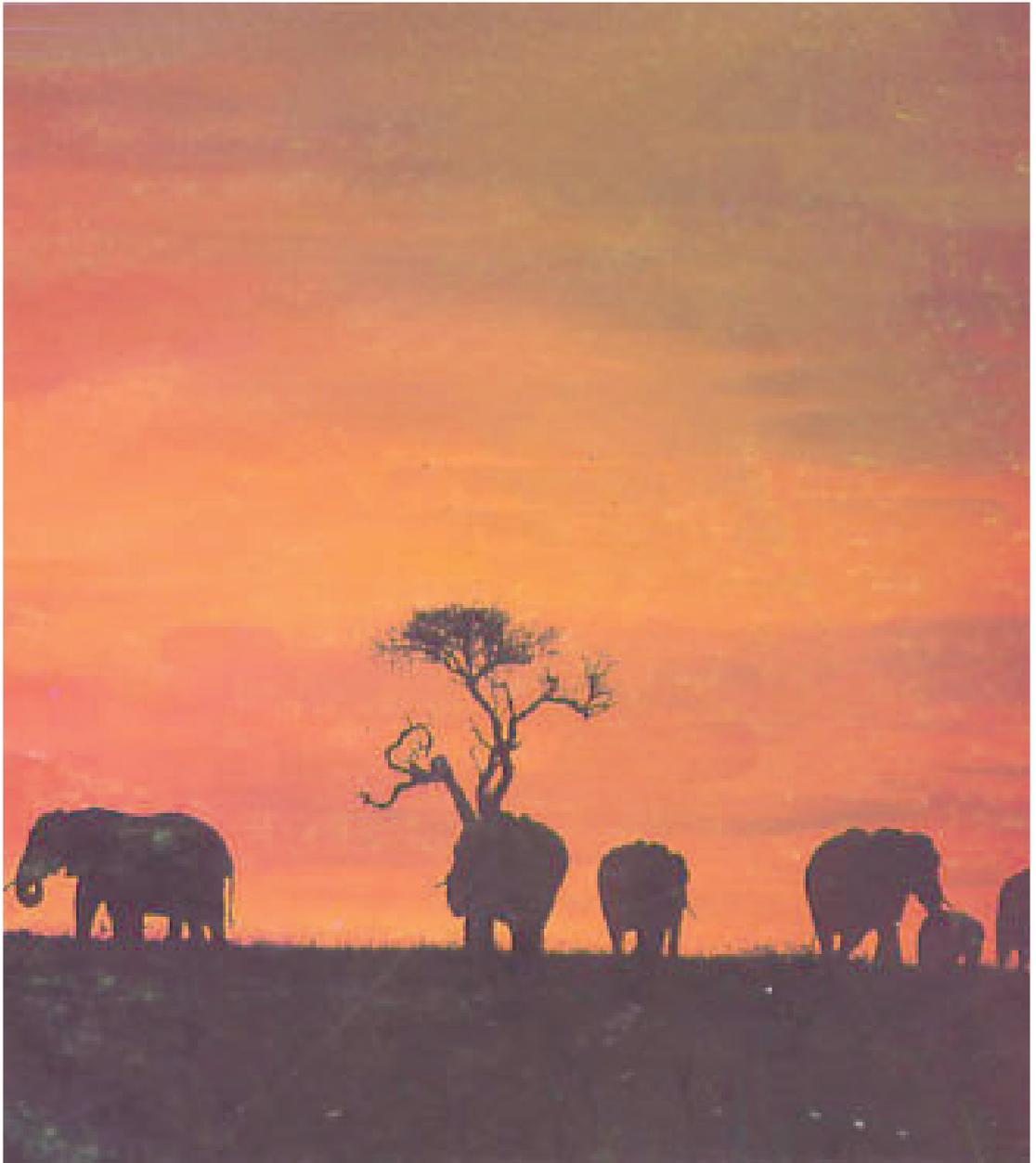
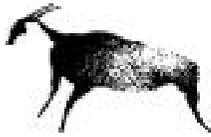


# Pachyderm

1993

Number 16





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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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Cover photo: Elephants at dawn

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# Chairman's Report African Rhino Specialist Group

Martin Brooks

The first meeting of the newly reconstituted African Rhino Specialist Group which was convened at Victoria Falls, Zimbabwe, from 17-22 November 1992, was attended by 33 members and observers. It provided a forum for the frank exchange of information and ideas on a wide range of issues ranging from captive breeding and genetics to a variety of fairly controversial alternative conservation strategies, such as dehorning safaris, trophy hunting and the option for legalising trade.

The main aims of the meeting were, however, to review the status and trends of the rhino populations in Africa, to identify the most important populations,

and to identify the priority conservation projects requiring funding in advance of UNEP's Rhino Range States and Donors' meetings.

## Rhino population size and trend

The 1992 population estimates and trends for black and white rhino are presented in Table 1 below.

Poaching continues to threaten these rhino populations throughout their range, and it is only in Kenya, Namibia, South Africa and Zaire that control is proving effective. The result is that black rhino numbers have continued to decline:

Table 1

COUNTRY	WHITE RHINO		TOTAL	TREND	BLACK RHINO				TOTAL	TREND
	<i>C.s. simum</i>	<i>C.s. cottoni</i>			<i>D.b. bicornis</i>	<i>D.b. kongipes</i>	<i>D.b. michaeli</i>	<i>D.b. minor</i>		
ANGOLA	Extinct?		Extinct?		10			40	50	Down
BOTSWANA	27		27	Down				5	5	Down
CAMEROON						35			35	Down
C.A.R.		Extinct?	Extinct?			Extinct?			Extinct?	Down
ETHIOPIA							Extinct?		Extinct?	
KENYA	74	Extinct?	74	Up			414		414	Stable
MALAWI								Extinct?	Extinct?	Down
MOZAMBIQUE	Extinct?		Extinct?					50	50	Down
NAMIBIA	91		91	Up	489				489	Up
RWANDA							15		15	Down
SOMALIA							Extinct?		Extinct?	
SOUTH AFRICA										
AFRICA	5297		5297	Up	20		28	771	819	Up
SUDAN		5	5	Down			Extinct?		Extinct?	
SWAZILAND	46		48	Down				6	6	Stable
TANZANIA							32	95	127	Down
UGANDA		Extinct?	Extinct?				Extinct		Extinct	
ZAIRE		31	31	Up						
ZAMBIA	Extinct?		Extinct?					40	40	Down
ZIMBABWE	249		249	Down				425	425	Down
<b>TOTALS</b>	5784	36	5820		519	35	489	1432	2475	

from 3,450 to 2,475 between 1991 and 1992, largely due to a drop of almost 1,000 in Zimbabwe. The largest populations occur in South Africa (819), Namibia (489) and Kenya (414); while there are only five discrete populations that number more than 100 animals. The northern white rhino population

increased from 30 to 31 between 1991 and 1992 and the southern white from 5,590 to 5,780, of which 5,300 occur in South Africa. Populations have declined in three of the seven countries, namely Botswana, Swaziland and Zimbabwe, all due to poaching.

Table 2

CATEGORIZATION OF KEY RHINO POPULATIONS : 1992			
CATEGORY	CRITERIA	BLACK RHINO	WHITE RHINO
A1	Population increasing or stable & N > 100 or N > 50% of subspecies	Cameroon Damaraland Etosha Hluhluwe-Umfolozi Kruger	Garamba Hluhluwe-Umfolozi Itala Kruger Mkuzi Pilanesburg Sabi Sand (P)
A2	Population increasing or stable & N = 51-100 or N = 26-50% of subspecies	Itala Midlands (P) Mkuzi Nairobi Selous Solio (P)	Loskop Manyaleti Ndumo Solio (P) Timbavati (P)
A3	Population decreasing ) <25% & N > 50 or N > 25% of subspecies  OR  N > 100 even if population decreasing > 25%	Hwange	Hwange
CATEGORIZATION OF IMPORTANT RHINO POPULATIONS : 1992.			
CATEGORY	CRITERIA	BLACK RHINO	WHITE RHINO
B1	Population increasing or stable & N = 20-50	Aberderes Addo Bubiana (P) Lake Nakuru Lonely Mine (P) Luangwa South Masai Mara Ndumo Pilanesberg Save Valley (P) Waterberg Plateau	Borakalalo Botsalano Klaserie (P) Madikwe Manyaleti Matobo Midlands (P) Mkhaya (P) Tembe Tsolwane Warerberg Plateau Weenen
B2	Population decreasing but N = 20-50 in breeding contact in protected area	Chizarira Laikipia (P) Matusadona Ngorongoro	
B3	Population = 20 + dispersed outside protected area with good potential (or creating sanctuary	Kenya Forest Areas Zimbabwe	

(P) : Private land

Population trend (increase, decrease or stability) is based upon a 5-year period (1987-1992) Unless more current information is available to assess the 3year trend ((989-1992) and is contraventive to (he 5-year (rend. Trend is considered independent of any population change due to census improvement or management interventions, e.g. rhino removals or re-establishment.

