable for them. Therefore, what is required is further enhancement and expansion of the grassland areas inside the sanctuary and park, and even possibly beyond to increase the habitat suitable for rhinos. A further requirement is that the rhino census techniques be as accurate as possible to remove any doubts on numbers based on discrepancies with past data collection, as occurred in Jaldapara.

Conclusion

The West Bengal Forest Department has successfully reversed the severe rhino poaching in Gorumara and Jaldapara that took place up to the late 1970s. Numbers of rhinos have increased from a low of about 26 then to over 100 today. The Forest Department, with additional financial help from the central government, has done this with virtually no assistance from NGOs. This is unlike Assam, Nepal, Malaysia and Indonesia, where protected areas with rhinos have received substantial NGO contributions. The key to West Bengal's rhino success has been due to its outstanding government staff and high government budgets. The Forest Department has put into place many honest, skilled, hardworking and motivated personnel. The staff is backed by a sizeable budget, one of the highest for any government-protected rhino area, which allows intensive patrolling. Although Gorumara is a national park and Jaldapara a wildlife sanctuary, both are well protected with staff density of over one person per square kilometre. Large financial inputs go to the poor communities living around Gorumara and Jaldapara. The Forest Department invests heavily in infrastructure, income-generating projects and education, and also provides compensation for human deaths, injuries and crop damage inflicted by wildlife. In turn the local people cooperate with the department by providing information on possible rhino poachers and even by carrying out their own foot patrols. The result is that there has been very little rhino poaching since the mid-1980s and a rapidly increasing rhino population.

Acknowledgements

I would like to thank the following organizations for their financial support for the fieldwork carried out in India: the John Aspinall Foundation, the Columbus Zoo and Aquarium Conservation Fund, and the Brevard Zoo in Florida. Grateful thanks also go to those who helped with the manuscript, including S.C. Dey, A. Guha, S. Roy Chowdhury, and especially Lucy Vigne.

References

- Bist S. 1994. Population history of the great Indian rhinoceros in North Bengal and major factors influencing the same. *Zoos' Print* 9(3–4):42–51.
- Martin E. 1996a. Smuggling routes for West Bengal's rhino horn and recent successes in curbing poaching. *Pachyderm* 21:28–34.
- Martin E. 1996b. The importance of park budgets, intelligence networks and competent management for successful conservation of the greater one-horned rhinoceros. *Pachyderm* 22:10–17.
- Martin E. 1998. Will new community development projects help rhino conservation in Nepal? *Pachyderm* 26:88–99.
- Martin E. 1999. West Bengal—committed to rhino conservation yet a major entrepot for endangered wildlife products. *Pachyderm* 27:105–112.
- Pandit P. 1997. *Management plan of Jaldapara Wildlife Sanctuary West Bengal for the period 1997–98 to 2006–07*. Wildlife Circle, Government of West Bengal, Calcutta.
- Raha A. 1996. *Wildlife conservation in West Bengal: a decade at a glance*. Wildlife Wing, Forest Department, Government of West Bengal, Calcutta.
- Singhal A, Gupta S. 1998. *Management plan of Gorumara National Park West Bengal for the period 1997–98 to 2006–07*. Wild Life Circle, Government of West Bengal, Calcutta.
- Struhsaker T, Struhsaker P, Siex K. 2005. Conserving Africa's rainforests: problems in protected areas and possible solutions. *Biological Conservation* 123:45–54.
- Thapliyal G. c. 2003. Biodiversity conservation in West Bengal. *West Bengal* 43(20):5–17.
- West Bengal Government. 2004. *Annual report 2003–2004 of Cooch Behar Division*. Office of the Divisional Forest Officer, Cooch Behar.

Assam leads in conserving the greater one-horned rhinoceros in the new millennium

Bibhab Kumar Talukdar

Aaranyak, 50 Samanwoy Path (survey), PO Beltola, Guwahati – 781 028, Assam, India;
email: bibhab@aaranyak.org

Abstract

Conservation of the greater one-horned rhinoceros in India and Nepal has been facing severe threats from poachers and wildlife trafficking. In the past four or five years poaching has increased in the rhino-protected areas in Nepal due to social unrest in the country, which provided good hunting for the well-organized poachers with links to international wildlife trafficking. Similar social unrest in Assam during 1983 saw the rhino exterminated from Laokhowa Wildlife Sanctuary in central Assam. During 1990–2000 social unrest around Manas National Park, Assam, also saw rhinos disappear from the park. In this new millennium, however, Assam has emerged as a strong initiator of conservation measures and protector of rhinos in the three existing rhino areas—Kaziranga, Orang and Pabitora. A rhino census carried out in these areas in March–April 2006 has showed increasing population in all the three. With new hope and aspirations, Assam thus leads in conserving the great Indian rhinoceros in this new millennium.

Résumé

La conservation du grand rhinocéros unicolore en Inde et au Népal fait face à de sévères menaces à cause des braconniers et du trafic de faune sauvage. Au cours des 4–5 dernières années, le braconnage a augmenté dans les aires protégées népalaises où vivent des rhinos, à cause de l'insécurité civile qui régnait dans le pays et qui a fourni bon terrain de chasse aux braconniers bien organisés qui ont des liens avec le trafic international de faune sauvage. L'instabilité civile similaire qu'a connue l'Assam en 1983 a entraîné la disparition du rhino du Sanctuaire de la Faune de Laokhowa, au centre de l'Assam. Entre 1990 et 2000, l'instabilité sociale régnant aux environs du Parc National de Manas, en Assam, a aussi entraîné l'extermination des rhinos du parc. Dans ce nouveau millénaire cependant, l'Assam émerge comme un initiateur solide de la conservation et un protecteur des rhinos dans les trois aires où ils vivent — Kaziranga, Orang et Pabitora. Un recensement réalisé dans ces trois zones en mars–avril 2006 a montré une population en augmentation dans les trois aires protégées. L'Assam mène donc la conservation des grands rhinocéros indiens dans ce nouveau millénaire avec un espoir et des aspirations renouvelés.

Introduction

There have been severe challenges to the conservation of rhinos throughout the globe over the years with wildlife poachers and smugglers eyeing rhino horns in a well-organized manner. The Indian rhinoceros, also called the greater one-horned rhinoceros, *Rhinoceros unicornis*, too has faced severe threats from poaching in its range countries in the past few decades, particularly in India and Nepal. Assam represents about 70% of the total wild population of the

Indian rhinoceros and poaching has remained a key threat to the wild population (Vigne and Martin 1998; Talukdar 2000, 2002, 2003; Choudhury 2005). In the past few years, rhino conservation in Nepal has received a severe jolt due to the social unrest in the country, which has resulted in increased poaching in the rhino areas of Nepal, and more importantly in the decline in information flow. Similar social unrest in Assam in 1983 witnessed an upsurge in rhino poaching in Laokhowa Wildlife Sanctuary, resulting in the total extermination of its rhino population. Similarly

the social unrest in Manas during the 1990s saw the rhino population decline to almost zero.

In spite of rhinos being exterminated from two of the protected areas in the last two decades, rhino poaching in Assam has diminished due to the aggressive strategy the anti-poaching units of Assam Forest Department adopted in the rhino areas of Assam during 2000–2005.

Poaching trend in Assam

Rhino-poaching trend has declined from 2001 to 2004 then marginally increased in 2005. In the past 10 years (1996–2005), 156 rhinos were poached from the three rhino-protected areas.

Current status of rhinos in Kaziranga National Park

In 2005 Kaziranga National Park (KNP) celebrated 100 years of successful rhino conservation. The first rhino census in Kaziranga was initiated in 1966 and since then there has been a steady increase in its rhino population. With the increase in rhino population and other wildlife species in Kaziranga, the tourist flow into the national park has also increased in recent decades (fig. 1).

Table 1 summarizes the increase in rhino population in Kaziranga since 1966.

Table 2 summarizes the rhino population of Kaziranga by block as enumerated in March 2006. During this count, it was observed that the western range of KNP harbours over 50% of KNP's total rhino population, followed by the central range and the eastern range. The western range is also popularly known as the Baguri range, while the central range as the Kaziranga range and the eastern range as the Agaratoli range. The Burapahar range was created a few years

Table 1. Rhino population in Kaziranga National Park according to censuses, 1966–2006

Year	Male	Female	Young	Unidentified sex	Total
1966	67	83	44	172	366
1972	203	188	148	119	658
1978	331	332	243	43	939
1984	283	296	201	166	946
1991	338	357	190	184 (+60) ^a	1069 (+60) ^a
1993	387	379	176	222	1164
1999	556	586	257	153	1552
2006	545	693	409	208	1855

Source: Directorate, Kaziranga National Park

^a rhinos counted in the additional areas in 1991



Bibhab Talukdar

Figure 1. Tourists enjoy a pachyderm in Kaziranga National Park.

ago with the addition of new areas to the western side of the Baguri range, which was providing shelter to about 109 rhinos at the time of the census. The Baguri block together with the western range harbours the highest number of rhinos out of the 10 census blocks with a population of 678.

Since 2000 rhino poaching in KNP has been greatly controlled with the proactive anti-poaching strategy park authorities have adopted. Intense patrolling by anti-poaching staff in and around Kaziranga has contributed to a significant decline in poaching (fig. 2). To enhance communication among the forest camps and range offices of the park, Aaranyak—a society for biodiversity conservation working in north-east India since 1989—and the David Shepherd Wildlife Foundation based in the United Kingdom have undertaken a 10-year project called 'Wireless Communication Network Project 2003–2012'. In the past one and a half years the project has bought 125 new wireless handsets and supported 28 wireless base stations (fig. 3) to strengthen the wireless network and assist in the anti-poaching approaches designed by the park authorities. Further, about 40 solar panels have been provided to charge the wireless batteries in the interior camps of KNP where electricity is not available.

