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Cover photo: An Amboseli elephant with her calf
Photo credit: Kadzo Kangwana

CHAIRMAN'S REPORT: ASIAN RHINO SPECIALIST GROUP

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After two years of development, the Global Environment Fund (GEF) project on the conservation strategy for rhinoceros in south-east Asia has been approved by the United Nations Development Programme (UNDP) and the governments of Indonesia and Malaysia. The project will be activated in January 1995 and will continue for three years. The development of this GEF project was initiated at the December 1992 "Preliminary UNEP Conference among Rhinoceros Range States, Consumer States, and Donors". The Asian Rhino Specialist Group (AsRSG) has been facilitating development of the project and will continue to provide technical co-ordination and support for its implementation.

It is believed that this project represents the first GEF project which specifically concentrates on the rhinoceros, and, in fact, on a species as opposed to on more general ecosystems or biodiversity. This is in recognition of the "emergency" situation which exists for the Sumatran and Javan rhino in south-east Asia. However, the project will use the rhinoceros in these areas as both an "umbrella" and a "flagship" species for conservation of its ecosystem.

The GEF project will help to catalyse full implementation of the conservation strategy and action plans for the rhino in both Indonesia and Malaysia, the only significant range states for the Sumatran rhino. The project will concentrate on the Sumatran rhino, but benefits will accrue to the Javan rhino. The Sumatran rhino is considered the more critically endangered of the two species. Although fewer in total number than the Javan rhino, the Sumatran rhino population has declined by perhaps 50% over the last decade, during which Javan rhino populations have remained relatively stable. It is considered that the Javan rhino, at least the Indonesian population in Ujung Kulon, is less exposed at the moment than the Sumatran rhino.

The project will provide technical training, operational support, and a long-term funding plan. Basically, the project has three major elements, each to be accomplished by specific outputs:

1. To enhance the capabilities of conservation agencies (governmental and non-governmental) to arrest and reverse the decline of the rhinoceros due to poacher activity and habitat disturbance.

Outputs

- Rhino protection units will be organised, for which personnel will be trained and deployed in both Indonesia and Malaysia (ten in each country). These units will be effectively engaged in both anti-poaching and community outreach programmes. Moreover, they will be able to train more units and serve as models for other areas with rhinos.

- Improved management structures with dedicated national co-ordinators (Rhino Conservation Officers or RCOs) in both Indonesia and Malaysia will be established.

- The rhino protection units will reduce poacher activity to the point of elimination within the areas covered. Reduction will be measured by numbers of traps and poachers detected, and numbers of rhinos known to be lost.

- A number of rhinos, particularly in Malaysia, will be translocated from isolated situations into intensive protection zones, represented by the operating areas of the rhino units.

- Monitoring of rhinos by radio-telemetry will provide improved information on rhino status and biology, which will benefit the conservation programmes.

2. To develop more involvement by, as well as benefits and incentives for, local human communities in rhino conservation.

Outputs

- Persons from local communities will be employed in the rhino protection units; income generating activities (e.g. eco-tourism) will be delineated and initiated; local communities will develop appreciation of, and pride in, the rhino, its ecosystem and its conservation.

- In conjunction with the World Bank Kerinci Seblat programme and possibly another project to be proposed, baseline data, which is required for the development of an effective community involvement programme, will be collected.

3. To formulate, catalyse and initiate a comprehensive, sustainable funding plan for rhino strategy.

Outputs

- A strategic funding plan will be formulated to link target donors with specific modules of the conservation programme.

- Proposals to these donors (government and nongovernmental, within and beyond Indonesia and Malaysia) will be prepared and presented.

- At least one major long-term income generating eco-tourism project will be facilitated in conjunction with the development of a Sumatran Rhino Sanctuary where rhinos, currently in captivity, will be placed. It is hoped that the more natural conditions of the sanctuary will stimulate propagation.

RAPPORT DU PRESIDENT: GROUPE DE SPECIALISTES DU RHINOCEROS ASIATIQUE

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Après deux ans de mise au point, le projet du Fonds Global pour l'Environnement (Global Environmental Fund - GEF) pour la stratégie de conservation des rhinocéros de l'Asie du Sud-Est a été approuvé par le Programme des Nations Unies pour le Développement (PNUD) et par les gouvernements d'Indonésie et de Malaisie. Le projet sera mis en route en janvier 1995 et durera trois ans. La mise au point de ce projet GEF a démarré lors de la "Conférence Préliminaire du PNUE pour les Etats de distribution des Rhinocéros, les Etats Consommateurs et les Donateurs", en décembre 1992. Le GSRAs a facilité la mise au point du projet et continuera à fournir une coordination technique et son soutien pour la réalisation.

On croit que ce projet est en fait le premier projet GEF qui se concentre spécifiquement sur les rhinocéros, et même réellement sur une espèce, par opposition à des écosystèmes plus généraux ou à la biodiversité. Cet événement souligne l'urgence de la situation qui affecte aujourd'hui le Rhinocéros de Sumatra et le Rhinocéros de Java en Asie due Sud-Est. Cependant, le projet se servira du rhinocéros dans ces régions à la fois comme une justification et comme une pièce maîtresse pour la conservation de son écosystème.

Le projet GEF aidera à catalyser la pleine réalisation de la stratégie et des plans d'application de la conservation des rhinos tant en Indonésie qu'en Malaisie, les seuls pays de distribution significatifs pour le Rhinocéros de Sumatra. Le projet se concentrera sur le Rhinocéros de Sumatra mais le Rhinocéros de Java en retirera des avantages accrus. On considère que le Rhinocéros de Sumatra est l'espèce la plus menacée des deux. Bien que leur nombre total ait été inférieur à celui des Rhinocéros de Java, les populations de Rhinocéros de Sumatra ont décliné de peut-être 50% au cours de la dernière décennie, alors que les populations de Rhinocéros de Java restaient relativement stables. On considère que le rhinocéros de Java, en tout cas la population indonésienne d'Ujung Kulon, est moins exposée pour le moment que le Rhinocéros de Sumatra.

Le projet fournira une formation technique, un support opérationnel, ainsi qu'un programme de financement à long terme. Fondamentalement, le projet a trois composants majeurs qui doivent chacun être réalisés par des moyens spécifiques:

1. **Améliorer les possibilités dont disposent les agences de conservation (gouvernementales ou non) pour stopper et inverser le déclin des rhinocéros dû à l'activité du braconnage et à la perturbation de l'habitat.**

Moyens

- On organisera des unités de protection des rhinos pour lesquelles on formera du personnel qui sera déployé tant en Indonésie qu'en Malaisie (10 dans chaque pays). Ces unités seront impliquées efficacement dans le programmes antibraconnage et dans ceux qui touchent les communautés concernées. De plus, elles seront à même de former des unités supplémentaires et serviront de modèles pour d'autres régions qui ont des rhinos.

- On installera de meilleurs structures de gestion, avec des coordinateurs nationaux dévoués (Responsables de la Conservation des Rhinos - en Anglais :Rhino Conservation Officers ou RCO) en Indonésie et en Malaisie.

- Les Unités de protection des rhinos réduiront l'activité des braconniers jusqu'à l'éliminer dans les régions sous contrôle. La réduction pourra se mesurer par le nombre des pièges et de braconniers que l'on aura détectés et par le nombre de rhinos dont on apprendra la perte.

- Un certain nombre de rhinos, particulièrement en Malaisie, seront déplacés, allant des endroit isolés vers des zones de protection intensive, c'est à dire là où les unités pour les rhinos seront opérationnelles.

- La surveillance des rhinos par radiotélémétrie apportera de meilleures informations sur le statut et la biologie des rhinos, qui aideront les programmes de conservation.

2. Susciter une meilleure implication de, ainsi que de plus grands avantages et stimulants pour les communautés humaines locales, dans la conservation des rhinos.

Moyens

- On emploiera des personnes venant des communautés locales dans les unités de protection des rhinos; on sélectionnera et on lancera des activités qui génèrent des revenus (par ex. l'écotourisme); les communautés locales ressentiront l'approbation et la fierté de posséder leurs rhinos, leur écosystème et sa conservation.

- En collaboration avec le projet Kerinci Seblat de la Banque Mondiale, et, peut-être, un autre projet qui devrait être présenté, on récoltera des données de base qui seront nécessaires pour la mise au point d'un programme efficace d'implications des communautés locales.

3. Formuler, catalyser et lancer un programme de financement général et durable pour la stratégie pour le rhino.

Moyens

- On formulera un programme de financement stratégique pour lier les donateurs cibles à des modules spécifiques du programme de conservation.

- On préparera et on présentera des propositions à ces donateurs (qu'ils représentent ou non des gouvernements, en Indonésie, en Malaisie et ailleurs).

- On facilitera au moins un projet majeur d'écotourisme, générant des revenus àlong terme, en conjonction avec la mise au point d'un Sanctuaire pour le Rhinocéros de Sumatra où l'on placera les rhinos qui sont actuellement en captivité. On espère que les conditions plus naturelles du sanctuaire stimuleront la propagation de l'espèce.

CHAIRMAN'S REPORT: AFRICAN RHINO SPECIALIST GROUP

Martin Brooks

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The African Rhino Specialist Group (AfRSG) has entered its second triennium since splitting from the combined elephant/rhino group, and invitations for 1994-96 membership have been sent to individual specialists and Range States for nomination of their representatives. Members are thanked for their wholehearted support of the Group's activities over the past three years and should draw significant encouragement from what has been achieved.

Since its Mombasa meeting in May 1994, the AfRSG has been actively assisting in the development of conservation management and funding strategies, and has secured the services of its first Scientific/ Programme Officer; the post being jointly funded by the Commission of the European Union, the United Kingdom Department of the Environment and WWF Africa and Madagascar. The Honourable Richard Emslie was appointed in mid-October 1994, and is based in Pietermaritzburg with the Chairman.

Northern white rhino strategy

At the request of WWF, the Chairman held a meeting in Nairobi in October 1994 to assess the progress with the report which aims to assess the various management options for the long-term conservation of the northern white rhino. The information collected by Kes Smith will be developed further by Holly Dublin and Tom Foose, and a final report should be completed by the end of April 1995. A workshop is planned for August or September 1995 in Kwa-Zulu/ Natal, South Africa, at which key players will discuss the management and funding options, and decide on appropriate action.

Interaction with UNEP

The Chairman attended a UNEP meeting at Gigiri, Kenya in October 1994 at which collaboration between UNEP's newly-created Elephant and Rhino Conservation Facility and IUCN's specialist groups for elephants and rhinos in Africa and Asia was discussed. A common mission was developed, the roles and responsibilities of the Facility and the Specialist Groups discussed, and a mechanism for sustained collaboration agreed upon. The most critical role of the Facility is seen by the Specialist Groups to be the acquisition of funds for both global and national rhino conservation projects.

CITES Conference of the Parties 9

The Scientific Officer and Tom Foose, who represented the AfRSG at COP9 as part of IUCN's delegation, contributed to a number of debates on rhinoceros issues.

In presenting their proposal to downlist the Southern White Rhino from Appendix Ito II, the South African delegation stressed that they had no intention of initiating trade in rhino horn under their proposal. The AfRSG's representatives pointed out that the South African population of white rhino qualified for downlisting to Appendix II under the Berne criteria, and that CITES should encourage self-reliance in Parties, noting that the proposal could provide financial and conservation benefits for South African rhinos.

The annotated South African proposal for 'Transfer of the South African populations of southern white rhinoceros *Ceratotherium simum* from Appendix Ito Appendix II for sale of live animals to appropriate and acceptable destimations, and hunting trophies only", was approved by 66 votes to 2 with strong range state support. This downlisting is valid until the next meeting of the Conference of the Parties when it will be reviewed.

The AfRSG was requested to introduce the draft resolution on "Conservation of rhinoceros in Asia and Africa" which it had prepared at the request of the CITES Standing Committee. The basic premise of the resolution was that current conservation measures, including some of the CITES provisions, have not succeeded in arresting or reversing the decline in rhino numbers. The resolution proposed that all conservation measures be evaluated; and that adaptive management be instituted based on such evaluations. The resolution advocated that a full range of options be considered and that opportunities to use those options had to be kept open. The need to expand funding sources to respond to substantial needs was articulated with a particular emphasis on sustainability and self-reliance within range states. WWF reported that provisional findings of a cost: benefit study on rhinoceros conservation indicated that the total budget allocated to in-situ conservation was the best predictor of rhino conservation success. The AfRSG pointed out that it had been estimated that to successfully manage and protect rhino sanctuary populations could cost as much as US$1,000 to $l,200/km^2/year.

The resolution was passed with minor modifications. Most importantly Resolution Conf 3.11 and 6.10 were repealed. The latter had called on parties to destroy horn stocks. The Group argued that this was no longer considered appropriate, and that burning horn stockpiles would in all probability lead to accelerated depletion of wild populations by increasing horn values on the illegal market and hence poaching pressure.

AfRSG activities for the coming period

- Design and initiate a regular newsletter.
- Design and set up databases to manage data on rhino numbers, distributions, poaching statistics and other key attributes.
- Compile an Action Plan for African rhinos.
- Establish basic survey and planning requirements of range states without "key" populations.
- Contribute to the revision of the regional black rhino conservation plan for Namibia and South Africa.

RAPPORT DU PRESIDENT: GROUPE DE SPECIALISTES DE RHINOCEROS AFRICAIN

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Le Groupe de Spécialistes de Rhinoceros Africain (GSRAf) a entamé son deuxième triennat depuis la séparation du groupe conjoint éléphants/rhinos, et on a envoyé à des spécialistes individuels ansi qu'aux états de distribution, des invitations à soumettre leurs représentants à la nomination pour être membres de 1994 à 1996. Nous remercions les membres pour le support enthousiaste qu'ils ont apporté aux activités du Groupe au cours des trois dernières années; ce qui a été réalisé devrait les encourager significativement.

Depuis sa réunion de mai 1994 à Mombasa, le GSRAf s'est impliqué activement dans 1' aide à la mise au point d'une gestion de conservation et de stratégies de financement et s'est assuré les services de son premier responsable de programme Scientifique: ce poste est financé conjointement par la Commission de l'Union Européenne, par le Département de l'Environnement du Royaume Uni et par le bureau Afrique et Madagascar du WWF. L'Honorable Richard Emslie a été nommé à la mi-octobre 1994 et est basé à Pietermaritzburg, avec le Président.

Stratégie pour le rhinocéros blanc du Nord

A la demande du WWF, le Président a tenu une réunion à Nairobi, en octobre 1994, pour estimer le progrès du rapport qui doit évaluer les différentes possibilités de gestion en vue de la conservation à long terme du rhino blanc du Nord. Les informations recueillies par Kes Smith seront analysées plus profondément par Holly Dublin et par Tom Foose, et un rapport final devrait être terminé pour la fin avril 1995. On a prévu un atelier en août ou septembre au Kwa-Zulu/Natal, en Afrique du Sud, lors duquel les partenaires principaux discuteront des options de gestion et de financement et décideront des actions appropriées.

Interaction avec le PNUE

Le Président a assisté à une réunion au PNUE à Gigiri en octobre 1994, au cours de laquelle on a discuté de la collaboration entre le nouvel Organisme pour la Conservation de l'Eléphant et du Rhino du PNUE et les groupes des spécialistes des éléphants et des rhinos de l'UICN en Afrique et en Asie. On a mis au point une mission commune,on a discuté du rôle et des responsabilités du nouvel organisme et des groupes des spécialistes et l'on s'est mis d'accord sur un mécanisme de collaboration durable. Le groupe des spécialistes estime que le rôle le plus délicat de l'organisme est d'obtenir des fonds pour les projets de conservation des rhinos tant globaux que nationaux.

9iéme Conférence des Parties CITES

Le responsable scientifique et Tom Foose qui représentaient le GSRAf à la 9ième CDP dans la délégation de l'UICN ont participé à nombre de débats touchant les rhinocéros.

En présentant leur proposition de déclassement du Rhino Blanc du Sud de l'Annexe I vers l'Annexe II, la délégation sudafricaine a souligné le fait qu'ils n'avaient pas l'intention de relancer le commerce de la corne de rhino en profitant de leur proposition. Les représentants du GSRAf ont fait remarquer que les populations sudafricaines de rhinos blancs répondaient aux Critères de Berne pour être déclassés à l'Annexe II et que la CITES devrait encourager l'autonomie des Parties, soulignant que leur proposition pourrait entraîner des avantages au point de vue des finances et de la conservation, pour les rhinos sudafricains.

La proposition sudafricaine annotée pour le "Transfert des populations sudafricaines de Rhinocéros Blancs du Sud, *Ceratotherium simum* de l'Annexe I vers l'Annexe II pour permettre la vente d'animaux vivants vers des destinations adéquates et acceptables et pour les trophées de chasse uniquement" a étè approuvée par 66 voix contre 2, avec le ferme soutien des pays de distribution. Ce déclassement est valide jusqu'à la prochaine réunion de la Conférence des Parties, lors de laquelle il sera révisé.

On a demandé au GSRAf de présenter un projet de résolution sur "la Conservation des rhinocéros en Asie et en Afrique", qu'il a préparé à la demande du Comité Permanent de la CITES. Le principe de base de la résolution était que les mesures de conservation actuelles, y compris certaines des conditions posées par la CITES, n'avaient pas réussi à stopper ni à renverser la baisse du nombre des rhinos. La résolution a proposé d'évaluer toutes les mesures de conservation et d'instaurer une gestion adaptée sur base de ces évaluations. La résolution a demandé que toute une gamme d'options soient analysées et que les possibilités de choisir ces options restent ouvertes. On a exprimé le besoin d'élargir les sources de financement pour répondre aux besoins substantiels, en insistant sur la soutenabilité et l'autonomie de états de distribution. Le WWF a rapporté que les conclusions provisoires d'une étude coût/bénéfice sur la conservation du rhino montrait que le montant total du budget alloué à la conservation *in situ* étaitle meilleur atout pour le succès de la conservation du rhino. Le GSRAf a souligné le fait qu'on avait estimé que pour gérer et protéger efficacement les populations des sanctuaires de rhinos, le coût pouvait aller de US$1.000 à l.200/km^2/an.

La résolution est passée avec des modifications mineures. Plus important, les Résolutions Conf.3. 11 et 6.10 ont été annulées. La dernière en avait appelé aux parties pour détruire les stocks de cornes. Le Groupe a expliqué qu'il ne considérait plus cette démarche comme nécessaire et que le fait de brûler des stocks de cornes conduirait selon toute probabilité à une réduction accélérée des populations sauvages en augmentant la valeur des cornes sur le marché illégal et, par là-même, une accentuation du braconnage.

Activités du GSRAf dans un proche avenir

- Concevoir et lancer une feuille de contact régnlière.
- Concevoir et instaurer une banque de données interne pour gérer toutes les données sur les nombres de rhinos, leur distribution, les statistiques de braconnage et les autres sujets d'importance.
- Composer un Plan d'Action pour les Rhinos Africains.
- Etablir les exigences de base pour l'étude et la programmation dans les Etats de Distribution, sans les "populations-clefs".
- Contribuer à la révision du plan régional de conservation du rhinocéros noir pour la Namibie et l'Afrique du Sud.

CHAIRMAN'S REPORT: AFRICAN ELEPHANT SPECIALIST GROUP

Holly T. Dublin
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On behalf of the AfESG

This past year, 1994, has been an important and active one for the African Elephant Specialist Group (AfESG), both as a whole and for many of its members in their individual capacities. With an AfESG meeting and a CITES meeting in the same year, the African elephant featured prominently in international conservation debates and on meeting agendas.

This issue of *Pachyderm* contains several papers which emanate from our last meeting in Mombasa, where the Group focused on describing and objectively examining the subject of human-elephant conflict. Together these articles present an excellent introduction to the topic for both "old hands" and relative "newcomers" to the field. Kangwana gives an overview of human-elephant conflict, highlighting the problems and proposing areas for future focus. Kiiru describes the general situation in Kenya while the papers by Barnes, Tchamba, Ngure, and Smith present specific conflict situations under different circumstances in individual countries. Lindeque puts the human-elephant issue in the context of a national management policy in Namibia. Hoare outlines the options for controlling elephants in conflict with people, using Zimbabwe's experience to provide examples of various methods being applied.

While these papers and our discussions at the meeting provided a firm basis to share experiences and work towards finding possible solutions, there is still much to be done. I believe that we can expect these problems to intensify in many range states before we see any improvement. The work of the AfESG in both predicting the occurrence of human-elephant conflict and in mitigating its effects, through innovative and practical solutions, will continue. At present, the AfESG is helping to finance research work in conflict areas and is encouraging other donors to work with members to develop techniques for evaluating and assessing damage, as well as for resolving the problems related to human-elephant competition for land and resources.

In early 1995, the AfESG will be releasing two important documents which are the product of extensive input from the membership as well as collaboration with many range state governments. The first is a report by Dublin, Milliken and Barnes entitled, *"Four Years After the CITES Ban: illegal Killing of Elephants, Ivory Trade and Stockpiles"*. This document summarises a comparison of elephant poaching, ivory trade and the accumulation of stockpiles in nine target countries covering all four regions of the species' range (Cameroon, Gabon, Ivory Coast, Kenya, Malawi, Nigeria, Tanzania, Zambia and Zimbabwe). The second document is an updated version of the African Elephant Database (AED), compiled by Said and Chunge, containing all survey results provided to the AfESG since 1992. The AED has been extensively revised. Maps have been redigitised, rivers, roads and major cities have been added and a new system of data quality categorisation and summation of numbers across data categories have been introduced. All members should expect to receive their own copies of these documents and we look forward to critical and constructive feedback.

In September 1994, several members of the AfESG took part in a technical meeting, sponsored by the European Union, to promote dialogue between the range states on the issue of the African elephant in the context of CITES. The meeting, held in Chobe National Park in northeastern Botswana, provided an excellent opportunity for range states to openly air their fears and share their concerns for the future of the species in national, regional and international contexts. AfESG members made several contributions to the meeting, by providing an overview on elephant numbers and distribution, summarising current levels of illegal killing, giving updates on human-elephant conflict in several regions of the continent, and explaining our current understanding of ivory trade volumes and dynamics.

The Botswana meeting was followed closely by the Ninth Meeting of the Conference of the Parties to CITES in Ft. Lauderdale, U.S.A.. As expected, elephants featured prominently in the debate with two formal proposals on the agenda. The first was a proposal from Sudan for the downlisting of its elephant populations to Appendix II, in order to dispose of a 48-tonne stockpile of ivory in 1995 followed by a zero quota thereafter. The second was South Africa's proposal for the downlisting of its elephants, which was annotated for a limited trade in hides and meat only, not ivory. Following many closed-door deliberations between the range states, both countries agreed to withdraw their proposals on the understanding that intersessional dialogue would continue in Africa. It was agreed that over the next three years, a series of meetings would be organised by the range states to cover topics of shared concern, such as the problems of growing ivory stockpiles, increasing human-elephant conflict and law enforcement issues. Overall, the spirit of the debate was positive and constructive. In accordance with its terms-of-reference, the AfESG will continue to provide information as required or requested in order **to** actively facilitate this dialogue.

Finally, I would like to bring you up-to-date on some business matters. A number of our funding requests have met with success and I am very pleased to report that the AfESG seems to be on firm financial footing for the next couple of years. This provides a tremendous sense of relief and allows us to go forward with some exciting planning for the future. For example, over the next 12 to 18 months, the AfESG intends to make a concerted effort to more actively support elephant work and the development of professional capacity in west and central Africa.

We have just undergone an extensive revision of the AfESG membership. We would like to take this opportunity to welcome all new members, request the continued collaboration of long-standing members and thank those of you who have served on the AfESG for your hard work and support over the years. We look forward to keeping in close contact with all of you and working together on behalf of the conservation and management of the African elephant. We will also, of course, be making plans for our next meeting of "the clan" and will look forward to seeing you all then.

RAPPORT DE LA PRESIDENTE: GROUPE DE SPECIALISTES DE L'ELEPHANT AFRICAIN

Holly T. Dublin
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Au nom du GSEAf

Cette année 1994 a été une année importante et active pour le Groupe de Spécialistes de l'Eléphant Africain (GSEAf), qu'il soit pris dans son ensemble ou considéré au niveau des capacités individuelles de chacun de ses membres. Avec une réunion du GSEAf et une réunion CITES au cours de la même année, l'éléphant africain a tenu la vedette des débats internationaux sur la conservation et dans les agendas de réunions.

Ce numéro de *Pachyderm* contient plusieurs articles qui font suite à notre dernière réunion, à Mombasa, où le Groupe s'est attaché à décrire et à examiner objectivement le phénomène de conflit homme/éléphant. Pris ensemble, ces articles fournissent une excellente introduction sur le sujet, tant pour les experts que pour les nouveaux venus en la matière. Kangwana y donne une vue globale du conflit homme/éléphant qui met en lumière les problèmes et propose des aspects à examiner à l'avenir. Kiiru décrit la situation générale qui prévaut au Kenya tandis que les articles de Barnes, Tchamba, Ngure et Smith présentent des situations actuelles de conflit, spécifiques dans des circonstances diverses et des pays bien précis. Lindeque replace le sujet homme/éléphant dans le contexte d'une politique de gestion nationale, en Namibie. Hoare souligne les différentes options possibles pour le contrôle des éléphants lors de conflits avec des hommes, puisant dans l'expérience du Zimbabwe pour fournir des exemples des différentes méthodes qu'on y applique.

Si ces articles et les discussions que nous avons eues lors de la réunion ont constitué une base solide sur laquelle on peut partager des expériences et le travail pour trouver des solutions possibles, il reste encore beaucoup à faire. Je crois que nous pouvons nous attendre à voir encore ces problèmes s'intensifier dans de nombreux pays de distribution avant de constater une amélioration. Le travail du GSEAf continuera à chercher à prévoir l'occurrence des conflits homme/

éléphant et à atténuer leurs effets, par des moyens novateurs et pratiques. Actuellement, le GSEAf aide à financer un travail de recherche dans les zones de conflits et pousse les autres donateurs à travailler avec ses members pour mettre au point des techniques d'évaluation et d'estimation des dommages ainsi qu'à la résolution des problèmes liés à la compétition homme/éléphant pour la terre et ses ressources.

Au début de 1995, le GSEAf publiera deux documents importants qui sont le résultat de la collaboration intense de ses membres ansi que celle de nombreux gouvernements dans les pays de distribution. Le premier est un rapport réalisé par Dublin, Milliken et Barnes intitulé *"Quatre ans après le Ban de la CITES: le Massacre illégal des Eléphants, le Commerce de I 'Ivoire et les Stocks".* Ce document résume une comparaison du braconnage des éléphants, du trafic de l'ivoire et de l'accumulation des stocks dans neuf pays cibles couvrant les quatre régions de distribution de l'espèce (Cameroun, Côte d'Ivoire, Gabon, Kenya, Malawi, Nigéria, Tanzanie, Zambie et Zimbabwe). Le second document est une version remise à jour de la Banque de données pour l'Eléphant Africain (BEA), compilée par Said et Chunge et réunissant tous les résultats des recherches qui ont été fournis au GSEAf depuis 1992. La BEA a été révisée en profondeur. Les cartes ont été redessinées à l'ordinateur, on y a ajouté les rivières, les routes et les plus grandes villes et on a introduit un nouveau système de catégorisation de la qualité des données et d' addition des nombres. Tous les membres devraient recevoir leur copie de ces documents, et nous nous réjouissons de recevoir leurs commentaires critiques et constructifs.

En septembre 1994 plusieurs membres du GSEAf ont participé à une réunion technique sponsorisée par l'Union Européenne pour promouvoir le dialogue entre les différents pays de distribution au sujet de l'éléphant africain dans le contexte de la CITES. La réunion, qui s'est tenue au Part National de Chobe, au nord-est du Bostwana, a donné aux états de distribution une excellente occasion de communiquer ouvertement leurs craintes et de partager leurs soucis quant àl'avenir de l'espèce dans les contextes nationaux, régionaux et internationaux. Les membres du GSEAf ont apporté plusieurs contributions lors de la réunion, apportant une révision du nombre et de la distribution des éléphants, résumant les tendances actuelles des massacres illégaux, donnant des informations récentes sur les conflits homme/éléphant dans plusieurs régions du continent et expliquant notre perception actuelle des volumes d'ivoire commercialisés et de leur dynamique.

La neuvième réunion de la Conférece des Patries de la CITES, à Fort Lauderdale, aux USA, a suivi de près notre réunion au Botswana. On s'y attendait, l'éléphant a tenu la vedette lors du débat, avec deux propositions officielles à l'agenda. La première était une proposition du Soudan de déclasser ses éléphants de l'Annexe I à l'Annexe II de facon à pouvoir disposer d'un stock de 48 tonnes d'ivoire en 1995, à la suite de quoi le quota redeviendrait de zéro. La seconde était la proposition de l'Afrique du Sud de déclasser ses éléphants, qui précisait qu'il s'agirait d'un commerce limité à la peau et la viande, pas l'ivoire. Après bien des délibérations à huis clos entre les états de distribution, les deux pays ont accepté de retirer leur proposition à la condition que le dialogue intersessionel continue en Afrique. On s'est mis d'accord pour que, au cours des trois prochaines années, soit organisée une série de réunions par les états de distribution pour traiter des sujets d'inquiétude commums, tels que les stocks d'ivoire qui s'accumulent, les conflits croissants entre homme et éléphant et l'application des lois. Toujours l' ambiance des débats est restée positive et constructive. En accord avec ses termes de référence, le GSEAf continuera à fournir toutes les informations requises et nécessaires pour faciliter activement ce dialogue.

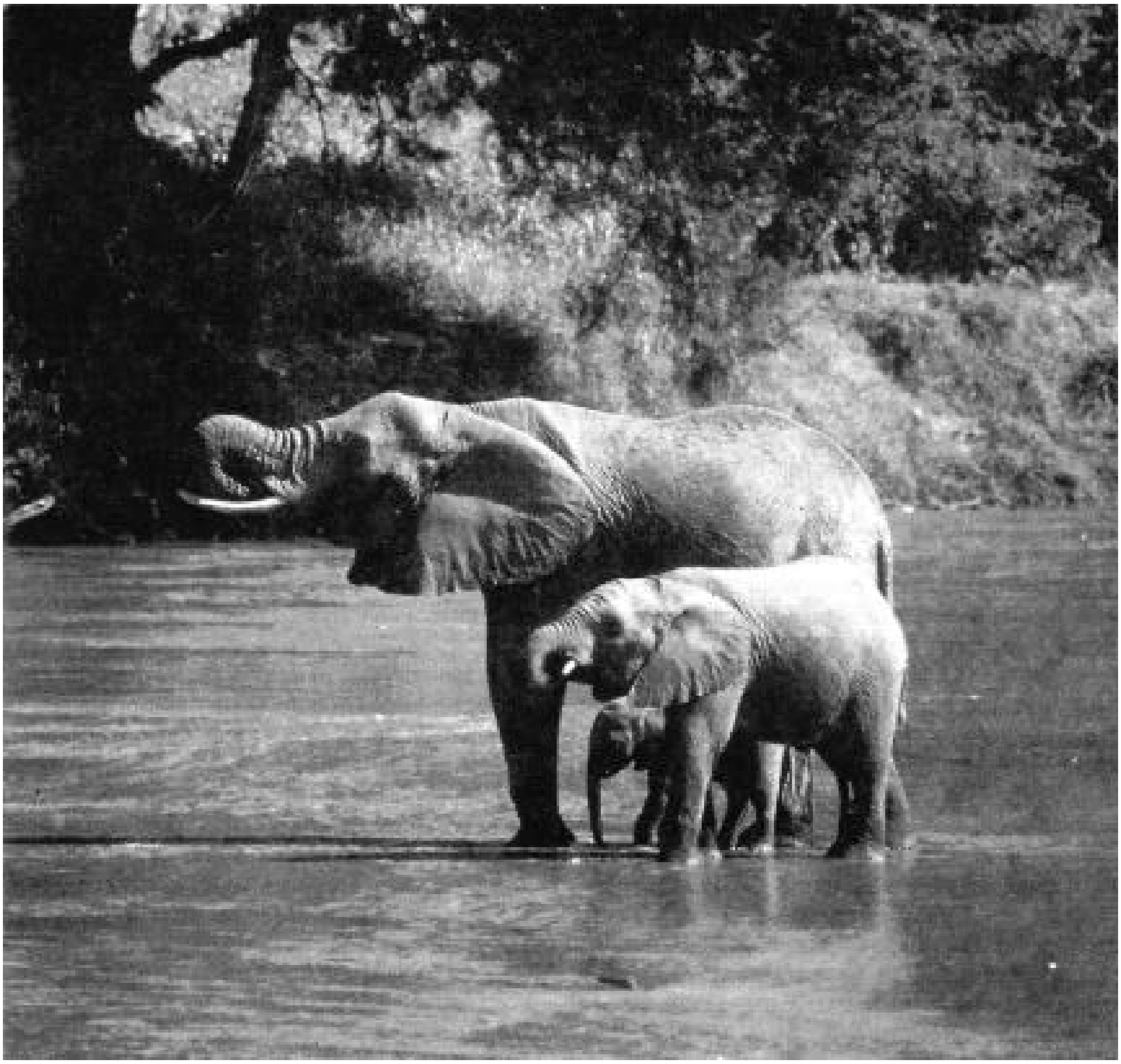
Enfin, je voudrais vous mettre au courant au sujet de nos affaires. Un certain nombre de nos demandes de financements ont réussi, et je suis très heureuse de pouvoir vous dire que le GSEAf semble être dans une situation financière solide pour les deux années qui viennent. Ceci procure une sensation de soulagement considérable et nous permet d'envisager l'avenir avec entrain. Par exemple, au cours des 12 à 18 prochains mois, le GSEAf prévoit de faire un effort concerté pour soutenir plus activement le travail sur l'éléphant et la mise au point d'un potentiel professionnel en Afrique de l'Ouest et du Centre.