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## Key rhino populations

In an effort to focus international attention on those populations considered to be the most important for the survival of the six recognised subspecies of white and black rhinos in Africa, a rating exercise was undertaken.

It was agreed that the most relevant parameters on which to judge the conservation value of populations were population size, the significance of the population in conserving the relevant subspecies, and the likelihood of protection measures being effective (as indicated by recent population trend). Two importance categories were recognised, namely “Key” [critically important] and “Important” [extremely valuable], and the reserves listed accordingly as shown in Table 2.

## Priority conservation projects

The critical situation of Africa’s rhinos and the limited extent of funds potentially available from the international community required the group to be very selective when identifying priorities. Project proposals were rated as either “Priority”, “Important” or “Other”, and where possible detailed “Project descriptions and funding applications” were completed.

The “Priority” projects or programmes were those considered essential to secure the survival of the various rhino subspecies in Africa, and which required international funding. These are listed below:

**The conservation of the western black rhinoceros *Diceros bicornis longipes* in Cameroon.** [Dr S. Gartlan, WWF].

**Monitoring and protection of *Diceros bicornis* in Damaraland/Kaokoland, Namibia.** [B. Loutit, Save the Rhino Trust].

**Design of strategy to develop a sanctuary in Damaraland, Namibia.** [B. Loutit, Save the Rhino Trust].

**Upgrading of the anti-poaching unit.** [Dr B. Joubert, Dept of Wildlife, Conservation and Tourism].

**Pilot project to evaluate a variety of highly sophisticated fencing/remote sensing security systems in the Hluhluwe-Umfolozo Park, Natal.** [A. Conway, Natal Parks Board] -

**Neighbour cooperation and fencing project, Mkuzi Game Reserve, Natal.** [T. M. Scheepers, Natal Parks Board] -

**Equipment requirements for antipoaching units in key rhino reserves in Zululand, Natal.** [A. Conway, Natal parks Board].

**Monthly aerial survey of specific areas in Kruger National park where rhinoceros poaching is prevalent.** [D. J. Pienaar, National Parks Board] .

**Development of a DNA typing method to establish individual specific DNA fingerprinting and forensic identity between rhino carcass tissue and rhino horn.** [Prof. A. S. Greeff, Dept of Microbiological Pathology, Medunsa] .

**The development of a reliable and repeatable ante mortem diagnosis test of tuberculosis infections in black and white rhino.** [Dr J. P. Raath, National Parks Board].

**Revision of the “Conservation Plan for the black rhinoceros *Diceros bicornis* in South Africa and Namibia”.** [Dr P. M. Brooks, Rhino Management Group].

**Development of an Action Plan for the black rhinoceros in Tanzania, and its implementation.** [E. Severre, Wildlife Division, Tanzania] .

**Supplementary support for development of the anti-poaching capability, Garamba National Park, Zaire.** [F. Smith (WWF), M. Mesi (IZCN), Dr K. Hillman-Smith (WWF), Dr M. Atalia (IZCN)].

**Supplementary support for rhino monitoring and research developments, Garamba National Park, Zaire.** [Dr K. Hillman-Smith (WWF), Dr M. Atalia (IZCN), F. Smith (WWF), M. Mesi (IZCN)].

**Monitoring and research in black rhino intensive protection zones, Zimbabwe.** [R. B. Martin, Dept of National Parks and Wildlife Management] .

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**Analysis of supply/demand/speculation/ black market trading factors under different trading regimes.** [Dr Tom Milliken, TRAFFIC East/Southern Africa].

**Far and Middle East Trade Studies.** [Dr Tom Milliken, TRAFFIC East/Southern Africa].

**African trade studies.** [Dr Tom Milliken, TRAFFIC East/Southern Africa].

**Potential and realised resource value of African rhinos.** [Dr Tom Milliken, TRAFFIC East/Southern Africa].

**Contingency fund for dehorning expertise.** [Dr M. Kock, Dept of National Parks and Wildlife Management, Zimbabwe].

**Biochemical studies for black rhino management.** [R. du Toit, WWF/Dept of National Parks and Wildlife Management, Zimbabwe].

**Operating budget for African Rhino Specialist group.** [Dr P. M. Brooks, ARSG].

**Workshop and handbook on African rhino survey techniques.** [Dr R. Brett, Hon. Richard Emslie - coordinators].

To be eligible, a project had to be linked to a "Key" population, unless dealing with trade or a

regional/continental concern. This linking of quality with the most valuable and protectable populations was designed to ensure the most effective use of international funds. "Important" projects, of which 16 were identified, were those considered to be of significant value to rhino conservation, but which should not be supported by the international community in preference to those rated as priorities; while those projects rated in the "Other" category were considered to be of only limited value. Further details on all these projects may be obtained from the ARSG Chairman.

The following projects were earmarked for special ARSG attention during 1993:

The conservation of the western black rhinoceros *Diceros bicornis longipes* in Cameroon.

Development of an Action Plan for the black rhinoceros in Tanzania, and its implementation.

Employment of a Scientific Officer for African Rhino Specialist Group.

Workshop and handbook on African rhino survey techniques.

**Analysis of supply/demand/speculation! black market trading factors under different trading regimes.**

# Rapport du Président du GSRA

Martin Brooks

La première réunion du Groupe des Spécialistes des Rhinocéros Africains récemment reconstitué s'est tenue aux Chutes Victoria, au Zimbabwe, du 17 au 22 novembre 1992. Elle a rassemblé 33 membres et observateurs. Elle fut l'occasion de francs échanges d'informations et d'idées sur un large éventail de problèmes allant de la reproduction en captivité et de la génétique à toute une variété d'alternatives de conservation ouvertement discutées, telles que les safaris de décornage, la chasse aux trophées et les options possibles pour légaliser le commerce. Les buts principaux de la réunion étaient cependant de revoir les statuts et l'évolution des populations de rhinos en Afrique, de déterminer les populations les plus importantes et d'identifier les projets de conservation prioritaires, nécessitant des subsides avant les réunions des Etats de distribution du rhino et des donateurs, à l'UNEP.

Le braconnage continue à menacer les populations de rhinos sur toute l'étendue de leurs habitats, et ce n'est qu'au Kenya, en Namibie, en Afrique du Sud et au Zaïre que le contrôle se révèle efficace. Il en résulte que le nombre de rhinos noirs a continué à baisser, de 3450 à 2475 entre 1991 et 1992, en grande partie à cause du Zimbabwe qui en a perdu près de 1000. Les plus nombreuses populations vivent en Afrique du Sud (819), en Namibie (489) et au Kenya (414). Il n'y en a que cinq autres, discrètes, qui comptent plus de 100 animaux. La population de rhinos blancs du Nord est passée de 30 à 31 entre 1991 et 1992, et celles des rhinos blancs du Sud de 5590 à 5780, dont 5300 vivent en Afrique du Sud. Les populations ont baissé dans trois des sept pays, le Botswana, le Swaziland et le Zimbabwe, partout à cause du braconnage.

## Importance des populations de rhinos et evolution

Les estimations des populations de rhinos noirs et de rhinos blancs et de leur évolution sont présentées au Tableau 1.

## Les populations-clefs de rhinos

Pour attirer l'attention internationale sur les populations qui sont considérées comme les plus importantes pour la survie des six sous-espèces reconnues de rhinocéros noirs et blancs, en Afrique, on a entrepris un exercice d'évaluation.