Between 2000 and 2005, 30 rhinos were poached in KNP (table 3). During the same period 353 rhinos died of various natural causes, including floods, infighting, old age and disease. Between 1990 and 1997, an average of 30 rhinos were poached in Kaziranga every year. Compared with these figures, the success in reducing rhino poaching in KNP in the new millennium is remarkable—30 rhinos poached in a span of six years. The local communities also have contributed significantly towards developing good liaison with park authorities and sharing intelligence about the movement of poachers around KNP. This combined effort of park authorities, local people and NGOs has made a huge difference in rhino conservation in the park in this new millennium.

Current status of rhinos in Orang National Park

Orang National Park, an area of 78.8 km², witnessed severe poaching during 1995–2000, with an average of 10 rhinos killed per year resulting in a fall in rhino numbers from 97 in 1993 to only 46 in 1999. But since then

Table 2. Population of rhinos in Kaziranga National Park by block, 2006

Range	Block	Block area (km)	Mother and calf			Adult		Subadult		Orphan- age calf	Total			
			Mother	0–1 yr	1–3 yr + 3 yr	Male	Female	Male	Female			Unknown	Unknown	
WR	Baguri	79.6	176	49	93	35	160	65	44	17	18	20	1	678
WR/CR	Bhawani	46.2	38	4	10	24	43	30	10	4	8	5	0	176
CR	Charigharia	48	28	7	15	6	33	18	9	3	2	2	0	123
CR/ER	Panbari	51.2	27	5	10	12	48	14	19	3	3	8	0	149
CR/WR	Haldibari	51.6	75	23	28	24	71	44	27	26	16	7	0	341
CR	Kaziranga	47.8	18	1	8	9	28	10	13	3	0	1	0	91
ER	Tamulipathar	55.1	16	5	7	4	48	24	11	2	2	3	0	122
ER	Boralimora	31.1	7	7	0	0	19	11	3	0	0	1	0	48
BR	Burapahar	58.7+	16	2	8	6	25	16	12	6	4	12	2	109
CR/WR/ER	RF and additions		4	2	2	0	6	3	0	0	0	1	0	18
Total			405	105	181	120	481	235	148	64	53	60	3	1855

Source: Directorate, Kaziranga National Park

WR – western range, CR – central range, ER – eastern range, Br – Burapahar range, RF – reserved forest

the park has emerged strong with no rhino poaching in the past 14 months (April 2005–May 2006), after losing three rhinos in March 2005. Orang has learned from its past mistakes and has identified the gaps in protection, resulting in efficient rhino protection in the past four or five years (table 4). Between 2000 and 2005, Orang lost 24 rhinos; 11 died of natural causes while 13 were poached. Significantly, no rhinos were poached in 2002 or 2004. In 2005, 3 were poached in March by well-organized poachers. It often happens that after a few successful years of good protection, some forest staff become complacent, and it was at that point that well-organized rhino poachers hit back.

From a mere 46 rhinos counted in 1999, the rhino population had increased to 68 in the March 2006 census carried out by the Assam Forest Department. Table 5 summarizes rhino population figures for 2006 as enumerated by the Assam Forest Department.

Current status of rhinos in Pabitora Wildlife Sanctuary

The population of the greater one-horned rhino has been increasing in the small protected area in Assam called the Pabitora Wildlife Sanctuary. From a population of 54 in 1987, rhinos now number 81 (30 female, 21 calves, 18 male and 12 subadults) in the census carried out in April 2006 by the Forest Department.

Firearms and electrocution are the two major methods used by rhino poachers at Pabitora Wildlife Sanctuary. There is a single instance only where two rhinos—mother and calf—were killed by chemical poisoning in 1987. Between 2000 and 2005, eight rhinos were poached in Pabitora WLS: five by gunshot and three by electrocution (table 6).

In Pabitora, poachers take advantage of the domestic electricity line passing along and within the sanctuary to kill rhinos; electrocution is a silent method. The first case of a rhino being electrocuted occurred on 29 August 1989. After the fringe areas



Figure 2. Patrolling in Kaziranga National Park.

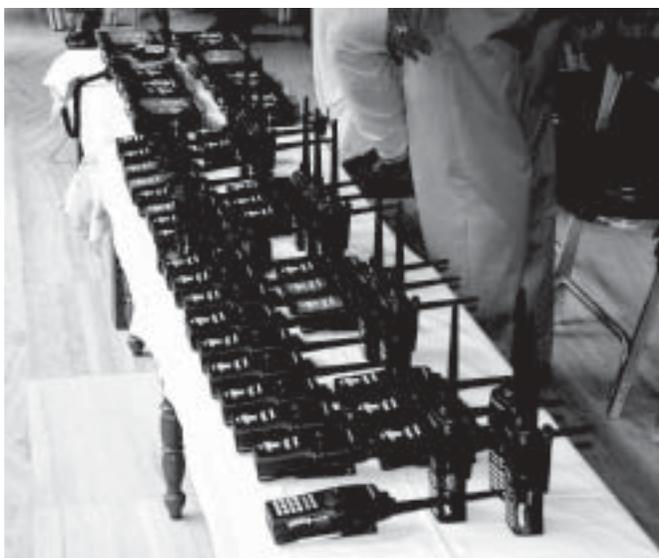


Figure 3. Wireless equipment donated to Kaziranga National Park.

Table 3. Causes of rhino deaths in Kaziranga National Park, 2000–2005

Cause of death	2000	2001	2002	2003	2004	2005
Gun	2	2	3	3	4	7
Pit	2	6	1	0	0	0
Natural	44	35	62	63	100	49

Source: Directorate, Kaziranga National Park

Table 4. Rhino deaths in Orang National Park since 2000

Cause of death	2000	2001	2002	2003	2004	2005
Gun	8	1	0	0	0	2
Pit	0	0	0	1	0	1
Natural	5	2	1	1	2	0
Total loss	13	3	1	2	2	3

Source: Range Office, Orang National Park

Table 5. Rhino population in Orang National Park, 2006

Census block	Male	Female	Calf	Calf < 1 yr	Total
Baghmari	6	3	1	—	10
Gaimari	2	1	1	—	4
Jhaoni	1	1	—	—	2
Magurmari	1	1	1	—	3
Molamari	2	3	1	—	6
Pabhomari	1	2	1	—	4
Rahmanpur	2	3	1	—	6
Ramkong	1	1	—	—	2
Saila	5	4	—	2	11
Satsimlau	6	4	2	1	13
Solmari	—	1	—	1	2
Tincona	1	3	1	—	5
Total	28	27	9	4	68

Source: Range Office, Orang National Park

Table 6. Rhino deaths at Pabitora Wildlife Sanctuary, 2000–2006

Cause of death	2000	2001	2002	2003	2004	2005	2006
Gun	2	0	0	0	1	2	1
Electric	0	0	1	2	0	0	0
Natural	1	1	2	3	3	4	2

Source: Range Office, Pabitora Wildlife Sanctuary
No deaths from pits.

around Pabitora Wildlife Sanctuary were developed, local people started using electric pumps for irrigation in their fields. For that purpose, the Assam State Electricity Board fixed numerous electric connections in the adjacent paddy fields and lands. This is one of the major headaches for anti-poaching staff of the sanctuary; they have to monitor every line every night, especially during the winter season, when the rhinos tend to go out of the sanctuary due to shortage of palatable fodder within the sanctuary.

Conclusion

The threats posed to rhinos in Assam and also in its distribution range, within both India and Nepal, need to be assessed periodically at regional level for follow-up action. The anti-poaching staff of the rhino protected areas cannot afford to be complacent. Combating poachers has been an ongoing exercise that needs to be strengthened with improved intelligence gathering and rapid action to surprise the poachers and foil their attempts to poach rhinos. Continued monitoring is of utmost necessity. The future of the rhino in most of its habitat depends on how effectively we deal with poaching threats.

Acknowledgements

Thanks are gratefully due to the David Shepherd Wildlife Foundation, UK, for continued assistance in carrying out wildlife crime-monitoring work in the eastern Himalayas, and to colleagues at Aaranyak for continued encouragement and assistance. The Assam Forest Department deserves special mention for their on-site field support during the study period, and for sharing data.

References

- Choudhury A. 2005. Threats to Pabitora Wildlife Sanctuary, Assam. *Pachyderm* 38:82–88.
- Talukdar BK. 2000. The current state of rhino in Assam and threats in the 21st century. *Pachyderm* 29:39–47.
- Talukdar BK. 2002. Dedication leads to reduced rhino poaching in Assam in recent years. *Pachyderm* 33:58–63.
- Talukdar BK. 2003. Importance of anti-poaching measures towards successful conservation and protection of rhinos and elephants, north-eastern India. *Pachyderm* 34:59–65.
- Vigne L, Martin E. 1998. Dedicated field staff continue to combat rhino poaching in Assam. *Pachyderm* 26:25–39.

DISCUSSION

Elephants, woodlands and ecosystems: some perspectives

Norman Owen-Smith

Centre for African Ecology, School of Animal, Plant and Environmental Sciences, University of the Witwatersrand, Wits 2050, South Africa; email: norman@gecko.wits.ac.za

Introduction

My purpose in this article is to summarize, somewhat provocatively, the different perspectives that exist on 'the elephant problem'—that is, how might elephants and woodlands coexist? These perspectives range from viewpoints focused narrowly on the damaging effects of elephants on trees to broader considerations of the consequences for ecosystem processes and biodiversity. Furthermore, I will highlight the pivotal importance of spatial heterogeneity and the contribution of surface water distribution to this heterogeneity, because I believe that inadequate recognition has been given to this aspect in the past. For more detailed information, and complete referencing of information see Owen-Smith (1988), Gillson and Lindsay (2003), Skarpe et al. (2004) and Owen-Smith et al. (in press).

Public perceptions

To the public visiting parks and to the managers of these parks, elephants are vexing animals. They feed wastefully, breaking off branches to chew twig tips, stripping bark from tree trunks, and pushing over whole trees to sample a few bites from the top branches sometimes perhaps just to show their strength. They leave behind a trail of vegetation destruction: fallen trees, standing woodlands debarked and dead, magnificent trees like baobabs turned into a heap of sawdust, shrublands where once there were woodlands, and

spreading grasslands where trees formerly grew. They are blamed for having destroyed most of the lush riparian forest that once flanked the Chobe River, and for transforming acacia trees in the adjoining woodland to standing skeletons amid a depleted shrubland dominated by *Capparis tomentosa*, *Combretum mossambicense* and *Croton megalobotrys*—species apparently unpalatable to elephants. Visitors to the park, tourist operators and many scientists generally view these vegetation changes as disturbing and regrettable. Furthermore, they are perceived as threatening the survival in the parks of other animal species, notably the Chobe subspecies of bushbuck.