Nous venons juste de mener une révision complète des membres du GSEAf. Nous voudrions profiter de cette occasion pour souhaiter de la bienvenue à tous les nouveaux membres, pour demander la poursuite de la collaboration des anciens et pour remercier ceux d'entre vous qui ont aidé le GSEAf pendant des années pour leur précieuse collaboration et leur soutien. Nous tenons beaucoup à rester en étroit contact avec chacun de vous et à travailler ensemble pour la conservation et la gestion de l'éléphant d'Afrique. Nous voulons aussi, bien sûr, élaborer un programme pour la prochaine réunion du "clan" et nous nous réjouissons de vous revoir à cette occasion.

AFRICAN ELEPHANT SPECIALIST GROUP MEETING, MOMBASA, KENYA, MAY 27TH TO JUNE 1ST, 1994:

PRESENTATIONS AND WORKING GROUP RECOMMENDATIONS

Photo credit: Reute Butler, Friends of Conservation



HUMAN-ELEPHANT CONFLICT: THE CHALLENGE AHEAD

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INTRODUCTION

This paper was presented as an overview paper at the Mombasa meeting of the African Elephant Specialist Group (AfESG), in May 1994. It draws together the contributions of group members and highlights the key issues, as I see them, that face those working in the field of human-elephant conflict. Several examples are taken directly from the articles which follow mine in this issue of *Pachyderm,* as well as from other reports given at the meeting.

Human-elephant conflict manifests itself in a number of ways. Direct costs to humans include crop depredation, the injury and killing of humans, the injury and killing of livestock, competition over water resources and the destruction of buildings and other property. Indirect costs to humans include social disruptions such as shorter school days for children (in a bid to travel in full daylight to and from schools and thus avoid contact with elephants), and nights spent awake trying to chase elephants from crops, resulting in reduced productivity of people.

Elephants also incur costs as a result of human-elephant conflict. The rampant poaching of elephants for their ivory throughout Africa in the 1970s and 1980s was an aspect of human-elephant conflict - here the interests of man superceding the interests of elephants. Elephants have also been compressed into smaller and smaller areas, and their traditional migration routes have been cut off as a result of human population growth and the expansion of people into areas that were previously elephant range. Elephants also compete with humans over resources such as grazing and water. More directly, an increasing number of elephants are being killed on control by wildlife authorities as a result of human-elephant conflict, and community members themselves also kill elephants in situations of conflict (Thouless, 1994).

The focus on these elements of human-elephant conflict has changed in recent times. From a grave concern with the number of elephants that were being killed by humans, which resulted in the ivory trade ban, our attention has now turned to the numbers of people being killed by elephants and the damage of human property. The ultimate challenge to conservationists now appears to be reducing the costs to humans of living with elephants, while conserving viable populations of elephants.

THE STATUS OF HUMAN ELEPHANT CONFLICT

Reports in the Kenyan newspapers could lead one to believe that human-elephant conflict has reached crisis levels throughout the elephant range. However, this does not seem to be the case. While reports from Kenya indicate a serious problem of human-elephant conflict, and the elephants of Kaélé in Cameroon surprised us all with the impunity they demonstrate by crop-raiding in large herds during the day, human-elephant conflict appears not to have reached crisis levels in all range states. AfESG members from central and west Africa stated that where both human and elephant densities are low, human-elephant conflict is at a minimum. Uganda, with more than 90% of its elephant population in protected areas, also experiences relatively few incidents of human-elephant conflict. These observations provide us with the first premises with which to predict areas of high human-elephant conflict, or conflict “hotspots”. Where elephant populations occur in areas with large human populations and widespread agriculture, conflict will be high. Where elephants are confined to protected areas, opportunities for elephants and humans to meet are minimised, and the incidence of conflict is therefore low.

TRENDS IN HUMAN-ELEPHANT CONFLICT

Trends in human-elephant conflict are difficult to ascertain. An increasing number of elephants are being shot on control in Kenya, and Tanzania reports an increase in the incidence of human-elephant conflict, but it is difficult to determine whether this reflects a real increase in conflict.

We could simply be observing the result of a change in focus. From the concern that too many elephants were being killed by people, we have now turned our attention to the fact that too many people are being killed by elephants. Our attention may also be drawn to human-elephant conflict as a result of the politicisation of conservation. It appears that in Kenya the issue is debated through the media in order to gain political ends.

The theory of bolder elephants moving out into human range as poaching diminishes after the ivory trade ban is a credible one. Studies have shown that elephants responded to heavy poaching by concentrating in "safe" protected areas (Douglas-Hamilton, 1987). Might we not expect that elephants would respond as quickly to a decline in poaching, by moving out of these safe havens into areas where they stand a higher probability of meeting humans, and coming into conflict with them?

Whatever the reasons behind the reported increase in conflict, and whether they are real or not, it is likely that, in the short term at least, human-elephant conflict will increase as the human-elephant interface expands with a growth in human populations.

THE CHALLENGES AHEAD

Given the current status and trends of human-elephant conflict, the key issues surrounding human-elephant conflict seem to be the need to recognise the political arena or context of elephant conservation; the need to draw up policies and legislation for dealing with human-elephant conflict at various levels; the need to mitigate conflict when it arises; and the need to deal with conflict in ways that are within the capacity of the range states in order to ensure long-term conservation strategies.

Recognising the political arena

Elephant conservationists need to recognise that when elephants impinge on people, solutions to the problem are needed. Pressures on governments to find these solutions come from grassroots level. A good example of this pressure is that of the demonstrations we have heard about in Gabon, where the citizens have stated that the Minister must choose between elephants and people. We have also heard of demonstrations against the government on the issue of human-elephant conflict in Cameroon. Kenyan newspapers have quoted local people asking the government whether elephants have become more important than people. The need to find solutions to the problems must be taken seriously. At the end of the day governments will have to make choices in favour of its citizens - that is until elephants get the vote!

Policy issues

We have been reminded that many attempts to deal with human-elephant conflict have been crisis-management orientated. The lack of clear policies on the human-elephant conflict has to be one of the largest set-backs to solving the problem.

Policies on human-elephant conflict are needed at a number of levels. On a national scale, the designation of areas for elephant conservation within broad land-use policies is of crucial importance. That is, there needs to be a definition of the present and future elephant range in the context of land-use planning.

We have seen how the whole of Namibia has been classified into areas with different levels of elephant use and the key elephant areas identified. The challenge now is to feed this sort of map into a national land-use scheme, so that plans for development may take into consideration the template of key elephant conservation areas, both inside and outside the protected area system.

Land-use planning can also take place at a more local level. In Zaire, for example, lo cal people have made a decision to put all fields for cultivation near settlements, so as to reduce the amount of damage to crops by elephants.

Perhaps some pragmatism is needed in the designation of elephant conservation areas. We need to face the fact that there are some areas where elephants cannot be maintained. High potential areas suitable for human settlement and agriculture are not likely to be areas where elephants can be maintained without considerable levels of conflict, which would require intensive and expensive means to reduce conflict.

Policies are also required on how to deal with the results of conflict. It needs to be ascertained who holds responsibility and what actions are appropriate in a specific conflict situation.

Mitigating human-elephant conflict

In what we have heard about the methods used to mitigate human-elephant conflict, there appear to be three main strategies in use: the erection of barriers between elephants and people; the use of problem animal control (PAC) measures; and the distribution of revenues from wildlife to local people, in the hope that this will influence people to tolerate wildlife.

Barriers of various designs have been erected as an attempt to separate elephants and humans, and experience shows that elephants are capable of going through the most sophisticated barriers, including highly electrified fences. From all reports, it seems that an elephant will roam where it wills: it will go through a six-strand 7,000 volt fence, yet be kept out of another field by a non-electrified two-strand fence. An expedient approach at this stage may be to examine the ecological reasons why elephants require access to certain areas. The strategic placing of barriers in this context may prove more effective.

The PAC measures we have heard about fall into two categories: those that are fatal to the elephants and those that are non-fatal. By most accounts, elephants habituate quickly to non-fatal measures such as thunder flashes and rubber bullets. These methods are, therefore, not effective in the longterm.

With regard to the control shooting of elephants, several very different activities are going on under the same name, making it difficult to generalise on their effectiveness in mitigating conflict. Historically, elephants have been shot on control to minimise conflict by reducing elephant numbers. Elephants are also shot on control at the sight and time of crop-raiding to condition them against it, and also as a public relations exercise to demonstrate action on the part of the government in the event of elephant damage.

Elephants are usually shot on control as a result of a human death or following persistent crop-raiding. In all cases, the people experiencing the elephant damage are required to report the incident to their local wildlife authority. The wildlife authority then arranges to have an elephant shot. Shooting thus takes place long after the event and, for the most part, becomes a public relations exercise with no opportunity to condition the elephants. Part of the problem is that the authority required to shoot elephants on control is centralised. A possible solution may be to decentralise the authority to shoot elephants and thus increase the opportunities for shooting culprit elephants on sight. This would maximise the deterrent effect of control shooting, as studies have shown that elephants lend themselves to negative conditioning and do avoid situations that can prove fatal (Kangwana, 1993).

This decentralisation may seem a risky option, with much room for abuse, and it will require careful consideration. However, we are already advocating for the need to distribute the benefits of wildlife to the people who live with wildlife, in order to conserve it successfully. We already recognise that effective fencing schemes need the support of local people for their maintenance. Perhaps the next step in this evolution is to provide local people with the ability to respond quickly to situations of conflict with elephants.

I have touched on the concepts of revenue or resource-sharing schemes with local communities, and of encouraging local people to participate in conservation, in a bid to change attitudes to wildlife and offset some of the costs of living with wildlife. This mode of mitigating conflict raises some interesting questions. For instance, are the benefits sufficient to offset the costs of living with elephants and to encourage coexistence?

Another problem noted with regard to the distribution of benefits from wildlife is that these benefits usually go to the community as a whole, but the costs of living with wildlife are incurred by individuals. Some resolution is required here if these efforts are going to work.

An important aspect to consider with respect to local people and wildlife is the ownership of the wildlife resource. In the longterm do we really expect people to conserve a resource that is not theirs? Even in situations where the government has gone as far as devolving custodianship to the local people, there is the perception that the status quo may change with a change in government or government policy, and so maximum benefit must be made of the wildlife resource before this happens.

Conservation within capacity

Overriding all efforts to solve the problems of human-elephant conflict, and indeed all conservation in Africa today, is the need to conserve within local capacity. With respect to human-elephant conflict the temptation has been to apply the newest technologies and donor-funded schemes with little regard for their sustainability. Methods used to mitigate human-elephant conflict must be financially and technologically within the capacities of the people implementing them, if they are to belong-term solutions.

APPROACHES TO THE PROBLEM OF HUMAN-ELEPHANT CONFLICT

The last decade or so has seen some very interesting attempts to understand human-elephant conflict. Several studies have been done to determine the extent of damage in economic terms. Coupled with this effort has been the attempt to understand the costs of living with wildlife as perceived by the local people themselves, and also an attempt to quantify the impact of human-elephant conflict on elephants.

The articles which follow mine are fine examples of how the economics of elephant damage to human property has become a science. One must now ask how far we should go in developing these techniques for assessing damage. At what point do we know enough about a situation of human-elephant conflict, and would be better off spending resources solving the problem? We must also decide what level of damage is supportable, and at what point authorities should intervene to mitigate conflict and reduce loss. When we know that farmers in a certain area are supporting over 40% damage to their crop each season, what do we do next? What percentage loss is high enough to warrant action?

LOOKING BEYOND THE CONVENTIONAL

Elephants and humans have lived together for thousands of years. The question of how they coped must be of interest to those trying to maintain mixed-use regimes in modern times. The example from my own work, of the spearing of elephants by Maasai resulting in avoidance of Maasai by elephants, and consequently the temporal separation of elephants and Maasai with minimal conflict in one range, has potential as a way of maintaining elephants and Maasai in the same range (Kangwana, 1993).

Currently experiments are underway in Zimbabwe to examine the use of a chemical derivative of *Capsicum* as a deterrent for elephants. What needs to be developed is the technology to deliver this chemical to the elephants from a safe distance (Osborn, L., pers. comm.).

In conclusion, I would postulate that there is much scope for looking beyond the conventional for possible solutions to human-elephant conflict. While numerous steps have been taken in the direction of understanding and dealing with human-elephant conflict, we are still faced with many challenges.

ACKNOWLEDGEMENTS

This paper draws upon presentation of members of the AfESG at the meeting in Mombasa, and from discussions with Russell Taylor.

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THE CURRENT STATUS OF HUMAN-ELEPHANT CONFLICT IN KENYA

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INTRODUCTION

Conflict between people and elephants in Kenya exists throughout most of the country's elephant range. In the local newspapers, headlines such as, "Elephants a threat to human life", "Woman and baby killed by elephant", are becoming disturbingly common. Occurrence books in Kenya Wildlife Service (KWS) field offices contain numerous reports of crop depredation, livestock deaths and injuries as well as damage to farm installations. The intervention column in the occurrence book typically reads, "...arrived at 9.00 am, inspected the damage, half an acre of maize completely destroyed". Frustrated wardens, usually unable to arrive on time to prevent the damage, refer to themselves as "damage inspectors". Peasant farmers in the affected areas are equally frustrated. Their efforts to keep the animals out of the "shambas" are often futile, sometimes resulting in fatalities. "Ndovu wa siku hizi ni jeuri (Elephants of today are full of spite)", they say.

Kenya's elephant population is currently estimated at about 24,000 individuals, a fraction of what it was 20 years ago. However, with an expanding human population and the commensurate demand for land, the elephant range has been greatly diminished, resulting in the perception that there are "too many" elephants in some pocketed populations. Land-use changes in areas such as Laikipia District, where large-scale ranches have been subdivided into small-scale farms, have led to compression of the elephant range and intense conflict as people and elephants compete for space. In other parts of the country, people who formerly practised pastoralism have been encouraged to turn to agriculture, thus creating conflict in places where elephants and people formerly co-existed. Examples include the Maasai in Kajiado and Narok Districts, the Pokot and Turkana near Nasalot and South Turkana Reserves, the Samburu near Isiolo and Maralal towns, and the Rendille and Borana around the Marsabit Reserve.

In many of the densely settled agricultural areas around forest reserves, excision of forest to provide land for the landless has led to the creation of "island farms" within elephant habitat or "forest peninsulas" surrounded by farms. These make perfect sites for crop-raiding because the elephants can hide in the forests during the day and come out to raid crops during the night. The Mount Kenya, Aberdare and Mau forests are examples of such areas.

The Elephant Programme of KWS has accumulated useful information on the conflict situation in Kenya, as a result of field surveys, and reviews and analysis of data from field stations. This presentation summarises some of this information in an attempt to give an insight on the status of human-elephant conflict in Kenya.

What constitutes conflict?

Conflict between people and elephants takes several forms. Crop depredation is probably the most common type of conflict. Encounters between people and elephants can lead to deaths and injuries of both people and elephants. Elephants are also known to cause damage to property such as farm installations, water reservoirs, fences and houses. All these forms of conflict are reported to occur in Kenya with varying severity.

Where does human-elephant conflict occur in Kenya?

Figure 1 illustrates the main areas of human-elephant conflict in Kenya. Efforts to categorise these areas according to severity of conflict has proved very difficult because most information on crop depredation is not quantified. Data on human deaths and injuries as well as elephant mortality data indicate that Laikipia and Narok Districts are the most affected regions.

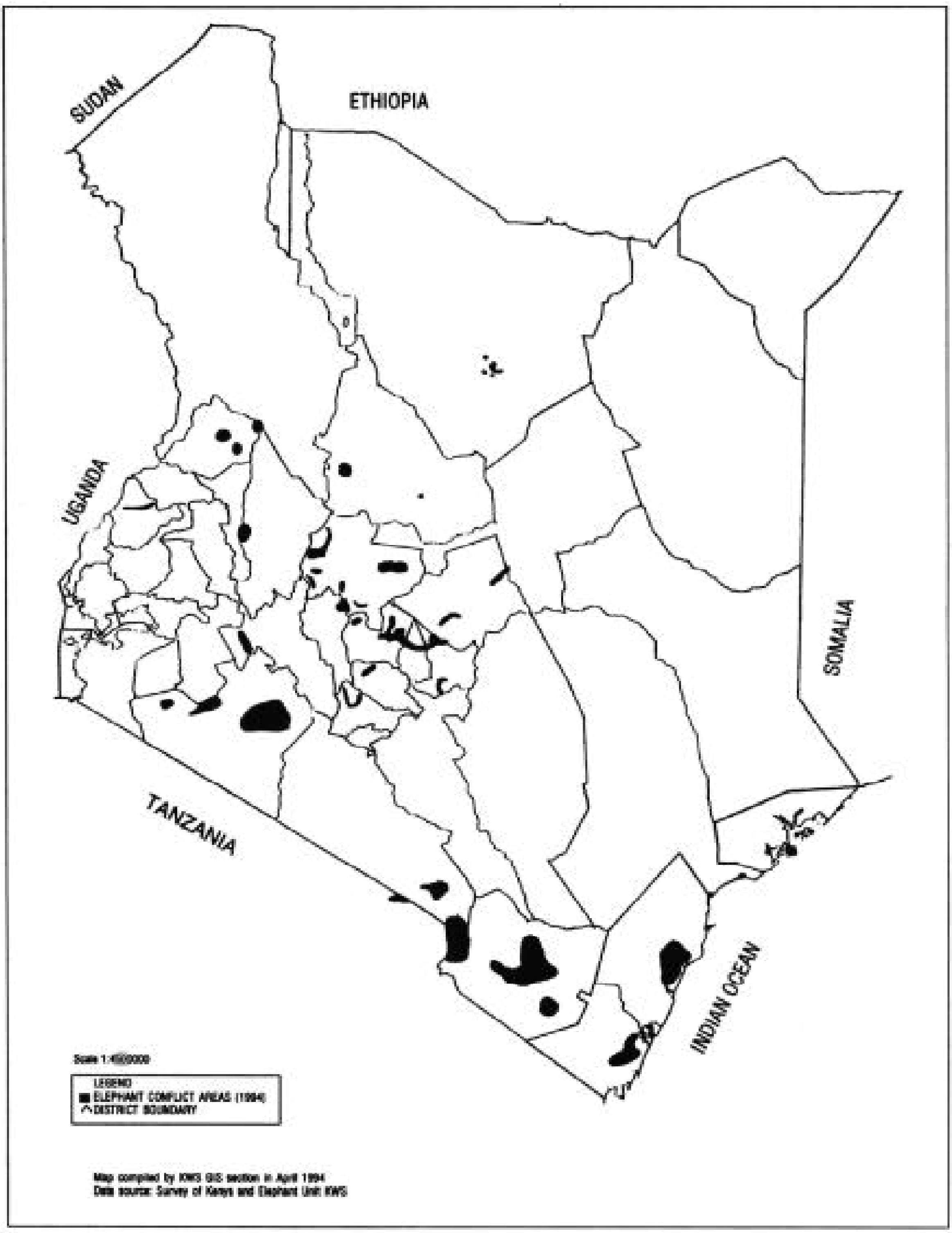

Figure 1. The main areas of human-elephant conflict in Kenya.

Crop depredation

Crop depredation is a major cause of conflict in Kenya. Farmers living in the fertile agricultural areas which frequently border forests, such as Mount Kenya and the Aberdare forest complex, report high incidences of crop-raiding. Farming communities which have settled near the boundaries of national parks, for example Tsavo and Amboseli, also experience severe crop-raiding. Elephants living outside the parks and reserve system, in the districts of Laikipia, Meru, Narok and Taita-Taveta, cause extensive crop damage in the cultivated areas within their range (Poole *et al.*, 1992, Ngure, 1992, Mwangi *et al.*, 1993, Thouless, 1994). Elephants are known to eat a wide variety of food crops which include maize, bananas, cashewnuts, pumpkins, sugarcane, cabbages, carrots, onions, etc. Maize ranks high on the list of preferred food crops. The main crop-raiding season parallels the crop-growing season in many parts of the country, which begins in July and continues through October. Mound forest reserves and irrigation schemes, however, raiding continues throughout most of the year. Crop damage assessment carried out by Irigia (1990) and Mulama (1990) in Laikipia District, as well as work by Ngure (1992) in Taita-Taveta District, indicate that farmers experience serious economic losses through crop damage by elephants. Occurrence books and annual reports from KWS stations such as Meru, Kiambu and Nyeri, as well as personal encounters with farmers from the affected areas around the country, attest to this fact. Better quantitative data on crop damage is required as very little is currently known about the extent of damage in specific areas. There is also a real need for scientific data on crops consumed, quantities and patterns of feeding, frequency and seasonality of raiding, characteristics of crop-raiding elephants (size and sex composition of raiding groups, raiding patterns), and causes of crop-raiding. Since crop depredation is a major cause of conflict, it is imperative that any meaningful categorisation of conflict areas incorporates data on the severity of crop damage.

Human deaths and injuries caused by elephants

KWS records show that between 1990 and 1993, at least 108 people were killed by elephants while 34 people were injured in different parts of the country. It is important to note that some deaths and injuries go unreported, often because they occur in remote areas.

Most incidents of death and injury are reported from Laikipia, Narok, Taita-Taveta and Kwale Districts, as shown in Table 1. Thouless (1994), speculated that the high number of human deaths recorded in Laikipia District in 1992 may have been partly an indirect result of drought, which in turn kept elephants in well-watered areas close to human settlements. Laikipia and Narok have maintained a higher rate of human mortality and injury relative to other districts, from 1990 to 1993. In Narok District, the influx of immigrants from agricultural communities in the densely settled central highlands, coupled with the recent change from pastoralism to agriculture by the Maasai, has led to compression of the elephant range. In the agricultural settlements of Ntulele and Seyabei near Narok town, human-elephant conflict has escalated in recent years with the increasing isolation of an elephant population of about 200 individuals (Litoroh, 1993).

Table 1. Human deaths caused by elephants in Kenya, 1990 to 1993, ranked by District.

District	1990	1991	1992	1993	Total
Narok	3	6	5	13	27
Laikipia	1	3	17	5	26
Taita-Taveta	2	6	5	6	19
Kwale	-	3	2	4	9
Marsabit	-	-	5	-	5
Meru	2	2	-	-	4
Nakuru	-	-	3	1	4
Isiolo	1	1	1	1	4
Kajiado	-	-	-	3	3
Samburu	-	-	2	1	3
Kiambu	-	2	-	-	2
Turkana	-	-	-	1	1
Nyeri	-	1	-	-	1
Total	9	24	40	35	108

The information kept at KWS is essentially maintained for administrative purposes. The data do not describe the circumstances surrounding death of a victim, such as time of day, activity during encounter, causes of aggression and characteristics of the attacking elephants. An interesting observation however, is that more men are killed by elephants than women. Out of the 74 entries where the sex of the victim was clearly indicated, 58 (78%) were male.

Elephant deaths and injuries

Elephant deaths and injuries also serve as indicators of levels of human-elephant conflict. The elephant mortality database maintained at KWS keeps records of “cause of death” whenever possible. Analysis of this data reveals the following categories:

1. **Control**
   Elephants shot by KWS rangers or land owners in defence of human life or property.

2. **Poaching**
   Elephants found dead with tusks missing.

3. **Unknown**
   Cause of death not established.

4. **Conflict**
   Elephants found dead, with spear, gunshot or snare wounds. This is differentiated from poaching when tusks are found intact.

5. **Accidents**
   Drowning etc.

6. **Natural**
   Includes sickness, death during a fight, death caused by predators.

KWS records indicate that 119 elephants were killed on control between 1990 and 1993. Further analysis reveals that the number of elephants shot on control has increased with every subsequent year since 1990. It is important to note that the control policy in KWS evolved from one of strictness, where field staff were required to seek permission from headquarters before shooting an elephant in 1990, to a more relaxed mode where field officers have the authority to make their own decisions. However, they often consult headquarters for advice. This evolution of policy has had a direct effect on the numbers of elephants shot.

Another notable point is that in 1993, a total of 15 elephants were shot during a Problem Animal Control (PAC) training exercise conducted in Laikipia and Samburu Districts between July and October of that year. The total number of elephants shot on control in these Districts may therefore have been distorted by this exercise. Overall, Laikipia District records the highest number of elephants shot on control, followed by Taita-Taveta, as seen in Table 2.

Table 2 Elephant mortality from problem animal control and conflict, 1990 to 1993.

District	1990		1991		1992		1993	
	CT	CF	CT	CF	CT	CF	CT	CF
Bungoma								
Isiolo							1	
Kajiado							1	
Kericho					2			
Kiambu	1				4		1	
Kilifi	1							
Kwale	1		2		2		2	
Laikipia	5		5		16		20	
Meru								
Muranga							1	
Nakuru							4	1
Narok			1		3	1	14	6
Nyahururu	1		1			1		
Nyeri	1				3			
Samburu					1	1	7	1
Taita-Taveta			2		11	2	2	
W. Pokot						1		
Total	10	1142	656	8				

CT- Control shooting
CF- Conflict deaths i.e. animals killed by non-K WS personnel, tusks recovered

Gaps in the data-set make it difficult to analyse factors such as sex of animal shot and activity of elephant at time of shooting. Seasonal patterns of control are also difficult to ascertain. In 1992, the KWS Elephant Programme designed PAC forms, which field staff are now required to fill after control shooting. The response has been encouraging and an analysis of these data will certainly be useful.

Other causes of conflict

These include damage to farm installations e.g. fences, dams, stores, water pipes and houses. Elephants in Laikipia have been known to raid grain stores in search of maize, totally destroying them in the process (Irigia, 1990; Litoroh, 1993). Elephants are also known to damage the most sophisticated electric fences (Thouless, 1993).

Disruption of social activity is a major cost incurred by communities living in close proximity to elephants. In areas such as Shimba Hills, Taita-Taveta and Narok, children are often unable to attend school because elephants block all possible routes. Parents are forced to escort children to school while teachers have to shorten the school day to give pupils time to select safer routes home. Sleepless nights are spent chasing elephants out of the fields, which affect the ability to work during the day.

CONCLUSIONS

From the above summary, it is clear that the human-elephant conflict situation in Kenya is real and worsening. It is also clear that there is a need for further research and quantitative data collection of various aspects of conflict. The survival of elephant populations in Kenya may depend upon the ability to minimise conflict between people and elephants. This can only be achieved with a clear understanding of the problem and a well-informed approach towards conflict management.

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Photo credit: Steve Njumbi

Cutting up the meat from n elephant shot on control.

PEOPLE-ELEPHANT CONFLICT MANAGEMENT IN TSAVO, KENYA

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ABSTRACT

Historically, conflicts between people and wildlife in Kenya have been dealt with by a process of fragmented crisis management. The underlying causes of conflict and the ecological consequences of conflict management have not been considered or documented. Where human population has increased, wildlife has often been excluded. On land abutting protected areas, land-use has intensified and is often accompanied by pressure to degazette the protected areas. The Tsavo area is a typical example of the latter. This paper examines people-elephant conflict in the Tsavo area and describes past, current, and planned conflict management activities of the Kenya Wildlife Service. Suggestions are made for an approach which will allow sustainable, mitigative intervention to prevent the conflict crisis from developing into a disaster.

INTRODUCTION

People-elephant conflict refers to a range of direct and indirect negative interactions between people and elephants which potentially harm both. Although the harmful effects are many in some areas (Ngure, 1992), the most publicised are crop damage by elephants and injury or death to people. There are also many negative impacts on elephants from people, but generally these only come into focus when they lead to a reduction in elephant numbers which adversely affects human interests (Douglas-Hamilton, 1988).

Whereas human interests in elephants extend beyond elephant range, the negative effects of elephants on people are usually confined within their range. Elephants, for example, also kill and injure livestock, damage property, and disrupt social and economic activities. Indirectly, elephants lead to unwarranted clearing of natural vegetation through an increased demand for fuel wood by people who guard their crops at night (Ngure, 1992). Local and external human interests tend to bring about marginalisation and even extermination of elephants, through hunting and competetive land-use policies. Regrettably, although conflict has a negative effect on both people and elephants, its outcome is often human-dominated.

The historical and prevailing conflict management approach in Kenya is the creation of protected areas for wild animals. However, the vulnerability of protected areas is illustrated by the dramatic decline in elephant and rhino populations in Tsavo (Douglas-Hamilton, 1988), and the current pressure for degazettment of Tsavo National Park. Strategies for protecting human life and property are also inadequate as demonstrated by the increase in conflict (Ngure, 1992).

In its 1990- 1995 management and development plan (Kenya Wildlife Service, 1990), the Kenya Wildlife Service (KWS) proposed an ambitious plan for the management of Kenya’s wildlife in and out of protected areas, which included the establishment of an Elephant and Community Wildlife Programme. One component of the programme was to reduce the people-wildlife conflict around key protected areas (including Tsavo) by (mostly electric) fencing. An initial Environment Impact Assessment (EIA) endorsed the proposed fencing, but suggested that a number of environmental, social, economic, technical and financial criteria be considered before proceeding with the construction of fences at Tsavo (DHV Consultants, 1992). In endorsing fencing as a solution to the people-elephant conflict in Tsavo, the EIA also had to recognise the intense political pressure, in response to public demand, to find a solution.

The Tsavo area

The Tsavo area refers to the Tsavo ecosystem in southern Kenya. It comprises the Tsavo National Park (East and West) and the surrounding areas (Figure 1) which form part of the home range of several large herbivores (Cobb, 1976), including the elephant. It is mainly a lowland semi-arid savanna ecosystem, with an annual average rainfall of 250-400mm, characterised by *Commiphora-Acacia* bushland or Nyika. The annual rainfall pattern is usually bimodal and soils are largely developed from basement system complex rocks (Van Wijngaarden & Engelen, *1985)*.

Deviation from this general description can be seen in the central localities which comprise the Taita, Sagalla and Kasigau Hills and their vicinity. These hills represent an area where the effects of increasing distance from the Indian ocean are counteracted by the influence of higher altitude and rainfall which rises to an annual average of 600-1200mm.

Land-use in the area

Current land-use in the Tsavo area is partly the result of historical events and partly due to more recent happenings. Most information on historical land-use is derived from notes compiled by early travellers, described in detail by Corfield (1974) and EcoSystems Ltd. (1982).

The lowland areas of Tsavo have been used by five indigenous peoples. The Waliangulu are believed to be the original inhabitants of most of the lowlands. Primarily hunter-gatherers, they yielded to the Galla-

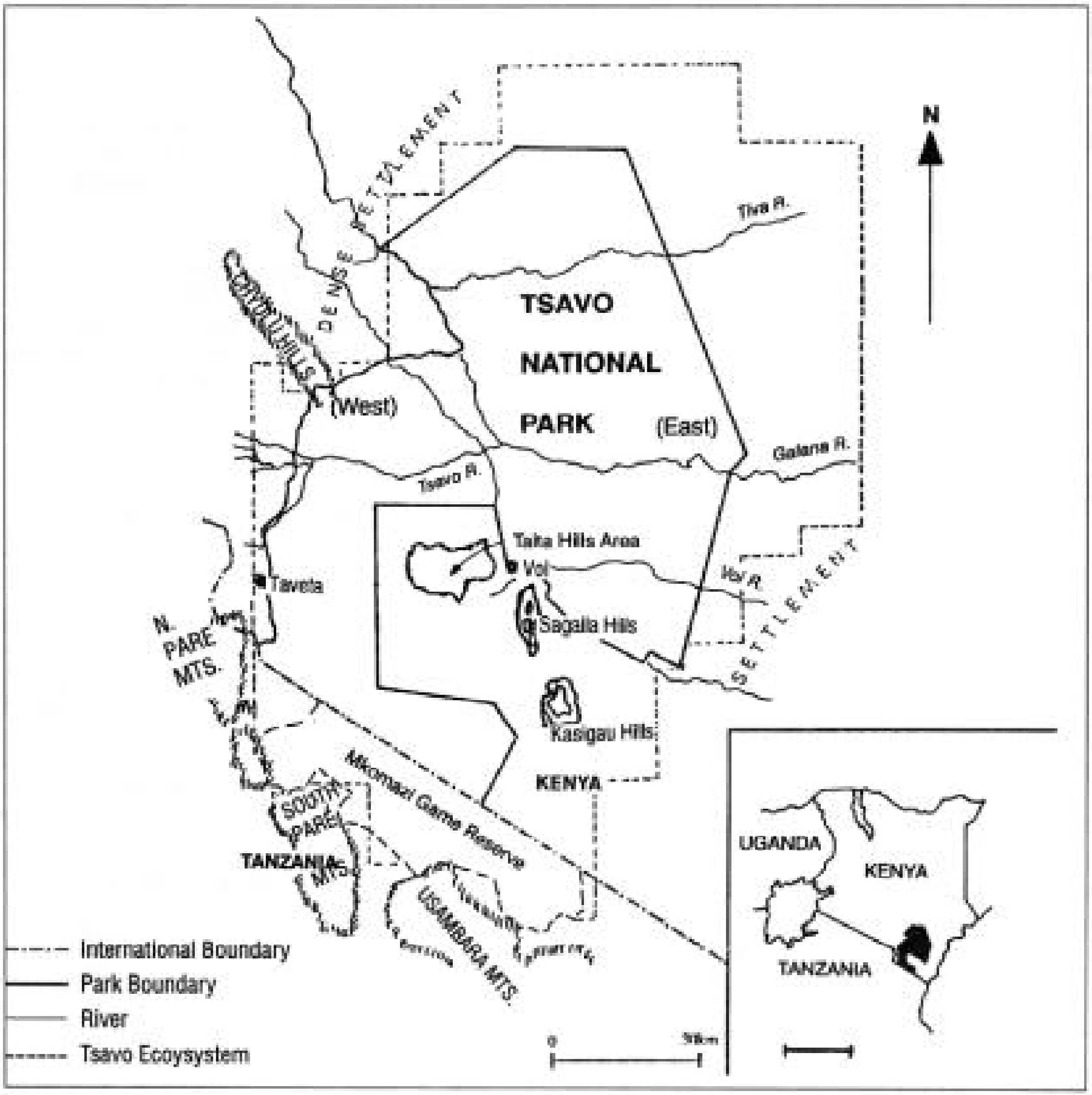

Figure 1. Map of Tsavo National/Park and surrounding areas.

speaking Orma pastoralists who invaded from Abyssinia. They became serfs of the invaders, paying one tusk per elephant killed to the Orma chief, and they also adopted the Galla language. The Orma later yielded to attacks from two other peoples (Maasai and Somali), as well as succumbing to unfamiliar coastal diseases and finally to the rinderpest epidemic in the last two decades of the 19th century. By the 1930s they only used a small part of the present north-east Tsavo National Park.