Tableau 1

PAYS	RHINO BLANC		TOTAL	EVOLUTION							
					<i>D.b. bicornis</i>	<i>D.b. kongipes</i>	<i>D.b. michaeli</i>	<i>D.b. minor</i>			
ANGOLA	Eteint?		Eteint?		10				40	50	En baisse
BOTSWANA	27		27	En baisse					5	5	En baisse
CAMEROON						35				35	En baisse
C.A.R.		Eteint?	Eteint?			Eteint?				Eteint?	En baisse
ETHIOPIA							Eteint?			Eteint?	
KENYA	74	Eteint?	74	En hausse			414		414	414	Stable
MALAWI									Eteint?	Eteint?	En baisse
MOZAMBIQUE	Eteint?		Eteint?						50	50	En baisse
NAMIBIA	91		91	En hausse	489					489	En hausse
RWANDA							15			15	En baisse
SOMALIA							Eteint?			Eteint?	
SOUTH AFRICA	5297		5297	En hausse	20		28		771	819	En hausse
SUDAN		5	5	En baisse			Eteint?			Eteint?	
SWAZILAND	46		48	En baisse			6		6	6	Stable
TANZANIA							32		95	127	En baisse
UGANDA		Eteint?	Eteint?				Eteint?			Eteint?	
ZAIRE		31	31	En hausse							
ZAMBIA	Eteint?		Eteint?								En baisse
ZIMBABWE	249		249	En baisse					425	2475	En baisse
TOTALS	5784	36	5820		519	35	489		1432	2475	

On a accepté le fait que les paramètres les plus appropriés pour juger de la valeur de la conservation d'une population sont sa taille, l'importance de la population en conservant la sous-espèce appropriée et la probabilité que les mesures de protection soient efficaces (d'après l'évolution récente de la population). On a établi deux catégories: "importance-

clef" (importance critique) et "important" (de très grande valeur), et on y a classé les réserves comme le montre le Tableau 2.

## Projets de conservation prioritaires

La situation critique des rhinos africains et la limite

Tableau 2

CLASSEMENT DES POPULATIONS-CLEFS DE RHINOS:1992			
CATEGORIE	CRITERE	RHINO NOIR	RHINO BLANC
A1	Population croissante ou stable & N > 100 Du N > 50% de sous-cspèces	Cameroun Damaraland Etosba Hluhluwe-Umfolozi Kruger	Garamba Hluhluwe-Umfolozi Itala Kruger Mkuzi Pilanesburg Sabi Sand (P)
A2	Population croissante ou stable & N=51-100 ou N = 26-50% de sous-espèces	Itala Midlands (P) Mkuzi Nairobi Selous Solio (P)	Loskop Manyaleti Ndumo Solio (P) Timbavati (P)
A3	Population décroissante (<25%) & N>50 ou N>25% des sous-espèces OU N>1 00 même si la population en baisse >25%	Hwange	Hwange
CLASSEMENT DES POPULATIONS DE RHINOS IMPORTANTES: 1992			
CATEGORIE	CRITERES	RHINO NOIR	RHINO BLANC
B1	Population croissante ou stable & N = 20-50	Aberdares Addo Bubian (P) Lac Nakuru Lonely Mine (P) Luangwa Sud Masai Mara Ndumo Pilanesberg Save valley (P) Waterberg Plateau	Borakalalo Botsalano Klaserie (P) Madikiwe Manyaleti Matobo Midlands (P) Mkhaya (P) Tembe Tsolwane Waterberg Plateau Weenen
B2	Population décroissante mais N = 20-50 rencontres et reproduction possibles en zones protégées	Chizari Laikipia (P) Matusadona Ngorongoro	
B3	Population = 20+ dispersée en dehors des zones protégées avec de bonnes possibilités de créer on sanctuaire	Zones foressières Kenya Zimbabwe	

(P) Domaine Privé

L'évolution des populations (croissance, baisse ou stabilité) est basée sur une période de 5 ans (1987 - 1992 à moins que de informations plus récentes ne soient disponibles pour évaluer l'évolution sur 3 ans (1989 - 1992) et qu'elle soit différente de celle sur 5 ans. Cette évaluation est faite sans tenir compte de ont changement de population des translocations.

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imposée à l'augmentation des fonds qui peuvent être accordés par la communauté internationale ont obligé le groupe à se montrer très sélectif dans l'identification des priorités. Les projets proposés ont été classés soit "prioritaires", soit "importants" ou "autres", et, lorsque c'était possible, on a complété des "Descriptions de projets et des demandes de fonds détaillées".

Les projets ou les programmes "prioritaires" furent ceux que l'on a considérés comme essentiels pour garantir la survie des différentes sous-espèces de rhinos en Afrique et qui nécessitaient un financement international. Ce sont les suivants:

**La conservation du rhinocéros noir de l'Ouest *Diceros bicornis longipes*, au Cameroun** [Dr.S.Gartlan, WWF].

**Surveillance continue et protection de *Diceros bicornis* au Damaraland/ Kaokoland, en Namibie.** [B.Loutit, Save the Rhino Trust].

**Elaboration d'une stratégie pour développer un sanctuaire au Damaraland, en Namibie.** [B.Loutit, Save the Rhino Trust].

**Revalorisation de l'unité antibraconnage.** [Dr.E.Joubert, Dept of Wildlife, Conservation and Tourism].

**Projet pilote pour évaluer toute une variété de clôtures hautement sophistiquées, de systèmes de sécurité sensibles à distance dans le HluhluweUmfolozzi Park, au Natal.** [A.Conway, Natal Parks Board].

**Coopération avec les riverains et projet de clôture, Mkuzi Game Reserve, au Natal.** [T.M.Scheepers, Natal Parks Board].

**Equipement nécessaire aux unités antibraconnage dans les Réserves-clefs de rhinos au Zululand, au Natal** [A Conway, Natal Parks Board].

**Surveillance aérienne mensuelle dans les zones spécifiques du Parc National Kruger où domine le braconnage des rhinos.** [D.J.Pienaar, National Parks Board].

**Développement d'une méthode de décodage de l'ADN pour établir une empreinte génétique individuelle de l'AND et une possibilité d'identification à partir de tissu de rhino mort et de corne de rhino.** [Prof.A.S.Greef, Dept of Microbiological Pathology, Medunsa].

**Développement d'un test fiable et répétable permettant d'établir *ante mortem* un diagnostic d'infections tuberculeuses chez les rhinos noirs et les blancs.** [Dr.J.P.Raath, National Parks Board].

**Révision du "Plan de Conservation du rhinocéros noir *Diceros bicornis* en Afrique du Sud et en Namibie".** [Dr.P.M.Brooks, Rhino Management Group].

**Développement et mise en application d'un Plan d'Action pour le rhinocéros noir en Tanzanie.** [E.Severre, Wildlife Division, Tanzania].

**Soutien supplémentaire pour le développement des effectifs antibraconnage, Parc National de la Garamba, Zaïre.** [F.Smith (WWF), M.Mesi (IZCN), Dr.K.Hillman-Smith (WWF), Dr.M.Atalía (IZCN)].

**Soutien supplémentaire pour la surveillance continue des rhinos et pour les développements de la recherche au Parc National de la Garamba, Zaïre.** [Dr.K.Hillman-Smith (WWF), Dr.M.Atalía (IZCN), F.Smith (WWF), M.Mesi (IZCN)].

**Surveillance continue et recherches sur le rhino noir dans les Zones de Protection Intensive, au Zimbabwe.** [R.B.Martin, Dept of National Parks and Wildlife Management].

**Analyse des facteurs d'offre/demande/spéculation/marché noir sous différents régimes de commerce.** [Dr.Tom Milliken, TRAFFIC East/Southern Africa].

**Recherches sur le commerce au Moyen Orient et en Extrême Orient.** [Dr.Tom Milliken, TRAFFIC East/Southern Africa].

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**Recherches sur le commerce en Afrique.** [Dr. Tom Milliken, TRAFFIC East/Southern Africa].

**Valeur marchande potentielle et réelle des rhinos africains.** [Dr. Tom Milliken, TRAFFIC East/Southern Africa].

**Fonds de réserve pour financer une équipe d'experts en décernage.** [Dr. M. Kock, Dept of National Parks and Wildlife Management, Zimbabwe].