A narrow ecological perspective

As they feed, elephants disturb the structural components of vegetation: they fell trees, uproot shrubs and pluck grass tufts whole. They depress or even eliminate populations of vulnerable tree species like baobab and marula. More broadly, they change the structure of the habitat for other species promoting less woody, more open conditions in savannas. By suppressing growth into canopy height classes, they make the woodland more shrubby to the detriment of birds requiring tall trees for nesting, like certain vultures and eagles. It has been claimed that they compete for food both with browsers like kudu and black rhinoceros, and with grazers like buffalo.

Adapted from the proceedings of a conference organized by the Botswana–Norway Institutional Cooperation and Capacity Building Project (BONIC), Vandewalle M, ed., *Effects of fire, elephants and other herbivores on the Chobe riverfront ecosystem*, Government Printer, Gaborone, 2003.

The concern of park managers is that a large elephant population will ultimately reduce habitat and species diversity, thus threatening the basic conservation objectives for protected areas. This was the justification for former culling programmes that capped elephant numbers in Kruger National Park in South Africa and Hwange National Park in Zimbabwe.

Broader ecological perspectives

Elephants as megabrowsers

All browsers to some extent affect plants negatively. Hares ringbark birch shrubs; steenbok, impalas and even rodents destroy tree seedlings; and outbreaks of defoliating insects like the spruce budworm can result in much tree mortality. The damage that elephants cause to individual plants, vegetation composition and structure is merely on a larger and more persistent scale, and thus more striking to human observers.

As expected from the niche theory, some degree of dietary separation is apparent between elephants and other browsers. Along the Chobe River front, kudus and impalas favour shrub species that elephants neglect. Thus some herbivores gain from the vegetation changes wrought by elephants, through complementary feeding habitats. Broader-scale habitat changes also benefit animal species favouring the new conditions, while other species lose out; thus an overall change in species numbers need not result.

Elephants as predators on woody plants

By definition predators are agents of the mortality of their prey. However, while individual animals or plants are killed, adverse changes in the abundance of the prey population need not result. Older individuals simply die sooner, opening opportunities for increased recruitment to fill the gaps and resources released. Nevertheless, there are circumstances in which vulnerable species may be held in 'predator pits' at greatly reduced density, or restricted to refuge habitats. A source-sink population structure may even develop, as indicated for baobab trees in the northern part of Kruger Park. Baobab stands on rocky hills, which elephants visit infrequently, show a wide range of sizes, while on the plains below there are isolated large trees but few saplings, suggesting that the plains subpopulation is maintained largely by seeds dispersed from the hills. Predation almost inevitably re-

sults in changes in the composition of the prey assemblage, with species robustly defended against predation increasing at the expense of those more vulnerable to being killed.

Elephants as agents of disturbance

Elephants can be viewed as agents of disturbance within plant communities through opening gaps for colonization where trees have been felled. According to the 'intermediate disturbance hypothesis', through creating such opportunities overall species diversity is enhanced, provided the disturbances are not too frequent or severe. Without disturbance, the most strongly competitive species eventually dominate the community. The vacant space generated periodically by the agent of disturbance enables pioneer species that are good colonists but not good competitors to coexist. Species diversity may be reduced within patches most heavily affected but over the landscape a mosaic diversity of habitats and associated species assemblages promotes higher diversity overall.

This concept implies that if there were too many elephants to the extent that their impact became persistent and pervasive over the landscape, plant diversity could be diminished due to the loss of species unable to resist such impact. On the other hand, too few elephants could also lead to lowered biodiversity following the disappearance of the gap colonists. Where lies the 'intermediate' abundance of elephants? We do not know at this stage and the question is not easily answered because diversity needs to be assessed at a variety of scales.

Elephants as ecological engineers

Elephants are supreme engineers in the sense that they radically transform their environment to suit their needs. In north temperate regions beavers are their counterpart, felling small trees to build dams, thereby flooding wetlands. Just as wildebeest cultivate grazing lawns in the Serengeti and white rhinos do likewise in Hluhluwe-iMfolozi, the impact of elephants feeding and breaking promote what might be called 'browsing lawns'. This term can be applied to the stands of small trees or shrubs 1–3 m tall—the ideal feeding height for elephants—that have developed on the Chobe alluvium and in mopane woodlands. Elephants prevent these plants from growing taller and hence out of reach by periodically breaking the

leader shoot. Pushing over big trees, each of which may be replaced by several shrubs, is not as senseless as it may seem to narrow-sighted human observers. A parkland of widely spaced big trees is pleasing to humans but not productive for elephants. Other browsers may benefit through more accessible foliage, although the elephants may consume a good part of it.

Elephants as promoters of nutrient cycling

Mineral nutrients taken up by plants from the soil become locked in tree trunks and bark and thus are no longer available to support further plant growth. By pushing over trees, elephants help release these nutrients for recycling, thereby promoting further plant growth. The nitrogen held in elephant biomass may even be protected from the leaching that would otherwise take place in sandy soils, being released periodically in dung and urine. Places where elephants concentrate their effect thus become nutrient enriched and may develop into hotspots for other herbivores. These effects seem especially important in nutrient-deficient, sandy-soil ecosystems where elephants predominate in the herbivore biomass, like the Kalahari Sand region of northern Botswana and adjoining parts of Zimbabwe and Zambia. On the other hand, the loss of large trees removes the nutrient pumping role that these trees may have played, drawing mineral elements from deeper soil layers to counteract ongoing leaching of these nutrients from surface sands.

Dismal scenarios

What might the ultimate outcome of the effect of elephants on woodlands be? What form might the ecosystem eventually take? Here are four possible scenarios that would have deleterious consequences for biodiversity.

1. Elephants transform wooded savannas into open grassy savannas, especially on clay soil substrates, generally in association with fire. Thereafter the elephants suppress woody plant regeneration and species diversity is reduced as a result of the lack of the tree component. An example is the Rwindi–Rutshuru Plain in Virunga National Park, eastern Democratic Republic of Congo, which appeared as a wooded savanna in 1935 but had become an open grassland by 1959 (Bourliere 1965). Elephants also suppressed tree regeneration in the

grasslands of the Masai Mara Reserve, although fire was implicated as the primary agent transforming the formerly wooded savanna into grassland (Dublin et al. 1990).

2. Elephants transform structurally mixed woodlands into monotonous shrublands, especially on sandy soil substrates. The elephants thrive but other organisms dependent on tall trees lose out, and structural diversity in the habitat is reduced. Tree populations may ultimately suffer from lack of seed inputs. This is the situation seen on the alluvial terrace adjoining the Chobe River and in mopane woodlands in some areas.
3. Elephants extirpate populations of vulnerable tree species like baobab, marula and various *Acacia* species, or at least restrict these at greatly reduced abundance levels in habitat refuges. Baobab trees have mostly disappeared from Tsavo East in Kenya and Gona-Re-Zhou in Zimbabwe. Nevertheless specimens of vulnerable species like *Acacia nigrescens* still persist along the Chobe River front, apparently resisting extirpation through their prickly defences. The woodland remains but becomes dominated by species not favoured by elephants.
4. Rather than attaining any stable state, elephant populations and woodlands cycle persistently, alternating between high and low abundance. This is Caughley's (1976) limit cycle concept, derived from observations made in mopane woodlands in Luangwa Valley. It may be expressed as a shifting patch mosaic across the landscape, with elephants abandoning places where the woody species they favour have become too sparse and moving into areas where plant populations have had time to recover, over time scales of centuries. With wide-scale movements by elephants now largely restricted by fencing and human settlements, the extreme swings could become worsened and prolonged with consequent losses of animal and plant species.

More optimistic scenarios

Recognizing the temporally highly variable environments that characterize much of Africa, it seems unlikely that any stable state would persist, not even the dynamic stability of a limit cycle. Instead populations of animals and plants must continually adjust to changing circumstances: seasonally, between wet and

dry years, decades of above- and below-average rainfall, and to climatic shifts taking place over longer periods. This perspective of hierarchical patch dynamics is consistent with the vegetation changes revealed by fossil pollen records (Gillson 2004), and with observations of vegetation changes documented in Hwange over the past 30 years (Valeix et al. in press).

The fundamental contribution of spatial heterogeneity towards dampening the consequences of temporal variability for consumer–resource interactions is becoming widely recognized (Illius and O'Connor 2000; Owen-Smith 2002a,b). A crucial component of such heterogeneity in African savanna ecosystems is the restricted distribution of perennial surface water (Owen-Smith 1996).

With surface water restricted largely to rivers by the late dry season, riparian trees growing alongside these rivers incur the brunt of elephant impact. However, these species must also cope with periodic floods and hence should thus have the regenerative capacity to resist or counteract elephant-inflicted damage, for example by deep rooting. During the wet season when elephants can spread more widely across the landscapes, regenerative stages have the opportunity to recover. Variation in the persistence of ephemeral pools between years also affects the period over which elephants concentrate near rivers, providing further windows of opportunity for regeneration. Climatic variability could additionally enable the episodic establishment of dense cohorts of seedlings, providing 'herd' security against predation by elephants and other browsers.

Furthermore, elephants incur the stresses of daily movement between surface water and foraging areas several kilometres away where food resources are less severely depleted. The doubling in birth intervals and severe retardation of age at first reproduction documented in Uganda at Murchison Falls and in Kenya at Tsavo East (Laws and Parker 1968) occurred only after elephants had devastated woodlands and become severely stressed nutritionally as a result. With water restricted, young calves would suffer in particular from the cost of travel to and from water, and be susceptible to heightened mortality as a result. The crowding of elephants near water also increases the vulnerability of young elephants to predation by lions, as recorded in northern Botswana and Hwange (Joubert 2006). In combination, these changes could reduce to zero the annual 5–6% rate of increase now shown by many elephant populations. When the rains

come elephants could spread widely across regions where food resources remain plentiful, so that the period of intense stress would be brief. Furthermore, with food abundant in these upland regions the pressure on tree species growing there would be reduced.