The Maasai, pastoralists who ranged far and wide while raiding cattle in the Tsavo lowlands, were also eliminated from the area by the rinderpest epidemic. Two other peoples traditionally used the Tsavo lowlands: the Kamba and the Taveta. The latter confined their activities to cultivation in the forests, which occur in the present day Taveta region, and fringe-grazing in western Tsavo. The Kamba influence extended beyond their traditional home into northern Tsavo where they are, up to now, primarily agro-pastoralists. They were heavily involved in commercial ivory hunting for the established east coast ivory trade (Spinage, 1973), and in livestock trade. They also practised subsistence hunting, as do those who still live close to the national park today.

In 1933 the colonial administration set up a commission to investigate land-use and recommend allocation. The commission categorised all sparsely occupied land as crown land, or government land. This included the whole area which later became Tsavo National Park. No land was allocated to the Waliangulu who were expected to integrate peacefully with other people. This was understandable as the new hunting rules (Ritchie, 1926; Game Department, 1928) proscribed their way of life. The creation of Tsavo National Park in 1948 further marginalised them and the Waliangulu are now virtually extinct as a tribe. The Kamba and Orma were also restricted to the north and north-east of Tsavo respectively. The park’s boundaries have only changed slightly since that time (Woodley, 1988).

In the 1970s the independent government allocated most of the remaining lowland Tsavo area for cattle ranching, giving the local people priority of ownership. Some of the ranches received substantial financial and technical assistance but were never successful. Others never developed at all and are now being converted for small-scale cultivation. Initial KWS extension work in the ranching areas generated considerable interest in wildlife among the owners. This interest, however, which is based on prospects for wildlife utilisation, is precarious, especially for ranchers who are unlikely to earn anything from wildlife for a long time.

There are also some large sisal plantations in the Tsavo lowlands, but they are increasingly being converted for horticultural use.

Subsistence, rain-fed agriculture, has always been confined to the hills. Only prior to the 1880s did the Taita people, who traditionally occupied the Taita hills, cultivate lowland areas. This period of cultivation was cut short by a major famine in the 1880s, which reduced the population, estimated at 152,000, by one-quarter, forcing a retreat to the hills. The Taita continued to hunt lowland elephants for subsistence and for the commercial ivory trade. Those living close to the lowlands today still practise subsistence hunting, albeit illegally.

The recent growth in human population density in the hills, where agricultural potential is high, has put tremendous pressure on the natural resources. Soil degradation due to continued cultivation and erosion is now a major concern (Otindo, 1992). This has led to encroachment of the marginal and agriculturally low potential areas near the hills, which until the 1 960s were largely uninhabited (Ngure, 1992). People from other parts of the country with similar population problems have also settled in the area. It is in these recently settled areas that people-elephant conflicts are concentrated.

People-elephant conflicts in the Tsavo area

The major causes of conflict are crop depredation and human death and injury by elephants. Data on human deaths and injury kept by the KWS Elephant Programme indicate a worsening situation (Table 1).

Table 1. Elephant-related human deaths and injury in the Tsavo area.

Year	Elephant-related human deaths and injury	
	Deaths	Injuries
1990	2	0
1991	6	3
1992	5	2
1993	6	2

In order to examine conflict in the area, a study was conducted between November 1990 and August 1991 (Ngure, 1992). Formal interviews were held with persons from randomly selected households (n=91). Elephant activity was also monitored during the main growing season, from March to mid-August. Three of the 1991 deaths occurred in the study area (344km^2) to the south of the Taita hills, while the victims were defending their crops. In the same area, apparently only three people had been killed by elephants in the previous 60 years (Ngure, 1992).

In the study area, 75% of the households had been affected by elephant damage in 1991, and 858 families cultivating 772.8ha recorded 4,036 incidents of elephant visits in the 1991 three-month growing season. Affected plots may receive 4.6 attacks by elephants per growing season. Crop losses per family ranged from a few individual plants to loss of the whole season's crop. Using current official prices for the area, these families lost US$ 64,975.00; maize accounted for 54% of the losses. Two other localities in the Tsavo area suffered the same level of crop depredations by elephants. In order to avoid damage, many farmers were observed to harvest crops before they were ready, which consequently reduced the quality of their produce.

As well as raiding crops, elephants damage water pipes, cattle sheds, houses, and also stores, which they occasionally break open while looking for harvested produce.

Apart from physical damage, elephants disrupt social and economic activities. In 81% of the households surveyed in 1991, school attendance by children was adversely affected by elephants. The perceived presence of elephants, even when none is near, also affects execution of social and economic activities. The 1991 survey showed that for 83% of the households, cultivated plots were guarded at night. Guarding is usually an all-night activity which can involve several members of a family.

On the other hand people also have negative effects on elephants. The negative effects from local people are, however, few. For example, the widespread poaching of elephants from the mid- 1970s to late 1980s (which reduced the Tsavo elephant population from about 35,000 to about 7,000) was mainly driven by external interests (Douglas-Hamilton, 1988). Furthermore, only about 5% of the area available to elephants in 1975 has since been converted for arable use by the local people, but this is where most crop-raiding by elephants occurs. This in turn leads to other negative effects from the local people to elephants: crop destruction sometimes provokes people to harm elephants, and there is pressure to degazette Tsavo National Park, which would consequently greatly reduce the habitat available to elephants and other species.

Past conflict management activities

Residents and wildlife authorities in the Tsavo area have in the past adopted several measures to reduce crop depredation and sometimes death and injury from elephants. Residents try to prevent death and injury by avoiding elephants. In 83% of the vulnerable households studied in 1991, crop-raiding was deterred using several methods: noise, from banging metal objects together; fire, either lit at the edges of plots, or as glowing wood missiles thrown by hand; use of any other available missile; and assistance from wildlife authorities. These strategies can have heavy social and economic costs.

Wildlife authorities have used three main methods to reduce elephant-related conflict in Tsavo. Collectively called problem animal control (PAC), these methods are thunderflashes, blank and live bullets. The latter are either used to kill elephants or to scare them. Thunderflashes, blanks and shooting in the air are used to drive elephants from specific areas. Although elephants may in fact move, this is usually temporary, and in some cases elephants are known to defy these bluffs.

The shooting of elephants to reduce conflicts with people, also referred to as control shooting, has been carried out for many years in Tsavo. Its use is poorly documented prior to 1990 and in general, its effects are not well known (Taylor, 1993). It is usually believed that the killing of one or more elephants in a certain area deters others from visiting the same area. Elephants are sometimes shot to quell hostility amongst the affected people, especially after extensive damage or when a person has been killed. When the decision to shoot follows a human death, it is often claimed that the "culprit" elephant has been identified. In other cases it is assumed that the most troublesome "ring leaders" are identified. Unless an individual elephant is already well known, the tendency to charge at people is used as the criterion to identify a "culprit". Since charging and bluff charging may represent a survival strategy (Dawkins, 1989), it is possible that the real "culprits" are rarely identified. A total of eight elephants have been shot in Tsavo since 1990 (Table 2).

Table 2 Number of elephants shot as problem animals in the Tsavo area since 1990.

Year	Number of elephants shot
1990	0
1991	4
1992	3
1993	1

A former way to appease farmers who lost crops to wildlife in Kenya was to pay compensation. This system was abandoned in 1989 amid allegations of blatant corruption. The scheme was also difficult to administer, thus incurring expenses and causing delays. By the time it was abandoned, less than 5% of affected farmers had received some compensation, which was not even to their satisfaction (Ngure, 1992). By that time the compensation scheme had existed for 12 years. Many people never launched claims, citing official insensitivity.

In 1989, wildlife authorities in conjunction with the Kenya Army, used two helicopters to drive elephants out of human settlements. The two drives were in the same locality and separated by about a month. In 1990 a three to four kilometre electric fence was put up to protect a large sisal plantation and a few subsistence agro-pastoralists. This fence lasted only two years. Initially, local people cut the insulators and lifted the wires to allow livestock into the national park and the energiser was later vandalised. The fence is reported to have been effective for the time it lasted.

A recent conflict mitigation initiative aims to use part of the revenue that accrues to Tsavo National Park to support development in areas which suffer elephant-related problems. A total of KSh 1.9 million has been spent on community projects since 1990 and a further six million has been allocated for this purpose. The consensus of opinion is that when revenue from wildlife is seen to benefit an area, residents are likely to tolerate some level of wildlife-related damage. A problem with this approach is that people suffer crop depredations as individuals, whereas it is the community which benefits from revenue.

National park authorities use law enforcement to curb poaching and encroachment by either people or livestock. Although this has helped in preventing settlement in the park, poaching for meat continues, as well as livestock incursions into the national park. However, there are no recent reports of elephant poaching by local people.

Planned people-elephant conflict mitigation activities

A reduction in crop depredations by elephants is viewed as the first step in mitigating conflict and several activities towards this end have been proposed. The main suggestion incorporates a combination of electric fencing and traditional PAC. The purpose of fencing will be the protection of cultivated land rather than confining elephants to the national park. The exact way to proceed has not been finalised, but ongoing activities are focused towards this aim and include:

1. A baseline survey is being undertaken of all major land holdings to establish details of current land-use activities and any likely changes to be expected in the future. The survey is being followed with discussions on how to obtain a consensus from the major landowners to conflict mitigation and future land-use that will not render the proposed activities obsolete.

2. Discussions are also being held with small-scale cultivators to obtain a consensus on their likely contribution to the conflict mitigation exercise and how it can be sustained.

3. The cost of current conflict mitigation activities is being analysed.

These exercises will help to evaluate the feasability of the proposed conflict mitigation activities. The major land-holding survey will, for example, determine the direction for future land-use planning in areas abutting Tsavo National Park. This will help to ensure that fences do not become obsolete by the spread of cultivation on both sides. It will also determine the acceptability of the proposed activities to the landowners and small-scale cultivators and their possible role in any conflict mitigation exercise.

The survey will assess the cost-effectiveness of the proposed activities, and it will also consider the costs of not implementing them, which includes the risk of degazetting Tsavo National Park.

DISCUSSION AND CONCLUSIONS

The above description of people-elephant conflict in Tsavo suggests a worsening situation and emphasises the need to find solutions. The underlying causes of conflict in Tsavo can be concluded as: 1) encroachment and cultivation of the Tsavo lowlands; and 2) the concentration of elephants close to human settlements following intense poaching in the interior of the parks (Ngure, 1992). It is also evident that increased political. awareness and better channels to communicate complaints have brought the issue of conflict into the limelight.

Three types of solution are envisaged: 1) those which relocate, human settlements and change land-use patterns in cultivated areas; 2) those which prioritise the control of elephant distribution and behaviour; and 3) those which attempt to modify human attitudes.

It is unlikely that any shift in human settlements or land-use systems would gather the required political support even if it was practically feasible. It is also difficult to address human attitudes without first reducing elephant-caused problems, although revenue sharing should help to placate the already negative attitudes of local people towards elephants and wildlife in general. The best option is to use solutions which address the control of elephant distribution and behaviour. The proposed fencing and PAC are examples of such solutions and it is hoped that the planned activities will pave the way for their successful implementation.

ACKNOWLEDGEMENTS

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THE PROBLEM ELEPHANTS OF KAELE: A CHALLENGE FOR ELEPHANT CONSERVATION IN NORTHERN CAMEROON

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INTRODUCTION

On a continental scale the population of the African elephant dropped from about 1.3 million in the late 1970s to approximately 600,000 a decade later (Douglas-Hamilton et al., 1992). However, some small populations have apparently become locally overabundant and are creating intense conflict problems (Thouless & Tchamba, 1992; Damiba & Ables, 1993; Taylor, 1993). Conservationists are faced with the dilemma of managing a species in urgent need of protection over most of its range, yet which occurs in such large numbers in certain limited areas that the need to cull must be considered.

Elephants are a major source of conflict between wildlife and people in the Kaélé region of northern Cameroon, largely on account of damage to crops and property and injury or death to humans. Conflict is limited to the wet season when more than 300 elephants invade the region. Although the exact origin of these elephants is not known, it is likely that at least part of the herd originates from Waza National Park located more than 120km away. Local strategies for deterring elephants are ineffective and often lead to fatal accidents. The government strategy for reducing conflict is limited to shooting a few elephants and providing food relief to the affected farmers.

This paper describes human-elephant conflict in the region and discusses possibilities for reducing conflict. The implications for long-term conservation of elephants are examined.

THE STUDY AREA

The Kaélé region or Mayo-Kani Division is defined here as the area comprising the sub-divisions of Kaélé, Moutourwa, Guidiguis, Mindif, and Moulvoudaye (Figure 1). It covers an area of approximately 5,033km^2 and is bordered in the west and north by the Diamaré Division, in the south-west by the Mayo-Louti Division, in the east by the Mayo-Danai Division, and in the south by the Republic of Chad. The Kaélé region has a population of some 267,000 people with a mean density of about 53 inhabitants/km^2 (MINAGRI, 1993). The annual population growth rate is estimated at 1.3% and is lower than the national average of 2.9% (MINEF, 1993). The active population, for which agriculture is the main occupation, represents 34% of the total population.

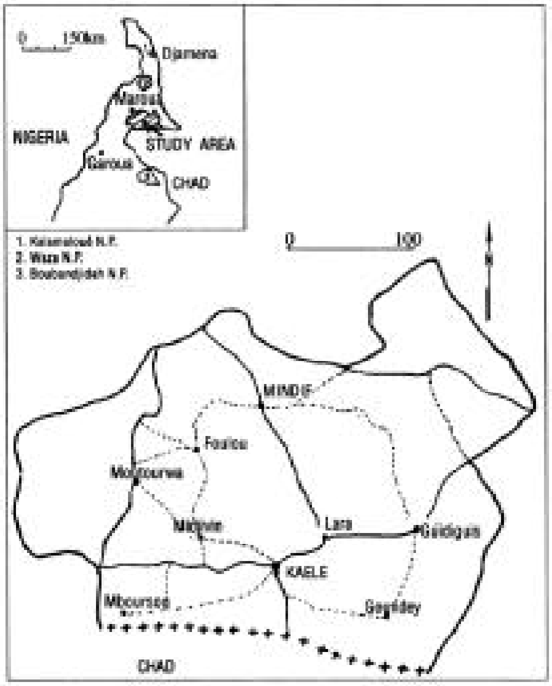

Figure 1. Sketch-map of the Kaélé region

The farming system is based on "slash and burn shifting cultivation" methods, using rudimentary equipment. The major food crops are millet, sorghum, and corn. The frequent invasion of birds like *Quelia quelia* is a serious threat to cereal cultivation. Cotton is the principal cash crop. Livestock holdings are confined mostly to goats and cattle, and do not provide substantial revenues because of their rudimentary nature. In recent years, millet has been replacing cotton as the major source of revenue because of the difficulties faced by cotton sellers on the international market.

The climate is soudano-sahelien with seasonal rainfall varying between 700 and 800mm per year, falling between May and October. Temperatures are high with the maximum in excess of 45 and minimum rarely falling below 19 The natural vegetation is a woodland savanna dominated by *Acacia seyal, Balanites aegyptiaca, Piliostigma reticulatum,* and *Combretum* spp. This natural vegetation is threatened by bush fires, “slash and burn” cultivation, and excessive cutting to satisfy the firewood needs of Maroua, the provincial headquarter.

Wildlife is very rare except in the wet season when the region is invaded by crop-raiding elephants, *Loxodonta africana africana.*

The region is a mosaic of small-scale farms and woodland which offers good cover and food for the elephants. Water is a serious problem in terms of quality and quantity. With the drying up of streams in the dry season and the reduction of the water table, the water supply cannot meet the needs of the people, domestic animals and wildlife. Infrastructure in the region is relatively good. Schools and health centres are found in nearly all villages. There are 130km of tarmac roads and 800km of dirt roads, which are hardly accessible in the wet season.

History of the conflict

Human-elephant conflict in Kaélé began in 1980 when a herd of more than 30 elephants from Waza National Park roamed the Mindif area throughout the rainy season. Two elephants were killed and elephant crop damages were estimated at l0ha (DDA, 1981). Elephants were noted in Lara, Kolara and Gaban in 1982 (DDA, 1983). In subsequent years, the number of elephants leaving Waza at the onset of the rains for the Mindif area increased and their home range enlarged (SPTEN, 1986). The number of elephants visiting the area and the extent of crop damage was not documented.

The conflict escalated in 1991 when a herd of about 50 elephants invaded the immediate vicinity of Kaélé. A total of some 260ha was destroyed and 600 50kg sacks of rice were donated by the central government as food relief (Thouless & Tchamba, 1992). In early July 1992, elephants reappeared in the region and it appears that the herds may have built up over the next few months. They left the area in November/ December when all the pools and seasonal streams dried up, and crops had been harvested. Even more elephants arrived in June 1993, causing further damage and human deaths.

Origin of the elephants

There are three known elephant populations within an area of 150km, and it is possible that the Kaélé elephants originate from one or more locations. A population of approximately 1,100 elephants (Tchamba, 1993) spends the dry season in the Waza Logone floodplain (about 120km north of Kaélé) which includes the Waza and Kalamaloué National Parks. During the rains they disperse widely into the far north of Cameroon (Tchamba, 1993). Since 1980 there have been about 30 Waza elephants roaming in the Mindif area (about 25km from the core area of the Kaélé elephants’ activity) in the wet season. In 1992 and 1993 there were no reports of unusually large numbers of elephants passing through Mindif to Kaélé. However, it is possible that some Waza elephants moved to Kaélé in small herds very early in the wet season. They did not attract much attention because crops had not matured and consequently there was little or no damage.

According to Daboulaye and Thomassey (1990) there are no more than 100 elephants in the whole area west of the Chari River. However, they indicated that the Binder-Léré Reserve and the Beinamar and Larmanaye regions in Chad were still unexplored. According to Chadian authorities, the Mayo-Kébi region of Chad, just across the border from Kaélé, suffered substantial elephant crop damage in 1992 and 1993. It was thought that these elephants were moving from the Binder-Léré Reserve or the Beinamar and Larmanaye regions (Daboulaye Ban-Imary, Director of Wildlife, Chad, pers. comm.). Local informants south of Kaélé were certain that there were still resident elephant populations just across the border in Chad. There is a need for more investigation within Chad, but it would be surprising if such a large population of apparently unpoached elephants should still be surviving there.

There is a belt of elephant range extending across the sudanian-savanna region about 140km south of Kaélé, which includes the Boubandjidah National Park on the border with Chad. There is little information on the current status of elephants in Boubandjidah. Although not based on accurate counts, the population is estimated at about 660 individuals. The insecurity in Chad has spilt over into Boubandjidah; it is not known how much poaching is taking place. It is believed that there may be wet season dispersal into the Mayo-Kébi floodplains in Chad, and if so it is possible that this dispersal may have extended as far as Kaélé.

Recent observations indicate that a relict population of about 100 elephants on the Chadian side of Lake Chad has moved to Cameroon as a result of disturbances in Chad. The elephants have actually settled in the Blangoua area but it is expected that they will emigrate towards Kalamaloué and Waza National Parks.

There is a small resident population of not more than 20 individuals spending the dry season around Goundey in the Guidiguis sub-division, about 8km from the Chad border. These elephants drink in the few small pools designed for domestic animals. They draw no attention from villagers because of the very limited damage they do on the dry season millet, locally called "mouskwari".

METHODS

Field work was conducted in the wet season of 1992 and 1993. In September 1992 an aerial survey was carried out to estimate elephant numbers and to assess the damage caused by crop-raiding elephants. Ground truthing and observations of elephant herds were conducted in 1992 and 1993. Determination of the age structure of the elephant population followed the technique of Laws (1966).

Interviews were conducted in Midjivin and Foulou, the two main centres of elephant activity. Persons from randomly selected households were interviewed using a questionnaire, which was divided into three sections. The first was designed to provide background information on age, sex and major occupation of the interviewee, and size of household. The second section asked questions about elephant damage, such as history and period of damage in the farm, size of farm, type of damage, size of farmland damaged, and traditional methods used to deter elephants. The third section sought to determine the local perceptions about elephant conservation. The questionnaire contained 22 questions, of which 12 were of fixed format and l0 were open-ended (Parry & Campbell, 1992). In addition, focused interviews (Bailey, 1982) were conducted in each of the two villages and allowed respondents to comment on potential strategies for reducing elephant impact in the region.

A Problem Animal Reporting (PAR) System (Hoare, 1990) was set up in Midjivin and Foulou, so that elephant movements and damages could be reported to the local enumerators. Enumerators were instructed on how to quantify elephant damage, spatially and temporarily.

RESULTS AND DISCUSSION

Behaviour of the elephant population

From observations made, the Kaélé elephants showed no signs of having been subjected to severe poaching pressure. When they smelt human beings they were just momentarily alarmed and returned to feeding immediately. The sound of humans caused more concern, but they returned to feeding after moving about 500m, and were not frightened by vehicles passing within 100m (Thouless & Tchamba, 1992). During the day time the elephants were usually concentrated in two or three herds of more than 100 individuals. They moved together in these large groups and started feeding on crops two hours before sunset. These aspects of behaviour differed considerably from crop-raiding elephants observed in East Africa, where crop-raiders tend to be in small groups of no more than 20 animals, only coming into the fields several hours after dark (Hoare, 1990; Ngure, .1992).

The fact that the elephants remained tightly grouped may be an indication of heavy stress due to permanent harassment from local people and the crop damage control operation.

Size, age and sex structure of the population

The elephant population was estimated at about 320 individuals in 1992 (Thouless & Tchamba, 1992). In 1993 about 400 elephants visited the Kaélé region. Figure 2 shows the age structure of the Kaélé elephants in 1993. It indicates that the Kaélé elephant population consists mostly of sub-adults and adults (71% of the total population). Compared to the age structure of the elephant population of Waza (Tchamba, in prep.) it appears that there is a marked scarcity of babies and juveniles in Kaélé (10% and 19% respectively compared to 14% and 25% respectively in Waza). This difference may indicate that the elephants of Waza and the elephants of Kaélé are two separate populations or that mostly mature elephants leave Waza National Park to roam in the Kaélé area. The sex ratio for immature elephants (<15 years old) was 1:0.9, whereas in mature elephants it was 1:1.2, not a significant departure from observations made in Waza (Tchamba, in prep.[a]); 1:0.8 and 1:1.4 for immature and mature elephants respectively.

The age and sex structure seemed to be typical of a very lightly poached population, with some largebodied adult bulls which had heavy tusks by Cameroonian standards. The proportion of calves to adults was relatively low (22%).

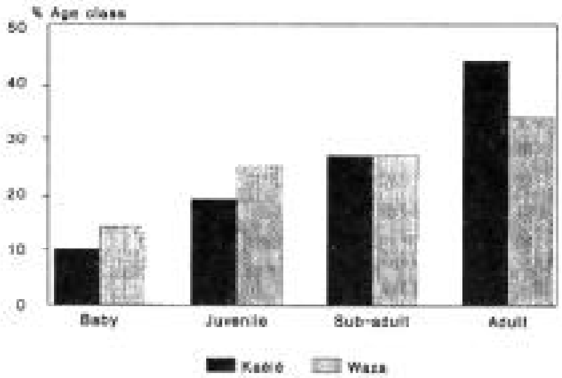

Figure 2. Age structure of the Kaé/é elephants in 1993

Elephant impact in the villages

Ninety-seven questionnaires were administered with the help of two local people.

Rainy season sorghum (53%) and dry season millet (37%) were the most frequently damaged crops. Cotton (5%) and corn (5%) were also affected. Most damage (54%) was caused by browsing elephants. Damage from trampling (35%) was observed when elephants were chased away from the field by farmers. Uprooting occurred only in 11% of observed cases of crop damage.

In Midjivin, elephant crop damage affected 22% and 42% of cultivated land in 1992 and 1993 respectively, while the corresponding rates in Foulou were 25% and 39%.

It is very difficult to get a true assessment of the cost of crop damage by elephants throughout the Kaélé region. This is because there is a tendency for local authorities and farmers to inflate estimates of crop damage in anticipation of compensation by cash, food assistance or meat from elephants which are shot for damage control. Using local production figures and typical market prices, the direct loss was estimated at US$ 38,740 and US$ 75,180 in 1992 and 1993 respectively in Midjivin, and at US$ 14,460 and US$ 22,170 in Foulou.

In the Kaélé region one and four persons were killed by elephants in 1992 and 1993 respectively. The dead included a military colonel leading an army batallion deployed to shoot crop-raiding elephants. It is difficult to attach a financial value to human life since no compensation can fully cover the loss.

In addition to the direct costs incurred by loss of crops which would otherwise be eaten or sold, or by the death of human beings, there are indirect environmental and social costs. Soils, for example, are affected by elephant trampling. Disruption of social activities occurs when people have to spend the whole day or night guarding their farms. School children loose many school days assisting their parents to guard farms or chase away elephants. Some people have even abandoned their cultivated land due to fear of crop-raiding elephants.

Local strategies for reducing elephant impact

The most common strategy is beating drums or empty barrels to scare elephants with noise, but this only has the effect of moving the problem to other areas. Stones and wooden sticks are thrown at elephants, but this exercise sometimes leads to fatal accidents. Farmers also light wood stocks around their crops or simply sleep outside with a flashlight to guard their fields from elephants. They also pray collectively to request the assistance of God and consult witches for magical practices to move elephants far from their villages. In September 1993, local people blocked the highway between Garoua and Maroua (the two largest cities of northern Cameroon) for eight hours, to demonstrate against the lack of government assistance with the “elephant problem”.

Government action to reduce elephant Impact

There is no official strategy for solving the human-elephant conflict in the Kaélé region. Wildlife authorities' actions are currently limited to shooting a few elephants to provide a cheap source of meat as compensation for crop damage. Two and seven elephants were killed in 1992 and 1993 respectively. The government recently indicated that US$ 1.8 million would be distributed to farmers in northern Cameroon to compensate them for losses incurred through drought, locusts, birds and elephants. The assistance has yet to materialise and is awaited with doubt and suspicion that it will be "lost" somewhere on its way to the villages.

Opinions, concerns and expectations of local people

All the 97 respondents expressed a common concern: what will happen to their farms with an increased elephant population in the Kaélé region? They look on the wildlife authorities primarily as a law-enforcement agency not willing to assist people and they expect the local administration to help them cope with elephants more effectively. Thirty-four percent of respondents were concerned that they might be asked to emigrate in order to make space for elephants. Most of the respondents (98%) indicated that they did not benefit from crop damage control in terms of game-meat. A large part of the meat, they said, was shared among administrative, military and political authorities. Fifty five percent of respondents did not believe in the possibility of government compensation.

Forty-one percent hoped that wildlife authorities would move the elephants and fence them elsewhere. Some respondents (18%) suggested that all the elephants should be shot while others (15%) thought that only the animals responsible for damage should be killed. Four percent suggested that the elephants could be scared away by gunshots. Nearly one-quarter of those asked (22%) had no idea what should be done.

CONCLUSIONS AND RECOMMENDATIONS

The conflict in Kaélé illustrates a situation which might escalate in the future given the notable increase of elephant numbers in northern Cameroon. Any solution to be chosen will have to take into account both the interests of the local people and the goals of sustainable elephant conservation. Kaélé tests the capacity of the government and its international partners to face and manage this type of challenge.

Five broad strategies can be considered to reduce human-elephant conflict. They are: (i) raising the tolerance threshold, (ii) deterrence of animals, (iii) culling, (iv) ecological infrastructure, and (v) physical barriers. These strategies have been applied to elephant management in different circumstances in southern and eastern Africa, with variable success (DHV, 1992).

Raising the tolerance threshold

One of the traditional ways of increasing the tolerance level of rural communities towards elephants has been to pay compensation to affected farmers. The compensation experiment in the Omay Communal Land, Zimbabwe, was abandoned in 1989, as was the official countrywide compensation scheme in Kenya (DHV, 1992). In Malawi, compensation appeared to have no beneficial effect on alleviating crop damage. A short-term solution for the Kaélé region may be to compensate farmers, whose crops have been damaged by elephants, by supplying them with millet or rice equivalent to the loss in yield. The drawback of such a scheme would be its administration -which would be open to abuse and corruption - and the difficulty of assessing damage. Therefore it appears that in this period of economic hardship, compensation is not a sustainable solution.

The distance separating Kaélé and the nearest national park (Waza, more than 120km away), along with legislation, complicate the sharing of revenues from wildlife-related activities by the Kaélé residents. Because tourist and hunting periods are limited to the dry season when elephants are not found in the Kaélé region, the linkage between costs and benefits of wildlife would be difficult to demonstrate to the local residents. Also, the implementation of a common property resource management scheme such as CAMPFIRE in Zimbabwe (Taylor, 1993) would hardly be compatible with present day realities in Kaélé.

One possible solution to reducing both the conflict and the number of elephants in Kaélé is to offer wet season safari hunting in the region. This could give residents the opportunity to earn some revenue from hunting activities. However, because of the potential abuse of the system, guidelines should be established to ensure a sustainable harvest of elephants at the height of the crop-raiding season, with adequate distribution of financial returns to the local community.

Deterrence of animals

Deterrence may take the form of shooting, fire, noise, use of light or chemical applications. Most such methods fail in the long run (Bell & Mcshane-Caluzi, 1984; La Grange, 1989; Deodatus & Lipiya, 1991; Ngure, 1992; Whyte, 1993). Once elephants are established in an area, they rapidly become habituated to any types of deterrence, accepting them as the price to pay for the bonus of feeding on tasty and easily harvestable human crops.

When the exact origins of the Kaélé elephants are known it will be important to establish a solid "front line" of well-defended farms to try and avoid the penetration of animals further into the region. This will probably require a full-time team of technicians and local informants with adequate transport and ammunition to follow the animals.

Culling

Culling, or selective removal of animals from a population, may be accomplished by killing or by translocation - the live capture and subsequent transportation of animals elsewhere (Jewell & Holt, 1981). Translocation is not applicable to the Kaélé elephants as they are not residents and move to the area only in the wet season.

In general, control shooting has failed to reduce damage rates to crops and in a few cases the value of destroyed animals has exceeded the value of damage inflicted (Bell & Mcshane-Caluzi, 1984; La Grange, 1989; DHV, 1992). Control shooting of elephants in the Kaélé region could be seen primarily as a palliative to local people who in turn, benefit from the indirect compensation of the meat.

Ecological infrastructure

The poor state of knowledge concerning the ecology of elephants in northern Cameroon hampers the development of a sound ecological infrastructure to reduce human-elephant conflict in the region. It is not clear, for example, how much the development of a buffer zone around Waza National Park, or the improvement of elephant habitat in Waza, or the setting up of elephant corridors and stepping stones, would modify the behaviour of elephants.

Physical barriers

The construction of physical barriers attempts to find a semi-permanent or permanent solution to a conflict problem. Moats, ditches and trenches have been dug in various parts of east. and southern Africa. However, they have achieved very limited success (DHV, 1992). In the Kaélé region of Cameroon conventional and electric fencing are clearly impractical, because of the large area involved, and the manner in which small fields are interspersed with uncultivated land. Waza elephants could be semi-confined by limiting their southward wet season migration with electric fences. However, this would increase elephant pressure within the natural habitat of Waza, which is already suffering from increased elephant density (Tchamba, in prep.). Successful use of fencing would require a clear understanding of elephant movements, with trained technicians employed to implement and maintain the fences (Hoare, 1992).