**Etudes biochimiques pour la gestion des populations de rhinos noirs.** [R. du Toit, WWF/ Dept of National Parks and Wildlife Management, Zimbabwe].

**Budget de fonctionnement du Groupe des Spécialistes des Rhinocéros Africains.** [Dr. P. M. Brooks, GSRA].

**Engagement d'un responsable scientifique pour le Groupe des Spécialistes des Rhinocéros Africains.** [Dr. P. M. Brooks, GSRA].

**Atelier et manuel sur les techniques de recherche sur les rhinos africains.** [Dr. R. Brett, Hon. Richard Emslie - coordinators].

Pour pouvoir être choisi, un projet devait être lié à une population-clef, ou traiter du commerce ou d'un

problème régional ou continental. Ce lien des projets de qualité avec les populations les plus intéressantes et les plus à protéger a été exigé pour garantir une utilisation optimale des fonds internationaux. Les projets "**importants**" - on en a identifié 16 - sont ceux qui semblent avoir une valeur incontestable pour la conservation des rhinos, mais qui ne devraient pas être soutenus par la communauté internationale, contrairement à ceux qui sont classés "**prioritaires**". On estime que les projets classés "**autres**" n'ont qu'une importance limitée. Il est possible d'obtenir plus de détails sur tous ces projets auprès du président du GSRA.

Les projets suivants ont été retenus pour une attention spéciale du GSRA pour 1993:

La conservation du rhinocéros noir de l'Ouest, *Diceros bicornis longipes*, au Cameroun.

Développement et mise en application d'un Plan d'Action pour le rhinocéros noir en Tanzanie.

Engagement d'un responsable scientifique pour le Groupe des Spécialistes des Rhinos Africains.

Atelier et manuel sur les techniques de recherches sur le rhino africain.

**Analyse des facteurs d'offre/demande/spéculation/marché noir sous différents régimes de commerce.**

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# Chairman 's Report

## African Elephant Specialist Group

Holly T. Dublin

On behalf of the AESG Co-Chairs

Our November 1992 meeting in Victoria Falls, Zimbabwe, marked an important cornerstone in the history of the African Elephant Specialist Group (AESG). This was our first meeting since separating from our sister group, the African Rhino Specialist Group (ARSG), in July of 1992. About 35 (approximately half) of our members were in attendance at a very lively gathering which included many new faces. In addition to members, we had the benefit of expertise from several invited participants including Dr. R. Sukumar, our able colleague from the Asian Elephant Specialist Group, who was rapidly assimilated into the African elephant clique by very competently chairing one of our topical working groups.

In rebuilding the AESG, we have made a concerted effort to bring both the membership and the meetings onto a more technical level. Our success in this endeavor is exemplified by the hard work and individual efforts portrayed in the papers, working group summaries and abstracts comprising this issue of *Pachyderm*.

It was an AESG decision that this issue be dedicated to the proceedings of the Victoria Falls meeting. We hope that the text gives those of you who were unable to attend a general sense of our progress and those of you who were present good memories. The fact that African elephants continue to provide a unique and dynamic conservation challenge was underscored by the definite change since the last meeting in the focus of our deliberations.

The first day of the meeting was devoted to general presentations on new initiatives in the conservation and management of the African elephant. On the second day we heard country reports from all those range states represented. While day three was spent in regional working groups, our fourth and fifth days were distinctive in that members broke up into working groups on three special topics - aerial surveys, ground surveys and elephant-habitat interactions (the latter to be overviewed in the next

issue of *Pachyderm*). The mixing and blending of personalities, skills and experience made for lively and productive sessions throughout the meeting.

While many important points emerged during the week, a few deserve special note. Unlike the focus of many previous meetings regarding the African elephant over the past decade, the impact of poaching pressure on elephant survival did not feature significantly in this gathering. This year, more than ever before, country after country reported an increase in the incidence of human/elephant conflict outside protected areas. Although few scientific studies have been undertaken, the general consensus was that the increase in conflict has been commensurate with a decrease in poaching activity. While elephant lives are clearly being saved, we are now faced with increasing loss of both human lives and property. The irony of the situation is inescapable but the problem is no less serious because of it. The need for dedication towards developing management strategies for elephants outside parks and reserves is taking on a definite sense of urgency.

All the regional working groups expressed strong interest in the monitoring and trafficking of the ivory trade, both within Africa and between Africa and the end-user markets in Asia. While members from central, west and eastern Africa expressed their belief that the trade was much diminished in their regions, a general concern was voiced that ivory trafficking in portions of the southern African region continues to be a problem. The AESG hopes to work closely with TRAFFIC to move forward on this initiative in the coming year.

In addition to the practical issues of conservation, the AESG membership voiced their strong support for the continuation of a continental database on elephant numbers and distribution. While formulating the necessary actions to achieve this goal was not possible in an abroad forum, such as an annual

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meeting; I felt that there was an urgent need for an overall review of all the data needs of the AESG with regard to its terms-of-reference. To this end, I appointed a task force to assist the AESG in defining and detailing the technical data needs of the Group. Among other issues, the task force is mandated to establish more quantitative guidelines for the assessment of data quality across populations, to develop more distinct definitions of elephant range, to set criteria for the “usable” life of population estimates and to more closely define the future role and character of the African Elephant Database. It is also our hope that this task force will provide general guidance on priority data needs in other topical areas of concern to the AESG.

And last, but by no means least, the AESG again strongly endorsed and emphasised the continued need to obtain realistic estimates of elephant numbers and

distribution in the largely unexplored Central African region. This daunting task is made ever more difficult by the gruelling field conditions and the constant struggle to secure sufficient funds.

To our traditional concerns for the African elephant are added new and more challenging dilemmas all the time. It is gratifying to know that so many of you are committed to working together to gain new insights to old problems and to formulate innovative approaches to new problems. There can be no doubt that our challenges are cut out for us! I believe the meeting in Victoria Falls clearly demonstrated to those of us present that the AESG has embarked on a period of reconciliation and technical growth. I hope you share my optimism and will each continue to contribute constructively, through your individual strengths and expertise, to the conservation and management of the African elephant.

## Rapport des Présidents du GSEA

Holly T. Dublin

Au nom des Co-Présidents du GSEA

Notre réunion de novembre 1992 qui s’est tenue aux Chutes Victoria, au Zimbabwe, a marqué un tournant important dans l’histoire du Groupe des Spécialistes de l’Eléphant Africain (GSEA). C’était notre première réunion depuis notre séparation d’avec le groupe frère, le Groupe des Spécialistes des Rhinocéros Africains (GSRA), en juillet 1992. Près de 35 (à peu près la moitié) de nos membres ont participé à une réunion très vivante, qui a présenté de nombreux nouveaux visages. En plus des membres, nous avons eu la chance de profiter de l’expérience de plusieurs invités, comme le Dr.R.Sukumar, notre compétent collègue du Groupe de Spécialistes de l’Eléphant d’Asie, qui fut rapidement intégré dans la coterie de l’Eléphant africain en dirigeant de façon très efficace un de nos groupes de travail.

En reconstruisant le GSEA, nous avons voulu solliciter de ses membres comme de ses réunions, un niveau plus technique. Nous voulons pour preuve de notre réussite en ce sens le travail intense et les efforts

individuels rapportés dans les articles, les résumés des groupes de travail et les extraits repris dans ce numéro de *Pachyderm*. C’est le GSEA qui a décidé que ce numéro serait consacré aux débats de la réunion des Chutes Victoria. Nous espérons que le texte donnera à ceux d’entre vous qui n’ont pas pu y assister une bonne idée de nos progrès et rappellera de bons souvenirs à ceux qui étaient présents. Le fait que les éléphants africains continuent à être un défi unique et dynamique pour la conservation fut souligné par le changement manifeste survenu depuis la dernière réunion quant au centre de nos discussions.

Le premier jour de la réunion fut consacré à la présentation générale de nouvelles initiatives touchant la conservation et la gestion de l’éléphant africain. Le deuxième jour, nous avons entendu les rapports de tous les pays abritant des éléphants qui étaient représentés. On a passé le troisième jour, répartis en groupes de travail régionaux, mais le quatrième et le cinquième furent différents en ceci que les membres

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se sont divisés en groupes de travail traitant de trois sujets spéciaux: les études aériennes, les études au sol et l'interaction entre les éléphants et leurs habitats (ce dernier sujet sera repris dans le prochain numéro de *Pachyderm*). Le mélange et les échanges des personnalités, de leurs compétences et de leur expérience ont rendu les sessions vivantes et productives tout au long de la réunion.