Conclusions

Narrow viewpoints emphasizing the necessity for population culling to restrict the severe effect that elephants can have on woodlands need not be applicable where ecosystems retain sufficient spatial heterogeneity. The problem is that managers have frequently intervened in ways that reduce this heterogeneity, for example by augmenting natural surface water with dams and boreholes. Furthermore, protected areas represent a circumscribed remnant of the range over which elephants moved in the past to exploit this heterogeneity.

Some intervention may be needed to restore or replicate the functional heterogeneity that may formerly have been effective within these areas. Where excessive artificial water points have been provided, as in Kruger, most should be closed. In Botswana where perennial water is restricted mostly to a few rivers, the temptation needs to be resisted to add boreholes to spread elephant impact. In Hwange, where available surface water is limited almost entirely to pumped pans, the distribution of these water sources needs to be restricted so as to concentrate the elephants while still providing sufficient access to water for other species (Chamaille-Jammes et al. in press). Such measures could be effective in dampening the extent of the fluctuations in the abundance of elephants and trees, thereby reducing the risk of species losses. The crucial question is, how large must the area be for these processes to operate unaided? To answer this, more information is needed on the factors governing elephant movements under different conditions, and on the processes governing the regeneration of savanna trees. It must be acknowledged that additional interventions may be needed in smaller protected areas to safeguard biodiversity objectives.

Acknowledgements

This article benefited from the critical comments provided by D. Balfour and H. Fritz. I am grateful also to the organizers of the BONIC workshop for stimulating me to prepare this summary overview.

References

- Bourliere F. 1965. Densities and biomasses of some ungulate populations in eastern Congo and Rwanda, with notes on population structure and lion/ungulate ratios. *Zoologica Africana* 1:199–208.
- Caughley G. 1976. The elephant problem: an alternative hypothesis. *East African Wildlife Journal* 14:265–283.
- Chamaille-Jammes S, Fritz H, Murindagomo F. In press. Climate-driven fluctuations in surface water availability and the buffering role of artificial pumping in an African savanna: implications for herbivore dynamics. *Austral Ecology*.
- Dublin HT, Sinclair ARE, McGlade J. 1990. Elephants and fire as causes of multiple stable states in the Serengeti–Mara woodlands. *Journal of Animal Ecology* 59:1147–1164.
- Gillson L. 2004. Evidence of hierarchical pack dynamics in an East African savanna? *Landscape Ecology* 19:883–894.
- Gillson L, Lindsay K. 2003. Ivory and ecology: changing perspectives on elephant management and the international trade in ivory. *Environmental Science & Policy* 6:411–419.
- Illius AW, O'Connor TG. 2000. Resource heterogeneity and ungulate population dynamics. *Oikos* 89:283–294.
- Joubert D. 2006. Hunting behaviour of lions on elephants in the Chobe National Park, Botswana. *African Journal of Ecology* 44:279–281.
- Laws RM, Parker ISC. 1968. Recent studies on elephant populations in East Africa. In: MA Crawford, ed., *Comparative nutrition of wild animals*. Symposium of the Zoological Society of London No. 21. p. 319–359.
- Owen-Smith N. 1988. *Megaherbivores: the influence of very large body size on ecology*. Cambridge University Press, Cambridge, UK.
- Owen-Smith N. 1996. Ecological guidelines for waterpoints in extensive protected areas. *South African Journal of Wildlife Research* 26:107–112.
- Owen-Smith N. 2002a. Credible models for herbivore-vegetation systems: towards an ecology of equations. *South African Journal of Science* 98:445–449.
- Owen-Smith N. 2002b. *Adaptive herbivore ecology: from resources to populations in variable environments*. Cambridge University Press, Cambridge.
- Owen-Smith N, Kerley GIH, Page B, Slotow R, van Aarde RJ. In press. A scientific perspective on the management of elephants in the Kruger National Park and elsewhere. *South African Journal of Science*
- Skarpe C, Aarestad PA, Andreassen HP, Dhillion SS, Dimakatso T, du Toit JT, Halley DJ, Hytteborn H, Makhabu S, Mari M et al. 2004. The return of the giants: ecological effects of an increasing elephant population. *Ambio* 33:276–282.
- Valeix M, Fritz H, Dubois S, Kanengoni K. In press. Vegetation structure and ungulate abundance over a period of increasing elephant abundance in Hwange National Park, Zimbabwe. *Journal of Tropical Ecology*.

FIELD NOTE

Mitigating human–elephant conflict in Africa: a lesson-learning and network development meeting

Matt Walpole,¹ Noah Sitati,² Belinda Stewart-Cox,³ Leo Niskanen,⁴ PJ Stephenson⁵

¹ Fauna & Flora International, Great Eastern House, Tenison Road, Cambridge CB1 2TT, UK; email: matt.walpole@fauna-flora.org

² Durrell Institute of Conservation & Ecology, University of Kent, Canterbury, Kent CT2 7NS, UK

³ Zoological Society of London, Regent's Park, London NW1 4RY, UK

⁴ IUCN/SSC African Elephant Specialist Group, PO Box 68200, Nairobi, Kenya

⁵ WWF International, Avenue du Mont-Blanc 1196, Gland, Switzerland

Introduction

Human–elephant conflict (HEC) is a major conservation challenge in Africa and Asia because it is fuelling an increase in killing of elephants and the loss of elephant habitat and range. Solutions lie in identifying appropriate mitigation methods that can improve local livelihoods and local tolerance of elephants, and that provide local communities with tangible benefits from elephant conservation. As a result, HEC is a growing field of conservation activity in both Africa and Asia, a fact reflected in the work of the African and Asian Elephant Specialist Groups.

Mitigating HEC strategically is important not only to increase local support and reduce elephant killing, but also from a moral perspective. Conservation agencies are increasingly accepting the position that wildlife conservation should not make poor people poorer, that those people living with wildlife should not bear a disproportionate share of the costs. The premise that wildlife should not negatively affect local livelihoods and human well-being is becoming increasingly central to both field conservation programmes and international policy (Walpole 2006). Finding solutions to mitigate HEC is a part of that broader drive towards equity.

In the last decade, many HEC projects have emerged and a range of tools has been developed to help mitigate the problem in situ (Thouless and Sakwa

1995; O'Connell-Rodwell et al. 2001; Hoare 2001; Karidozo and Osborn 2005; Parker and Osborn 2006; Sitati and Walpole 2006). Numerous projects are now testing different mitigation methods including alternative planting regimes, economic incentives, early-warning systems, deterrents (especially chilli-based deterrents), and communal guarding. However, few analytical case studies have been published and there has been little opportunity for project managers to come together, compare experiences and learn from each other, particularly between Africa and Asia where histories of human–elephant conflict differ but mitigation methods being tried and tested are similar.

In 2003 WWF organized a meeting in Nairobi of several African HEC projects. Before that the Wildlife Conservation Society (WCS) organized a more general human–wildlife conflict meeting in Uganda that included HEC studies from across the continent (Hill et al. 2002). Both of these meetings offered African project managers an opportunity to meet and learn from each other's work. In 2003 a ground-breaking cross-continental conference was held in Sri Lanka where representatives from projects around Africa and Asia presented their work on a range of elephant conservation issues including conflict and its mitigation (Jayewardene 2004). This conference facilitated cross-continental communication and exchange. However, this large and well-attended meeting did not afford an opportunity to explore and

discuss in detail conflict-mitigation methods, the science behind them, and the evidence of either short- or long-term success using different approaches. Nonetheless, a follow-up meeting led to a team of elephant researchers from different countries in Asia being formed and visiting various project sites in Kenya to learn and share experiences about HEC mitigation strategies.

In 2004, collaboration began between a long-running HEC project in Transmara District, Kenya, and an elephant conservation project in western Thailand. The Elephant Conservation Network and the Zoological Society of London (ZSL) are testing HEC mitigation methods in an Asian context that have been successfully tested in Kenya by WWF and the Durrell Institute of Conservation and Ecology (DICE) (Sitati et al. 2005, 2006; Sitati et al. 2003, 2005; Sitati et al. 2003). The programme also aims to develop a network of HEC practitioners and researchers to communicate and share lessons.

As part of this collaboration, meetings were planned in Africa and Asia to discuss and share HEC mitigation methods and experiences. Focusing on a small number of projects where such methods have been rigorously applied, tested and evaluated, these meetings would synthesize the most up-to-date findings in this field in both continents while expanding the network of practitioners pioneering these approaches.

The first of these meetings was held in Nairobi, 27–28 September 2006. It was supported by Fauna & Flora International (FFI), ZSL, DICE and WWF. This meeting brought together HEC practitioners and researchers from a range of institutions and projects across Africa, with representation from the Asian HEC community.

Aim and objectives

The aim of the Nairobi meeting was to improve the science and understanding of HEC and its mitigation, and the contribution it makes to elephant conservation and local livelihoods. The objectives were:

- to share and critically review selected HEC case studies, primarily from eastern and southern Africa, in which trials on mitigation methods have been run and objectively tested
- to identify synergies, common findings, differences and challenges in studying and mitigating HEC, and to highlight best practices
- to explore the practicalities of establishing an African learning network for community-based

elephant conservation and conflict mitigation (as the first step towards a wider Afro-Asian learning exchange network), and to identify a strategy for developing such a network

A number of HEC projects are under way in Kenya and Tanzania, supported by organizations including the Born Free Foundation, WCS, Frankfurt Zoological Society, Kenya Wildlife Service and the Tanzania Wildlife Research Institute, all of which were represented at this meeting. In total, 40 representatives from five African elephant range states (Kenya, Tanzania, Uganda, Zambia, Zimbabwe) and three Asian elephant range states (Cambodia, Indonesia, Thailand) attended. As KWS is based in Nairobi, it had a strong presence alongside various Kenyan NGO projects. KWS is currently developing a national elephant strategy in which HEC mitigation will be a major component, and this meeting offered potential to influence development of the strategy.