Finally, sustainable solutions for reducing conflict between humans and elephants need to tackle the problem at its source. Elephant conservation and management outside protected areas will largely depend on the perception of local communities towards elephants.

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TIMBER, COCOA, AND CROP-RAIDING ELEPHANTS: A PRELIMINARY STUDY FROM SOUTHERN GHANA

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INTRODUCTION

Crop-raiding by elephants is a problem wherever cultivators live in close proximity to elephants. In southern Ghana elephants are usually found in forests surrounded by cultivation, and complaints of crop damage are common. Farmers living around the Kakum and Assin Attandanso forests complain that crop-raiding intensified after management of the forests was turned over to the Wildlife Department in 1989. In this paper we describe the losses suffered by farmers. We then present a hypothesis to explain why crop-raiding has increased. This hypothesis is based upon the effects that logging has on forest structure, the activities of cocoa farmers, and a simple conceptual model of a shrinking forest.

Measurements of crop damage were made in August and September 1992, and the rest of the field work was conducted in September and October 1993.

STUDY AREA

Kakum and Assin Attandanso forests (Figure 1) cover 212km^2 and 154km^2 respectively (Hawthorne & Musah, 1993). They lie in the moist evergreen zone of south-west Ghana (Hall & Swaine, 1981). They were demarcated with concrete pillars and established as forest reserves in 1925-26 and 1935-36 respectively to protect water catchments (Kpelle, 1993). Logging started in 1936 and was intensified during the 1 950s, and especially between 1973 and 1989 (Kpelle, 1993). In 1989 logging was suspended and the responsibility for management was transferred from the Forestry Department to the Wildlife Department. Kakum was designated a National Park (NP) and Assin Attandanso became a Wildlife Resource Reserve. (Figure 1).

Although once part of a larger forested area, today Kakum and Assin Attandanso form an isolated block surrounded by cultivation except for the adjacent Pra Suhien and Ajueso Forest Reserves. Elephants do not cross the road into the Pra Suhien Forest Reserve, and the Ajueso Forest Reserve is small, so the elephant population appears to be an isolated fragment (Dudley, Mensah-Ntiamoah & Kpelle, 1992). A rough estimate of 100 to 150 elephants was made by Dudley *et al.* (1992) who pointed out that their methods were crude.

DAMAGE TO CROPS

Cocoa is the main cash crop in the area. Farmers also grow subsistence crops interspersed with their cocoa plantations. Most elephant damage is caused in the wet season. An assessment was made of the losses suffered by farmers around Kakum NP who complained of depredations by elephants. In each case the dimensions

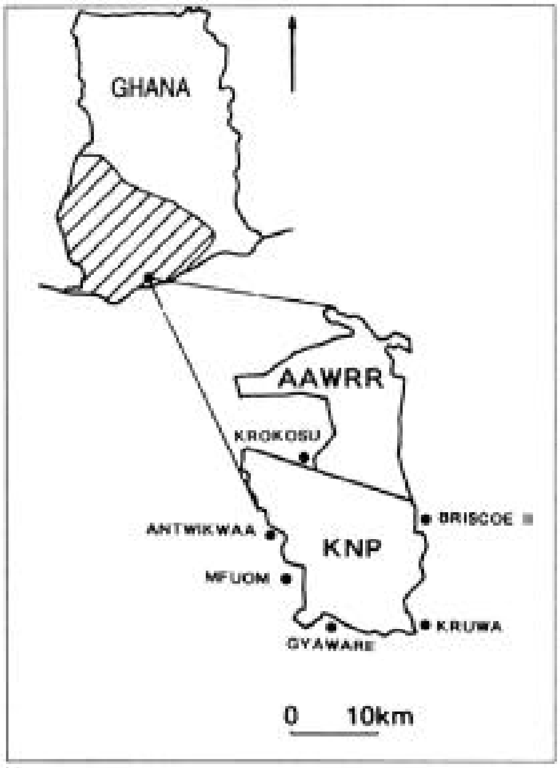

Figure 1. Map of Ghana, Kakum National Park (KNP), and Assin Attandanso Wildlife Reserve (AAWRR). The shaded area shows the forest zone.

of the field were measured with a tape measure. Then the dimensions of the patches damaged by elephants within the preceding 30 days were measured.

Altogether 140 fields were examined in six areas around Kakum (Tables 1 and 2). Maize and cassava were the crops that were most frequently reported to be damaged (Table 1). Yarns and maize were the crops which suffered the greatest percentage losses (Table 1). On average these farmers had lost 50% of their crops within the preceding 30 days (Table 1). These figures show that farmers who are afflicted suffer severely.

Farmers living on the west side of the Park (in Mfuom, Antwikwaa, and Krokosu) complained most frequently about elephants in their fields (Table 2). But the small number of fields damaged on the east side suffered a greater percentage loss. For example, the eight fields at Briscoe II lost more than nine-tenths of their crops (Table 2).

Table 1. The extent of damage caused by elephants to different types of crops. Data are from farmers who complained of crop damage.

Crop	Area of crop (ha)	Percentage Damaged	Number of Fields
Cassava	14.6	42	31
Cocoyam	5.4	43	18
Pineapple	0.4	25	1
Maize	16.0	68	48
Plantain	9.2	43	27
Yam	2.1	76	14
Cocoa	4.0	25	1
Total	51.7		140
Average		50	

Note that although cocoa is cultivated all round the Park, only one cocoa field was reported damaged (Table 1). In this part of Ghana elephants very rarely touch cocoa, whereas further north they eat the pods (Dudley et al., 1992).

We have no data yet on the percentage of farmers who suffer crop damage. But it is clear that those close to the edge of the forest are at greatest risk (Dudley *et al.*, 1992), and the probability of crop damage declines with distance from the forest edge. Thus farmers living a kilometre or more from the forest are less likely to complain of elephant depredations.

Table 2. Crop damage measured in different areas around the Kakum National Park. The data are from farmers who complained of crop damage.

Location	Area of Farms Measured (ha)	Percentage Area	Number of Fields Damaged
Mfuom	22.5	55	39
Antwikwaa	8.8	12	24
Krokosu	9.2	64	44
Briscoe II	1.1	91	8
Kruwa	1.3	66	6
Gyaware	8.7	44	19
Total	51.6		140
Average		48	

LOGGING

Logging has resulted in marked changes in forest structure. Two physiognomic changes are of particular importance: the reduction in fruiting trees and the increase in secondary growth (Dudley *et al.*, 1992). Fruit is an important part of the diet of forest elephants (Merz, 1981; Short, 1981; White, Tutin & Fernandez, 1993; White, 1994). At present we have no data on the reduction of fruiting trees caused by logging. Nor do we have measurements of the enhanced availability of browse. However, the marked differences in the undergrowth between the unlogged and logged compartments has led us to suspect that the greater abundance of secondary growth, which is the preferred feeding habitat of elephants (Merz, 1981, 1986; Barnes *et al.*, 1991; Dudley *et al.*, 1992), far outweighs the loss of fruit resources. Nothing is known about the response of forest-dwelling elephant populations to changes in food abundance. However, if forest elephants respond in the same way as savanna elephants to variations in food supply (Laws, Parker & Johnstone, 1975), then the improvement in habitat has resulted in higher pregnancy rates and improved survival rates. The long gestation period plus the prolonged juvenile growth (family groups with infants rarely raid crops [Sukumar, 1991; Dudley *et al.*, 1992]) means that there would be a time lag between the improvement in the food supply and consequent increase in crop-raiding.

When it became known that the forest would be turned over to the Wildlife Department in 1989, there was a flurry of logging activity, especially in Assin Attandanso. The loggers concentrated on the timber near the periphery because it was more accessible. Also, logging intensified in forest patches outside the reserves. Thus the greatest change in forest structure was probably around the edges of the forest. The greater abundance of food attracted elephants to the edge where they were more likely to smell nearby crops.

COCOA

Forty-seven farmers living around the Kakum and Assin Attandanso forests were interviewed (note that this was a non-random sample). Of the 31 who gave their place of origin, none had been born in the place they now lived. Five came from villages within the general vicinity, 12 came from other parts of Central Region, and 14 came from outside the region. Those who had moved into the area said they had come with the specific intent of growing cocoa.

The trend in world cocoa prices is shown in Figure 2. Prices (in constant 1980 dollars) rose in the 1950s, fell back, and then rose steeply in the 1970s to peak in 1977. They then fell sharply, rallied in 1983, but then continued their decline. We suggest that the higher prices in the 1970s drew immigrants into the area. They cleared forest around the park to establish cocoa plantations. One farmer told us that 20 years ago the forest extended 3km to the west of its present boundary at Antwikwaa. If we assume that the forest extended 3km on all sides from its present boundary, then in the early 1970s it could have covered 1.9 times the area it covers today, or about 700km^2. This fringe has been replaced by cocoa plantations, subsistence farms, and “farm bush” or secondary growth on abandoned fields.

How would the changes in forest area since 1970 affect the interface between elephants and farmers? Figure 3 shows the results of a simple model in which it is assumed that in 1970 there were 50 elephants dwelling in a circular forest with an area of 700km^2. Between 1970 and 1993 the radius of the forest decreased by 3km, so the area of forest was halved. Even if elephant numbers did not change, the contraction of the forest would have caused the elephant density within the forest

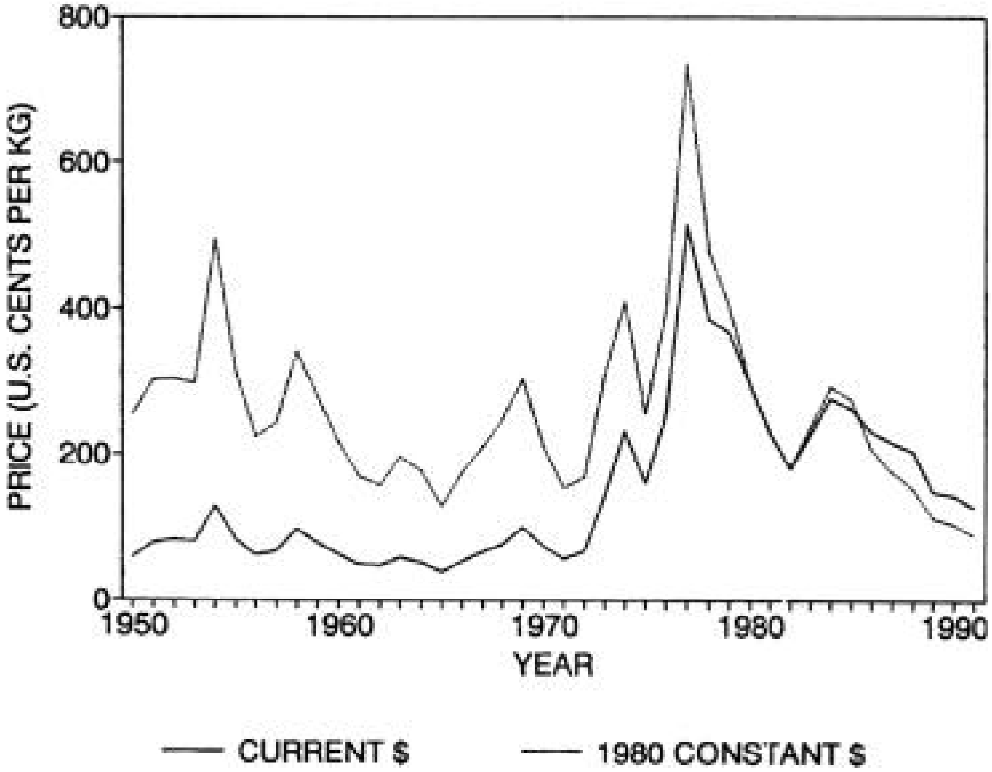

Figure 2 The trends in prices of Ghanain cocoa beans atthe London commodIty exchange between 1950 and 1991. Data from World Bank (1994)

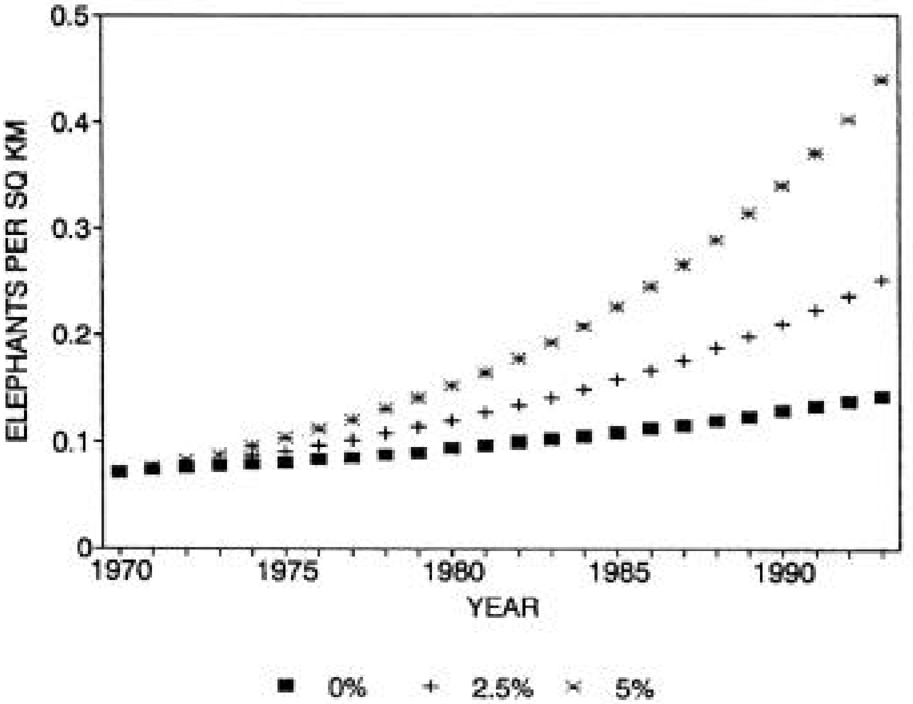

Figure 3. Modelled trends in elephant densities as their forest habitat decreased in size, assuming that the elephant numbers remained constant or in creased at an annual rate of 2.5% or 5%.

to double (Figure 3). If numbers increased at an average rate of say 2.5% per annum, because of the improved food supply caused by logging, then the density increased to 3.5 times its initial level. If numbers increased at an average rate of 5% per annum, then the final density would have been six times its initial level.

Rather than the density of elephants being the critical factor determining crop-raiding, it might be the number of elephants close to the periphery where they may smell crops. Let us assume that elephants within one kilometre of the forest edge are more likely to be tempted into the fields. As a circle shrinks, its radius diminishes and a greater proportion of the circle's area lies within one kilometre of the periphery. In 1970 the ring of forest within one kilometre of the boundary covered $91km^2$. If the 50 elephants were evenly distributed through the forest, then six or seven elephants would have been found within this ring. In 1993, when the forest was half the size, the area of the outer ring was $63km^2$. Assuming there were still 50 elephants, then nine would have been found within one kilometre of the boundary. Thus the shrinkage of the forest would result in more elephants being within easy reach of the forest boundary and the nearby fields. If elephant numbers had increased by 2.5% or 5%, then the number of elephants in the outer ring would be 16 or 28 respectively.

The perimeter of the forest has also decreased. In 1973 our circular forest would have had a perimeter of 94km, compared with 66km in 1993. If the average farm size had not changed, then for every 94 farms adjacent to the forest in 1970 there would be 66 today. Thus today there would be fewer farms at the interface between forest and cultivation. But those at the interface today could expect to suffer a greater intensity of elephant damage than in 1970 because of the higher elephant density in the forest.

DISCUSSION

As cocoa prices rose in the 1970s, people moved to the Kakum and Assin Attandanso area. Gradually they cleared the forest up to the boundary pillars. At the same time timber companies were unintentionally improving the structure of the forest in favour of elephants. Dudley *et al.* (1992) pointed out the link between world timber markets and changes in the quality of forest elephant habitats. The better food supply per unit area may well have balanced the decline in forest area, in which case elephants prospered. There would have been a lag between the changes caused to the vegetation by logging and the consequent increase in crop-raiding.

Even without any change in elephant numbers, the contraction of the forest resulted in more elephants within easy reach of the forest edge and adjacent fields. Logging exacerbated this by attracting them towards the periphery. Thus we suggest that cocoa farming and logging have stimulated crop-raiding because they both (a) caused an increase in elephant density and (b) resulted in a greater number of elephants close to the edge of the park.

The apparent increase in crop-raiding after the Wildlife Department assumed responsibility for the forest is probably explained by the concentration of logging activity at the periphery just before logging ceased in 1989. This must have attracted elephants to the edges of the forest in the years after 1989.

We have presented a hypothesis in this paper to explain the increase in crop-raiding around Kakum and Assin Attandanso forests. Most parts of the hypothesis can be tested. For example, when new aerial photographs become available, they can be compared with those taken in the 1970s to show the rate at which the forest has contracted, changes in the distribution of cocoa plantations and other forms of cultivation, and the effect of logging (by measuring changes in the density and distribution of emergent trees). Changes in the structure of the forest could also be investigated by field surveys combined with examination of compartment records kept by the timber companies. The preference of elephants for heavily logged areas could be demonstrated by studies of elephant distribution. A properly conducted sample survey of cocoa farmers could show the relationship between cocoa prices and immigration to the area. However, it will not be possible to assess the trend in elephant numbers because there are no data on elephant abundance in the past.

If our hypothesis is not falsified, then we will argue that the forest is a system of which the elephants are but one component. Economic forces, such as world demand for cocoa or timber, can exert an effect on the forest and the people living around it. Meddling with one component of the system, such as removing the larger trees, may result in unintended consequences elsewhere, such as damaged crops outside. Time lags can obscure the causes of the problem. For example, we would suggest that although the timber companies have long gone, it is only today that the farmers are suffering the consequences of their activities.

ACKNOWLEDGEMENTS

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Photo credit: Kadzo Kangwana

A maize crop damaged by elephants.

FACTORS AFFECTING ELEPHANT DISTRIBUTION AT GARAMBA NATIONAL PARK AND SURROUNDING RESERVES, ZAIRE, WITH A FOCUS ON HUMAN-ELEPHANT CONFLICT

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INTRODUCTION

Human pressures on elephants *(Loxodonta africana)* caused by poaching and by conflict for resources, and the modifying effects of elephants on vegetation and on domestic crops, are widespread throughout Africa (Douglas-Hamilton, 1987; Barnes *et al.*, 1991; Barnes & Kapela, 1991; Dudley *et al.*, 1992). They are exacerbated when there is an unequal distribution of the resources across protected area boundaries (Lewis, 1986). We examine here the interplay of these effects, with a focus on human-elephant conflict, in one protected area of Zaire.

The 4,920km^2 Garamba National Park in north-eastern Zaïre contains the densest elephant population in the country. The park is surrounded on three sides by reserves in which there is limited human settlement and agriculture, and on the fourth side by the border with southern Sudan, a country currently suffering chronic civil war.

The reserves are significantly more wooded than the open long grass savanna of the park. The elephants have always used both park and reserve habitats in differing degrees depending on contemporary factors (Cornet d'Elzius, 1957), but since the gazetting of the National Park in 1938, they have inevitably concentrated more in the park with its greater protection, increasing to over 22,000 in 1976.

An immediate expression of human-elephant conflict is poaching, which affects both elephant numbers and distribution. Between 1978 and 1983 heavy poaching, particularly in the north, reduced elephant numbers by 80% and compressed the population into the south of the park. Improved protection since 1984 resulted in a marked increase in the elephant population in the south of the park, with continued repression of woody vegetation. The cessation of control shooting and stricter protection in the reserves, linked with a higher diversity of forage availability, have led to a notable increase in elephant movements into the reserves and more reports of crop damage since 1990.

This paper makes a preliminary examination of the background factors and current situation of human-elephant conflict at Garamba, with the help of a Geographic Information System (GIS). Our aim is to present an overview of the situation, as a basis for planning both integrated management and further research.

HABITAT DESCRIPTION

The Garamba ecosystem falls within the sudanoguinean savanna biome between latitudes 3 and 5˚N and longitudes 28 and 30 The soil is of lateritic origin and well drained. Within the park, it is leached with very little humus, which is rapidly converted by fire and termites, in contrast to the higher humus and carbon content of soil outside the park. Towards the north the ground rises to the Zaire-Nile watershed, with gneissic schist and granite outcrops. Altitude varies from 800 to 1060m. Mean annual rainfall over the ten-year period, 1981-1991, was 1,346mm, which is lower than previous records (1940-1949: 1,514mm; 1951-1963: 1,627mm). It falls mainly in one wet season from April to November.

The southern two-thirds of the park is undulating with long grass savanna, dominated by *Loud etia arundinacea* and *Hypparrhenia* species. Flowing water courses and freshwater springs are widely dispersed, some with varying degrees of relict riparian woodland. Towards the north is an increasing gradient of tree/bush savanna and woodland with dense gallery forest.

The park is bordered to the west by the Domaine de Chasse Azande (2,892km^2), to the south by D.C. Gangala na Bodio (2,652km^2) and to the east by D.C.

Mondo-Missa (1,983km^2). The vegetation in these reserves is largely woodland and dense to medium treel bush savanna, dominated by such species as *Combretum collinum* and *Piliostigma thonningii*, with gallery forest or riverine swamp. The human population density averages 0.21km^2, although two dense centres of human settlement occur on the borders of the south-eastern and south-western corners of the reserves. Land-use is mainly shifting subsistence agriculture with traditional use of bush meat for protein, and there are areas of open-cast gold mining.

METHODS

Aerial survey data

The overall elephant, human and vegetation distribution maps are based on systematic aerial surveys (Norton-Griffiths, 1978; Savidge *et al.*, 1976; Hillman *et al.*, 1983; Smith & Smith, 1993). The elephant population sizes are also based on these and on a comparable series of sample counts, plus one species-specific elephant count in 1989 (Hillman Smith, 1989). Human population distribution has been mapped on the basis of hut counts taken during the 1993 general aerial census. Ground work was undertaken to establish person/hut ratios.

Poaching assessment

Elephant numbers from aerial counts and records of ivory recovered by guards are used as indicators of the poaching pressure on elephants. Reports of poaching and anti-poaching activities are made by guards on patrol. Since 1992, however, improved reporting procedures similar to those outlined by Bell (1984), have made it possible to assess the intensity and distribution of poaching on a monthly basis.

Ground transects

Aerial survey data give elephant distributions only during the day. Many of the elephant movements into the Domaines are known to be at night. Evidence includes observations of elephant movements across the park boundary in the evenings and early mornings, spoor, vegetation damage and crop damage. The more detailed distribution of elephants within the Domaines de Chasse is based on 42 x 5km line transects. They were surveyed during the dry season, from February to April 1994.

The techniques adopted were those of Barnes and Jensen (1987) for estimating elephant densities based on the number of dung piles recorded along the transect, combined with defecation and dung decay rates. The latter rates were calculated from data collected from the domestic elephants in Garamba, while feeding freely in natural habitat. (Hillman, in prep.). The programme of Dawson & Dekker (1992) was used for analysis.

Each transect was classified by vegetation type and sampled for the type and extent of damage caused by elephants. Elephant damage could still be recognised more than six months after it had occurred, but the dung counts only indicated elephant distribution within the preceeding month. Relative abundances of other species were also recorded along the length of each transect, as were all signs of poaching.

Preliminary study on crop damage

In November 1993, the pre-harvest and harvest period, a short study of crop damage by wildlife was made in the Nagero area in Gangala na Bodio Reserve. Forty-eight interviews were conducted, giving information concerning 68 cultivated fields. The subsistence agriculturalists interviewed around the station of Nagero are all employees of IZCN, living adjacent to the park boundary. They therefore have a vested interest in the wildlife, which provides their livelihood.

Data collected included details of ownership, location and situation (i.e. the number of sides adjacent to other fields as opposed to open bush), crops grown, actual damage to each crop, animal species causing damage, period of damage, frequency of damage, trend and preventative measures used. Direct observations of the fields were also made to verify damage estimates.

Data were collected on the incidence of crop damage in two other areas of the reserves. One area was identified as having high potential conflict, the other as low.

GIS modelling

The purpose of the GIS modelling was to interpolate sample data to the whole region and to relate elephant distribution to spatial factors. The IDRISI and

ARCINFO systems were used for the modelling exercise.

All data relating to elephant and human distributions were taken from sample surveys. Confidence interval for the sampled data were determined according to Jolly's Method 2 (Norton-Griffiths, 1978), in the case of the aerial count data.

Information on the distribution of elephants, elephant damage and human settlement was extrapolated using GIS interpolations, whereby values for unsampled areas were calculated from the six nearest sampled points using a distance weighting factor of 2 (i.e. a sampled point at distance x will have twice the influence on a point to be calculated as a sampled point at distance 2x). The statistical accuracy of this model is being researched and it was felt that the results should be treated with some caution. Elephant use of the reserve was mapped on the basis of elephant damage to vegetation. This variable was chosen as being representative of a long-term distribution of elephants, covering more than one season, rather than the short-term distribution based on dung data.

It was hypothesised that the distribution of elephants in the reserves would be explained by proximity to the areas of highest (core) elephant density within the park, and also by the distance from centres of human settlement in the reserves (Michelmore *et al.*, 1990).

Areas of extensive elephant damage to natural vegetation, and areas of high human population densities, were modelled using a GIS overlay, as areas with a high potential for elephant crop-raiding. These areas were defined using two sets of parameters:

i. The population density and natural vegetation damage as found at Nagero (1,820 trees/km^2) in order to locate areas of high crop-raiding intensity. This figure was based on the results of the sample study of crop damage around the Nagero station.

ii. The parameters in i. were arbitrarily lowered to a population density of >5/km^2 and a natural tree damage level of >1 ,000/km^2, to identify areas of potential conflict at a lower level.

Satellite radio tracking

Between April 26th and December 21st 1992, locations of an adult female elephant were tracked using a Platform Transmitter Terminal mounted on a collar and transmitting to a NOAA satellite. The collar, constructed by Telonics Inc. was the property of the Wildlife Conservation Society (WCS/NYZS), which carried out the study, and was attached by Dr William Karesh, Field Veterinarian International. Eighty-one locations were received, of which 74 were useable, based on the Argos Centre's classification of accuracy.

RESULTS

Distribution of elephants and poaching in the park

Figure 1 gives the elephant population estimates from successive counts, showing decrease at the time of heavy poaching, a time lag and then a recovery under protection.

In 1976 the elephant population was 22,670 ± 11,790 (Savidge *etal.*, 1976) and the elephants were distributed throughout the park (Figure 2a) at an overall density of 4.6/km^2. By 1983 the elephant population in the park was estimated at 7,742 ± 3,690 (Hillman *et al.*, 1983). The densities plotted in Figure 2b are lower overall and show a compression into the south of the park, at a density of 3.6 /km^2, compared with an overall density for the park of 1 .6/km^2. Figure 2c shows the distribution of elephants in the park in 1993.

According to local park staff, heavy poaching began in 1978. It continued at an average annual rate of 2,154 elephants per year throughout 1983 and half of 1984. It was widespread, but heavier in the north. The dead to live ratio of elephants overall in the park in 1983 was 1:8 compared with 1:28 in the south. The focus of

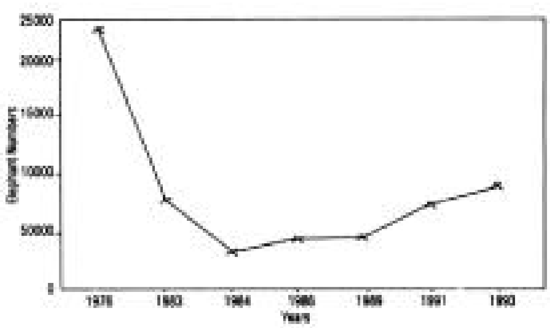

Figure 1. Number of elephants in Garamba National Park as estimated from aerial surveys from 1976 to 1993.

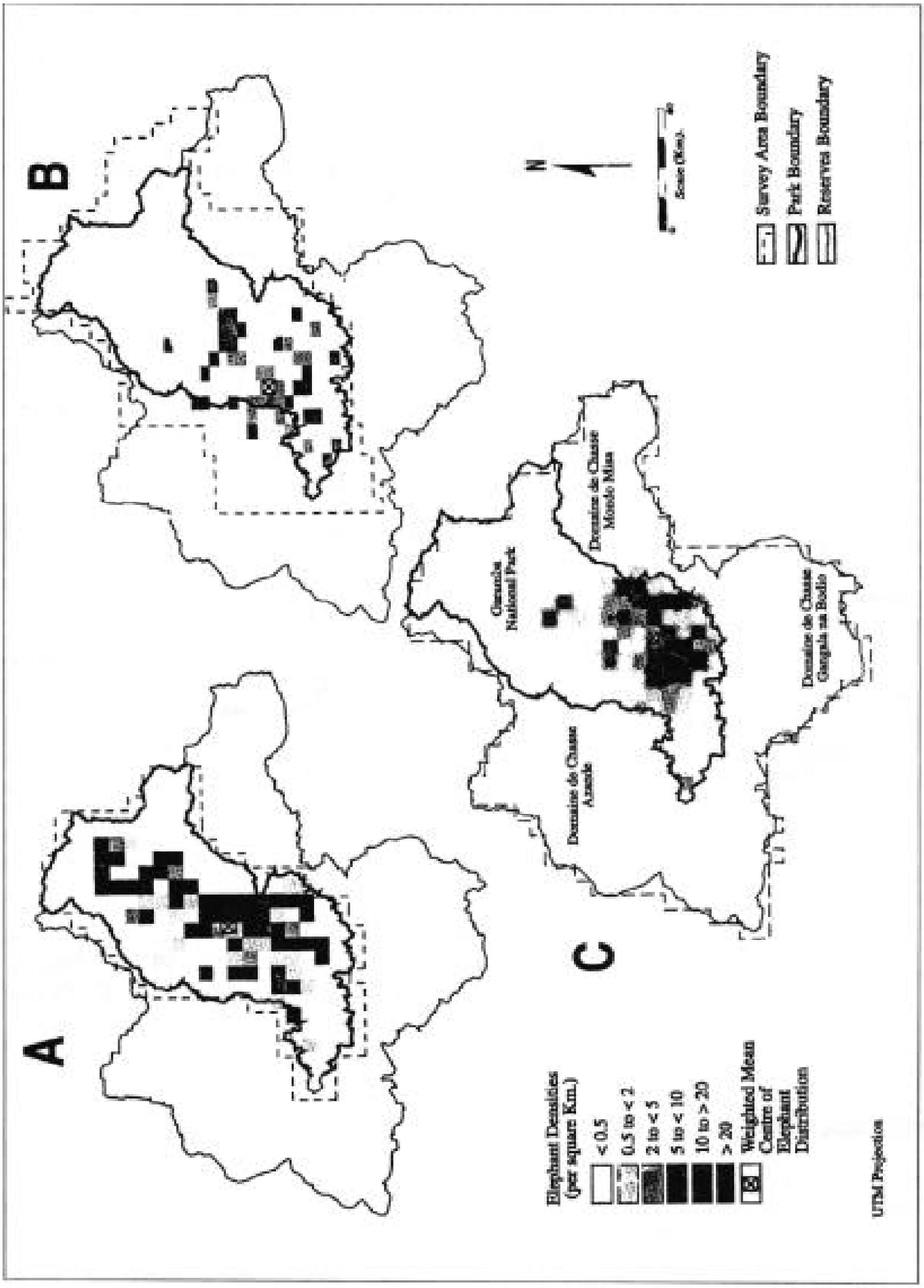

Figure 2. Elephant density per square kilometre in Garamba National Park in A) 1976; B) 1983; and C) 1993.

poaching in the north is due to a combination of isolation and distance from the park headquarters, and to the proximity with Sudan, where automatic arms are readily available.

From the end of 1984, the co-operative support of an aid project working with IZCN was able to bring the poaching largely under control. Elephant poaching virtually stopped. Dead to live ratios of elephants changed from 1:8 in 1983, to 1:23 in 1984; and 1:86 in 1986 to 1:576 in 1991. No dead elephants were seen in 1993.

Despite the control of elephant poaching during the period from 1984 to 1992, there continued to be limited poaching for meat, but primarily buffalo *(Synceros caffer brachyceros)*, in the north of the park and this continued to have a deterrent effect on the redistribution of elephants northwards.

Effects on vegetation

Figure 3 shows tree cover in the park and reserves, mapped from the 1993 aerial census. It illustrates the contrast between high tree density in the reserves and very low density in the park. There is a significant negative correlation ($p<0.1$) between the distribution of bush and the day-time distribution of elephants, as mapped from the 1993 aerial sample count. The contrast between the higher density of woody vegetation in the reserves and the low density in the south of the park would appear not only to be causally related to elephant distribution, but to be one of the major factors which attracts elephants out of the park at night.

Elephant distribution in the reserves

Figure 4 plots the distribution of elephant use of the reserves as indicated by the interpolated map of vegetation damage. It shows three main areas of high density use by elephants. Three core areas of more than 20 elephants/km^2 can be identified in the 1993 distribution (Figure 2c). It is known from direct observation that these, particularly the easternmost one, represent areas where elephants congregate when they return to the park in the morning, and from whence they move out into the reserves at night. The three areas of high density use outside the park correspond with the three core retreat areas inside. The southeastern area of 10 to 20 elephants/km^2 in the park corresponds to an area of long unburnt grass favoured by elephants.