Bien des aspects différents ont été abordés pendant cette semaine, certains méritent une attention particulière ici. Alors qu'il était le centre de nombreuses réunions sur l'éléphant africain au cours de la dernière décennie, l'impact du braconnage sur la survie de l'espèce n'apas tenu une grande place lors de cette réunion. Cette année, plus que jamais auparavant, chaque pays, l'un après l'autre, a relevé l'aggravation du conflit entre les hommes et les éléphants en dehors des zones protégées. Bien que l'on ait entrepris peu de recherches scientifiques, l'avis général était que l'intensification de ce conflit était proportionnelle à une diminution du braconnage. Si l'on sauve effectivement la vie d'éléphants, nous assistons actuellement à des pertes croissantes en vies humaines et en propriétés. L'ironie de la situation ne rend pas le problème moins sérieux pour autant. Il devient tout à fait urgent de s'atteler à l'élaboration de stratégies de gestion des éléphants en dehors des parcs et des réserves.

Tous les groupes de travail régionaux ont manifesté un grand intérêt pour la surveillance continue et la traque du commerce de l'ivoire tant à l'intérieur de l'Afrique qu'entre l'Afrique et les marchés des consommateurs en Asie. Les membres venant d'Afrique Centrale, de l'Ouest et de l'Est ont donné leur assurance que le commerce avait fort diminué dans leurs régions, mais la préoccupation générale concernait certaines parties du sud de l'Afrique où le trafic illégal de l'ivoire reste un problème. Le GSEA espère travailler pendant l'année qui vient, en étroite collaboration avec TRAFFIC pour faire progresser cette initiative.

En plus des sujets pratiques de conservation, le GSEA a manifesté son ferme soutien à la continuation d'une banque de données à l'Échelle du continent sur le

nombre et la distribution des'éléphants. Pourtant, il n'était pas possible de formuler les démarches nécessaires pour ce faire devant une vaste audience comme cette réunion annuelle. Il m'a semblé qu'il fallait d'urgence une révision globale de toutes les données nécessaires au GSEA au vu de ses termes de référence. A cette fin, j'ai nommé une équipe pour aider le GSEA à définir et à détailler les données techniques nécessaires au Groupe. Entre autres sujets, cette équipe doit établir des directives plus quantitatives pour évaluer la qualité des données parmi les populations pour donner des définitions plus précises de la distribution de l'éléphant, pour établir des critères au sujet de la "durée de vie" des estimations de populations et pour définir plus précisément le rôle futur et le caractère de la Banque de données sur l'éléphant Africain. Nous espérons que cette équipe pourra orienter les besoins prioritaires de données concernant d'autres problèmes qui inquiètent le GSEA.

Enfin, le GSEA a réitéré et insisté sur le besoin permanent d'obtenir des estimations réalistes du nombre et de la distribution de l'éléphant dans la partie centrale de l'Afrique, largement inexplorée. Cette t,che énorme est rendue encore plus difficile par les conditions très dures qui règnent sur le terrain et la lutte incessante que nécessite la récolte de fonds suffisants.

A nos inquiétudes traditionnelles touchant l'éléphant africain s'ajoutent sans cesse de nouveaux dilemmes' à résoudre. Il est réconfortant de savoir que vous êtes si nombreux à vous impliquer dans ce travail en commun, pour trouver de nouvelles façons d'aborder d'anciens problèmes et pour exprimer de nouvelles approches aux nouveaux problèmes. Il n'y a aucun doute, ces défis sont taillés à notre mesure! Je crois que la réunion des Chutes Victoria a montré clairement à ceux qui y assistaient que le GSEA est entré dans une période de réconciliation et de croissance technique. J'espère que vous partagez mon optimisme et que chacun voudra continuer à contribuer de façon constructive, par ses qualités et ses compétences personnelles, à la conservation et à la gestion de l'éléphant africain.

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**PROCEEDINGS OF THE  
AFRICAN ELEPHANT SPECIALIST GROUP  
MEETING, VICTORIA FALLS, ZIMBABWE,  
NOVEMBER 17<sup>th</sup> TO 22<sup>nd</sup>, 1993 .**



Photo by: Ralph Klumpp

# Plenary Paper One

## Options for Aerial Surveys of Elephants

G. Colin Craig

In most areas where elephants occur, aerial surveys are the only means used to establish their numbers. The most common methodology is that of the systematic reconnaissance flight, sometimes called the transect sample-count (Norton Griffiths (1978), Jolly (1969)).

Sample-counts estimate the total number of animals in an area by counting the actual number in a small sub-area, and extrapolating the density found to the whole area. The sub-area, or sample, is divided into unbiased sampling units, so that the overall estimate will be, on average, a fair reflection of the true number. Though there is obviously error inherent in this approach, its magnitude can be estimated using appropriate statistics.

Despite the usefulness of the transect sample count, it is commonly criticised as being inadequate. There are other methods, which are appropriate under some circumstances. The purpose of this paper is to examine some of the alternatives to all or part of the standard methodology. Admittedly this is done from the standpoint of some commitment to sample counts but it is hoped nevertheless to stimulate further discussion of the most contentious points.

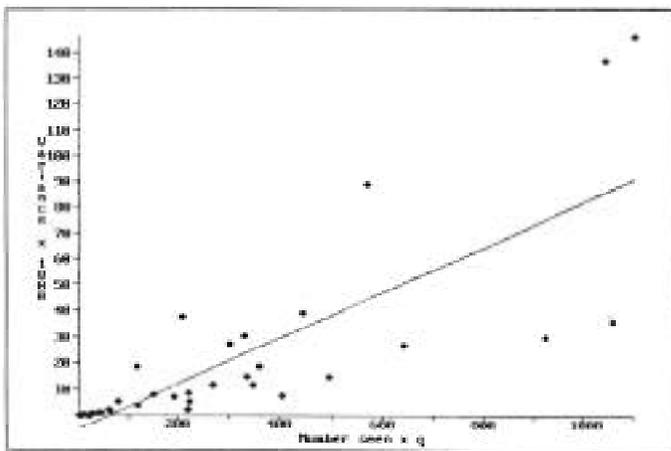


Figure 1 : Relationship between sampling variance of number seen on a survey and the number seen. Data from a 4% sample of an elephant population. Line is  $y = 87.4x - 5423$

Since many of the arguments revolve around the efficiency or uncertainty of surveys, it is important to start out with some appreciation of the pattern and causes of variation in elephant surveys. A model, based as closely as possible on actual population properties, is needed to serve as a basis for evaluation of the effects of different counting strategies. The following is proposed as such a model.

### Sample/Number/Variance Relations in Elephant Surveys

The precision of a survey result predicts the likely spread of results if the survey were repeated many times, i.e. is a measure of confidence in the result. The confidence limits themselves derive from the standard error which is, in turn, the square root of the variance of the estimate. Jolly's (1969) formula for calculating the variance of the estimate for unequal sized sampling units (EQUATION 1) is normally used for sample surveys.

$$s^2_{EST} = \frac{N(N-n)}{n} (s^2_y + 2R.COV_{zy} + R^2 \cdot s^2_z) \cdot 1$$

The right hand bracket contains the sampling variance, which is the variance among sample units (transects or blocks). This is converted to the variance of the number seen by dividing by  $n$ , the number of its units sampled. This in turn gives

the variance of the estimate when multiplied by:  $N(N-n)$ , where  $N$  is the total possible number of units, if all the ground were searched.

For actual elephant surveys, done at a particular sampling intensity, the variance of the number seen is related to the number seen. Figure 1 shows this for a number of results for blocks in northern Botswana all sampled at about 4%. This gives us two useful pieces of information.