Structure and content of the meeting

Thirteen cutting-edge case studies were presented, focusing mainly on the mitigation methods used and their efficacy (table 1). Each case study described:

- the local context of HEC and its impact on local livelihoods and wellbeing, and on elephant conservation
- the historical development of the project and the mitigation methods used; why these methods were chosen and who chose them
- how the mitigation strategies employed were or are being monitored and/or tested, and reasons for the success or failure of project trials
- any effects that the HEC mitigation methods have had in reducing HEC; whether they have improved local livelihoods and well-being and elephant conservation
- any negative changes that have resulted from project interventions, and any other changes that have influenced the outcome of project interventions

The case studies described mitigation methods ranging from fencing and guarding to the increasingly widespread use of chilli-based deterrents, and to other novel approaches such as the use of bees. In addition there were broader topics discussed such as the economics of HEC management and the 'bigger picture' issues that need to be taken into account alongside technical solutions to the problem.

Table 1. Case studies presented during the Nairobi meeting

Case studies	Presenter
HEC mitigation trials in Transmara District, Kenya	Noah Sitati
Human–elephant conflict: WWF case studies from Cameroon and Tanzania	PJ Stephenson
Human–elephant conflict around Amboseli National Park, Kenya	Winnie Kiiru
Human–elephant conflict and mitigation trials in Laikipia District, Kenya	Max Graham
Human–elephant conflict mitigation in Kenya: KWS perspective	Patrick Omondi
HEC mitigation trials in Zimbabwe: can bees deter elephants from raiding crops?	Malvern Karidozo
Systematic recording and assessment of HEC in western Serengeti, Tanzania	Lucas Malugu
Investigating the potential for chilli as a wildlife-resistant crop in Zimbabwe	Guy Parker
Cost-benefit analysis of land-use types in Transmara District, Kenya	Anne Kiplimo
The Elephants, Crops and People Project, Queen Elizabeth National Park, Uganda	Michael Keigwin
New developments in the study and management of HEC in Africa	Richard Hoare
HEC problems and solutions at Kui Buri National Park, southwest Thailand	Mattana Srikrajang
The Elephant Conservation Network/ZSL HEC mitigation project in West Thailand	Belinda Stewart-Cox

After each morning and afternoon session, the moderator highlighted the key issues then facilitated a group discussion to synthesize knowledge gained from each case study and to identify best practices for mitigating HEC (research, monitoring, implementation, testing). At the end of the workshop, participants discussed the most pressing contemporary issues in HEC, and how to develop an exchange and learning network.

Discussions and conclusions arising from the meeting

Following is a synthesis of the main themes and lessons that emerged from the presentations and subsequent discussions:

- *Simple, community-based methods of crop protection*, especially those combining chilli or tobacco deterrents with greater vigilance, continue to be promising in various sites across Africa. However, to remain effective, combinations of methods must be used to provide the required effect. There is no silver bullet; no one strategy will work everywhere.
- *Comprehensive land-use planning*, locally and nationally, can go a long way towards reducing conflict, for example, zoning to maintain elephant migration by ensuring connectivity between main elephant ranges, creating buffer zones between cultivation areas and elephant refuges, and integrating fields better into more easily defendable units.
- *Community-based wildlife management* schemes or sanctuaries offer a lot of potential for improv-

ing local livelihoods, improving attitudes towards elephants and their habitat, and reducing HEC.

- *The role of immigrants* (that is, people not originally from the area and not used to living with elephants) in HEC was raised by a number of presenters. It appears that the start of major HEC problems often coincides with the arrival of immigrants into an area. This has been a recurring theme across the continent and is linked to the importance of land-use planning outlined above.
- *Political instability and insecurity* and other forms of human–human conflict can disrupt the implementation of HEC mitigation strategies.
- *Ownership of the problem* (that is, whose responsibility is HEC?) is a fundamental question. A standard reaction by communities affected by HEC is to expect the government ‘to solve the elephant problem’. When government does not do so, animosity towards wildlife in general, and elephants in particular, often escalates. Therefore an important first step is to persuade affected communities to accept some responsibility for tackling the problem. They are unlikely to do so for long however, unless they receive tangible benefits from elephants, such as tourism revenues.
- *Community-based strategies incur costs*. If communities affected by HEC are expected to bear these costs in the long term, they must receive a greater share of benefits earned from elephants.
- *Revenue generation from wildlife schemes* encourages community support for elephant conservation and HEC mitigation. However, poor governance (such as misappropriation of funds destined for affected communities) creates resent-

ment and discourages local efforts to manage and protect wildlife, including elephants.

- *Outdated or non-existent national policies and legislation* (wildlife, land-use planning, agricultural promotion, livestock development, etc.) often stymie efforts to mitigate HEC. A more integrated approach to policymaking is required.
- *Communicating the HEC problem* including its economic implications effectively and accurately to politicians and decisionmakers is a challenge. HEC continues to be misunderstood and politicized.
- *The sustainability of site-based HEC mitigation projects* is an issue. There may be little or no community and government interest or capacity to maintain activities after external support has ended. Long-term monitoring of the effects of HEC and its mitigation may also be difficult to sustain in sites where there is no ongoing research project.
- *To ensure lasting outcomes* for both people and elephants, it is necessary to move beyond the site level towards more integrated cross-sectoral approaches to conflict mitigation. Such approaches need to simultaneously address the various technical, socio-economic and political issues at different levels, from site to national. This requires the involvement of more stakeholders and solid support from government at all levels. The IUCN/SSC AfESG is currently investigating the possibility of piloting such approaches in a few countries.

The study of HEC is still a work in progress. As situations evolve, so will the challenges change. More research and lesson-learning will help understand the driving factors and help develop more effective strategies.

Key questions that repeatedly arose were these:

- Are the methods replicable in other contexts?
- How do we define and measure the success of HEC interventions in the short, medium and long term, and from whose perspective?
- How do we ensure the social, economic and environmental sustainability of HEC interventions after a project, especially an externally funded project, has ended?

Recommendations

Several recommendations emerged from the meeting, which those involved in HEC research, management and mitigation (including range state governments, NGOs and individuals) might find useful:

- Move towards a multisectoral or integrated approach to mitigating HEC.
- Develop more effective tools to communicate HEC issues to politicians and decisionmakers.
- Update existing conflict-mitigation tools, such as the IUCN/AfESG Decision Support System.
- Share HEC data sets within each country to make sound arguments at national levels.
- Involve the private sector in improving the design and innovation of HEC mitigation.
- Develop a network of those who work with elephants, for sharing information and experience.
- Establish funding priorities for HEC mitigation and management work for the donor community.
- Develop standard tools or guidelines for incorporating social research into HEC to help researchers harmonize data collection across the elephant range states.

Next steps

The meeting achieved its objectives of sharing lessons and identifying common findings and challenges. The discussion regarding a mechanism to facilitate a learning network was not conclusive, although it did suggest that practitioners were keen to stay connected. Participants committed themselves to stay in touch, to share information, and to explore in more detail a means of keeping the network alive and expanding its membership.

Two further outputs are planned. First, the papers presented will be published as proceedings with a synthesis of the findings and conclusions from each case study and recommendations from the discussion sessions. This will complement and build on existing literature and tools, and thus be of both scientific and practical value to other researchers and HEC project practitioners. The proceedings, expected to be completed by early 2007, will be distributed in print and electronic form to reach a wide readership.

Second, plans are under way for a follow-on meeting to be held in Thailand in early 2008. This will repeat the process of the Nairobi meeting, but in an Asian context with African representation, and will further contribute to building the foundations for a cross-continental information exchange network among HEC mitigation practitioners.

Acknowledgements

We are grateful to the donor agencies that made this meeting possible, in particular the Dutch Ministry of Foreign Affairs, which supports FFI's Biodiversity and Human Needs Programme, and the UK's Darwin Initiative for the Survival of Species, which funds the Thailand Elephant Project and previously funded the Transmara Project in Kenya. Additional support was provided by WWF and the Frankfurt Zoological Society. We would also like to thank Joy Juma for all her efforts in coordinating the preparation and organization of the meeting, and all the participants for their instructive contributions.

References

- Hill CM, Osborn FV, Plumptre AJ, eds. 2002, *Human wildlife conflict: identifying the problem and possible solutions*. Wildlife Conservation Society, New York.
- Hoare RE. 2001. *A decision support system for managing human–elephant conflict situations in Africa*. IUCN/SSC African Elephant Specialist Group, Nairobi.
- Jayewardene J, ed. 2004. *Endangered elephants past, present and future. Proceedings of the symposium on human–elephant relationships and conflicts, Sri Lanka, September 2003*. Biodiversity and Elephant Conservation Trust, Colombo, Sri Lanka.
- Karidozo M, Osborn FV. 2005. Can bees deter elephants from raiding crops? An experiment in the communal lands of Zimbabwe. *Pachyderm* 39:26–32.
- O'Connell-Rodwell CE, Rodwell T, Rice M, Hart A. 2000. Living with the modern conservation paradigm: can agricultural communities co-exist with elephants? A five-year case study in East Caprivi, Namibia. *Biological Conservation* 93:381–391.
- Parker GE, Osborn FV. 2006. Investigating the potential for chilli *Capsicum* spp. to reduce human–wildlife conflict in Zimbabwe. *Oryx* 40:343–346.
- Sitati NW, Walpole MJ. 2006. Assessing farm-based measures for mitigating human–elephant conflict in Transmara District, Kenya. *Oryx* 40:279–286.
- Sitati NW, Walpole MJ, Leader-Williams N. 2005. Factors affecting susceptibility of farms to crop raiding by African elephants: using a predictive model to mitigate conflict: mitigating crop raiding by African elephant. *Journal of Applied Ecology* 42:1175–1182.
- Sitati NW, Walpole MJ, Smith RJ, Leader-Williams N. 2003. Predicting spatial aspects of human–elephant conflict. *Journal of Applied Ecology* 40:667–677.
- Thouless CR, Sakwa J. 1995. Shocking elephants: fences and crop raiders in Laikipia District, Kenya. *Biological Conservation* 72:99–107.
- Walpole MJ. 2006. Partnerships for conservation and poverty reduction. *Oryx* 40:245–246.