Results from the satellite tracking in 1992 (Koontz, 1993) also support the fact that these same areas of the reserves are attractive to elephants. There appear to be frequent movements within a core area within the park and infrequent movements out to the reserves and back.

Human-elephant conflict: crop damage

Of the 48 interviews conducted, 85.4% claimed damage to crops by wildlife. In a few cases, 100% of the annual crop was lost. In ranked order, elephants were found to be causing the most damage. Hippos *(Hippopotamus amphibius)* were second. While hippo damage was limited to within 2km of the river, which forms the park boundary, and had even caused 47% of the growers to move their fields in the last year, elephant damage occurred throughout the study area, which extended 4km from the river.

Manioc was the main staple crop grown until the past three to four years, but growers reported that with the increasing elephant population there has been a significant increase in damage to manioc, which as well as being favoured by elephants, is more difficult to protect since it grows all year round. Many growers have therefore been forced to change their main crops to rice and millet. Only 24 (50%) of the growers interviewed are currently growing any manioc at all, and of these, five of the manioc fields sustained 100% damage. Millet, although not favoured, is now grown by 83% of the farmers interviewed.

The growers have found that unless they stay at their fields to protect them every night in the pre-harvest period, they risk losing all their crops. Damage prevention methods include staying in the field, keeping a fire burning, drumming on a metal surface and chasing the animals. Pilipili *(Capsicum)* seeds are often burned in the fires to give the smoke an extra deterrent effect.

Field verifications were carried out in May 1993 of one location identified as being susceptible to a high level of elephant crop-raiding and of one area where no damage was expected. At the first location, of the 24 family units studied, 96% had experienced crop-raiding within the previous week. This is comparable to the results obtained at Nagero. At the second site, no crop damage by elephants was reported at all.

Peak damage periods by elephants are May-June during the mango season and September-November, the pre-harvest and harvest period. Major movements of elephants out of the park at night have also been noted

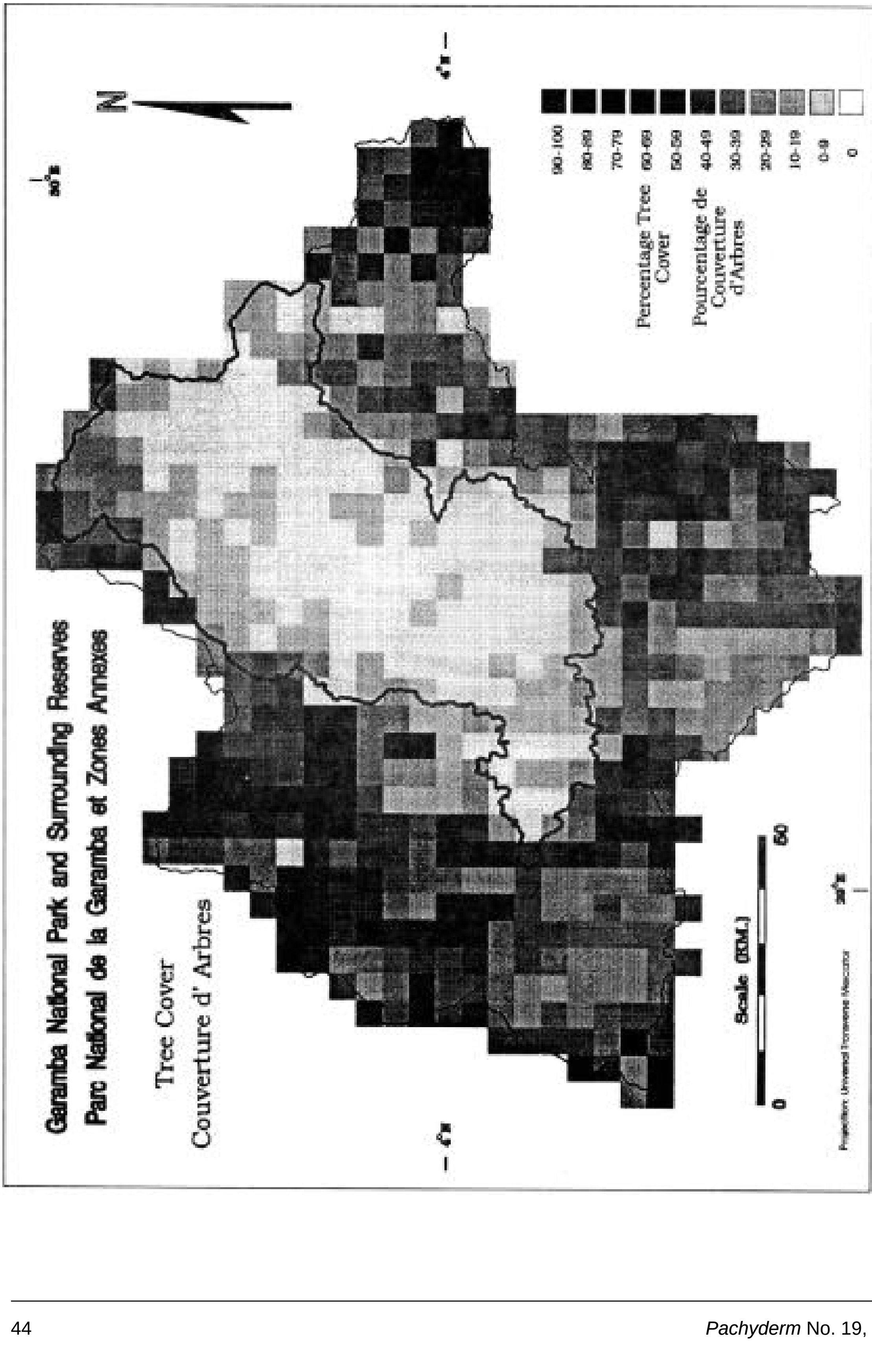

Figure 3 Percentage tree cover in Garamba National Park and surrounding reserves.

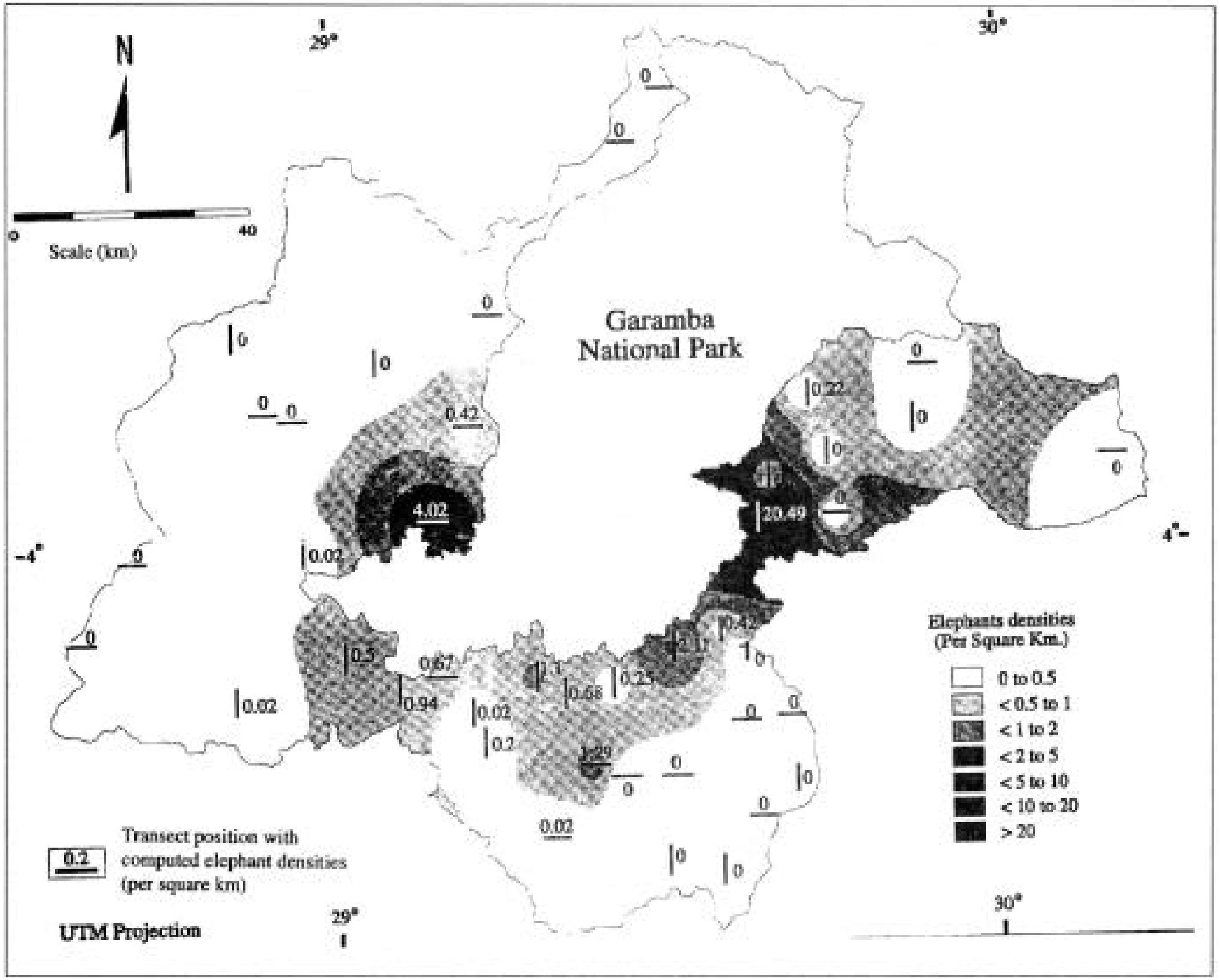

Figure 4. Elephant density per square kilometre in the reserves which surround Garamba National Park.

during the dry season, when the trees in the reserves are coming into new leaf, but virtually no crops are being grown.

Attitudes and conflicts were assessed as part of a facilitated workshop held for management planning purposes in October 1993. Of 34 problems raised, human-animal conflict was ranked second in importance. The primary problem was inadequate salaries, which also has a direct bearing on conflict, since in the current economic climate of Zaïre, the staff cannot live on their salaries alone and rely on growing their food for subsistence.

Results of the GIS modelling exercise

The ground survey of huts revealed a ratio of 1.92 persons per hut, on which the final interpolation was based.

The relationship between natural vegetation damage by elephants and proximity to the core area of elephant density within the park was positively significant at the 0.01 level. Proximity to human settlement showed a strong negative correlation (0.01 level) against the distribution of vegetation damage.

Figure 5 identifies areas of high human-elephant conflict. In case A the level of tree damage was set at ≥1,820 trees/kin^2, which is the level of damage found around the station of Nagero. In case B a lower level of damage (≥1,000 trees/kin^2) was used as a more sensitive indicator. The heavy shading represents areas with a high incidence of crop-raiding and which therefore require follow-up work to establish the extent of the problem to the people.

DISCUSSION

The interpolated mapping, together with data on elephants and poaching, shows how the current situation has developed over the last few years. Broadly speaking, the distribution of elephants has been primarily affected by poaching. Although it is probable that the park area has been more open than surrounding areas for a long time, elephants have concentrated there in its relative safety since the establishment of the park. There has also been a history of hot fires, particularly in the south. These two major factors are associated with a continued loss of mature trees and a repression of tree regeneration in the park. According to longterm observation (Verschuren, J. and Cornet d'Elzius, C., pers. comm.) woody vegetation has, over the same period, increased outside the park. Concomitant with these factors has been the increase in coarse grass grazers, notably the buffalo - which may further reduce the proportion of palatable grasses - and an apparent reduction in browsers, such as the giraffe *(Giraffa camelopardalis congoensis)*. This change is reinforced by the development of a contrasting nutrient status of the soil inside and outside the park.

The contrast in habitats inside and outside the park, and the availability of woody vegetation with its higher protein content outside the park, was therefore hypothesised to be a major factor attracting the elephants out of the park at night. This was supported by the observed elephant damage, particularly fresh damage, to natural vegetation around the boundary of the southern part of the park, where the elephants are concentrated. The strong positive correlation between elephant vegetation damage and distance from the elephant population core in the south of the park, together with the absence of this type of elephant distribution during the day, demonstrates how damage is largely caused by night-time elephant movements and limited by the distance which can be covered in a night. This is supported by many observations of elephants crossing the river boundary of the park at dusk and early in the morning, and by crop-raiding being largely limited to the night. The apparent increase in this type of movement in recent years coincides with better protection due to stronger law enforcement in both the reserves and the park.

There is evidence that some elephants are more or less resident in the reserves, but their distribution in the reserves is mainly affected by proximity to the core population in the south of the park and distance from humans. It is known from direct observation that considerable elephant movement out of the park occurs in the dry season, despite the absence of crops. The strong negative correlation of elephant distribution with that of humans indicates that elephants are largely avoiding areas of human settlement. Crop-raiding for specific resources in the dry season is therefore not a primary attractant. The main periods of crop-raiding are associated with the time when mangos are ripe, from April to June, and later in the wet season when crops are close to harvesting. However, in the dry season much of the grass in the park is either long and dry, or burnt, and the trees outside the park are coming into new leaf. Further work will examine this aspect of seasonal elephant use of the reserves and the effect of different vegetation zones and favoured tree species on the distribution of elephants.

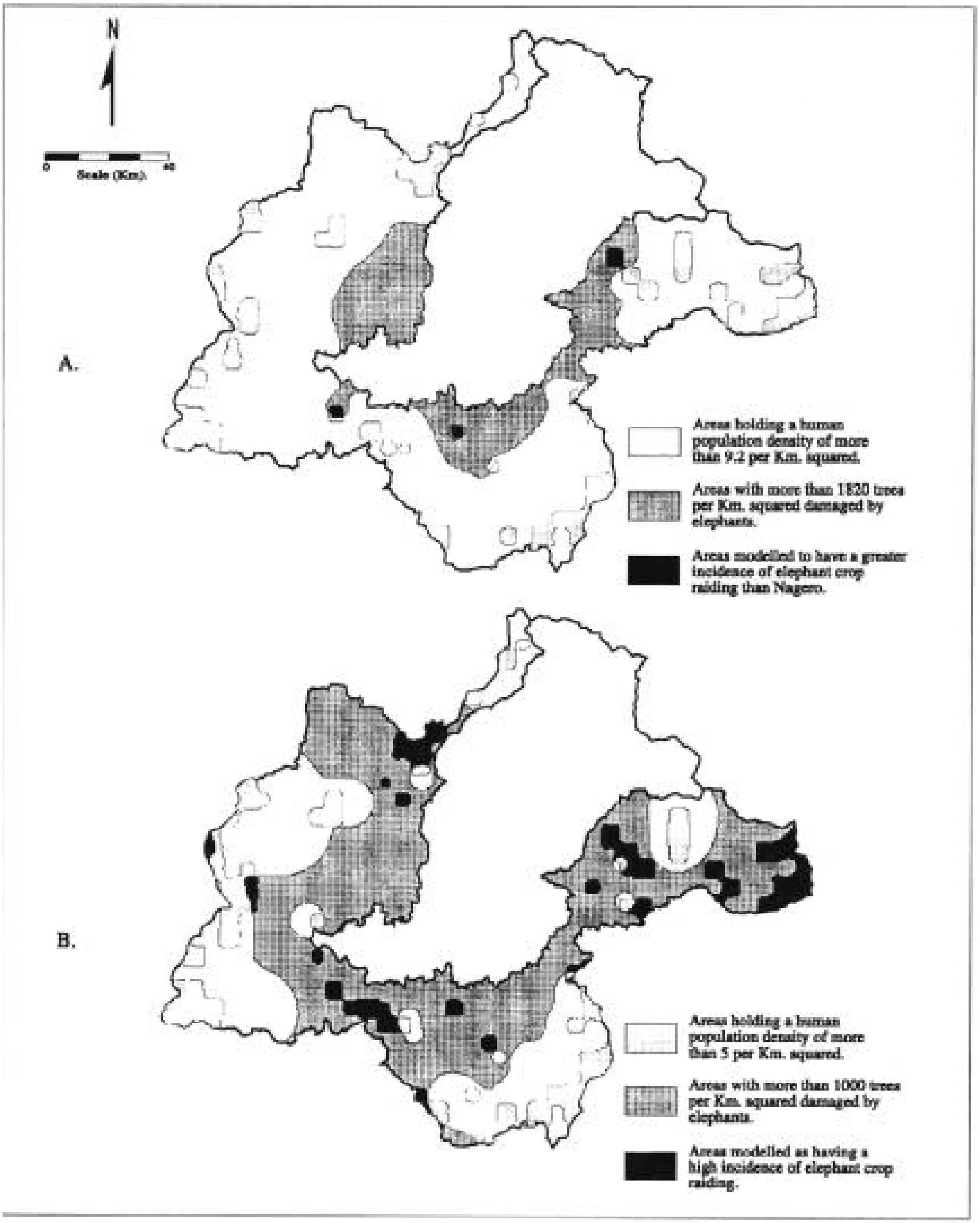

Figure 5. The results of GIS modelling to predict areas in the reserves with a high incidence of crop-raiding. A) shows those areas expected to have a greater incidence of crop-raiding by elephants than Nagero. B) shows those areas with a high/eve/of crop damage using a human population density of .>5/km^2 and more than 1,000 trees/km^2.

The crop damage study indicated that elephants are threatening the livelihood of certain human communities, particularly those living close to the park boundary. However, the modelling exercise which predicted areas of potential human-elephant conflict illustrated how limited these areas are. Although elephant distribution is associated more with the distribution of natural vegetation in the dry season than with crops, the impact of crop damage is nevertheless recognised as an important problem by the people who are affected.

The above information is being used to contribute to the preparation of a zoned management plan for the park and reserves. It is not possible, given the current financial and manpower resources, to protect the reserves by conventional forces. In principle it may be possible to make the reserves more safely available through schemes which identify the most important areas for elephants and other wild species and which involve local human communities.

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CONSERVATION AND MANAGEMENT OF ELEPHANTS IN NAMIBIA

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ABSTRACT

Namibia's elephant population recovered from near extinction due to uncontrolled hunting for ivory at the turn of the century, to over 7000 elephants since the 1980s (currently estimated at approximately 8000), with a range of about 80,000km^2. The increase is attributed to effective management practices and a conservation policy based on law enforcement, habitat protection and sustainable use. Elephants in Namibia are amongst the most migratory-nomadic of any elephants on the continent, primarily as the result of scarce surface water resources. The elephant population is therefore unusually vulnerable to changes in access to water and migration routes.

Most elephants in Namibia occur outside protected areas on marginal agricultural land, along with some of the poorest people in the country. Conflicts between people and elephants are increasing throughout Namibia's elephant range, following the cessation of war, drought, and the acceptance of agricultural policies promoting food self-sufficiency. The preliminary elephant management strategy of the Namibian Ministry of Environment and Tourism is based on classification of elephant range, definition of elephant management units, development of preferred management densities, and formulation of simple rules to aid decision-making. This strategy promotes the use of elephants for the benefit of people and attempts to retain a high value, and thus a role, for elephants in the rural landscape in the next century.

HISTORY OF ELEPHANT CONSERVATION IN NAMIBIA

Elephants formerly occurred throughout Namibia, wherever surface water was available. Densities were likely to have been very low in the southern half of the country, where savanna vegetation is replaced mainly by karroid scrub and annual desert grasslands. Most elephants seem to have inhabited the areas along drainage lines, which in Namibia are often the only sources of shallow subterranean water or springs. As in the northern Namib Desert today, elephants are likely to have been dependent on riverine vegetation, with seasonal rivers serving as linear oases.

The scarcity of surface water and springs in Namibia indirectly led to the rapid decline in elephant distribution and numbers following the 19th century introduction of firearms and the arrival of commercial elephant hunters. By approximately 1900, perhaps only a few hundred elephants remained in the extreme north-western and north-eastern parts. The German Colonial Administration (1890-1915) had already passed hunting laws to protect elephants in 1892 and proclaimed the first three game reserves in 1907. Apart from a significant decline in the number of elephants in the Kaokoveld (northern Namib Desert and transitional zone) during the 1970s and early 1980s while northern Namibia was under South African military administration, the elephant population has continued to recover and increase throughout its range. The elephant range is also expanding southwards through the establishment of elephants on game ranches by private land owners.

KEY FEATURES OF THE NAMIBIAN ELEPHANT POPULATION

The most striking feature of the elephant population is its distribution across a rainfall gradient of <50mm->700mm per annum, along the same latitude. Despite the dramatic variation in habitat from true desert to sub-tropical forests, the population tends to share similar characteristics. Elephant densities tend to be highest along drainage lines, wet or dry, and almost all elephants show marked seasonal/migratory/ nomadic movements. Elephants in north-western and north-eastern Namibia move approximately 100km between wet and dry season ranges, and in the northwest, home ranges extend to approximately 7,000-10,000km^2.

Short-term movements and seasonal distribution nevertheless vary according to local rainfall, accounting for the ca. 80,000km^2 Namibian elephant range with an extremely low crude density of 0.06-0.10 elephants/km^2. The elephant population is dependent on sparse surface water sources, and has become increasingly vulnerable to human settlement. Regional elephant densities vary considerably from year to year, and cross-border movements occur primarily along the northern Botswana border, but elephants also move between Namibia, Angola and Zambia. Annual population size accordingly ranges from approximately 4,500 to 8,000 and is largely unpredictable from year to year.

CURRENT ELEPHANT CONSERVATION PROBLEMS

Conflict with people

A sharp increase in conflict between elephants and people occurred after Namibia gained independence from South Africa, because of the cessation of war and the settlement of people in formerly unused parts of communal lands which make up a large part of the elephant range. A national campaign to increase and diversify food production in the communal areas resulted in higher aspirations and greater intolerance towards elephant damage. The crop-growing season in Namibia is short, and only one crop can be harvested per year. The gap between perceptions of elephants internationally and locally is widening, with increasing numbers of rural people regarding the revered animals of western fantasy and wonder as irredeemable agricultural pests and obstacles to their development. People in some marginal agricultural areas have nevertheless agreed to tolerate elephants, as long as they can receive a benefit which exceeds the losses caused by elephants. The challenge remains to generate sufficient revenues, given the international ban in legal trading of ivory.

Displacement by people

One of the most serious issues in Southern Africa, including Namibia, is the normalsing of post-colonial land tenure systems and the development of land-use policies aimed at sustainable development. In practice, however, human land-use patterns within the elephant range are determined by basic short-term subsistence needs. As most elephants occur outside protected areas, they are currently losing range to human settlements and agricultural expansion. Lack of intra-governmental coordination on land-use and sustainable development planning will only result in an unmanageable escalation of human-elephant contact and conflict, with a predictable outcome for the elephant.

Viability of protected area populations

Protected areas in Namibia, with the questionable exception of Etosha National Park, are inadequate to maintain isolated elephant populations through the next century. It has proven virtually impossible and economically unsustainable to attempt to confine elephants to protected areas with less than a cable fence. Confining elephants to any unit is furthermore undesirable in view of annual variation in local rainfall and availability of surface water. The vegetation and associated biodiversity of smaller parks, in particular, are highly susceptible to impacts from elephants, and some units already show signs of elephant over-abundance and require management intervention.

Resource or burden?

In some parts of Namibia elephants are, or may become, the single most valuable, renewable resource for people, especially considering the limiting effects on agriculture imposed by an arid climate and nutrient deficient Kalahari sands. The only way that elephants, with their migratory/nomadic movements, will survive on communal lands is if the people in contact with them can benefit more than they lose to elephants. Acceptable economic incentives to retain elephants are nevertheless compromised by the continued listing of Namibian elephants on CITES Appendix I, banning the legal trade in ivory. If legal ivory trading is not possible, the gradual displacement and ultimate loss of elephants as a resource are inevitable.

POLICY FRAMEWORK FOR ELEPHANT MANAGEMENT

The Namibian Ministry of Environment and Tourism (MET), as the national elephant management authority, is in the process of revising its elephant management strategy. Aspects of the current draft conservation and management policy which might be of wider interest are explained below. This particular approach considers the available human resources for implementing a management plan and monitoring its consequences, rather than being confined to theoretical elegance. MET is undergoing a rationalisation programme aimed at decentralising decision-making and management responsibility. This additional aspect requires that the management plan should be immediately relevant and useable by a new generation of relatively inexperienced staff.

Classification of the national elephant range

The elephant range in Namibia has been provisionally classified according to recent land-use by elephants (Figure 1). It is intended that this classification be incorporated into land-use planning processes in northern Namibia. Of principal importance is the retention of access for elephants to the most important migratory corridors. Such corridors mainly follow drainage lines which present favourable habitat for agriculture and settlement.

Elephant management units

The management strategy for elephants in protected areas needs to be integrated with general land-use planning and with the management of elephants on adjacent land. This concept thus reflects the existing land-use pattern of elephants, described above, superimposed on the classification of the elephant home range as "protected area" and, for example, "communal land". Protected areas in Namibia will increasingly be regarded as protected cores or refuges for mobile species within a region, rather than the artificial conservation islands which they resemble now. Park management will thus become increasingly integrated with the management of a particular region. Elephants, as a species not confined within any park, present the ideal test case of this integrated approach.

Preferred management density

Rainfall, grass biomass, fire, elephant density and tree recruitment vary almost unpredictably from year to year in Namibia. The concept of a "carrying capacity for elephants" seems to be particularly inappropriate as a parameter in management planning for this type of system, where time lags are very long, and complex factors determine the particular state of the vegetation. Rather than use scarce research resources for a series of elephant-habitat studies - which over the usual period of study might not have revealed significantly more about elephant-tree interactions than an educated guess - a team from MET developed preferred management densities. Such densities are used as management targets within an adaptive management philosophy. Given the potential annual variation in elephant densities, preferred management densities are expressed as a minimum and maximum figure (Table 1). These figures were derived by combining the field experience and best intuitive understanding of elephant populations of 12 MET senior wildlife managers and biologists with direct responsibilities for elephant management, possessing about 170 years of collective experience between them. Preferred management densities take into account average

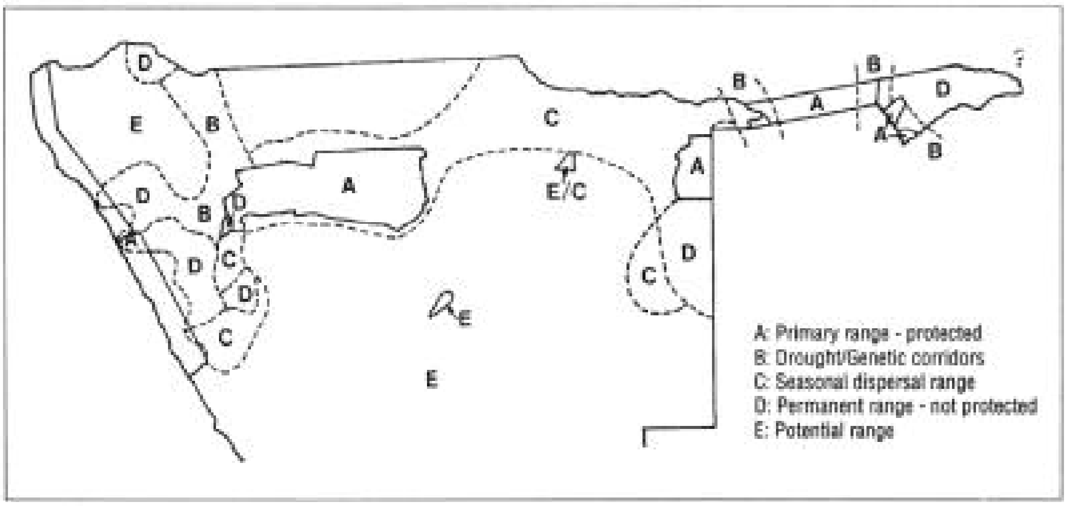

Figure 1. A preliminary classification of the elephant range in Namibia.

Table 1. Preferred management densities and target elephant population sizes for some categories of land in Namibia.

	Elephant range ca.(km²) *	Provisional preferred management densities (n/km2)	Present pop. (approx.)	Target range
(Protected areas and known contiguous elephant range on adjacent land)				
Etosha Management Unit				
Etosha N.P.	18600	.08-.13	1500	1500-2500
Hobatere	300	.10-.30	30	30-90
Adjacent land[1]	3000	.05-.08	50	150-250
	21900	.08-.13#	1580	1680-2840
Kunene Management Unit				
Skeleton C.P.	2000	0- .02		0-40
W. Kaokoland[2]	4000	.02-.05		80-200
Palmwag Conc.	7000	.02-.04	300	140-280
Huab-Ombon. bas	6000	.03-.04		150-250
	19000	<.02-.04#		370-770
Khaudom Management Unit				
Khaudom G.R.	3840	.15-.30		580-1150
Adj. Kavango[3]	10000	<.01-.01		50-100
E. Bushmanland	6000	.03-.08	1100	150-450
W. Bushmanland	12000	0-.01		0-120
N. Hereroland	1000	0-.01		0-10
	32840	.02-.06#		780-1830
Okavango RiverManagement Unit				
Mahango G.R.	250	0-.50		0-125
W. Caprivi’	1200	.42-.83	500-1800	500-1000
Kavango[5]	500	0-.10		0-50
	1950	.26-.60#		500-1175
Quando River - Eastern Caprivi			**Management Unit**	
W.Caprivi[6]	1600	.38-1.00		600-1600
Mamili N.P.**	320	0-1.00		0-320***
Mudumu N.P.	900	0-.50	500-3500	0-450***
E.Caprivi[7]	2500	0-.60		0-1500
	5320	.11 -.73#		600-3870
	81010	.05-.13		3930-10485

Footnotes

1. Adjacent land here includes indeterminate sections of former Owamboland, eastern Kaoko, and possibly as far north as southem Angola and as far east as the Mangetti area of south-western Kavango.

2. Estimated extent of marginal elephant range west of the escarpment in former Kaokoland, included in the unproclaimed Kaokoland “G.R.”

3. A large part of the Okavango region bordering the Khaudom G.R. has no surface water, but forms part of the wet season dispersal range of elephants of the region.

4. & 5. Parts of the Okavango region and the Caprivi G.R. adja cent to the Okavango River and Mahango G.R.

6. Remainder of the Caprivi G.R. including settled areas.

7. The distribution of elephants in the Eastern Caprivi region seems to be highly variable, but the area adjacent to the two small national parks could be regarded as part of the centre of elephant distribution in the Caprivi region.

*not corresponding to actual sizes of land units/ variable

** *Nkasa-Lupala*

****elephant numbers are highly unstable*

crude preferred management density per elephant management unit

rainfall, amount of surface water available, size of unit, other management objectives, state of vegetation, incidence of fire, amount of staff available, current and expected future budget allocations in each management unit, existing degree of conflict with people, apparent trend in human land-use of the unit, and the elephant management policies of neighbouring countries, where appropriate.

Rule-based management

In order to deal with the unpredictable annual variation in elephant densities in a given region, a qualification was required in the decision-making process. Simple rules were developed from the same intuitive process described above, particularly to facilitate decisions about starting any management intervention. Provisionally, the first general rule is applied when elephant densities begin to approach the upper preferred limit. For this rule the specific target management density must be evaluated by assessing the status ad behaviour of an indicator or system close to the threshold elephant density, eg. by monitoring tree recruitment, etc. The second general rule is applicable when elephant densities begin to approach the minimum preferred density, and involves evaluating whether local limiting factors could have caused a population decline, rather than short-term changes in density and distribution in response to rainfall. This necessitates, for example, determining carcass ratios, examining the incidence of illegal hunting, calculating the proportion of calves in annual mortalities, etc.

Examples of provisional rules applicable to a specific management unit or sub-unit are:

- If elephant densities exceed 0.3/km^2 (1,150 elephants) in the Khaudom Game Reserve in more than two consecutive dry season population estimates, the density should be reduced through intervention (e.g. sport hunting, culling, live capture, or providing water on adjacent land).

- As the upper limit is approached on the state land component of the Khaudom Management Unit, management plans to cope with or prevent further elephant increases should be initiated jointly by MET and the relevant communities.

- If elephant densities exceed 0.5/km^2 (125 elephants) west of the Okavango River in Mahango Game Reserve for longer than two consecutive dry seasons, the density should be reduced through intervention, regardless of relative abundance of the combined Mahango Game Reserve- western half of the Caprivi Game Reserve population.

- If elephant densities exceed 1.0/km^2 (1,600 elephants) in the eastern half of the Caprivi Game Reserve for longer than two consecutive dry seasons, the density should be reduced through intervention.

- If elephant densities exceed **0.5/km^2** in Mudumu National Park in more than three consecutive dry season population estimates, the population should be reduced through intervention. Brief episodes of much greater elephant densities exceeding 1.00/km^2 can be expected to occur as this area serves as a cross-border migratory corridor.

Sustainable use

MET remains convinced that elephants are doomed on the communal lands, and thus ultimately also in the protected areas of Namibia, unless elephant and other wildlife utilisation is allowed to surpass subsistence farming in terms of benefits. Numerous cases throughout southern Africa show that wildlife populations on communal or private land, in competition with another form of land-use, eg. agriculture, remain viable in the long run only if the economic value and yield from wildlife exceed that of another land-use, or at least significantly supplement the yield from other competitive forms of land-use. In a free and democratic society, the role of the central government diminishes to a level which people will allow. People living throughout Namibian elephant range can make a conscious decision about whether they want to live with elephants or just have a few token elephants confined to a game reserve. Unless a real incentive is provided, people in harsh environments will insist on living in security from elephants, ad will not be prepared to carry a burden created by any so-called "international conservation community". The listing of Namibian elephants on CITES Appendix I, against which Namibia holds a reservation, will therefore not save the elephants of Namibia from gradual loss of range and displacement by people. The only option in Namibia is to provide people with a real economic incentive for retaining elephants as part of their rural resource base. No one can otherwise deny them their intention of making all the important land-use decisions themselves.