Table 1. Composition of census alternatives

Option	Advantage	Disadvantage
Total count	Results believed by laymen.	Costly, less precise than believed. Encourages low search intensity leading to low accuracy.
Sample count	Cost efficient. Permits highest accuracy. Permits fulfillment of simple assumptions.	Low precision for low sampling intensity
Block sample count	Cost efficient for simple aircraft. Calibration unnecessary. Possible in most places.	High requirement for commuting between blocks. High preparatory work load. Difficult navigation. Returns poor information on distribution and exacerbates the problem of non random distribution.
Transect sample count	Cost efficient in searching vs commuting time. Returns good information on estimates and distribution. Simple navigation and preparation.	Requires high capital and running cost: aircraft and equipment and large crew. Subject to transect width calibration error. Physically impossible in places.
Stratified count	Enhanced precision and cost effectiveness,	Loss of distribution information towards edge of range.
Unstratified count	Not as above	Not as above.
Corrected estimate	Enhanced accuracy.	Correction factors very imprecise. High probability of overestimate.
Uncorrected estimate	Results tend to be conservative,	Always biased, usually toward underestimate.

The first of these is a prediction of how the number of animals in a population will affect the precision of any estimate from a 4% sample. The equation which results from Figure 1 is  $y = 87x - 54000$ . This predicts that an estimate of 60000 elephants will have a 95% confidence interval of  $\pm 35\%$ .

The second is the insight that variance, being proportional to number, is analogous to the situation with a binomial distribution, where the variance of the number in a sample is related to the total number and the sample size. i.e. the variance is  $Np(1 - p)$  where  $N$  is the number in the population and  $p$  is the proportion sampled. If individual elephants were randomly distributed the variance of a 4% sample of 60000 elephants would be  $60000 \times .04 \times .96 = 2304$ . This means that the confidence interval on the 60000 would be  $\pm 4\%$ . The reason that it is larger in reality is because elephants are not randomly distributed but clumped into herds and larger concentrations.

The above suggest that a model assuming a binomial relationship of variance with sample size, corrected to give the expected amount of variance from an actual population, might be a model that would adequately represent precision of an elephant survey in relation to size of the population being surveyed and to the proportion sampled.

It is hoped that this is true at least as far as is necessary to draw conclusions about different sampling strategies and this model is used here for that purpose.

## Evaluation of Alternatives

The cases for various alternatives, discussed under separate headings below, are summarised in Table 1.

### Total Counts

Many people, even professional wildlife managers, have a difficulty with sample counts, and ask the obvious question: why not count all the animals so



Figure 2. Proposed relationship between precision and sampling intensity

that we can be certain of the number?

At one time, of course, all counts were total counts, or attempts, statistics and uncertainty being an even more general anathema then. Total counts were rejected in Zimbabwe when the first attempts at sample-counting elephants yielded results which consistently suggested that populations had previously been greatly underestimated. This was seen to be due to the fact that the smaller areas being searched on a sample-count were able to be searched more intensively than had previously been thought necessary.

This alone does not rule out a total count, provided searching intensity is raised to the level prevailing on sample counts. It is clear from Equation 1 that when  $n$  (the number of units sampled) =  $N$  (the total number of sampling units in the area), as would be the case for a total count, that the variance of the estimate becomes zero. Although a total count appears there fore, to be the extreme case of a sample count, there are other reasons for rejecting it on most occasions.

As sample size increases, there is a diminishing return in terms of an increase in precision of the result. This is illustrated by Figure 2 which models decrease in the confidence interval as sample size increases. It can be seen that with over 20% sampling there is very little improvement in precision for a very large increase in effort.

The assumption that variance becomes zero for a total count is actually unjustified except where very small areas are concerned. Equation 1 assumes that all animals within a sample area are seen and that none are seen more than once. In practice this assumption cannot be fulfilled except for small samples. With large samples of large areas it might be better to assume more independence of individual sampling units which would imply replacing  $N(N - n)$  with  $N^2$ . This would mean that total counts do not give absolute certainty of numbers. This aspect has been incorporated into Figure 2 by assuming some independence of sampling units for samples over 20%.

Large sample counts may be useful in areas that are small enough that time and cost are not problems. Total counts could be considered reasonable in situations where the conditions are such that the above assumptions are fulfilled.

### Block or Transect Sample Counts

Block sample counts differ from transect counts basically in the shape of the sampling unit. Transects are delimited by markers on the aircraft and boundary decisions are made in relation to those markers. Blocks are delimited on maps in advance of the survey, and boundary decisions are made by navigation. There is little to choose between the methods statistically.

There are advantages to both methods (see Table 1). The main disadvantages of block counts are that they are inefficient in terms of ground covered per unit effort (see Figure 3) and that they give poor information on animal distribution. They are useful where transect counts are not feasible, as in mountainous country.

### Stratified or Non-Stratified Sampling

Stratification involves breaking up the area to be surveyed into separate areas (strata) which may be sampled at different intensities, hopefully in such a way as to improve the precision without expending greater effort. The common criticism that when a stratum which contains more elephants is surveyed more intensively, the overall result must therefore be biased towards obtaining an overall higher result, is of course wrong. A stratum containing 1 000 elephants will, on average, be estimated to contain 1000 elephants regardless of how intensively it is sampled. There is some question

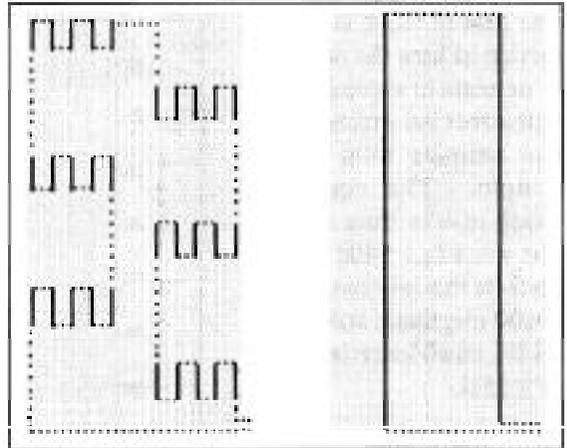


Figure 3. Comparison of block count (left area) with strip count at same overall sampling intensity (right area). Dotted lines represent commuting flights

of how effort should be allocated to obtain optimal precision. Gasaway *et al* (1986) calculated the allocation of sampling effort using a quantity called the relative variation factor for each stratum. If the relative variation factor for stratum  $i$  is  $R$  and the total area to be sampled in all strata is  $A$ , then the area  $S_i$  to be sampled in stratum  $i$  is given by

$$S_i = \frac{AR_i}{R_j} \quad 2$$

There are alternatives for  $R$ , which give different results. Gasaway *et al.* (1986) use:

$$R_i = N s_i \quad 3$$

where  $N$  is the total number of possible sampling units in stratum  $i$ , and  $0$  is the square root of the sampling variance in that stratum. This is known as the Neyman allocation (Cochran, 1977).

Norton-Griffiths (1978) uses:

$$R_i = d_i \quad 4$$

where  $d_i$  is the density of animals in the  $i$ th stratum .

Zimbabwe Department of National Parks (eg. Gibson, 1989) use

$$R_i = a_i d_i \quad 5$$

where  $a$  is the area of the  $i$ th stratum. Note that only Norton-Griffiths method takes no account of the size of a stratum.

To model the effects of these stratification techniques on an elephant survey, some real data are required. Figure 4 shows the cumulative frequency distribution of elephant numbers by density for the 1989 dry season survey of Northern Botswana as mapped in Craig (1990). The available area has been divided into three strata according to the root cumulative frequency rule (Cochran, 1977). These strata are summarised in Table 2.

Table 2. Summary of high, and low density sampling strata proposed for the elephant population of Figure 4.

Stratum	Area (km <sup>2</sup> )	No.elephants	Density (km <sup>2</sup> )
High (H)	7073	34515	4.8800
Medium(M)	13437	19016	1.4150
Low (L)	63776	5469	0.0858

Table 3 shows the allocation of sampling effort to these three strata according to the three methods above i.e. Norton-Griffiths (N.G.), Gasaway (Gas.) and Zimbabwe (Zimb.). Allocation of the same sampling effort per unit area through all strata (null) is also simulated. Precision was calculated from the total predicted variance worked out on the above binomial model.

Table 3. Allocation of sampling effort to the three density strata of Table 2 by four different methods, and predicted precision of each method.