RHINO NOTES

Rhino population sizes and trends

Richard Emslie

IUCN SSC African Rhino Specialist Group: email: remslie@kznwildlife.com

Population statistics for all wild populations of black and white rhinos as at the end of December 2005 are presented in tables 1–3. These statistics were revised and compiled at the AfRSG meeting held at Mlilwane Wildlife Sanctuary, Swaziland, from 27 June to 2 July 2006. This meeting was sponsored by UK's Department for Environment, Food and Rural Affairs (DEFRA). Estimates based on speculation or old data (speculative guestimates) are not included in the population totals given in these tables. Only country totals by subspecies are presented here as individual population details are kept confidential for security reasons.

White rhino

The number of northern white rhinos (*Ceratotherium simum cottoni*) has declined rapidly (table 1) in response to an upsurge in poaching pressure. Only four animals have so far been confirmed by intensive aerial surveys, follow-up flights and limited ground patrolling. This subspecies currently faces the greatest threat to its continued existence since 1984.

Southern white rhino (*C.s. simum*) numbers continue to increase rapidly. The population estimate for the biggest population (Kruger National Park) is higher than in 2003 and to some extent this reflects inherent sampling variability associated with getting population estimates for this very large population in a very large park. However, when viewed over time, population estimates for Kruger's white rhino population show a clear and marked upward trend. In the remaining southern white rhino populations, overall numbers have also increased by 780 since 2003. Numbers of southern white rhinos on private land in South Africa, however, are likely to be underestimated, as survey data for most of South Africa's privately owned southern white rhino populations were available only for 2004 and not 2005.

Black rhino

Foot surveys were recently undertaken over much of the range of the western black rhino (*Diceros bicornis longipes*) in Cameroon. Before the fieldwork started, survey leaders Jean Francois and Isabelle Lagrot spent time with experienced black rhino monitors in both KwaZulu-Natal, South Africa, and Zimbabwe, where they gained field experience in finding and identifying black rhino signs. For part of the survey they were joined by Africa's foremost rhino tracker, Jackson Kambwe from Zimbabwe. Unfortunately the survey teams failed to find any rhino signs in the areas covered. They also confirmed the strong suspicions of a number of AfRSG members that the supposed photographic evidence produced by an NGO to justify claims that rhinos still survived in greater numbers were of faked, not real spoor. As there were no rhinos left to monitor, trackers had taken to faking spoor in an attempt to keep their jobs. The survey teams also came across regular evidence of poaching and poachers. Thus it is feared that the western black rhino may have become extinct. Surveys continue in other areas not yet covered.

The number of eastern black rhinos (*D.b. michaeli*) continues to increase with marked increases in the major range state, Kenya. This is in part a response to more attention being paid to biological management. The single black rhino remaining in Rwanda died in 2006, but it is included in the 2005 statistics. There has been no confirmation of the continued existence of a possible 2–4 in Ethiopia. Numbers of this subspecies continue to increase rapidly in Tanzania and out of range in South Africa.

Estimated numbers of south-western black rhinos (*D.b. bicornis*) in 2005 were slightly lower than for 2003. However, this appears to be solely a function of the sampling variability inherent in the method used to

Table 1. Numbers of white and black rhinos in Africa as of 31 December 2005 by country and subspecies

Species	White rhino				Black rhino					Trend	
	C.s. <i>cottoni</i> (northern)	C.s. <i>simum</i> (southern)	Total	Trend	<i>D.b. bicornis</i> (south-western)	<i>D.b. longipes</i> (western)	<i>D.b. michaeli</i> (eastern)	<i>D.b. minor</i> (south-central)	Total		
Botswana		99	99	up+intro				5	5	extinct?	extinct?
Cameroon											
DR Congo	4		4	down							
Ethiopia							?			extinct?	?
Kenya		234	234	up			540	10	540	10	up
Malawi								?		?	?
Mozambique		?	?	?							?
Namibia		293	293	up	1,141				1,141		up
Rwanda							1		1		stable
South Africa		13,521	13,521	up	80		41	1,258	1,379		up
Swaziland		75	75	up				16	16		up
Tanzania							57	44	101		up
Uganda		4	4	new							
Zambia		2	2	down				6	6		up
Zimbabwe		308	308	up				527	527		down
Totals	4	14,536	14,540	up	1,221	0	639	1,866	3,726		up

Compiled by IUCN SSC African Rhino Specialist Group

Table excludes speculative guesstimates.

Numbers were primarily compiled at the UK DEFRA-sponsored 2006 IUCN SSC AFRSG meeting held in Swaziland.

Numbers of *D.b. minor* in Tanzania *D.b. longipes* in Cameroon and *C. cottoni* in DRC may be higher but this requires confirmation.

South African white rhino total = 2005 figures used for state and defence force areas and 2004 figures for private, municipal, zoo and biosphere reserves

Numbers of *D.b. bicornis* in Namibia show a slight decline since the last meeting, but this is due to a decline in the estimate of the largest population, which most

probably is just a function of the inherent precision of the method used to estimate numbers in this park. Other data indicate the underlying trend in this population

remains up. Numbers of this subspecies continue to increase in other populations.

Species totals >500 have been rounded to nearest 5 rhinos.

survey the largest single population of this subspecies. Other indicators for this population such as recorded mortalities and demographic data indicate that it continues to increase. Since 2003, numbers have also increased in other populations of south-western rhinos on state, private, custodianship and communal land.

The number of south-central black rhinos (*D.b. minor*) has also increased slightly but is below the minimum target level of 5% per annum due to continued suboptimal performance in some donor populations (following a period of conservative biological management) and increased snaring and poaching deaths in some Zimbabwe populations. With increased implementation of the Ezemvelo-KZN-Wildlife black rhino biological management policy, it is hoped that underlying growth rates of the South African metapopulation can once again increase above the minimum target figure of 5% per annum. While poaching and increased snaring in some Zimbabwe populations of south-central black rhinos are cause for concern, fortunately underlying growth rates in a number of Zimbabwean populations continue to be among the highest in Africa. And in joint Zimbabwe Wildlife Authority/WWF operations, over 50 rhinos have been treated for snare wounds, and others have been moved from vulnerable areas affected by land resettlement to new safer areas. The result is that despite increased mortalities, total numbers of this subspecies in Zimbabwe in 2005 are only slightly (-1.7%) lower than 2003. Had it not been for these field actions coupled with the good underlying growth in a number of lowveld populations, Zimbabwe black rhino numbers would have declined markedly. However, if high levels of poaching and snaring continue, numbers may decline further in this important range state. The numbers in Kruger National Park are conservative, and may well be higher. A block count trial is planned for one of the major areas in this park, and if successful its application to the whole park should improve knowledge of this AfRSG-rated *Key 1* population.

Overall, the number of black rhinos in the wild has increased by 1316 in 10 years, since numbers bottomed out at 2410 in 2005. This represents an annual growth rate of 4.45% per annum. However, some of this 'growth' is due to much improved population estimation in Africa's biggest black rhino population, and as a result the actual underlying growth in numbers is likely to be a little below the minimum target of 5% per annum.

Changes in numbers of AfRSG-rated *Key* and *Important* populations

The continued increase in overall numbers of both black and white rhinos is reflected in increases in the number of AfRSG-rated rhino populations (table 2). There are now 112 populations in Africa rated *Key* and *Important*, up from only 60 in 1995.

By the end of 2005 the 6 white and 6 black *Key1*-rated populations conserved 9273 (63.79%) of Africa's white rhinos and 1768 (47.45%) of the black. The 14 *Key2* and *Key3* white rhino populations conserved an additional 936 (6.48%) rhinos, with the 9 *Key2* and *Key3* black rhino populations conserving 563 (15.11%) more. Thus the AfRSG-rated *Key*-rated populations conserved 70.27% of white rhinos and 62.56% of black.

The number of *Important* white rhino populations has more than doubled in 10 years, from 22 in 1995 to 51 in 2005 with the number of *Important* black rhino populations also increasing over the last 10 years, from 16 in 1995 to 26 in 2005. *Important* white and black rhino populations in 2005 conserved a further 1593 (10.96%) white and 868 (23.3%) black rhinos.

The remaining unrated 352 white and 74 black rhino populations conserved 18.77% of wild white and 14.14% of wild black rhinos in 2005.

Rhinos under the various ownership models

The estimated number of African rhinos and the number of rhino populations as at the end of 2005 are given in table 3, broken down according to species, subspecies and management or ownership models. White rhinos in the Kruger National Park area of Greater Kruger National Park are listed under 'state', while those resident in the adjoining three private nature reserves are listed as privately owned.

Numbers of populations by model

In 2005, of the 423 known discrete white rhino populations in Africa, 349 (82.5%) were on private land (either privately owned or managed under custodianship for the state), and 51 occurred in state-run protected areas. While more numerous, many of these

Table 2. Total number of *Key* and *Important* African rhinoceros populations by country at 31 December 2005

Rating	Black rhino			White rhino			Total Key and Important
	Key1	Key2 + (Key3)	Important	Key1	Key2 + (Key3)	Important	
Botswana	0	0	0	0	0	2	2
DR Congo				1	0	0	1
Kenya	0	4	7	0	1(1)	2	15
Malawi	0	0	0				0
Mozambique	0	0	0	0	0	0	0
Namibia	2	0	2	0	2	2	8
South Africa	3	1(1)	7	5	8(1)	37	63
Swaziland	0	0	0	0	0	2	2
Tanzania	0	0	3				3
Uganda				0	0	0	0
Zambia	0	0	0	0	0	0	0
Zimbabwe	1	3	7	0	1	6	18
Total 2005	6	8(1)	26	6	12(2)	51	112
Total 2003	5	7(2)	22	6	11	45	98
Total 2001	5	11	19	5	9	44	93
Total 1999	5	6	18	5	6	36	76
Total 1997	5	7	15	5	6	33	71
Total 1995	5	6	16	6	6	21	60

privately owned white rhino populations are small with an average size of only 11 rhinos, compared with an average of 203 in state-run parks.