OPTIONS FOR THE CONTROL OF ELEPHANTS IN CONFLICT WITH PEOPLE

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ABSTRACT

With increasing frequency, the management of elephants outside protected areas in Africa has to address the problem of conflict between elephants and people in rural, agricultural situations. In the last decade, three major changes have occurred in the process of human-elephant interaction: the conflict interface has generally increased, even where the elephant range has contracted; elephants have acquired a much greater economic value; and wildlife management is becoming decentralised, with emphasis on utilisation for economic benefit. In Zimbabwe's unprotected areas, elephants are now simultaneously the most valuable wildlife resource and the greatest wildlife pest species. This paper outlines a systematic, more efficient approach to dealing with the problem of conflict, while still conserving elephant populations. It involves a simple system of assessing problem elephant activity over large areas, and using the information to formulate a district strategy which ameliorates, but does not eliminate, the burden of 'problem' elephants. The relative merits and disadvantages of various traditional and contemporary methods of dealing with problem elephants are also discussed. Mention is made of research being conducted on the ecological nature of the interactive processes between human and elephant populations.

INTRODUCTION

Inhabitants of Communal Lands (CLs) in Zimbabwe, where people and elephants are sympatric and often in conflict, have been formally granted authority to manage their own wildlife (Martin, 1986). Rural District Councils (RDCs) have accumulated the financial and development benefits of wildlife utilisation but have also had to assume responsibility for the negative, cost aspects, of their wildlife. In practice this involves having to develop the capability to carry out Problem Animal Control (PAC). Zimbabwe is probably the first country to try to formalise elephant control as part of a wildlife management strategy at the level of local authorities (Department of National Parks and Wild Life Management, 1993).

CLs with elephant populations exist alongside formally protected State wildlife areas. An example is the Sebungwe region in the central Zambezi valley which is situated in an eco-climatic zone of very low agricultural potential where subsistence crops are nevertheless widely cultivated, providing up to 70% of annual local food requirements (Taylor, 1994). The mean crude density of elephants is 0.6/km^2 (Taylor *et al.*, 1992) with the density of people varying from 1-7/km^2 (Government of Zimbabwe, 1992). Such CL elephant populations are being managed primarily for the sustainable offtake of hunting safari trophies. This generates rapid, high financial returns (Taylor, 1993a) in areas where the terrain and low wildlife densities preclude most non-consumptive wildlife activities. The proportion of revenue being generated by elephant utilisation, in CL districts collectively, was 64% of the total CL wildlife earnings in 1992 (Bond, 1994). At the same time elephants have been found to be responsible for *75%* to 90% of problem animal activity caused by dangerous species Hoare & Mackie, 1993), resulting in considerable losses of both economic and social importance. An increase in the elephant-human conflict interface has arisen in the past decade, principally due to the immigration of settlers into areas cleared of tsetse fly infestation and also because elephant numbers have naturally increased within this contracted range (Taylor, 1993b).

Traditional control of elephants

Hitherto, selective shooting of elephants by wildlife authorities has been widely employed throughout Africa as the main method of control. Bell and Mcshane-Caluzi (1984) showed empirically that it had very little effect on crop-raiding elephants in Malawi. In Zimbabwe, a wealth of anecdotal information and circumstantial evidence (Jones, 1992) suggests that this method provides at best a temporary respite from problem elephants, especially bulls. Elephant shooting has traditionally been employed because it is a cheap method of control with considerable public relations value, especially through the supply of free meat to local inhabitants as a form of indirect compensation for crop damage. However, it does not provide a permanent solution to the problem. In Zimbabwe it simply became a ritual palliative from the government to the affected CL people. Implementation was largely at the discretion of individual wildlife officers. It is suspected that control shooting has been eroding the trophy quality of CL elephants (Child, 1992; Mackie, 1992).

A new approach to elephant control

When elephants had no value to anyone other than the State, unsystematic control shooting sufficed as a control measure. However, this approach is no longer justifiable and the onus is now on each district to develop its own PAC capacity. Under the present approach, technical advisors assist RDCs in developing options for problem elephant control which can ameliorate the burden, bringing it below the tolerance threshold which exists in rural communities. The long-term aim is to decrease the use of control shooting and instead use indirect control methods. At the same time maximum benefit should be gained from those elephants that have to be destroyed on PAC. In these early years of the community-based wildlife programme, called CAMPFIRE (Martin 1986), these objectives have to be achieved without making unrealistic demands on the basic level of management.

ASSESSMENT OF PROBLEM ELEPHANT ACTIVITY

The first stage in a district strategy to control problem wildlife is to quantify problem animal activity. Where crop damage is a problem, there are three broad assessment methods available, which were developed mostly in Malawi and India. These are outlined by Msiska ad Deodatus (1991), as follows:

1. Measuring damaged area in fields
2. Estimating damaged area in fields
3. Counting damaged planting stations.

The detailed economic focus of these methods is time consuming, requiring sampling, extrapolation and analysis by qualified people. The situation in our CLs demands a system that can be used over large, remote areas to give abroad picture of wildlife damage quickly and cheaply, involving local people in the process. A simple Problem Animal Reporting (PAR) system has therefore been developed (Mackie, 1992; Hoare & Mackie, 1993), for which the objective is to determine the frequency, severity ad distribution of problem animal activity. The immediate use of the information is for management purposes but some data can be utilised for later scientific analysis.

A problem animal reporting (PAR) system

The process starts with the complainant whose property is affected. The complainant alerts the Problem Animal Reporter (PAR) employed in each RDC Ward. These reporters visit the complainant's dwellings or fields as soon as possible after the problem animal incident, recording all relevant particulars on simple but fairly comprehensive report forms. In cases of crop damage the reporters employ the most simple damage evaluation technique - i.e. measuring dimensions of a field and its damaged area by pacing (a form of method 1, above). All incidents are grid referenced by the reporters who are trained in map reading procedures.

The information thus recorded is then summarised and quantified according to area, seasonal incidence, species responsible, type of incident and level of damage. An illustration of such data collected from two districts is shown in Figures 1 ad 2. The gross patterns of problem animal activity are similar in each district within and between years. Crop damage is by far the biggest problem category with a late wet season peak (Hoare & Mackie, 1993; Taylor, 1993b) around harvest time, from February to April, caused mainly by elephants raiding maturing food crops. Bull

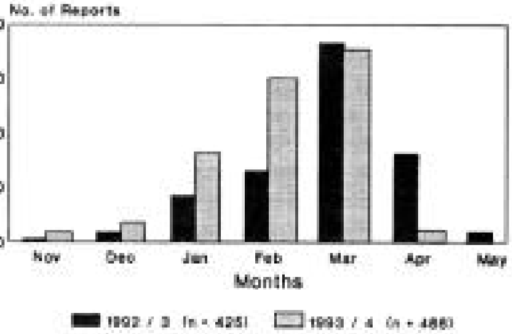

Figure 1. Monthly problem animal reports in NyamiNyami District.

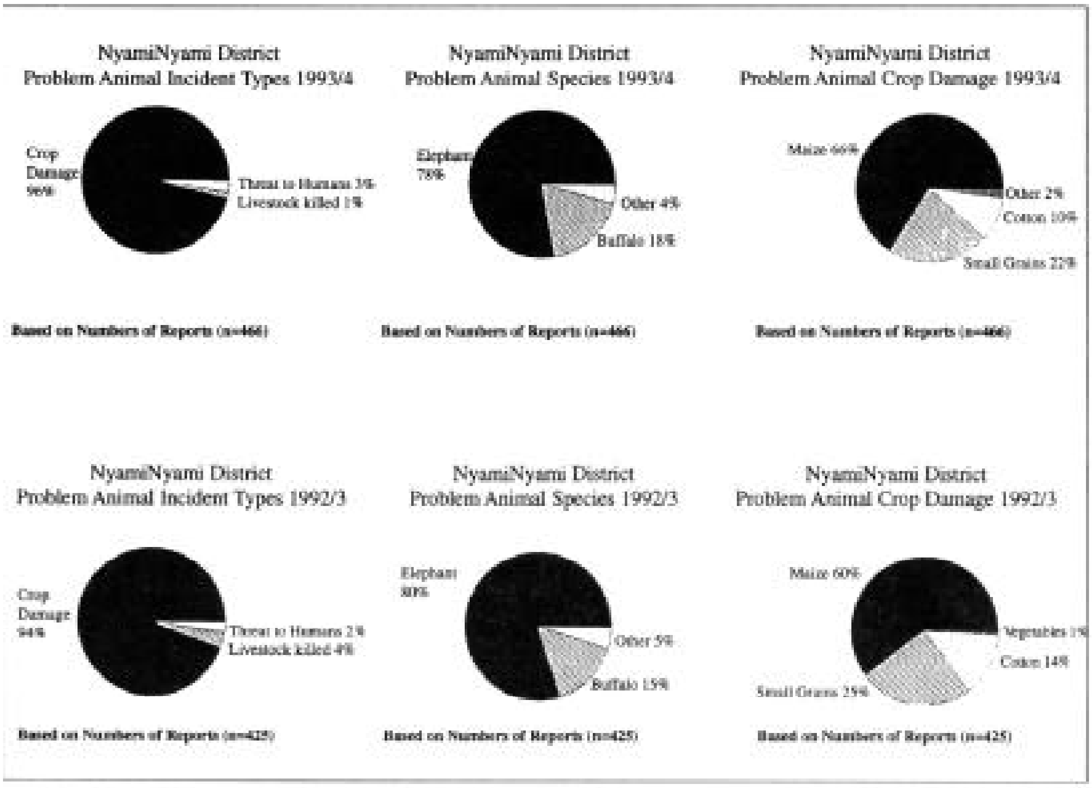

Figure 2. Problem animal reports in NyamiNyami District in 1992/93 and 1993/94.

elephants, either singly or in groups, are primarily responsible for crop damage. This pattern is similar to that observed in Asian elephants (Sukumar & Gadgil, 1988; Sukumar, 1990) and elephants in other African countries (Hoare, 1990), where much of the damage is caused by males who become habitual crop-raiders.

Reacting to serious problem animal incidents

The wildlife unit in the RDC must decide, using its own criteria, if a field-based reaction to problem elephants is required, what form it should take and who should carry it out. While a complainant will argue that all incidents involving elephants are serious, the following protocol can be used to set practical limits, by defining incidents of social or economic importance which should be reported promptly ad acted upon without delay. Serious problem animal incidents (Mackie, 1992; Hoare & Mackie, 1993) are those which merit a reaction ad are classified as:

- Person killed
- Livestock killed
- Wounded or aggressive animal in or near human habitation
- Immovable property destroyed (e.g. grain store damaged, contents eaten)
- Entire standing crop destroyed in one area
- Repeated, substantial crop -raiding in same area.

In practice, a reaction to problem elephants involves some form of control shooting, usually beginning with disturbance shooting but resorting to killing if the former has been recently shown to be ineffective in the area concerned.

REACTION TO PROBLEM ELEPHANTS

Improving the efficiency of elephant control methods

There are a large number of widely differing measures which can be consolidated into a district elephant control strategy, each contributing in a small way towards increasing the efficiency of the process. The concept is represented as a chain of events and shown diagrammatically in Figure 3. This is a model and represents all possibilities for refining PAC. Rarely are all measures used simultaneously in any district. The measures are briefly evaluated according to whether they act directly or indirectly on problem elephants.

Direct non-fatal methods

Disturbance shooting
Training field scouts in elephant shooting techniques and equipping PAC teams with motorcycles are techniques which produce, greater mobility and increase the use of local human resources. A field programme to carry these out requires financial resources and clear organisation. In many areas elephants rapidly habituate to non-fatal disturbance shooting, rendering it ineffective.

Experimentation With alternative non-fatal deterrents
Examples of these include bird shot, salt, rubber bullets, bright lights, thunderflashes, olfactory agents (e.g. a *Capsicum-based* irritant spray is being investigated by Osborn [1994]). Generally, skilled or trained personnel are required to operate these methods, and animals habituate to most of them.

Translocation of problem elephants
Recently much attention has been focused on translocating elephants, following the relocation of some 800 animals from a drought-stricken region of Zimbabwe (Putterill, 1993). The purpose of this exercise was to restock new wildlife areas. For the first time whole elephant family units were immobilised and moved. However, the extension of this technique to problem elephant control brings forth a multitude of problems. Exceptionally skilled people are required and great expense is involved: the cost-effectiveness for PAC is very doubtful. Problem elephants are extremely difficult to identify individually and may return to their capture site, as recorded in Asia (Lahiri-Choudhury, 1993), or become problematic at the relocation site. The concept may also be opposed on the grounds that it leads to the removal of a valuable wildlife resource from its owners.

Immobilisation and treatment of problem animals
This has limited application. An example is the treatment of an animal which has become aggressive due to a snare or an injury. A skilled person is required.

Direct fatal methods

If non-fatal methods are impractical or prove to be ineffective, killing may have **to** be resorted to. There are a number of measures which can be employed at the district level in Zimbabwe **to** make killing more efficient while limiting its adverse effects on a valuable resource.

Division of quotas
A legal offtake quota is mandatory because the combined elephant offtake consists of safari hunting, PAC and illegal activity. Elephant quotas for each district are set in advance of the calendar year (Child, 1993), based on *0.75%* of population numbers from annual aerial surveys (Martin, 1990). The total elephant offtake quota for each district is agreed upon between the Department of National Parks and Wild Life Management (DNPWLM) ad RDCs who are now permitted to decide how to allocate their quota between trophy hunting and PAC offtake. Am elephant offtake form, with full details of all elephants shot, has to be maintained and updated throughout the year for return to the DNPWLM.

Female (non-trophy) elephants can be used to increase the quota. This has taken the form of a culling quota of females to provide meat as a form of compensation, since no females are killed by safari hunters. The reality is that in many areas of severe problem elephant activity, male elephants are predominantly present.

Marketing wet season hunts by safari operators
Revenue can be obtained from problem elephants by safari-hunting them and returning the revenue directly to people in affected localities. This is an innovative scheme in Zimbabwe, explained in detail by Taylor (1993b). Without close monitoring, however, there is some potential for non-culprit animals to be killed ad the PAC quota to be manipulated. Although such wet season hunts are cheaper, in practice safari operators have experienced some difficulties in marketing them. Table 1 illustrates that a coherent problem elephant management strategy, such as shown in Figure 3, can drastically reduce the number of bulls destroyed and simultaneously extract a considerable benefit from the few that are killed.

Restriction of PAC for elephants to a designated season
The peak time for problem elephant activity is when crops are maturing (Figure 1). If elephant control

Figure 3. Problem elephant control strategy at district level in Zimbabwe.

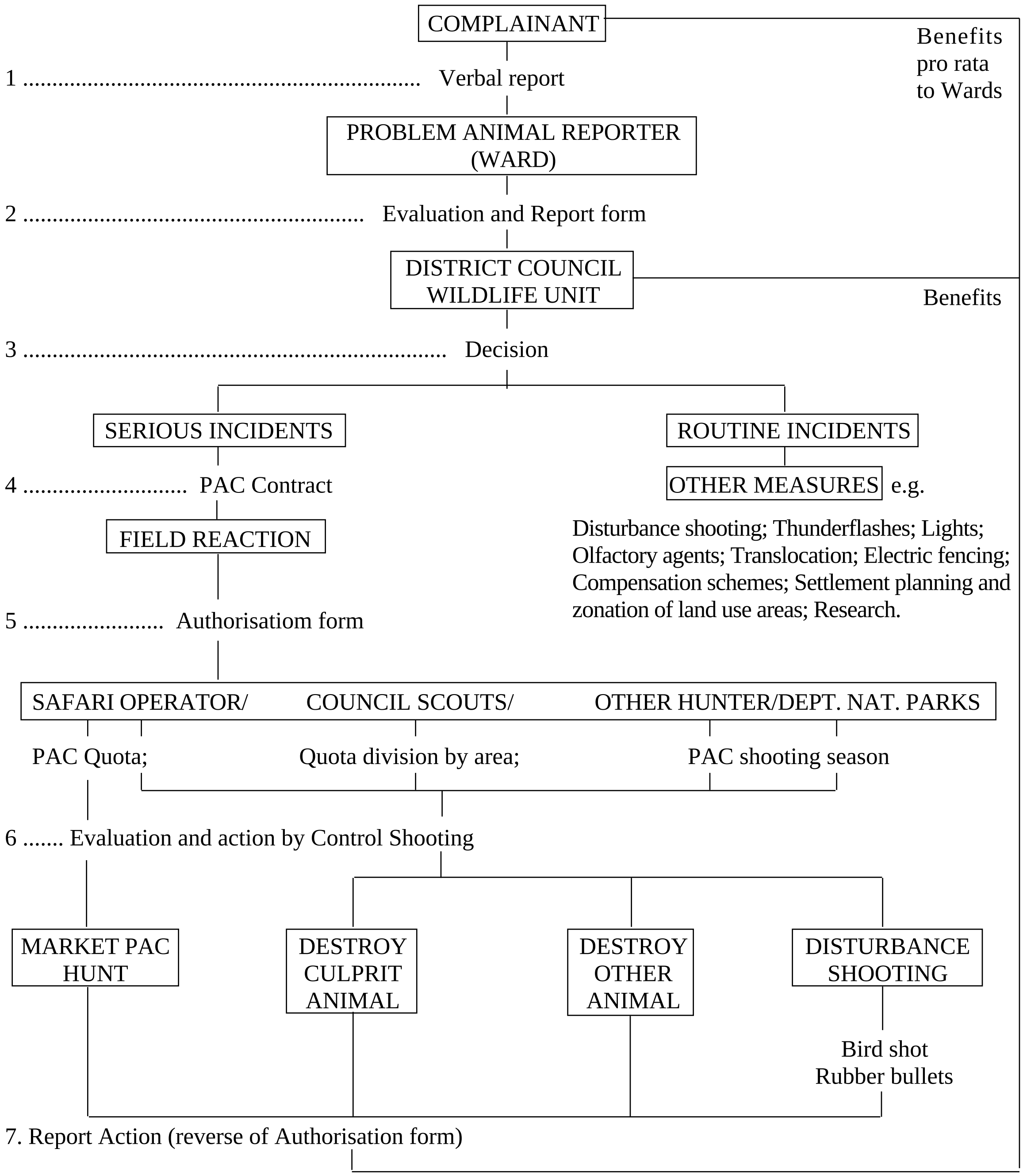

Table 1. Revenue from problem elephants destroyed: Gokwe District, Zimbabwe.

Season	Total problem animal reports	% elephant reports	Elephant bulls shot on PAC	Revenue gained (US$)	Comments
1990/91			44	0	Before CAMPFIRE was started
1991/92	163	76%	14	400	Skin sales only
1992/93	182	60%	4	9530	Marketed PAC hunts
1993/94	246	84%	1	3600	Marketed PAC hunts

Resident elephant population estimate:700.

efforts are maximised during this time, more effective use of limited resources can be made and the temporary deterrent effect of control shooting can be exploited fully. The use of a short PAC season facilitates monitoring the effect of PAC on animals, marketing wet season hunts and controlling quota abuse. Shooting females, as mentioned above, has only been attempted in one district. If shooting females is carried out at the peak of crop-raiding activity in the wet season, the deterrent effect on elephants can be dramatic (B. Ball, pers. comm.).

PAC contract between RDC and PAC hunters
A clear contract can define authority and clarify the protocol for reacting to problem elephant incidents. A contract (Figure 3, Step 4) defines the overall responsibilities and ensures that incidents of control shooting are carried out with an authorisatiom form (Step *5).* The reverse of the form is used to record details of the control action taken (Step 7). The original PAR form (Step 2) should accompany the team.

Division of PAC quotas fairy amongst worst aff ected areas
Up to now, the distribution of animals shot has not been sufficiently coincidental with the distribution of problem elephant activity. The fairest way to help complainants is for the RDC to divide the district elephant quotas according to severity of problem activity in different areas. This requires a working PAR system to be in place.

Use of professional hunter trainees for control work
Field evaluation of problem elephant activity, prior to action being taken, is a much neglected side of PAC. Trainee hunters, who have been engaged by some districts during their apprenticeship period, represent a cheap and widely available source of semi-skilled manpower which could be considered for field evaluation exercises. However, licence regulations do not permit trainees to be unsupervised during actual control shooting exercises.

Indirect methods

Monetary compensation schemes
Compensation schemes for crop damage have been tried in several countries and abandoned. They do not work and are not recommended for a number of reasons: schemes are cumbersome and expensive to administer; widespread cheating occurs on claims; there are never sufficient funds; fair quantitative evaluation is impossible and there are unquantifiable opportunity costs (Ngure, 1992) which cannot be taken into account; the strategy does not attempt to solve the problem.

PAC dividend
The money realised from a marketed PAC hunt (Taylor, 1993b) should be promptly returned as a household dividend to residents of the Ward where the elephant was destroyed. This is the only form of monetary compensation which appears to be workable. It establishes a linkage for the local people between the cost and benefit of living with dangerous or destructive animals.

Electric fencing
The use of electric fencing in order to separate agricultural activity from the elephant range is perceived as the most permanent solution to problem elephants. The use of this technology has been tested in Zimbabwe through a number of pilot projects which have been carefully planned and monitored. Interfaces between

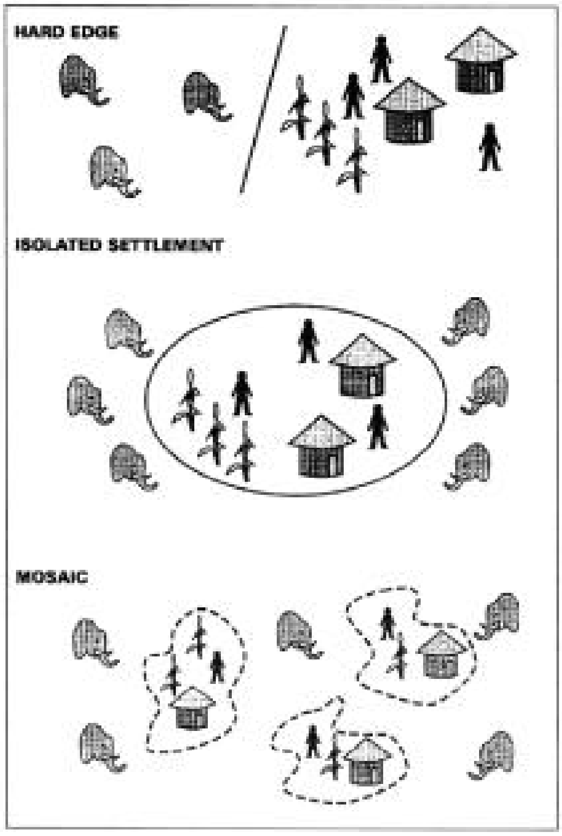

Figure 4 Interfaces between elephants and people.

elephants and CL people were first defined (Figure 4), and where the use of electric fencing was appropriate, projects were conceptualised for planning purposes according to models (Hoare & Mackie, 1993) which are illustrated in Figure 5.

As long as they are sited well and maintained assiduously, simple electric fences can withstand high levels of problem elephant challenge, as shown in Table 2. If abrupt separation of land-use is desirable for a fairly small area, and if the high capital cost (Table 3) can be met and the capability exists to carry out thorough daily maintenance, electric fencing is the deterrent method of choice against elephants. It is not, however, universally applicable and definitely works best for smaller projects (Hoare & Mackie, 1993). The pilot project sample is small and circumstances are very site-specific, but the following can be concluded (Figure 5): Model 4 (park boundary fence) gave poor results, while Model 3 (deflecting fence) was mediocre compared to complete exclosures (Models 1 & 2). This would strongly suggest that exclosures around agricultural targets deter problem elephants better than attempts to demarcate wild land and enclose elephants within a designated range.

In practice, such projects still suffer from an unacceptably high level of institutional or common property management problems. Accordingly, the next stage is to experiment with the use of small individually-owned fence projects (Model 5, Figure 5) encompassing only the area cultivated by one or two households. The benefits of this method could be threefold: the use of locally-made components with very low specification (one or two wires as in India [Schultz, 1988]) would overcome the high capital costs and be more efficient in terms of the area protected (Table 3); the incidents of component theft could be eliminated; and the maintenance deficiencies seen in community projects could be much reduced.

Table 2 Effectiveness of a well-maintained community exclosure (Figure 5, Model 2) fence.

SEASON	ELEPHANT ACTIVITY OUTSIDE FENCE	ELEPHANT ACTIVITY INSIDE FENCE
1991/2	132 Crop Raiding Incidents	No Crop Raids
1992/3	27% of Fields Raided	No Crop Raids
1993/4	43% of Fields Raided	No Crop Raids

Land-use and settlement planning

The RDC should co-ordinate the expansion of settlement taking into account the needs of wildlife, but avoiding the development of a mosaic situation (Figure 4) which only increases the human-wildlife interface. Land-use areas should be zoned on the basis of their natural resources. The creation of buffer zones around core wildlife areas has been advocated for many years (Taylor, 1982). It is becoming a feasible option now that local authorities have more authority. The immigration of settlers into potential conflict zones and areas unsuitable for cultivation must be curtailed.

The RDC should mount a vigorous publicity campaign to explain to affected people the limitations of short-term PAC measures and the importance of development planning as a longterm preventative measure. It is especially important, from a public relations point of view, to make the populace aware of how control shooting measures have been reorganised and who has contractual obligations to carry them out.

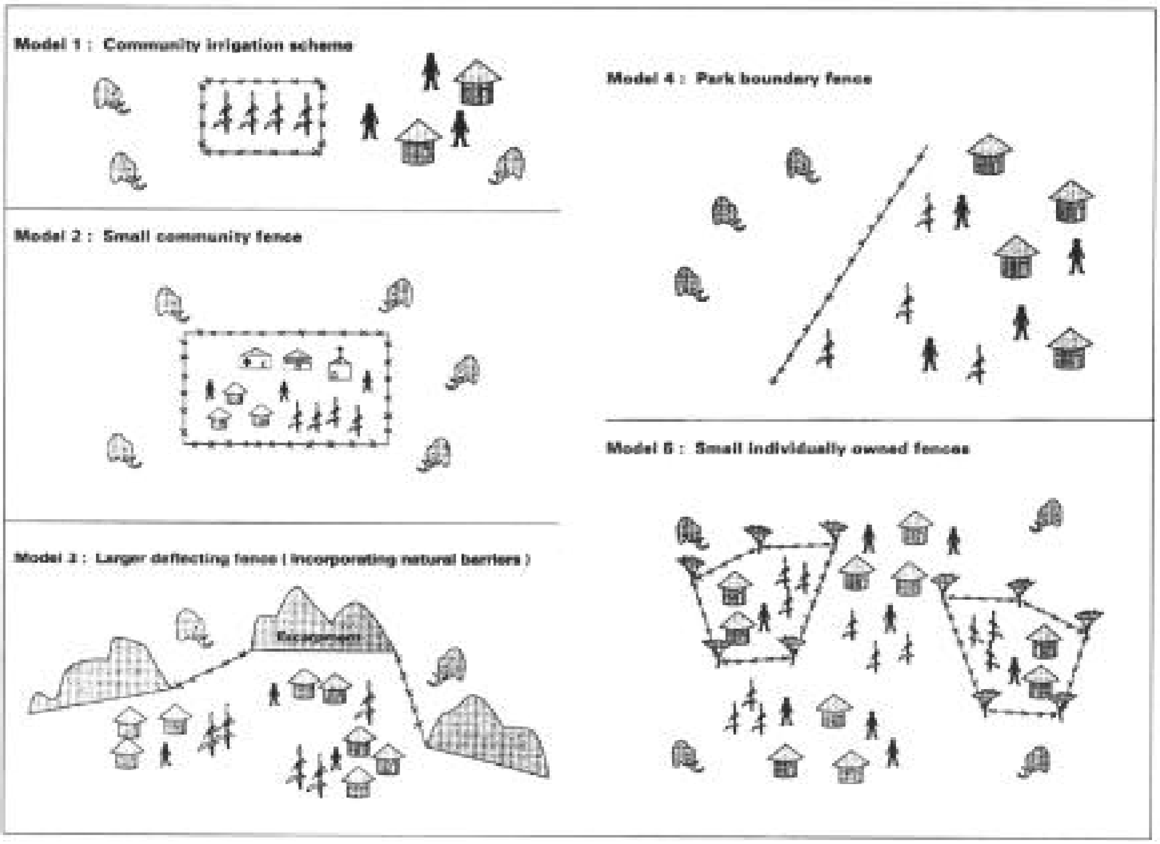

Figure 5. Fencing projects to deter problem elephants.

Table 3. Costs of fencing against elephants in Zimbabwe (US $).

FENCE MODEL (Fig. 5)	**2**	**2**	**3**	**4**	**5***
Cost/km fencing	1185	1368	1476	495	170
Cost/km² protected	484	1430	503	104	255
Cost/household protected	41	123	50	?	?
Elephant density in area (maximum per km²)	1.7	1.8	0.5	1.0	?
Maintenance cost (% of capital cost/year)	?	5%	?	8%	?
Fencing elephant IN/OUT	OUT	OUT	OUT	IN	OUT
Fence is a community property resource	Yes	Yes	Yes	No	No
Efficacy	+++	++++	+++	+	?

** = not yet tested*
? = no data
Data from pilot projects 1991 - 1994.

Participation by local people in any planning process is of paramount importance. Without their input, the whole PAC strategy will be regarded with suspicion and will ultimately fail.

Research

Technical support personnel would be unjustified to make recommendations for any of the above management strategies without the backup of research to investigate and attempt to understand the interactive processes between people and elephants. A research initiative is currently being pursued in which three doctoral thesis projects operate at different but complimentary levels in the same eco-climatic zone. Firstly, an investigation is being conducted into the socio-economics of subsistence agriculture at village level in an environment having many types of problem wildlife. Secondly, the behavioural ecology of male problem elephants is being studied and alternative deterrents, such as olfactory agents, are being tested against them (Osbom, 1994). Thirdly, there is a study to ascertain the nature of seasonal ecological interactions between sympatric human and elephant populations. Aspects of elephant biology will be compared both inside and outside protected areas, and **the study will try to determine whether human activity is the cause of any observed differences. The study areas encompass a land-use and agricultural mosaic where the full spectrum of conservation endeavour, both traditional and contemporary, is represented.**

DISCUSSION

Although in Zimbabwe the adoption of a socioeconomic philosophy of decentralised utilisation of wildlife has challenged the traditional model of government-controlled conservation, the conflict between rural peoples and elephants remains a widespread problem. The costs of living with elephants, which are presently borne by CL people, cannot be offset entirely by harvesting economic benefit from the elephant resource (Anon., 1994; E. Nobula, pers. comm.). Furthermore, the perceptions of affected people and of wildlife managers as to what constitutes effective elephant control are often radically different. A coherent but flexible strategy to limit problem elephant activity is therefore essential. This must be based on 'adaptive management', by mixing old and new control measures with support from appropriate research.

The subjective assessment of problem elephant activity (e.g. by a hunter) and the unsystematic action which accompanied it, as was traditionally practised by state wildlife control officers, is no longer acceptable on conservation and economic grounds. Assessments on the basis of mere counts of incidents in Wild Life Department reports or occurrence books, or totals of annual human deaths in each district, such as is done in Kenya (Ngure, 1992; Thouless, 1994), are considered inadequate indices of real problem elephant activity.

The *PAR* system, whereby individual incidents are recorded on forms in some detail and used to quantify the frequency, severity and distribution of incidents, is a suitable method of assessment. It supplies enough data for a district elephant control strategy to be developed. A chain of responsibility in the district (Figure 3) should allow for accountability at each step, so that local management of a local problem by local people can be realistically achieved. Such a scheme is possible to implement even in countries where trophy hunting is not practised. The only constraint which CL districts now have in Zimbabwe is that of the legal offtake quota for elephants, approved by the DNPWM. District authorities and affected people naturally feel the offtake quotas do not reflect the extent of the PACproblem. However, at this stage, abolition of quotas is not negotiable as far as the DNPWLM is concerned (Child, 1992), regardless of the severity of the problem. This represents the last vestige of central government control over local-level wildlife management of all hunted species.

The conflict between humans and elephants is the greatest long-term threat to the species outside declared refuges (Dublin, 1994). While valuable conservation lessons can be learnt from the situation in Asia (Jayewardene, 1990; Sukumar, 1990, 1991), the great social, cultural and ecological differences existing between Asia and Africa demand that solutions be found which are tailored to Africa's changing local requirements.

ACKNOWLEDGEMENTS

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AFRICAN ELEPHANT SPECIALIST GROUP MEETING, MAY 27TH TO JUNE 1ST, 1994.

WORKING GROUP RECOMMENDATIONS

Two main working groups were convened during the meeting, which took the themes of the two plenary sessions: **(1) Human-elephant conflict** and **(2) Trade and illegal hunting.** Within each group, sub-groups were created to discuss specific aspects related to the theme. Each sub-group was guided through its discussions by a chairman and rapporteur.