Method	% sampling allocation				predicted precision
	basis area	H	M	L	
Null	area	5	5	5	± 30%
N.G.	dens	45.6	6.95	0.089	± 72%
Gas.	No	18.5	9.97	2.460	± 21%
Zimb.	a dens	18.5	9.97	2.454	± 21%

The Zimbabwe and Gasaway type allocations give almost identical results although they are not precisely mathematically identical. They also result in some increase in precision, unlike the Norton-Griffiths method which results in a decrease in precision. The latter method is clearly wrong in its failure to allow for size of stratum as well as density in the allocation of sampling effort. It must be noted, however, that this does not mean that the estimates using that method would be wrong, just that the level of precision might be less than could otherwise be expected.

distribution information is required, an unstratified sampling might be a better approach because the latter would require less sampling effort in the peripheral low density areas, resulting in less information about the elephant range.

## Use of Correction Factors

The above discussion has dealt with the problems of precision, the potential variation of survey estimates

An even more important point demonstrated by Table 3 is that the gain in precision from the two acceptable methods over no stratification at all is not great, at least for these three strata. It should be noted that to obtain the improvement in precision predicted, there would have to be very precise *a priori* information on the distribution of elephants. A rough prior idea of their distribution would result in a lesser gain. This tends to call the value of stratified sampling effort into question. When good

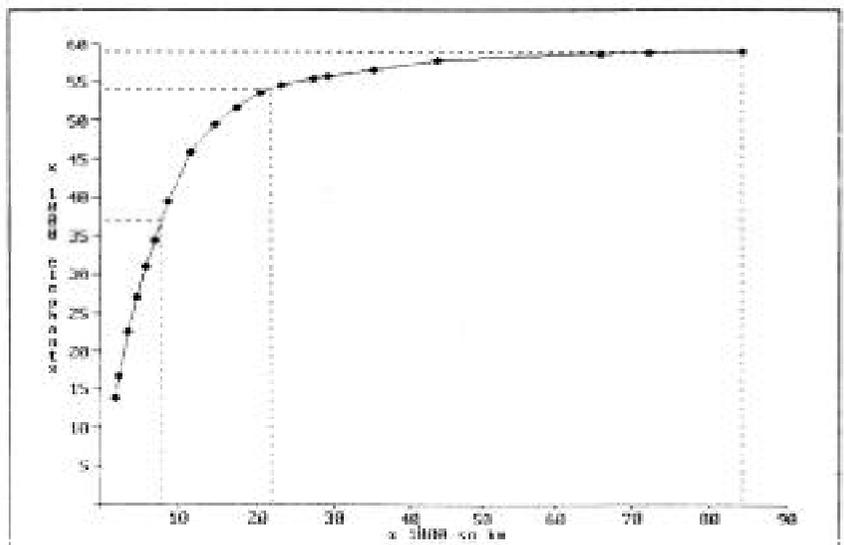


Figure 4. Cumulative number of elephants vs cumulative area of range, starting with high density part of range. packed lines delimit high, medium and low density strata.

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around a mean result. It has ignored the problem of accuracy which refers to the closeness of the mean result to the true number. It is usually assumed that the true numbers are underestimated by surveys due to animals within the sampling units not being seen. As stated above, one of the successes of sampling is in permitting much more intensive search effort within slumping units. Nevertheless undercounting probably still occurs and the question often arises whether an attempt should be made to apply correction for this. Methods exist (eg. Magnusson *et al* 1978) for calculating such correction factors.

Correction factors of course have their own errors of estimation so they may add some accuracy while decreasing precision considerably. This will tend to lead to a greater number of results being overestimates, bringing with it the danger that bad management decisions could become more likely.

## Conclusions

The above deals mostly with problems of maximising the information gain from a particular amount of effort. The question of how much effort has been left open. Although it has been shown that there is a diminishing return for greater levels of effort, high effort might be necessary for some applications.

Necessary effort depends on the requirements of the user of the information to be produced. Does he want to be able to estimate the rate of increase to  $\pm 1\%$  over a period of a year, or is he hoping to detect a large decline, should one occur, over a number of years? The former will require a much greater effort than the latter. The identity of the user and his information requirements will be paramount in this decision.

An effective census should be designed to make the best use of the available human, capital and financial resources. This implies making sufficient effort to obtain the answer to the question, and no more, because in conservation all resources should be used wisely.

## Acknowledgments

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# Working Group Discussion One

## Aerial Survey Working Group

Thirteen persons, under the chairmanship of Dr. Simon Stuart, spent most of the fourth and fifth meeting days deliberating in the aerial survey working group. It should be noted that the recommendations formulated during the discussions were preliminary. They are currently undergoing careful review by the data review taskforce which was appointed by Dr. Holly Dublin at the close of the AESG meeting.

### Terms of reference

#### Goals:

To critically assess the current aerial census techniques. Discuss the weaknesses and strengths of aerial census for estimating elephant numbers. Develop standard methodologies to enable comparisons between and within populations over time. Address the decline in data relevance/value through time (ageing). Suggest means to improve survey efficiency through the use of new technologies.

#### Focal Topics For Discussion:

- \* Review of all the current methods employed in aerial surveys. Discuss individual experiences with the strengths and weaknesses of aerial survey techniques.
- \* Cite the benefits and short falls of total counts and sample counts. The accuracy and precision of these two methods of data collection should be considered and the relevance of each method in different situations discussed.
- \* Categorise the quality of these data acquired from different surveys and sources for input to national, regional or continental databases.
- \* Clarify appropriate means of collecting these data to allow for proper statistical trend analysis.
- \* Find a working definition for the terms “RANGE” and “DISTRIBUTION”, and discuss how the African Elephant Database can distinguish between these two terms when inputting data.

- \* Discuss the use of new technologies (ie. GPS/ GIS links) to enhance the efficiency, accuracy and precision of aerial surveys and produce realistic recommendations.
- \* Determine when estimates should be considered “outdated” and no longer of use as relevant, quotable data.
- \* Clarify how adequate sampling intensity is determined (the problem of precision vs. cost).
- \* Discuss the role of the African Elephant Database. What can range states or individuals provide towards this facility, and what can they expect in return from this tool?

Other topics that are considered relevant to the discussion.

### Discussion Summary

The group reviewed current aerial survey methods, categorizing them as *total and sample* counts. Total counts can be classified further depending on their *searching rates* (high, medium or low), while sample counts divide into two: *block* and *transect* counts. The latter can also be classified according to their sampling intensity.

The group pointed out that the main advantage of an aerial survey is that large areas can be covered, permitting access to remote locations. However, limitations are brought about by variations in observer skill and experience, along with the obvious restrictions that thick vegetation imposes.

The group discussed in detail, with examples, the benefits and shortfalls of each of the two main methods (total and transect counts), and clarified the important distinction between *accuracy* (the closeness of the estimate to the number) and *precision* (the repeatability of the estimate).

It was agreed that while *total* counts can be precise, there is no way to assess their accuracy without independent information.

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Sample *transect* counts, with repeated surveys, are potentially the most accurate method but are less precise (unless the sampling intensity is high). **Block** counts are less precise than transects because of the non-random distribution of animals, but they are at least as accurate, if not more, per unit effort as transects.

The determination of adequate sampling intensity for sample transect counts should relate to the precision required by the client to answer management questions. In relation to this, the group thought that the model developed by C. Craig in his plenary presentation could be adapted for use in different areas.

The group had important preliminary discussions on the categorization, by quality, of data for input into the African Elephant Database (AED). At present, all aerial survey data are included in category 1 for quality. Members felt that this category should be subdivided further as follows:

### **Total Counts**

T1 = Searching rate <100 km<sup>2</sup>/hr

T2 = Searching rate 100-200<sup>2</sup>/hr

T3 = Searching rate >200 km<sup>2</sup>/hr

In the absence of searching rate data, the results of total counts should be included in T3.

### **Sample Transect Counts**

S1 = 95% confidence limits < ± 25%

S2 = 95% confidence limits ± 25 - ± 50%

S3 = 95% confidence limits > ± 50%

In the absence of confidence limits, the results of sample transect counts should be included in 53.

### **Block Counts**

B1 = 95% confidence limits < ± 25%

B2 = 95% confidence limits ± 25 - ± 50%

B3 = 95% confidence limits > ± 50%

In the absence of confidence limits, the results of block counts should be included in B3.

These suggested new categories must be reviewed more thoroughly for their ability to discriminate meaningfully between data of various quality and should, therefore, be considered preliminary recommendations.