Of the 115 discrete black rhino populations in 2005, 45 occur on state-protected areas with an average size of 55 rhinos. Of populations that are privately managed, 37 (roughly a third) were managed on a custodianship basis (average size = 22). The number of privately owned populations continues to increase, numbering 23 in 2005, although with the odd exception these are generally very small (averaging only 11 rhinos each).

State-run national parks and game reserves

Table 3 shows that just over two-thirds (70.32%) of African rhinos are still conserved in state-run protected areas, with 23.18% privately owned and a further 4.36% managed by the private sector on a custodianship basis for the state. Rhinos on communal land account for a further 1.09% with only 1.04% of the continent's rhinos under other models.

Private ownership

In 2005 an estimated 3989 (27.43%) of Africa's southern white rhino were privately owned. Five out of the 20 AfRSG-rated *Key* white rhino populations in the world and a further 29 of the 51 AfRSG-rated *Important* white populations (that is, more than half) occurred on private land. One of the 6 *Key1* populations was a national park linked to adjacent private game reserves.

The number of privately owned black rhinos continues to increase, reaching 245 in 2005, up from only 76 in 1999. In 2005 there were 6 privately owned *Important* black rhino populations.

Private custodianship

In contrast to the pattern with white rhinos, there are many black rhinos on private land in Kenya, Namibia, Swaziland and Zimbabwe that are managed on a custodianship basis for the state (as opposed to being privately owned). The bulk of privately managed black rhinos are under custodianship on behalf of the state (21.39% of all black rhinos) with only 6.58% of

Table 3. Numbers of African rhinos under the various management systems in Africa, 31 December 2005

Species and subspecies	White rhinos		Black rhinos			Total black and white rhinos	
	<i>C.s. cottoni</i> (northern)	<i>C.s. simum</i> (southern)	Total	<i>D.b. bicornis</i> (south-western)	<i>D.b. michaeli</i> (eastern)		<i>D.b. minor</i> (south-central)
<i>Rhino populations (no.)</i>							
Communal		39 (3)	39 (3)	148 (1)	1 (1)	1 (1)	150 (3)
Communal with state mgmt		10 (1)	10 (1)			1 (1)	11 (2)
Other defence force/zoo NRs		48 (9)	48 (9)			0 (0)	48 (9)
Municipal/county council		39 (7)	39 (7)		34 (2)		73 (9)
Privately owned		3,989 (349)	3,989 (349)	22 (1)	41 (1)	182 (21)	4,234 (372)
Private custodianship		0 (0)	0 (0)	172 (22)	221 (6)	404 (9)	797 (37)
State		10,355 (51)	10,355 (51)	879 (9)	334 (10)	1276 (26)	12,844 (96)
Biosphere (state and private)		28 (1)	28 (1)			0 (0)	28 (1)
State owned with joint state and contractual management	4 (1)	28 (1)	32 (2)		8 (1)	2 (1)	42 (4)
TOTAL	4 (1)	14,536 (422)	14,540 (423)	1221 (33)	639 (21)	1,866 (55)	3,726 (115) 18,266 (539)
<i>Percentage of rhinos</i>							
Communal		0.27	0.27	12.12	0.16	0.05	4.03
Communal with state mgmt		0.07	0.07			0.05	0.06
Other defence force/zoo NRs		0.33	0.33				0.26
Municipal/county council		0.27	0.27		5.32		0.40
Privately owned		27.44	27.43	1.80	6.42	9.75	23.18
Private custodianship		0.00	0.00	14.09	34.59	21.65	4.36
State		71.24	71.22	71.99	52.27	68.38	70.32
Biosphere (state and private)		0.19	0.19				0.15
State owned with joint state and contractual management	100.00	0.19	0.22		1.25	0.11	0.23

Table excludes speculative guesstimates. Rhinos within Kruger National Park listed under state, those in adjoining three private reserves listed under privately owned.

black rhinos being privately owned. In 2005, the 15 AfRSG-rated *Key* populations of black rhinos included 4 Zimbabwean and 1 Kenyan custodianship population; with a further 8 *Important* custodianship populations. From 1997 to 2005 the number of black rhinos managed by the private sector on a custodianship basis has doubled—from 394 to 797.

Communal land

More black rhinos than white rhinos occur on communal land (150 vs 39), accounting for 4.03% of all black rhinos.

Municipal, county council, area authority reserves

In South Africa and Kenya there are a limited number of reserves and conservation areas run by local area or municipal authorities. The Masai Mara National Reserve in Kenya is run by the local Narok and Trans

Mara county councils. South Africa also has seven small municipally owned and run parks that have a few white rhinos.

Global status of rhinos in captivity (intensive management)

The latest estimates, presented by Evan Blumer at the 2006 AfRSG meeting, indicate that there are an additional 240 black rhinos (171 eastern, 69 southern, 0 south-western) and 760 white rhinos (10 northern and 750 southern) under intensive management worldwide. One of the northern whites has since died.

Postscript

Just before going to press the existence of one population of 7 southern white rhino was confirmed in Mozambique (as of 31/12/2006). Other reports of rhinos in the country still require confirmation.

Black Rhino Range Expansion Project

Pam Sherriffs

Black Rhino Range Expansion Project; email: psherriffs@wwf.org.za

Thirteen black rhinos were recently released onto the Pongola Game Reserve in northern KwaZulu-Natal, South Africa. The animals form the third founder population of the Black Rhino Range Expansion Project, a partnership between WWF and the provincial conservation organization Ezemvelo KZN Wildlife. To create the Pongola Game Reserve, six neighbouring landowners brought together 13,000 hectares of land under single management for the benefit of black rhinos.

Through the Black Rhino Range Expansion Project more than 80,000 hectares of land in KwaZulu-Natal have been brought under more rational conservation use over the last three years.



A translocated rhino is released on to Pongola Game Reserve.

Ezemvelo-KZN Wildlife



These large blocks of uninterrupted land provide new areas in which rhinos are breeding.

‘The project has contributed more than anything in recent years to creating large blocks of uninterrupted land devolved to sound conservation principles. It has been talked about for years—the project has proved that it can happen,’ says WWF project leader Dr Jacques Flamand.

The project aims to increase the number of black rhinos by increasing the land available for their conservation, thus reducing pressure on existing reserves and providing new areas in which they can breed rapidly. It does this by facilitating partnerships between neighbouring landowners to create large areas of land with good black rhino habitat.

The project’s first founder population of 15 animals was released on to Mnyawana Game Reserve in 2004. The second population of 21 animals was released onto the Zululand Rhino Reserve in 2005. Both reserves were created by a number of neighbouring landholders in order to receive black rhinos from Ezemvelo KZN Wildlife.

‘We are delighted at how well things have gone at both of those sites. We have three calves so far and are expecting more,’ Dr Flamand said. He also praised the many landowners who have helped the project succeed. ‘Landowners have committed themselves to partnerships with one another and with Ezemvelo KZN Wildlife to look after black rhino on a custodianship basis. For many this has required brave sacri-

ifice. They have given up a degree of independence by taking down fences with their neighbours and they have contributed significantly, in cash and kind, to protecting black rhinos on their land.’

The uninterrupted blocks of land catalysed through the project range in area from 13,000 hectares to 24,000 hectares and there is the exciting prospect of links between them. There are also excellent

prospects of bringing in community-owned land, Dr Flamand said. ‘Through the Black Rhino Range Expansion Project we hope to make black communities real stakeholders in conservation, which is important for the long-term security of the black rhino and other endangered species.’

The WWF and Ezemvelo KZN Wildlife Black Rhino Range Expansion Project is made possible through funding from WWF-Netherlands, through WWF-South Africa, and is supported by the Mazda Wildlife Fund.

As part of the ongoing attempt to minimize stress for translocated animals, a new release technique was tried this year. The animal is given an anaesthetic in the crate. As it is about to fall asleep, the door is opened and it wanders out. A rope is held to slow its momentum. Ideally, it falls asleep just outside the crate. All equipment, lorries and staff leave the area, except for the person who administers the antidote. When the animal wakes up a few minutes later, there is nothing around to disturb it.

In almost all of the releases at Pongola, the translocated rhinos immediately started browsing.

For more information contact
Dr Jacques Flamand
email: jflamand@wwf.org.za
tel: +27 (0)82 705 9710; +27 (0)35 550 0666

TRIBUTES

A jungle in mourning: Nepal loses its leading defenders of large mammals

Eric Dinerstein

Chief Scientist and Vice President for Science, WWF-US; email: eric.dinerstein@wwfus.org

On 23 September 2006, Dr Tirtha Man Maskey, Mr Narayan Poudel, Mr Mingma Norbu Sherpa and Dr Chandra Prasad Gurung perished along with seven other irreplaceable leaders in conservation in a helicopter crash on the steep slopes below Mt Kangchenjunga, the third highest peak in the world. The team had just departed from Ghunsa village in eastern Nepal after officially handing over the recently created Kangchenjunga Conservation Area—the centerpiece of WWF’s Sacred Himalayan Landscape—to local communities to manage.

I cannot recall any time in recent history when a single nation suffered the loss of so many top conservationists in a single tragic accident. This memorial dwells not on the staggering void created by their deaths but rather highlights the magnitude of their accomplishments as well as their endeavours to save large Asian mammals.

Not long ago I had the good fortune to accompany them in the Terai Arc Landscape in the plains of southern Nepal. This was the spring of 2004. This landscape is the site of an ambitious plan to reconnect 12 parks and reserves through some of the world’s most densely populated areas spanning 950 km in lowland Nepal and continuing through northern India. It has the goal of managing Asia’s megavertebrates, which include the tiger, the Asian elephant and the greater one-horned rhinoceros as a single population linked by dispersal or translocations.