(1) HUMAN-ELEPHANT CONFLICT

The overall goals of discussion group (1) were:

- **Describe and attempt to classify the types of conflict experienced throughout the continent's elephant range.**

- **Review any existing official policy with regard to conflict between humans and elephants in all the range states and put forward recommendations for policy revision and/or creation.**

- **Make specific recommendations for resolving the different types of conflict.**

Four sub-groups were created within discussion group (1). The main discussion points and recommendations of each sub-group are summarised below.

Sub-Group 1

The use of barrier and deterrent methods, such as fences, ditches, walls, traditional and experimental deterrents

This sub-group listed traditional, experimental and barrier methods currently being employed or tested against problem elephants, and described the advantages and disadvantages of each, as summarised in Table 1.

Table 1. Methods to deter problem elephants.

TRADITIONAL METHODS

Method	Advantages	Disadvantage :
Watchmen	Immediate effect; can be used in combination with other methods	Opportunity costs; elephants become habituated
Noise	*	Elephants become habituated
Fire	*	Elephants become habituated
Olfactory e.g engine oil, elephant hide, burnt chillies, human urine	Unknown	Unknown
Barriers e.g. thorn bomas, bark ropes, spikes	Easy to construct	Detrimental to environment, may wound elephants
Missiles e.g. spears, arrows	Deterrent effect; not usually fatal to elephants	May wound elephants; may cause aggression in elephants
Poisoning	Killing elephants can have public relations value	Illegal; detrimental to environment, renders meat useless

Table 1. (contd.)

EXPERIMENTAL METHODS EMPLOYED AGAINST PROBLEM ELEPHANTS

Method	**Advantages**	**Disadvantages**
Paintmarking	Provides identification mark on elephant which can be used for other purposes	Limited effect; dangerous procedure
Olfactory e.g. *Capsicum,* ? other gases	Has potential for wide application	Spray method: short range, upwind approach; remote-detonate method; still too expensive
Unpalatable Vegetation Barriers e.g. Opuntia cactus,(eucalyptus, chillies, tea, pyrethrum)	Unpalatable to elephant; plants with limited feral growth	Slow, uneven establishment of cactus; (other plants listed have no effect as a barrier)
Palatable Vegetation Barriers e.g. melons	Cheap	Very temporary effect
Sound e.g. audible alarm, infrasound calls	Long range; omni-directional effect	Elephants may habituate; limitations due to high technology required; expensive

EXISTING BARRIER METHODS AGAINST ELEPHANTS

Method	Advantages	Disadvantages
Stone Wall	Cheap to construct; little maintenance required	Limited effect; material not easily available
Ditch/Moat	Cheap maintenance; method is reversible	High cost of construction; disruption of natural drainage; soil erosion; elephants can refill ditch/moat; no road and river crossings
Conventional Fencing	Little maintenance required	High cost; method is not reversible; vegetation overgrowth may occur; potential for fire damage; not very effective
Electric Fencing	Rapid construction; the design can be easily changed; effective	Daily maintenance is required; high cost

Having listed the methods the sub-group made the following specific recommendations:

- Field trials on the effectiveness of *Capsicum-based* deterrents (which have shown promising initial results), should be pursued, prior to stimulating any commercial interest in the production of marketable preparations. Trials on the deterrent potential of broadcasting certain natural infrasound calls recorded from elephants should also be carried out. In this context, studies are needed to establish the potential for elephant habituation, the technological feasibility and cost limitations.

- *The* sub-group concluded that the most effective barrier is electric fencing, which has been proven to withstand high elephant challenge more often than not. It was recommended as the deterrent method of choice provided that abrupt separation of land-use is desirable, high capital cost can be met, and thorough daily maintenance can be achieved. However, it was recognised that little is known about the effectiveness of electric fencing as a deterrent to forest-dwelling elephants.

In relation to fencing the sub-group further noted that:

- Exclosures around agricultural targets deter elephants better than attempts to demarcate and enclose the elephant range.

- Smaller fencing projects work better than larger ones due to fewer maintenance difficulties and fewer common property management problems.

- Prior cost/benefit analysis of fencing projects should be undertaken but interpreted with caution, due to a large number of poorly-quantifiable factors.

- Ownership of a barrier and maintenance responsibilities must be clarified in advance of construction. Sufficient recurrent expenditure must be available for maintenance. Local or individual ownership is more desirable than state ownership.

The sub-group recommended that the following factors should be evaluated with the proposed use of fencing:

- The inducement for elephants to cross the barrier; the experience shown by elephants locally, in respecting or disarming barriers; whether disturbance shooting (non-fatal) or disturbance hunting (fatal) would have to be employed strategically to reinforce new barriers. Shooting should not be employed to mask barrier maintenance deficiencies.

- The sub-group noted that the formulation of general guidelines on fencing is complicated by the high degree of site-specific circumstances. Furthermore, the issue of expanding the use of elephant barriers is to a large degree subject to broader national issues, particularly land tenure systems and ownership and use of wildlife resources.

Sub-Group 2

Involvement of local communitis, for example in revenue sharing programmes (park fees, trophy hunting, etc)

The sub-group listed ways in which local communities are already involved in human-elephant interactions throughout the range states and explored new approaches which could be incorporated into existing situations. In nearly all examples cited, it was agreed that greater local involvement in decision-making and participatory action is desirable, with a gradual shift in authority from central government to local level being highly appropriate. The group felt that problem animal control (PAC), whilst now widely practised, is inconclusively effective in terms of appeasement. The deterrent effect of control shooting remains dubious and needs more careful, critical examination, while for many deterrent methods, such as shooting and fencing, there is little local involvement. The sub-group felt that a distinction needs to be made between communities which are involved in wildlife management programmes within a communally occupied area, with or without an adjacent protected area, and those which are adjacent to protected area boundaries.

The following recommendations were made which are summarised in Figure 1.

- Participatory local level land-use planning, in relation to wildlife in general and elephants in particular, should be actively encouraged and pursued.

- Where necessary, appropriate training and transfer of skills in PAC, damage assessment and maintenance of barriers, should be undertaken.

- Local participation in wildlife management must be active rather than passive.

- Where financial benefits accrue from elephant management activities (e.g. PAC, safari hunting, tourism), these benefits should be returned at appropriate levels to the affected community.

- Resource management, including responsibility and accountability for elephant management, should evolve in a process-orientated manner commensurate with community development and capacity.

- Existing (or future) enabling legislation, to support and enhance the above, should be developed (or created).

- High-cost technological interventions must be critically tested and evaluated before being advocated. Where available, traditional knowledge in developing elephant management options and plans should be recognised and incorporated.

- Elephant management strategies which are sustainable and participatory within the local capacity should be promoted.

The above recommendations should be facilitated in a participatory manner within local communities.

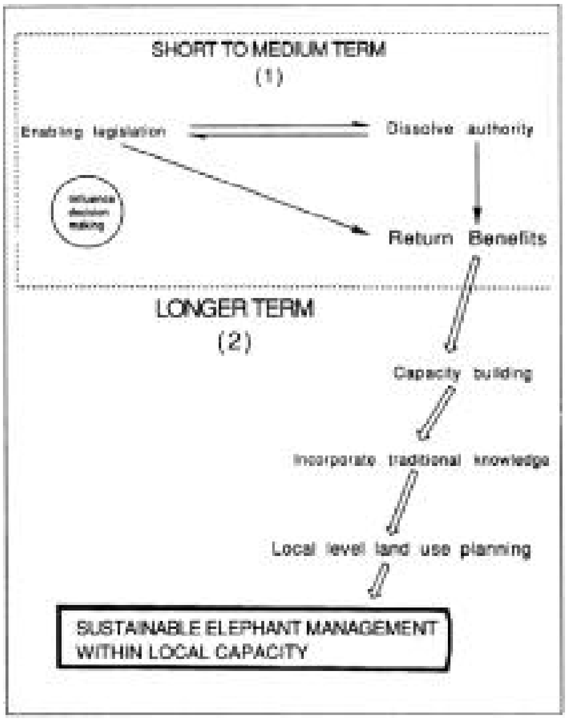

Figure 1. Possible strategy for the implementation of a sustainable elephant management strategy at the local level.

Photo credit: Kadzo Kangwana

Involving the local community in wildlife management:

Sub-Group 3

Methods to deal with problem animals, such as killing of individuals, drives, culls, translocations, contraceptives

From the discussion. it quickly became apparent that there were clear differences in dealing with problem elephants among forest and savanna populations, partly due to differences in habitat as well as the vast array of cultures throughout the range states, meaning that methods of control which are acceptable to one country may be completely unacceptable to another. However, the wide experience of the members of the sub-group allowed a workable assessment of these topics which are summarised below, in Table 2.

Table 2. Summary of methods for controlling problem elephants.

1. KILLING INDIVIDUAL ELEPHANTS

Method	**Advantages**	**Disadvantages**
Traditional Methods (includes bows, arrows and spears)	Cheap; good deterrent effect; carried out by local people; immediate response; meat available to local people	Dangerous to people; risk of wounding elephants; increases aggression in elephants; there is less control on how many and why elephants are killed; people who have lost traditional skills have to be retrained
Shooting (i) By Game Department	Tighter control on how many and why elephants are killed; usually a more skilled operation; meat available to local people	Not an immediate response; wrong animal often shot; elephants do not learn from this process; dissatisfaction of people if service is not prompt
(ii) Sport hunting	Elephants have high economic value; benefits and meat available to locals; skilled operation; high level of control on number killed	Long time-lag after the offence; wrong elephant often shot; no learning process for elephants; temptation to shoot a trophy rather than the offender; no hunting allowed in some countries
(iii) Firearms in the hands of local people	Immediate response; high level of learning for elephants; meat available to locals	Open to abuse of firearms and poaching; unacceptable to most governments; little control on number killed; unskilled operation
(iv) Honorary wardens*	Quick response; high level of learning for elephants; meat available to locals; control lies with a responsible member of the community; high level of accountability and control	Expensive in terms of training and equipment; open to a certain level of abuse and corruption
Crossbow (new method)	More acceptable to most governments; more effective than traditional weapons; meat available to locals;	Expensive in terms of training and equipment; low deterrent level to elephants
Poison	The problem animals are killed	Due to the many environmental and health risks this method was unanimously rejected

2. DRIVES

(i) Aerial	Effective for a short while; elephants can be moved fairly long distances; high level of operational control	Very expensive; may not be effective in longterm; difficult or impossible in the forest
(ii) Beaters	Relatively cheap; more effective than aerial drives in forest	Dangerous to beaters; time-consuming; distances that elephants can be moved are limited;may not work in longterm

Table 2(contd.)

3. CULLS**

Method	Advantages	Disadvantages
General (i) From helicopters	Efficient and effective; less dangerous to people	Expensive, not an option in forests
(ii) By ground crews	Cheaper; could work in forest	Requires skilled marksmen; less effective
Specific (i) Culls	May induce other offenders to move; meat potentially available to locals; resource not totally lost	May not work in longterm
(ii) Elimination	Effective final solution	Ethical considerations; total loss of resource

4. TRANSLOCATION

	Elephants not killed; family units stay together; proven effective; more acceptable as a final solution	Expensive; high technology required; difficult or impossible in forest; loss of resource; possibility that elephants may return

5. CONTRACEPTION***

	Animals not killed	Not yet shown to be practical; may only work through long-term reduction in elephant population

** This method involves the identification and training of a prominent member of the local community who is then issued with a firearm. The sub-group felt that this method held great potential for most areas where human-elephant conflict occurs.*

***It was felt that the term 'cull' was inadequate and so the topic was split into tow: 'culls", which refer to a reduction in numbers of elephants present and 'elimination by which all the animals in a particular population are killed Both these options can either be conducted by ground crews or from a helicopter, and each method has advantages and disadvantages.*

****It was recognised that contraception is not a technique which can be applied to the immediate control of problem animals, but rather a long-term solution which might pre vent small populations from increasing to levels in excess of the carrying capacity of limited habitats.*

Sub-Group 4

Methods of evaluating conflict and assessing damage to life and property

The sub-group first defined the reasons why the assessment of human-elephant conflict should be carried out. These were: to allow informed and balanced discussion of the policy issues at a national level; to allow national and local wildlife officials to respond appropriately to problems; to compare the costs of problems and their solutions; and to monitor the success of management actions.

The levels of required monitoring were listed *as:*

1. local level assessment to allow response to conflict situation;
2. national co-ordination of information collected at a local level;
3. specific detailed projects.

These three levels were further defined by the subgroup, as follows:

1. Local level evaluation

The sub-group prioritised the questions which need to be included in any conflict evaluation exercise. Three main questions were posed with several specific questions related to each, *as* follows:

1.1 How serious is the problem?
- Is there a problem?
- Where is it? Does it follow a gradient?
- Is it getting worse?
- How bad is the problem at national, local and individual levels?

1.2 What is the context?
- Where is the area of conflict relative to protected areas or permanent elephant range? What is the availability of resources, e.g. food, water, minerals?
- Is raiding, e.g. of crops, purposeful or incidental?
- What other species of animals are involved?
- What is the history of development of the problem, and what interactions and actions have been taken to counteract it?

1.3 Types of evaluation
- What percentage of crops have been damaged?
- What crops have been damaged?
- When were they damaged?
- What is the value of the crops in simple financial terms?
- Full economic assessment.

2. National co-ordination of information collected at the local level and routine reporting.

The sub-group made the following recommendations:

- A relevant national agency needs to take responsibility for setting up a system of data collection and assigning the task to a specific person with allocation of sufficient resources.

- Reports on human and stock deaths should be quantitative, but for most countries a qualitative system for reporting crop damage by geographical regions should be adopted.

- Problems with other wildlife species should be included in reports.

- There should be co-ordination with other relevant government departments.

- There should be feedback to the local level.

- Monitoring of protected areas by departmental and project teams should incorporate the broader ecosystem outside the protected area.

- A link should be established with data sets on human demography and social issues.

- There should be monitoring of management actions for adaptive management.

3. Detailed human-elephant conflict assessment for specific projects.

The sub-group recommended that:

- Assessment should be done before and aftermanagement action.

- Ecological impact assessment must be included.

- Consideration should be given to historical causes.

- Due attention should be given to political and non-financial considerations. Some of the most important issues may be difficult to quantify.

- Donors must recognise the technical difficulties of carrying out damage assessment which become more difficult if damage is widespread. A sampling strategy is needed, and if climatic conditions are variable, standard figures cannot be used.

The sub-group finalised their discussions by listing examples of ongoing evaluation activities in range states.

(2) TRADE AND ILLEGAL HUNTING

The overall goals of discussion group (2) were:

- Examine national, regional and international mechanisms which deal with illegal hunting and trade.
- Discuss appropriate strategies which might improve monitoring of illegal hunting and trade.
- Discuss future management of ivory stockpiles and trade in elephant products.

Two sub-groups were created within discussion group (2). The main conclusions and recommendations are summarised below.

Sub-Group 1

Trade in elephant products and ivory stockpiles

The sub-group made the following observations and recommendations:

Future policy on elephant products other than ivory

In general, the prevailing opinion was that trade in non-ivory products poses a lesser threat to African elephant populations than trade in ivory. However, any future trade in such products would require clear policy positions on domestic trade, change of inappropriate legislation as well as clarification and enforcement of existing legislation by national governments.

Monitoring of illegal trade

The sub-group concluded that more data on illegal trade are necessary, although these are recognisably difficult to obtain. It was also considered important to have up-to-date information on national legislation related to trade. The sub-group proposed the need to develop informant systems and to share information with the TRAFFIC network.

Ivory stockpiles

There is a general expectation that ivory stockpiles will, at some time in the future, realise economic value. It is also clear that stockpiles will continue to grow, which raises important questions about the security and storage of stockpiles. If trade is ever to resume, the first important step is to ensure adequate registration and marking of tusks. C1TES already has an established registration process, whereby countries are obliged to mark each tusk with an indelible pen with the date of acquisition, the ISO country code, a unique identifying number, and the weight of the tusk in kilograms. However, the sub-group proposed that additional information be recorded, where known, as: precise geographical location of where tusks were found; cause of elephant's death; how the ivory was acquired; date of elephant's death (as opposed to date of registration). This additional information can be marked on each tusk in the field, while the remaining information can be marked at the registration site. It is important to avoid duplication of codes when moving tusks from field sites to district or national stockpile locations.

Future management of stockpiles

Tusks degrade over time without adequate storage procedures. Correct storage should be the responsibility of the state. Ideally, tusks should be consolidated into one or two stock rooms where they can be secured and monitored. The sub-group noted that this is clearly difficult in countries where a domestic ivory trade exists and where a substantial amount of ivory is in the hands of private dealers. The sub-group suggested that an AfESG sub-committee be established to investigate the issue of stockpiles in more depth. The group further suggested that at future AfESG meetings, country status reports should include information on ivory stockpiles, infractions related to domestic or international ivory legislation, and changes in national legislation.

Sub-Group 2

Monitoting the illegal killing of elephants

The sub-group broadened the subject to include discussions on the monitoring of law-enforcement and illegal activities including illegal killing, because generally, patrols have to investigate all types of incidents.

The group noted the severe lack of data around the continent, both on elephant status and distribution, and on law-enforcement activities. Several reasons were listed why such data remain difficult to obtain: data are often not collected; or if they are, they are of poor quality or get lost. There are inadequate funds and manpower for data collection, and in many cases, there is corruption.

The sub-group proposed a layout for a report form, as shown in Table 3. Range states should use similar forms, standardised for analysis, and the sub-group stressed that proper patrol reports must be written each time. For aerial patrols, the sub-group suggested recording the hours of flying time, and the route taken. A key statistic to note is the number of **effective** patrol days.

The sub-group realised that forests and unprotected areas may not be possible to patrol, yet a measure of effort is still required. For example, the number of incidents reported per interviewing session could be noted. For this to work, one must establish trust with the local people, and probably set up an informer network. One might also need to know the local human demography and geography - to identify hunters per village for example.

Poachers should be interrogated to gather information on their profiles, activities, and the time to detection after entering an area. Data required from a poacher include: name, nationality, area, weapon and supplier, middleman for trophies, colleagues, duration in the park, past history, trophy prices, method of operation. Use of tape recorders is recommended and cross-checking is vital.

The sub-group recommended that only simple analysis of the data collected on patrol is required. Data should be extracted from the park level first, and certain results can be fed back to the scouts doing the patrols. The report forms can then be centralised at headquarters. Security of report forms is vital - both those stored in the park and those at headquarters. Data must belong to the state, and are under the responsibility of the relevant department. It should be at the department's discretion whether to expose/publicise data or not. Perhaps departments could be asked to co-operate with *bona fide* international organisations (e.g. AfESG, TRAFFIC), but these must be expected to respect any confidentiality and secrecy.

National approaches should include compilation/analysis/feedback of the data action on any lack of equipment and/or manpower. At the regional level, information can be passed to investigation branches.

The sub-group suggested that the AfESG could produce a simplified manual, and could distribute any relevant information in the form of books, articles and relevant computer software. The AfESG could also stimulate range states at the department level.

Table 3. Suggested patrol report form.

Dates of Patrol: .... GeneralArea: ....

Names of patrol members:..

Camps/itinerary (route followed by localities): ....

Method of movement: ....

Times of events: ....

Results:

1. Offences:

   serious (armed poachers sighted, gunshots heard, poachers' camp, etc) minor (non-armed poachers seen, trespassers, tracker, fire, etc)

2. Carcasses: species/sex/age? location, cause of death, any ivory collected, how carcass found

3. Items recovered (guns, magazines, cartridges, snares, etc.)

4. Observations on live animals – priority/key species, nos./herds, any unusual spp.

ELEPHANTS IN THE LOBEKE FOREST, CAMEROON

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ABSTRACT

The Lobeke forest appears to be an elephant refuge during the long, hard, dry season, when the overall density of elephants reaches 2.14±1.23 per km^2 (95% C.L.). By the end of the rainy season, density drops to 0.56 ± 0.33 elephants per km^2 (95% C.L.). The mean defecation rate is estimated at 17.2 ±1.7 (95% C.L.) per day and the mean dung decay rate at 0.0093 ±0.0043 (95% C.L.) per day. Elephant distribution changes with season. The main migratory movement is north-bound.

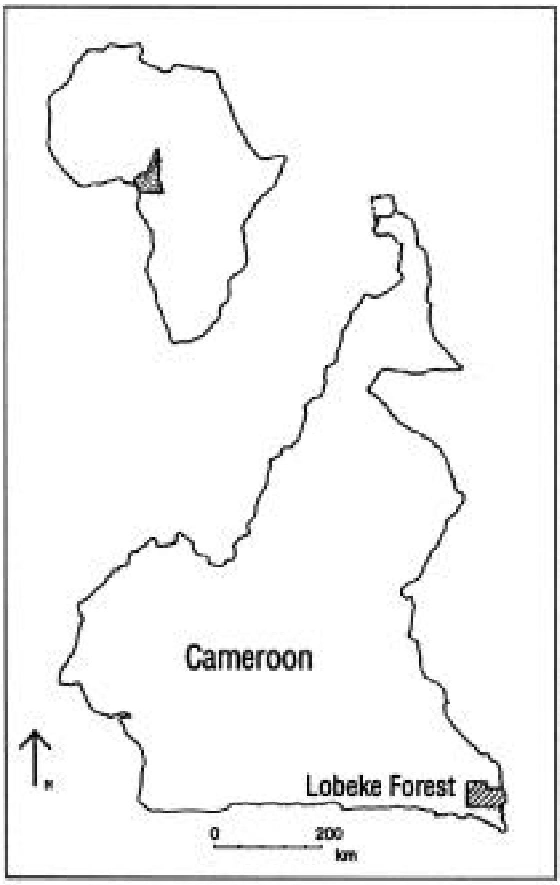

Figure 1. The location of Cameroon and the Lobeke Forest

INTRODUCTION

Since 1992, WWF-US has been engaged in a conservation research programme in the Lobeke forest, located in south-eastern Cameroon (Figure 1). The programme is divided into two main parts: a study of the ecology of the Baka and Bangando people, who are the owners and users of Lobeke forest, and secondly, the design of a future protected area, which will include recommendations for the conservation of the Lobeke-dwelling elephants. The results presented in this paper represent a component of the research programme.

The study area

The proposed Lobeke Forest Reserve covers an area of $2,125km^2$. It lies between the latitudes 20 and 2 N and the longitudes 15 the east by the Sangha River (which also serves as the international boundary between Cameroon, Congo and the Central African Republic), to the north by the Lobeke and Longue Rivers, to the west by the Djombi River and to the south by the Boulou and Moko Paka Rivers (Figure 2).

The climate

The climate is equatorial with four seasons. Average annual rainfall is about 1,400mm. The main rainy season runs from September to November and the secondary one from March to June. The long dry season lasts from December to February and the short one from July to August. In 1993, the rainfall pattern differed slightly from the norm with rainfall occurring throughout the year. However, there was still a relatively dry season from December to March and a sharp decrease of rainfall in September. Rainfall reached a maximum of 245mm in April and a minimum of 31mm in September (Table 1).

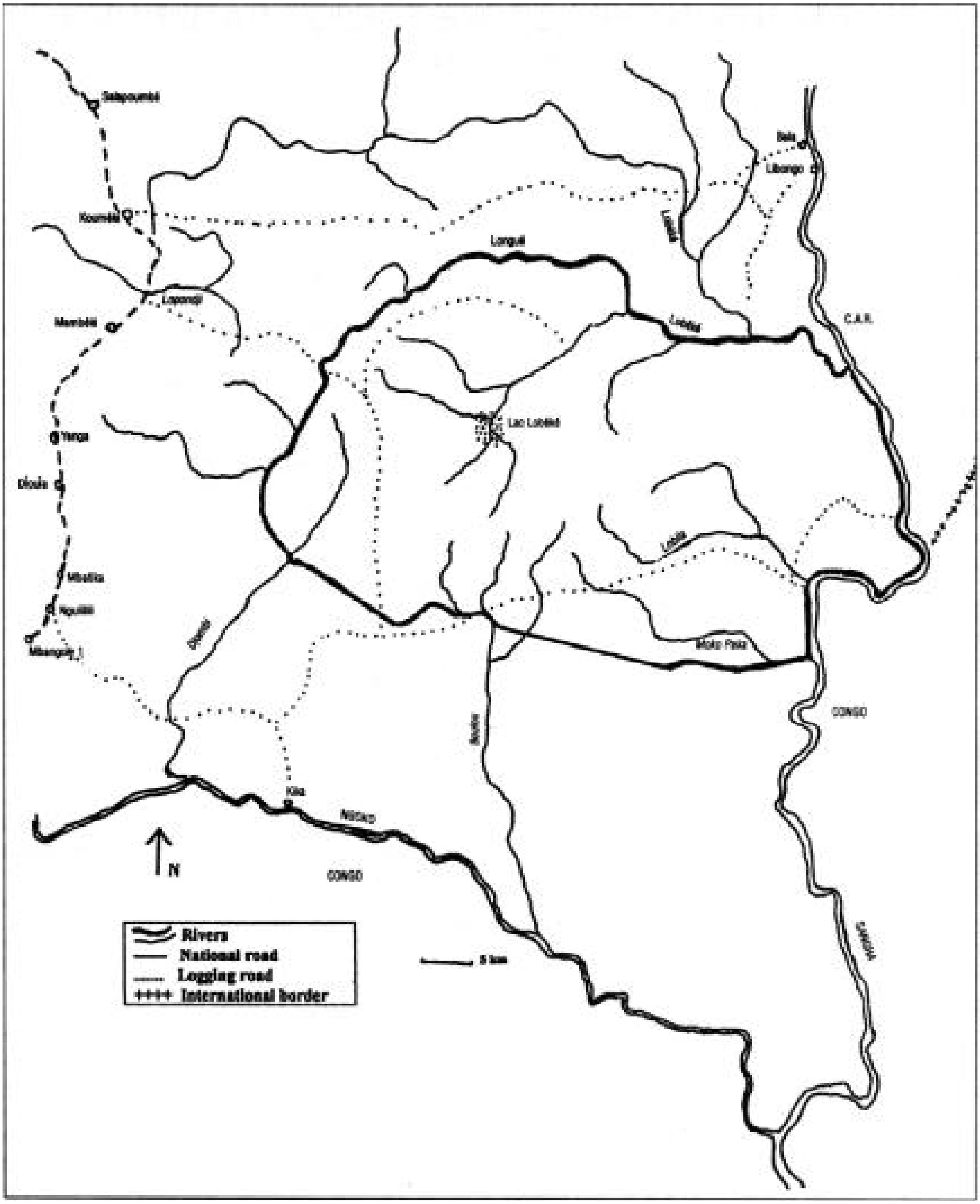

Figure 2. The proposed Lobeke Forest Reserve.

Table 1. Rainfall (mm) in the Lobeke Forest, 1993.

Jan	Feb	Mar	Ap	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	TOTAL
62	52.5	72.5	245	94	192	164.5	158	31	223	95	87	1476.5

The mean annual temperature is 24 and relative humidity remains high throughout the year.

Geology and soils

The Lobeke forest is located on a plateau belonging to the Sangha basin. The region is of Precambrian origin, consisting of a crystalline base of granite and metamorphic rocks overlain with schists, limestone and sandstone quartzite. It is a flat relief, with few hills or steep slopes. The altitude rises from 400m in the valleys to 700m on three hills, which lie on a SW-NE alignment in the proposed reserve. The Lac Lobeke itself is a large, shallow, swampy clearing.

In general, soils are ferrous, red or red-brown, being derived from the ancient metamorphic bedrock. They are acid and clay-like, with a thin, humic layer which bears little organic material and ins low in nitrogen and exchangeable bases. Soils in some areas bordering the Sangha River, including part of the Lac Lobeke basin, are hydromorphic due to permanent stagnant water, making them rich in organic material.

Vegetation

The area was mapped by Letouzey (1985). He classified Lobeke as a transitional forest between the Dja evergreen forest and the semi-deciduous forest. The Lobeke forest is dominated by semi-deciduous forest (60% of the area) and is rich in Meliacees *(Entandrophragma spp)*, Sterculiacees *(Nesogordonia, Triplochiton, Sterculia spp., Eribroma, Pterygota)*, Mimosacees *(Piptadeniastrum, Tertrapleura, Pentaclethera, Albizia spp.)*, Sapotacees *(Autranella, Gambeya spp., Omphalocarpum)*, Annonacees *(Anonidium, Polyalthia, Xylopia)* and also *Terminali superba*, *Pterocarpus soyauxii* and *Drypetes gossweileri*. The undergrowth is rich in herbaceous monocotyledon plants, in particular Maranthacees *(Megaphyrnium macrostachyus, Ataenida conferta, Haumania dankelmanniana, Sarcophyrynium spp.)*, Zingiberacees *(Aframomum spp)* and Commelinacees *(Palisota spp)*. There are also two types of transitional forests: the Dja evergreen forest with semi-deciduous elements (covering 19% of the area), and the semi-deciduous forest with elements of Dja evergreen (which covers 21% of the area). The Dja evergreen forest is marked by a poverty of Caesalpiniaceae. One notable exception is the abundant *Gilbertiodendron dewevrei*, a Caesalpiniaceae which grows in extended single-species stands. The flora of the semi-deciduous forest is dominated by the families of Sterculiaceac and Ulmaceae. Other species are well represented, particularly *Terminalia superba, Entandrophragma cylindricum* and *Pericopsis alata.*

Drainage

The northern, eastern, south-eastern and central part of the proposed reserve are drained by the Lobeke, Longue, Lobila and Moko Paka Rivers which flow east as tributary of the Sangha River. The west and southwestern part of the proposed reserve are drained by the Djombi and the Boulou Rivers which flow in a southerly direction to the Ngoko River. There are thus two major drainage systems within the proposed reserve.

The local people

The local people are the Baka and Bangando. They are concentrated along the Moloundou Yokadouma national road. They have no permanent settlements in the proposed reserve. The principal cash crop of the largely subsistence farming community is cocoa. The dominant industry is forestry. Other minor commercial activities include trading of bush meat and fish.

METHODS

The estimation of the number of elephants living in a given forest is generally only possible through dung counts, whereby the density of dung-piles in a given area is translated into the density of elephants, taking into consideration the rate of elephant defecation and the dung decay rate in the forest. A line transect dung count, a defecation rate experiment and a dung decay rate experiment were all therefore initiated for the study. The results of dung density, elephant density, elephant distribution and estimates are presented and discussed in this paper. Defecation and decay rate results are presented here (since they are used in the calculation of elephant density) but will be described and discussed elsewhere.

Dung density measurements

The Lobeke forest was divided into 80 strata of 25km^2, as illustrated in Figure 3. One 2.5km line transect was randomly cut into each of the first 78 strata, making sure that each transect started from one of the existing five base-lines (Figure 3). A total length of 195km of line transect was therefore cut along 235km of baseline. A minimum of 860km was covered on foot to survey the whole area. Dung density measurements were taken three times during the year (January to March 1993; May to August 1993; November 1993). Burnham et al., (1980) and Barnes and Jensen (1987) provide a good description of the theoretical and practical aspects of the line transect sampling method used in this study.

During data collection, it was ascertained that each transect was a straight line by following trees along a compass bearing. The centre of the line was determined by using a 50m measuring tape which was also used for measuring transect length. The line transect survey was carried out by a team of five, consisting of a leader (the author), two labourers and two assistants. The leader was responsible for making sure that the selected compass bearing was maintained. He also conducted dung searching and recorded the data. The two labourers were responsible for clearing the transect along the compass bearing, while the two assistants helped with measurements, dung searching, and ensuring that the measuring tape lay straight on the ground. The “hunter’s technique” was used to cut the transects. It entails marking trees along the compass bearing with cutlasses, breaking a few shrubs, and cutting climbers and some undergrowth where it is too thick. This technique proved advantageous for the survey, since neither elephants nor poachers used the transects. Care was taken during data collection not to miss any dung-piles on the line, and to measure accurately distances to the nearest centimetre with measuring tapes. None of the dung-piles (being immobile objects) were counted twice. It was assumed that the sighting of one dung-pile was independent of the sighting of another.

The following data were recorded when a dung-pile was seen: the distance of the pile along the transect using a 50m measuring tape; the. distance from the centre of the transect line to the centre of the dung-pile, using a 20m measuring tape; the dung-pile grade (as defined in the decay rate experiment), a description of its location and the surrounding vegetation types. In addition, information on other elephant sigus (feeding, footprints. digging, etc.), vegetation change (primary forest, logged forest, secondary forest, swampy forest, clearing, etc.), human activities, and presence of streams and swamps, were also recorded.

Before doing any analysis, the strata were grouped into five different zones as follows:

Zone 1: Very highly used areas (number of dung-pile sightings ≥ 100)
Zone 2: Highly used areas (number of dung-pile sightings ≥ 50 and < 100)
Zone 3: Moderately used areas (number of dung-pile sightings ≥25 and <50)
Zone 4: Lowly used areas (number of dung-pile sightings ≥ 10 and <25)
Zone 5: Very lowly used areas (number of dung-pile sightings <10)

Data analysis

Data analysis was facilitated by the computer programme ELEPHANT, offered for use in the study by the Wildlife Institute of India. The programme ELEPHANT is divided into four parts:

Part 1 is based on the Line Transect Sampling and the Fourier Series Model (Burnham *et al.,* 1980). It analyses perpendicular distance data and outputs dung density.