We met in Chitwan National Park to help shoot a segment on rhinoceros translocation for the CBS news show *60 Minutes-II*. After an hour on elephant-back of searching for rhinos, some of our elephants suddenly formed a circle around a female rhinoceros standing defiantly in the tall grass. The driver of one



WWF/ASRSG office, Kathmandu

The late Dr Tirtha Man Maskey

of the domestic elephants positioned himself to allow Dr Tirtha Man Maskey, then director general of National Parks and Wildlife Conservation, get a clean shot with a tranquilizer dart.

It was fitting that Dr Maskey be given the honour of darting the rhino as he served as the first warden of



The late Mr Mingma Norbu Sherpa



The late Dr Chandra Prasad Gurung

Chitwan back in 1972 and as director general, had stressed the need to translocate large mammals to re-establish extirpated populations in the Terai reserves. The operation was routine because Nepal's wildlife officials had embarked upon a ground-breaking effort in 1986 to be the first nation to capture, radiocollar,

study, and eventually translocate this species to reserves where they historically occurred but had been poached to extinction more than two centuries ago. By this point in the spring of 2004, more than 150 rhinos had been captured either for research or for translocation to Bardia or Sukla Phanta National Parks in Nepal's western lowlands, without a single mortality during capture.

Also on hand were Dr Chandra Gurung, the country representative of WWF-Nepal, and Mingma Norbu Sherpa, an early protégé of Sir Edmund Hillary and the first Sherpa warden of Mt Everest National Park. For many years Mingma served as WWF's director for the Eastern Himalayas programme, which included Nepal, India, Bhutan and Tibet Autonomous Region.

Chandra and Mingma had garnered international acclaim for their efforts to create the Annapurna Conservation Area, the first large landscape managed by an NGO for the benefit of montane wildlife and mountain peoples. Chandra hailed from a Gurung village several days' walk from Pokhara, on the slopes of Annapurna. He was a local hero, well recognized for his achievements. Mingma joined Chandra in an effort to create a conservation area with an innovative self-financing mechanism that set the stage for a tremendous leap forward promoted under Maskey's tenure as director general: the government of Nepal declared that 50% of all revenue generated by parks be recycled to buffer zones surrounding nature reserves rather than deposited in the national treasury. Overnight, those living around parks had a much larger stake in conservation.

Maskey hailed from Kathmandu, but between his stint as warden of Chitwan and his pioneering dissertation field work on the biology of the gharial, an endangered crocodylian, he was at home in the hot and steamy terai jungle. Mingma and Chandra were two Himalayan mountain men, but together with Maskey, they were the driving force behind the creation of the Terai Arc Landscape. While Chandra and Mingma helped secure funds and bring global attention to this landscape, Maskey was their government ally, often working behind the scenes to leap bureaucratic hurdles. Their efforts culminated when the Nepal government made the Terai Arc Landscape part of its five-year plan and recently even created an office in the Department of Forests dedicated to implementing the Terai Arc Landscape plan.

Mr Narayan Poudel had half a year ago been promoted to director general of the Department of Na-

tional Parks and Wildlife Conservation, taking over the helm from Dr Maskey. He did his bachelor's and master's degrees in botany in the USA. He was one of the key persons in establishing Makalu-Barun National Park. Recently he was faced with the difficult task of restoring security in Nepal's rhino areas after a spate of poaching caused by the political unrest of the last two years had reduced the number of rhino by about one-third.

None of these four were men of modest dreams. They envisioned vast landscapes in the eastern Himalayas region where corridors connected protected areas, spanned elevational gradients and transcended national boundaries. Above all, they also envisioned involving local people from the outset in planning these conservation areas, and in entrusting them with stewardship of managing these landscapes. Their vision was to fully integrate community-based conservation with contemporary conservation biology.

They were doers who served as the best role models for aspiring Asian conservationists. They could grasp new ideas and adapt them to local realities; they were willing to take risks and be on the leading edge

of conservation techniques. They cut through bureaucracy and red tape, ensured that field efforts were based on the best science, championed the causes of those living near parks, and charmed international donors into supporting their field programmes. They impressed everyone with their field experience and their professionalism.

Maskey used to say, 'If you are a friend of wildlife you are my friend.' He applied this to everyone, no matter what their country of origin. At the time of his death he was the Co-Chair of the Asian Rhino Specialist Group, thus assuming a leadership role to ensure the future of Asia's rhinos. Mingma and Chandra were committed to seeing the blueprints and foundations of the Sacred Himalayan Landscape and the Terai Arc Landscape, two big landscapes they championed nationally, regionally and globally to become a reality, and the successes achieved there are testament to their leadership.

Conservation and the large mammals of Nepal have lost four of their greatest friends and defenders. The world should honour them by picking up where they left off and completing their noble mission.

Andries Marthinus (Clem) Coetsee

13 May 1939–4 September 2006

Russell Taylor

email: rtaylor@wwfsarpo.org

A world without Clem is hard to believe. We all thought Clem would endure forever and that he was without time. This modest, unassuming man was unsparing of himself for the wildlife he loved and served so well. His commitment, dedication and compassion for both his fellowmen (especially children!) and the wildlife he worked so hard for are immeasurable.

Clem's outstanding and exemplary wildlife conservation career in the Zimbabwe Game Department and later the Department of National Parks and Wildlife Management, began with Tsetse Control Operations in the early 1960s, in the Copper Queen and Gokwe areas of the Sebungwe District, south of the then newly filling Lake Kariba. With his brother Paul and others, he was responsible for large-scale game

control activities, and together these two men become legendary for their bushcraft and hunting skills.

Clem then moved closer to the Zambezi Valley, firstly to Mana Pools, his favourite and probably most loved station, and then in the early 1970s on to Matusiadonha Game Reserve, as it was then known. He was also intimately involved at this time with the early capture and translocation of black rhinos from newly settled areas in Binga and Gokwe. He continued with the early work of developing Matusadona National Park, which Rob Francis had so ably commenced at the end of the 1960s.

The next posting Clem took up was that of running the Game Management Unit at Umtshibi in Hwange National Park. Here he was responsible for

running game management operations across the country. It was here also that Clem perfected the art and science of large-scale elephant reductions, a task that no one ever enjoyed but which Clem, together with his team of young rangers, tackled with formidable energy and fortitude, but never without humour. Always with a twinkle in his eye, Clem's humour never failed to restore lagging spirits and morale when the going was tough.

During the severe droughts of the early 1990s, which were especially devastating in the south-east lowveld, Clem pioneered the mass capture, movement and translocation of live elephant herds, from

Gonarezhou National Park mostly to the Save Conservancy but also elsewhere, notably to South Africa. For these innovative and remarkable conservation efforts, Clem gained well-deserved international recognition.

Thereafter Clem left the Department of National Parks to run and manage his own game management business in the lowveld.

Clem Coetsee was, in every respect, a good man who will be sorely missed. Our deepest sympathies go to his wife, Em, daughter, Beth, son, Vicus, and his brothers, Paul and Vic, and sisters, Anne and Mimie, and all their families.

GUIDELINES TO CONTRIBUTORS

Aim and scope

Pachyderm publishes papers and notes concerning all aspects of the African elephant, the African rhino and the Asian rhino with a focus on the conservation and management of these species in the wild. At the same time, the journal is a platform for disseminating information concerning the activities of the African Elephant, the African Rhino, and the Asian Rhino Specialist Groups of the IUCN Species Survival Commission.

Submission of manuscripts

Submit manuscripts electronically by email. Alternatively, submit a hard copy and floppy disk or CD by mail.

Email contributions should be sent to:

afesg@iucn.org

with copy to: hvh@wananchi.com

Contributions by post to:

The Editor, *Pachyderm*

IUCN/SSC AfESG

PO Box 68200 – 00200

Nairobi, Kenya

tel: +254 20 3876461; fax: +254 20 3870385

Preparation of manuscripts

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

Title and authors: The title should contain as many of the key words as possible but should not be more than 25 words long. Follow with the name(s) of the author(s) with institutional affiliation and full postal and email address(es). Indicate the corresponding author, to whom proofs and editorial comments will be sent; give post and email addresses for the corresponding author.

Research papers: Should be not more than 5000 words and be structured as follows: 1) Title (as above), 2) Abstract of not more than 250 words (informative type, outlining information from the Introduction, Materials and methods, Results, Discussion, but not detailed results), 3) additional key words (if any), not appearing in the title, 4) Introduction, 5) Materials and methods, 6) Results, 7) Discussion, 8) Conclusions if appropriate, 9) Acknowledgements (optional, brief), 10) References, 11) Tables, 12) Figure and photo captions, 13) Figures and photos.

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

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

Field notes: The journal welcomes notes from the field. They may contain figures and tables but should be brief.

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

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

Journal conventions

Nomenclature

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

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

Spelling

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

Numbers

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

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

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

References

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

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

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

- Adams JX. 1995b. Seizures and prosecutions. *TRAFFIC Bulletin* 15(3):118.
- Dobson AP, May RM. 1986. Disease and conservation. In: ME Soulé, ed., *Conservation biology: the science of scarcity and diversity*. Sinauer Associates, Sunderland, MA. p. 123–142.
- Struhsaker TT, Lwanga JS, Kasenene JM. 1996. Elephants, selective logging and forest regeneration in the Kibale Forest, Uganda. *Journal of Tropical Ecology* 12:45–64.
- Sukumar R. 1989. *The Asian elephant: ecology and management*. Cambridge Studies in Applied Ecology and Resource Management. Cambridge University Press, Cambridge.

Cite unpublished material as follows:

- Tchamba MN. 1996. Elephants and their interactions with people and vegetation in the Waza–Logone region, Cameroon. PhD thesis, University of Utrecht, The Netherlands. 142 p.
- Woodford MH. 2001. [Title]. [*Journal* or publisher]. Forthcoming. [if publication date is known]
- Woodford MH. [Title]. [*Journal* or publisher]. In press. [if publication date is not known]

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

‘Pers. comm.’ accompanied by the date and name of the person is cited in the text but not given in the reference list.

ISSN 1026 2881