Part 2 estimates the decay rate. The decay rate is expressed as the proportion of dung disappearing per day.

Part 3 calculates the defecation rate.

Part 4 calculates elephant density. It is based on the equation E=Y* r/D (Barnes & Jensen, 1987) where Y = dung density; r = dung decay rate; D = defecation rate.

RESULTS

Elephant densities and numbers

These were calculated from dung densities, dung decay rates and defecation rates.

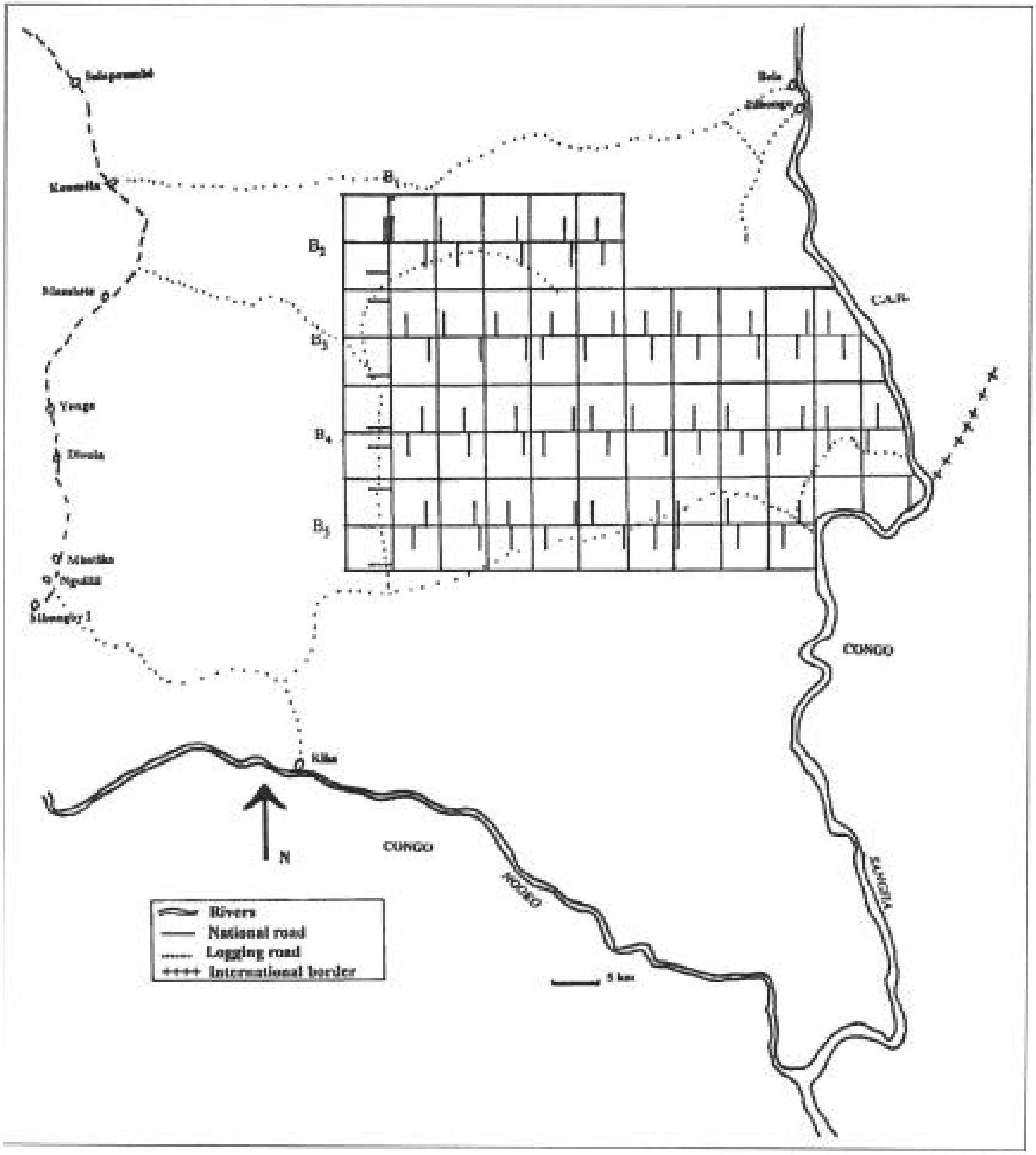

Figure 3. The location of 80 strata, five base-lines B1- B5) and 78 transects, the latter totaling 195km, in the Lobeke Forest

Table 2. *Results of the long dry season line transect survey (January-March 1993).*

Zone	Estimated dung density/km^2 (95% C.L)	Estimated elephant density/km^2 (95% C.L)	Area (km^2)	Estimated number of elephants (95% C.L)
Zone 1	12,302.41 ± 2,203.71	6.64 ± 3.82	209.5	1,391 ± 800
Zone 2	7,480.36 ± 1,122.89	4.04±2.31	375	1,515±866
Zone 3	3,385.58 ± 542.80	1.83 ± 1.05	333.5	610 ± 350
Zone 4	1,626.77 ± 283.35	0.88 ± 0.51	592.5	520±302
Zone 5	794.14 ± 254.65	0.43±0.28	475	204±133

Table 3. Results of the short rainy and short dry season line transect survey (May-August 1993).

Zone	Estimated dung density/km^2 (95% C.L.)	Estimated elephant density/km^2 (95% C.L.)	Area (km^2)	Estimated number of elephants (95% C.L)
Zone 2	9,633.66 ± 2,443.02	5.20 ± 3.01	116.5	606 ± 351
Zone 3	3,793.83 ± 308.97	2.05± 1.15	876.5	1,797±1,008
Zone 4	2,851 .53 ± 418.61	1.54 ± 0.88	542.5	835 ± 477
Zone 5	959.53 ± 323.41	0.52 ± 0.3	450	234 ± 153

Table 4. Results of the rainy season survey (November1993).

Zone	Estimated dung density/km^2 (95% C.L.)	Estimated elephant density/km^2 (95% C.L.)	Area (km^2)	Estimated number of elephants (95% C.L)
Zone 3	2,336.20 ± 366.39	1.26 ± 0.72	323	407 ± 233
Zone 4	1,697.42 ± 283.08	0.92 ± 0.53	575	529 ± 305
Zone 5	306.96 ± 101.72	0.17±0.11	1,087.5	185±120

The results of the defecation rate experiment (not described) are:

Total number of observations: 46
Total number of elephant hours: 571.93
Mean defecation rate: 17.2205 per day
95% confidence limits: ± 1.7162

The results of the dung decay rate experiment (not described) are:

Number of fresh dung-piles initially marked for regular observations: 40
Number of observations in data file: 29
Mean decay rate: 0.0093 per day
Standard deviation: 0.00218
95% confidence limits: ± 0.0043

The long dry season survey

The total number of elephants estimated to use the study area during the long dry season was 4,241 ± 2,451. The overall elephant density was calculated as 2.14 ± 1.23 elephants per km^2. For the proposed reserve (2,125 km^2) the estimated number of elephants is estimated at 4,548 ± 2,614. Table 2 gives the breakdown of results according to the five zones.

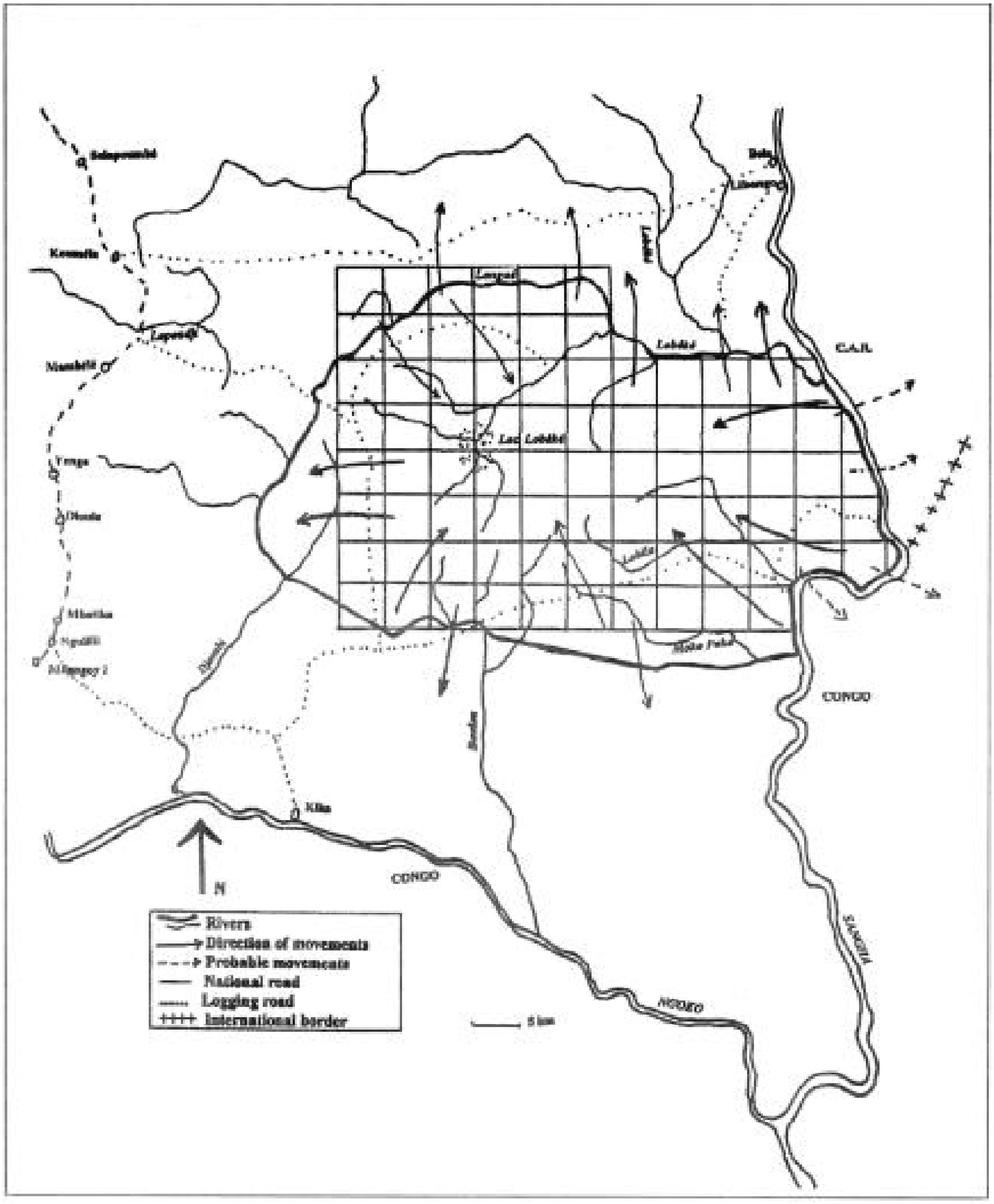

Figure 4. Movements of elephants in the Lobeke Forest.

The short rainy season and short dry season survey

The total number of elephants estimated to use the study site during the short rainy and dry season was 3,472 ±1,989, with an overall elephant density of 1.75 ± 1.00 elephants per km^2. For the proposed research, the estimated number of elephants is 3,719 ± 2,125. Table 3 shows the breakdown of results by zone.

The long rainy season survey

The number of elephants estimated to use the study site during the long rainy season was 1,121 ± 658, which gives an overall density of 0.56 ± 0.33 elephants per km^2. For the proposed reserve, the estimated number of elephant is 1,190 ±701. The breakdown of results by zone is shown in Table 4.

Movements

By the end of the long rainy season, 74% of elephants had migrated out of the Lobeke forest. Two types of movements were observed, as illustrated in Figure 4:a centripetal (reduced) movement and a centrifugal movement.

The centripetal movements begin with the short rainy season and become more accentuated in the short dry season when fruits are available all over the Lobeke forest.

The centrifugal movements tend to be directed towards the north. Movements towards the southern and eastern parts of the Lobeke forest are very reduced. Elephants do not appear to go very far beyond the Djombi River. A questionnaire survey of inhabitants from Salapoumbé to Kika indicated that for the time being, elephants have not been crop-raiding in the area. Careful monitoring of the Molondou-Yokadouma road from Moloundou to Salapoumbé did not reveal any elephants crossing the road, or any elephant footprints. It is not yet known how far elephants go northwards, and if they cross the Sangha River. We hope to find out during the second phase of the project.

DISCUSSION

Stromayer and Ekobo (1992) estimated a density of 4.64 elephants per km^2 for the Lobeke forest. The highest overall density estimated during this study was 2.14 ± 1.23 elephants per km^2 during the long dry season. The large difference between these two densities might be explained by the high mean decay rate (0.0233 per day) and the low mean defecation rate (17 per day) used in the 1992 calculations. This discrepancy highlights the necessity of undertaking decay and defecation rate experiments specific to the site, in order to arrive at a more accurate density estimation.

The above results suggest that the Lobeke forest becomes an elephant refuge during the long dry season, from January to March. Densities of more than one elephant per km^2 were mainly located around the Sangha and Longue-Lobeke Rivers during this period. The distribution of elephants in November, and from May to August, were much more homogenous, perhaps because of a more even distribution of resources during these two periods.

ACKNOWLEDGEMENTS

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SURVEY EXPERIMENTS AND AERIAL SURVEY OF ELEPHANTS IN THE SOUTH LUANGWA NATIONAL PARK AND THE LUPANDE GAME MANAGEMENT AREA, ZAMBIA, 1993.

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INTRODUCTION

The Luangwa Valley Ecosystem, covering a total of 144,000km^2 in Zambia's Eastern Province, runs from the Nyika highlands in the north to the Zambezi Valley in the south. It is one of the last unique wilderness areas remaining in Africa. The South Luangwa National Park (SLNP) covers some 9,050 km^2 and is located in the central part of the Luangwa Valley. Together with the adjacent Lupande Game Management Area (LGMA) covering approximately 5,000 km^2 to the east of SLNP (Figure 1) they form the operational area of the Luangwa Integrated Resource Development Project (LIRDP). LIRDP is a community-based resource management project, mainly funded by the Norwegian Government (NORAD) and The Netherlands Government (DGIS).

As a result of commercial illegal hunting for ivory and rhino horn, from the mid-1970s to the late 1980s, the populations of both rhinos and elephants have been severely reduced, with the rhino now close to extinction. In the LIRDP area, the elephant population declined from approximately 35,000 in the early 1970s to 2,400 in 1988, while during this same period the rhino population was reduced from several thousand to a mere remnant (Bell *et al.,* 1994; Jachmann 1993a, 1994). With the onset of the law-enforcement operations of LIRDP in 1988, illegal hunting rates declined to a level of approximately 10 elephants killed per year. As a result, from 1988 to 1993, the elephant population increased from 2,400 to approximately 6,000, partly due to immigration and partly due to natural recruitment (Jachmann, 1993a, 1994).

In 1993, two aerial counts were carried out using different survey designs in order to estimate numbers of elephants and some of the other large herbivores, for use as feedback for law-enforcement operations and to provide baseline data for use in the preparation of a management plan, scheduled for 1994.

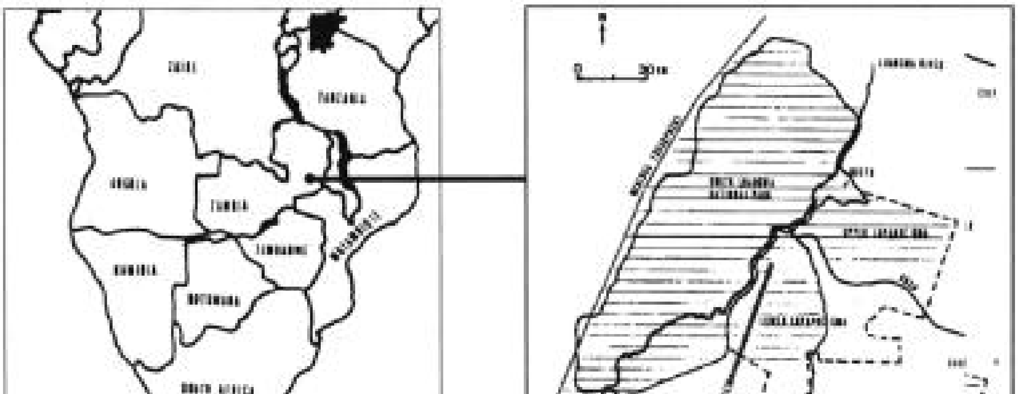

Figure 1. Location of South Luangwa National Park and the Lupande Game Management Area in the central Luangwa Valley in Zambia's Eastern Province. Horizontal lines are flying paths on 5km gird lines.

STUDY AREA

The survey area incorporated the SLNP, including the small Nsefu Sector (200 km^2) on the east bank of the Luangwa River, and the LGMA, divided into the Upper Lupande and Lower Lupande hunting blocks (Figure 1). With the exception of the Chideni Hills in the Lower Lupande area and some hills in the eastern part of the Upper Lupande area (eastern escarpment), most of the survey area was flat and only slightly undulating towards the Mchinga escarpment.

The vegetation of the alluvial complex consists predominantly of deciduous dry woodland with *Colophospermum mopane* on shallow alkaline clay soils and *Combretum/Terminalia* on freely draining soils. In the north of SLNP and part of the Nsefu Sector there are several vast grassland plains with *Setaria eylesii* and *Hyparrhenia rufa.* The vegetation of the escarpment and plateau areas is dominated by miombo woodland with *Julbernardia* and *Brachystegia* species.

The dry season runs from mid-April to mid-November. Approximately 700-800mm of rain falls mainly from December to March.

METHODS

Survey Design

The survey area was not stratified on account of a limited budget and small groups of elephants, more or less evenly distributed over most of SLNP (confirmed by ground observations). In addition, the minimal gain in precision from stratified counts does not usually outweigh the extra expense and the loss in information on the distribution of the population under study.

The first aerial count was carried out in the early dry season (4-7 June) and covered the entire project area. Transects were accurately flown with the aid of a global navigation unit, whereby the beginning and end of a transect were determined by distinct features in the landscape. In SLNP, transects were flown east to west between the Luangwa River and the Mchinga escarpment. In the Lower Lupande transects were flown east to west between the Luangwa and Lupande Rivers, and in the Upper Lupande, transects were flown east to west between the Luangwa River and the eastern boundary of the GMA (Figure 1).

The second count was carried out in the late dry season (16-18 October), and incorporated SLNP only. The Nsefu Sector had been covered during a separate survey, funded by the World Wide Fund for Nature (WWF), carried out annually in the month of October (A. Pope, pers. comm.). During the second count in SLNP, some of the other large herbivores were also counted (e.g. buffalo, eland, giraffe, hartebeest, kudu, roan, waterbuck and zebra), while in the small Nsefu Sector, all species larger than impala were counted (A. Pope, pers. comm.).

Flying paths were along 5km grid lines (Figure 1), with a sampling intensity of 6%. For the WWF sponsored survey of the small Nsefu Sector, flying paths were 1km grid lines with a sampling intensity of 20% (circumstantial stratification!).

Flying Procedures

For both surveys, a Cessna 206 aircraft was used, flying 100m above ground level (AGL), maintained with the use of a barometric altimeter. Height control was not as satisfactory for the hilly parts of the Lupande GMA as for the mainly flat parts of SLNP. However, elephant densities in the hilly areas of the GMA were extremely low, limiting this potential source of error.

Strip widths were set at 140m to each side, with a total transect width of 280m calibrated as indicated by Norton-Griffiths (1978). Flying speed was maintained at an average of 110 knots, giving a searching speed of 57km^2/hour.

During the first survey, the aircraft was manned by a pilot, a navigator and two experienced observers. During the second survey, hc wever, the aircraft was manned by an additional two observers. In order to correct for visibility bias and estimate the bias related to observer experience, the double-count procedure was followed (Caughley, 1974; Graham & Bell, 1988). During the second survey, four observers were used, out of a total of 12, each with a different level of experience.

For the small Nsefu Sector, a Cessna 182 aircraft was used, flying at 100m AGL, maintained with a radar altimeter. Strip widths were set at 100m to each side and flying speed was an average of 95 knots, giving a searching speed of 35km^2/hour (A. Pope, pers. comm.).

Analyses

Live elephants and dead elephants were counted. Dead elephants were categorised as fresh carcasses (skin still visible) and skeletons (bones only), retaining the division used in former aerial surveys covering the LIRDP area.

Visibility bias

During the second survey, the double-count method was used to correct for visibility bias. On both sides of the aeroplane, two observers, one experienced and one less experienced, independently and without collusion, counted groups of nine large herbivores. At the beginning of a session, all watches were set to agree to a second. With each observation, species, time and group size were indicated. If both observers sitting in line recorded a sighting at exactly the same time, it was assumed that it had likely been of the same group (Graham & Bell, 1988).

The corrected number of animals was calculated using an adaptation of the Petersen Estimate (Seber, 1982), Y=yl y2/m, where: Y is population size, yl is the number of animals seen by the front observer, y2 is the number of animals seen by the rear observer and m is the number of animals seen by both observers.

For seven of the nine large herbivore groups counted, a visibility correction factor was estimated. A multiple-linear regression analysis was performed, with the correction factor as the dependent variable. Mean group size, unit weights (Coe *et al.*, 1976) and number of observations for each species were the independent variables. Unit weights, based on age-weight data and population structure, were used as an indication for the average size of individuals of a particular species. The number of observations of each species was used as the independent variable relating to abundance. Tests of the multiple-regression assumptions were performed and met in all cases. The resulting regression coefficients were compared and tested with t-statistics to determine which of the independent variables had the most influence on the relationship.

Final analysis followed Jolly's Method 2 for unequal sized sampling units (Norton-Griffiths, 1978).

Observer experience bias

For each session, the true total number of visible animals in the transects were calculated using the Petersen Estimate. Then, for each observer, the percentage of animals seen as compared to the total number of visible animals was calculated. With the percentage of animals seen by each observer for each separate session as the dependent variable, a multiple-linear regression was performed, using aerial survey experience (hours), current survey experience (hours) and flight duration (session in hours) as the independent variables.

RESULTS

Live Elephants

The survey carried out in June 1993, gave an estimate of 5,263±1,081 elephants for SLNP (including Nsefu) and 666 ± 258 for the LGMA (Jachmann, 1993a). The second count, in October 1993, provided an estimate of 4568+ 649 for SLNP, using a visibility correction factor for elephants of 1.06, and 702 ± 202 for the Nsefu area (A. Pope, pers. comm.) resulting in a total of 5,270 ± 680 elephants for SLNP (including Nsefu), as shown in Table 1.

Table 1. Summary of aerial survey results.

Area	Date	Estimate	S.E.	%	95% C.I. Lower	95% C.I. Upper
SLNP (+Nsefu)	June	5,263	1,081	20.5	3,144	7,382
SNLP (+Nsefu)	October	5,270	680	12.9	3,937	6,603
Lower LGMA	June	438	192	43.8	9	867
Upper LGMA	June	228	172	75.4	0	707

For the October survey, population estimates were corrected for visibility bias, using an adaptation of the Petersen Estimate through a double-count procedure.

Dead Elephants

No fresh carcasses were observed during the surveys. However, in June, the total number of old skeletons in the project area was estimated at 169, while the October survey gave an estimate of 379. The high count during the October survey is mainly due to the improved visibility of skeletons in burned areas. The average carcass ratio for 1993, calculated as a percentage of the combined total number of carcasses and live animals counted, was 4.4%. It should be noted, however, that most of the skeletons observed were a collection of scattered and bleached bones of elephants killed more than four or five years ago.

Visibility Correction Factor

The estimated visibility correction factors ranged from 1.06 for elephants to 2.05 for hartebeest. The multiple-regression model, relating mean group size, individual size and abundance to the sighting probability of the various species counted, was not significant. However, the multiple correlation coefficient was 0.8398, and the model explained 71% of the variation.

Although none of the independent variables had a significant t-statistic (Table 2) the variables of abundance and mean group size had a much greater influence on the sighting probability than the size or the actual biomass of the individuals of a particular group of herbivores. Thus larger group sizes give a higher sighting probability, while an increasing abundance of a particular species enhances the formation of a searching pattern by the observers.

Table 2 Estimated regression coefficients, standard deviations (SD), percentage standard error (SE), computed t-values (t) and significance levels (p).

Variable	Coefficient	SD	%SE	t	p
Mean Group Size	-0.039886	0.029959	75.11	-1.331	N.S.*
Individual Size	0.000080	0.000310	387.50	0.256	N.S.
Abundance	-0.016895	0.009517	56.33	-1.775	N.S.
Intercept	1.986229				

*N.S.= Not Significant

Observer Experience Bias

A multiple-regression analysis was performed using the percentage of animals seen by each observer as the dependent variable, and the Total Survey Experience (TSE) in hours, the number of hours counted in the Current Survey Experience (CSE) and the Flight Duration (FD) of a single session as the independent variables. Although the model had a reasonably good fit, with a multiple correlation coefficient of 0.7045 and a significant F-statistic ($p<0.05$), it explained only 50% of the variation. This implies that several other variables such as eye sight of the observer, capability to concentrate for long periods and familiarity with the area, also play an important role.

Both the variables, TSE and CSE, had significant positive coefficients (i.e. with increasing survey experience more animals were observed), while the variable FD was almost significant at the 5% level, but with a negative coefficient (i.e. with a longer counting session, fewer animals were observed), (Table 3).

Table 3. Estimated regression coefficients, standard deviations (SD), percentage standard error (SE), computed t-values (t) *and significance levels (p).*

Variable	Coefficient	SD	%SE	t	p
TSE	0.278973	0.105267	37.73	2.650	0.02
CSE	4.005720	1.559011	38.92	2.569	0.02
FD	-7.679495	4.678217	60.92	-1.642	N.S.*
Intercept	77.488110				

*NS.=Not Significant

The overall equation has the following form:

% Animals Observed = 0.28 TSE + 4.01
CSE - *7.68* FD +77.49

Using this formula, we can estimate the optimum FD of a single session, as well as the level of experience necessary to observe, for example, 95% of the visible large ungulates in the survey area. The most experienced observer during the October 1993 survey had a TSE of approximately 100 hours. Using a CSE of one hour, the optimum FD for this particular observer would be about two hours. This implies that a less experienced observer would require a longer CSE, i.e. a long session to get acquainted with the area and animals, or alternatively a shorter FD of a couple of hours, because shorter flights will be uneconomical. For the same reason, the parameter CSE should be no longer than two hours.

If the objective is to attempt to spot at least 95% of the visible large ungulates, the observers should have at least 89 hours of TSE.

DISCUSSION

Population Estimates

The two different survey designs gave almost identical results with regard to elephant population estimates, and it is safe to conclude that in 1993 there were approximately 6,000 elephants in the LIRDP area. The double-count procedure resulted in an additional 6% of elephants observed compared to the regular sample survey, using two experienced observers only. However, for the purpose of counting elephants, the slight gain in precision when using the double-count procedure does not outweigh the extra fuel expenses and the risks involved in low-level flying with six crew on board.

From the early 1970s to 1987, the elephant population in the SLNP and LGMA declined from 35,000 to 15,000 (Bell *et al.*, 1994). A further decline occurred between 1987 and 1988, when a large proportion of the population moved away from the project area. Since 1988, the elephant population in the LIRDP area has progressively increased from 2,400 to approximately 6,000. From 1988 to 1989, the population more than doubled, mainly as a result of elephants returning to the LIRDP area from GMA's to the north and to the south of SLNP. From 1989 to 1993, the population increased by a modest 3% per year (Jachmann, 1994).

From 1990 to 1993, on average 10 elephants were killed by illegal hunters each year (Jachmann, 1993b). This, however, should be considered a conservative approximation, because some elephants killed by poachers may not be detected by patrols. However, during this period, elephant mortality cannot have been much higher than this estimate, because no fresh carcasses have been observed from the air since 1990. Hence the majority of skeletons observed during the most recent aerial surveys are at least four or five years old.

Elephant Distribution and Group Size

Both elephant distribution and group size are a function of habitat condition, i.e. mostly seasonal changes in habitat, and disturbance from illegal hunting (Jachmann, 1980, 1983, 1984). Elephants are social animals and maintain close family bonds. During the wet season, when the food situation improves in the form of abundant fodder and grass, group size increases as a result of lowered food competition. In the Luangwa Valley, during most of the wet season, elephants congregate in the alluvial belt, mainly feeding on grasses.

When grass quality falls, during the late rains and early dry season, elephants disperse over the floor of the valley, utilising woodland species that have high concentrations of sodium and simple sugars, but low concentrations of certain plant secondary compounds (Jachmann, 1989a). Any disturbance through illegal hunting results in a more compressed distribution and therefore larger groups, which avoid the most hazardous areas (Jachmann, 1989b).

During both surveys, the population was more or less evenly distributed over the valley floor, with very few elephants east of the Chideni Hills. The mean group size was 4.2 ± 3.8 in June and 3.8 ± 3.0 in October, with the largest observed group numbering 18 animals. These observations, in combination with the absence of fresh carcasses, confirm that there is currently little to no illegal elephant hunting in the area, and that law-enforcement operations under LIRDP are still very effective (Jachmann, 1993b).

Visibility Bias and Observer Experience Bias

While the simultaneous double-count offers an attractively simple method of investigating observer bias, it is emphasised that only the visible population is accessible to this type of investigation (Graham & Bell, 1988). In every aerial survey, depending upon the species, there is a population of invisible animals, hidden from the observers by obstructions such as tree canopies. This source of bias cannot be estimated. Of the visible population, only some groups are seen, while others are overlooked for a variety of reasons. Operational factors, such as speed and height, affect the proportion seen and must be kept within practical limits. A strong decline in sighting probability with height can be expected among observers counting solitary animals and groups of less than four (Graham & Bell, 1988). Although group size strongly influences sighting probability, it is not so much determined by the actual biomass of the individual members of the group, but by the number of individuals in that particular group.

In summary, the sighting probability is a function of aircraft speed and height, species abundance and group size, and also of vegetation density, light conditions, colour patterns of objects to be counted and several unknown factors. In addition, the observer experience bias experiments show that sighting probability is also a function of the total survey experience of a particular observer and, to a similar extent, the experience gained within a particular survey. The intuitive reaction to this may be that each observer has to form a series of searching patterns, a process that depends upon the capabilities of the observer, the abundance of the species, the state of the vegetation and the number of species to be counted. With an increasing experience level of the observer, this process may develop more rapidly.

In the current survey, the observer with the lowest level of experience spotted only 33% of the total visible population during his first two hours of counting, while the observer with the highest level of experience spotted 95% of the visible population during his first two hours of counting. However, with five more hours of counting, the least experienced observer spotted almost 80% of the total visible population, while a slightly more experienced observer with a total of seven hours only spotted 54% during his first two hours.

From the above we may conclude that besides keeping the operational factors within reasonable limits, observers should have a high level of experience and should be allowed to practise (and form search patterns) for several hours prior to each survey, while the duration of each counting session should be kept within the limit of two to three hours.

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BOOK REVIEW

THE ELEPHANT IN SRI LANKA

by Jayantha Jayewardene

Reviewed by John Eisenberg, Katharine Ordway Professor of Ecosystems Conservation, University of Florida

This is a very interesting summary of the natural history of the elephant in Sri Lanka. It is a fine mix of early historical literature and modern findings. Especially useful is the chapter concerning the domestication of elephants and their use and integration with the human culture of the island.

Chapter 5, "Concerning the Elephant in the Wild", is a wonderful historical summary, which includes valuable data on early distribution, movements, and the present situation. Especially useful to wildlife managers and those individuals responsible for the management of elephant populations in the modern world, are chapters 6, 7 and 8.

Conflicts between elephant and man are age-old, and the author puts the problem into perspective, but then goes on to discuss the attempted solutions as developed in Sri Lanka. Naturally, attempts at management involve both successes and failures. I consider an honest discussion of all aspects of the problem to be refreshing and useful, even when efforts have failed. The inclusion of a discussion concerning the Mahaweli project and the attempt to construct elephant corridors is of great value.

The final chapter assessing the future of the Ceylon elephant is excellent. I found the appendices to be useful.

There are many, many workers in the area of wildlife management confronted with the problems that large mammals present to human populations, who will find this honest account extremely valuable.

Mr. Jayantha Jayewardene is to be congratulated for presenting a very fair account of the attempts to preserve the wild elephant populations in Sri Lanka. He certainly does not avoid tough questions and his honesty is commendable.

Pachyderm

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Pachyderm welcomes original manuscripts (not published elsewhere) dealing with the conservation and management of elephants and rhinos. All submissions are reviewed by at least two referees. Manuscripts should preferably not exceed 4,000 words; shorter ones have a greater chance of being published. Contributions may be written in English or French and should be typed on one side of A4 paper, double-spaced with ample margins. Al manuscripts must have an abstract or summary. Final versions of manuscripts should be submitted on IBM-compatible 3.5" diskettes in WordPerfect or Microsoft Word (preferred) format if possible. The full postal address of the first author should be included as well as the address of any other author.

Tables and figures should be submitted on separate sheets along with the captions to illustrations typed out on another sheet. Figures should be black-and-white high quality graphics, suitable for reduction. Photographs should be unmounted, glossy prints of good quality. Abbreviations and references should be made using the same format provided by the African Journal of Ecology.

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