On the subject of **statistical trend analysis of population data**, the group clarified that determination of trend depends on *standard errors* being recorded on population estimates. The ability to detect statistically significant trends depends on high precision of individual counts, or less precise but repeated counts over many years, as opposed to accuracy.

*Carcass ratios* are likely to be an important subjective indicator of trend when undertaking counts in areas unlikely to be censused again for many years. However, the use of this ratio needs to be assessed in different climatic situations. Although *age structure* can indicate population trend, this is difficult to assess from the air. However, it is a technique which deserves further consideration.

The group made precise definitions of *elephant range* as follows:

The African elephant range is the entire area in which the species occurs in the wild at any time. Vagrants should be excluded from the database, these being animals that are off course in areas where they are unlikely to recur.

The range is made up of the following four components:

*Core range* where elephants are present throughout the year.

*Seasonal range* where elephants are present seasonally.

*Erratic range* where elephants occur periodically, but not every year.

*Situation unknown* where elephants are known to occur, but there is insufficient information to state which of the three above categories applies.

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The use of outdated data was also discussed, with the recommendation that for data believed to be extremely outdated, upper and lower population levels should be given. The upper level should be the same as the last reliable estimate. The lower level should assume a very rapid decline due to poaching. For countries without any previous data-based estimate, it is best not to give an estimate at all- until an estimate can be made.

The group agreed that the AED is of fundamental importance to the work of the AESG, its role being to maintain the continental overview of the status of the African elephant. It was accepted that the database should not try to operate at a scale to answer national

management questions, or else it would become unmanageable. Certainly it can act as a useful starting point on which national databases can be built.

The group suggested **that training** in aerial survey techniques deserves high priority. Training needs were identified and countries with virtually no aerial survey capacity were listed. The group also discussed the potential use of several new technologies for improving aerial survey techniques. In its conclusions, the group recommended that the AESG should form a task force to look at aerial surveys and the AED with the objective of addressing both technical and management issues.

Photo by: Holly Dublin



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# Plenary Paper Two

## Indirect methods for counting elephants in forest

Richard F.W. Barnes

### Introduction

The techniques for counting elephants in open habitats have been intensively studied, but those for counting elephants in forest have received much less attention. This paper will discuss the two methods most frequently used for estimating forest elephant numbers: guesses and dung counts.

### Guesses

Many opinions about the abundance of forest elephants are subjective impressions based on brief perambulations in the forest. These are guesses, not estimates. Guesses for the number of elephants in the central African forests range from 106,000 (Pfeffer, 1990) to 500,000 or three million (Anon, 1982). Elephants are not unusual in being the subject of wildly varying guesses. For example, in 1924 very different guesses of both number and trend of the Kaibab deer (*Odocoileus hemionus*) population were made by people familiar with the area (Rasmussen, 1941; Caughley, 1970). Andersen (1953) described how forest rangers guessed the numbers of roe deer (*Capreolus capreolus*) in a Danish wood to be one third

of the number actually there. Similarly, 80 Asian elephants (*Elephas maximus*) were thought to live in a patch of forest in Sumatra Selatan, but 232 were flushed out (Santiapillai, 1991).

These examples show how people familiar with an area grossly under-guessed the numbers of animals or had completely different impressions of the population trend. Therefore people who have only a superficial knowledge of a forest are likely to make guesses which are even less reliable.

Another reason for mistrusting guesses is shown by Figure 1. Studies in Gabon, Congo, CAR, and eastern Zaire show that forest elephant densities increase with distance from roads or villages (Barnes *et al*, 1991; Fay, 1991; Fay & Agnagna, 1991; Alers *et al*, 1992). Most people who go into the forest leave from a road. Travel in the forest is slow and the paths meander. One can spend all day in the forest and return exhausted to the road without having traveled more than 10 km from the road as the crow flies. Most people who pontificate on forest elephant abundance have never been deep into the forest where the high elephant densities are found.

Photo by: Ralph Klumpp



## Indices of Abundance

Indirect counts are those where animal signs (e.g. burrows, tracks, calls, nests, or droppings) are counted to give an index of abundance. Such indices fall into two categories: non-convertible and convertible. Convertible indices can be transformed into an estimate of animal numbers, but only if estimates of other variables are available. The density of elephant dung-piles is a convertible index.

The earlier dung counts in forest were made on permanent transects or plots (Wing & Buss, 1970; Jachmann & Bell, 1979, 1984; Short, 1983; Merz, 1986). Barnes & Jensen (1987) worked in remote forests where revisits were impractical. They were also worried about elephants walking on permanent transects and leaving misleading quantities of dung to be recorded. They adopted the line-transect technique and assumed a steady state (McClanahan, 1986) which allowed them to pass only once down each transect. The method described by Barnes & Jensen (1987) was then critically evaluated and then adopted by the Asian Elephant Specialist Group (Sale, Johnsingh, & Dawson, 1988; Dawson, 1990). During the last two years there have been further developments in both field and analysis methods (Dawson, 1990; Hiby & Lovell, 1991; Tchamba, 1992; Barnes & Barnes, 1992). A "how-to-do-it" manual has been produced by Dawson & Dekker (1992).

## Stratification and Sampling

The accuracy and precision of dung counts can be improved by better sample design: stratification and the arrangement of transects. The type of stratification will be determined by the scale on which one is working. Elephant densities on a small scale are often determined by vegetation type, especially secondary forest, which is the preferred habitat (Merz, 1986; Barnes *et al.*, 1991), and one should stratify accordingly. But on a large scale, e.g. a province or country, people are the prime determinant of elephant numbers and distribution, even in the remotest forests (Barnes *et al.*, 1991). Therefore stratification should account for: intensity of ivory poaching, human population density (a measure of general human disturbance), and distance to the nearest source of human disturbance (village, road, or major river).

For surveys in huge areas like a province of Congo or Cameroun, where the daily costs of employing

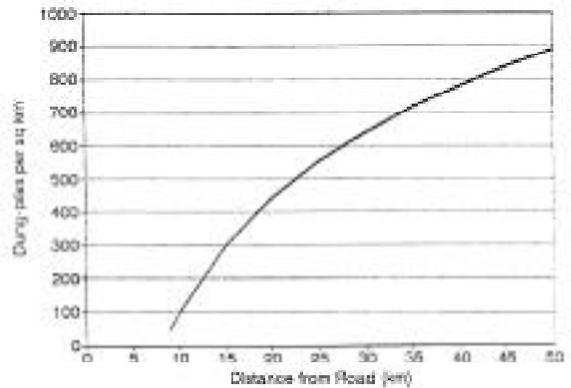


Figure 1: The distribution of dung-piles in relation to roads in Gabon. The curve is described by  $Y=491 \log_e X - 1031$  (unpublished data)

porters and labourers are high, one must minimise the dead time spent moving from the end of one transect to the beginning of the next. One solution is to cut a base-line perpendicular to the road (or river), and then cut transects randomly spaced along the base-line (Figure 2a). In each stratum there might be two or three sets of transects like this. The data would then be used to estimate the parameters describing the curve in Figure 1. Another solution is appropriate where there is no apparent relationship between elephant density and distance to road or village, e.g. where human disturbance is uniform over the census area. In this case, the transects are arranged in a zig-zag or sawtooth design (Figure 2b). This is used for marine mammal surveys which face the same problems of minimising logistical costs (e.g. Hiby & Hammond, 1989).

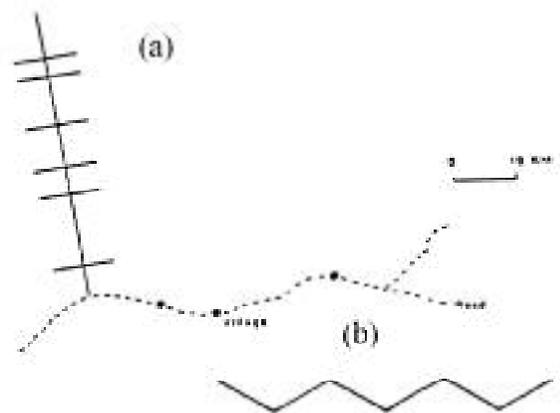


Figure 2: Two possible designs for forest elephant survey. (a) Transects randomly distributed along a 50 km baseline (b) Sawtooth pattern. Each element is treated as one transect

## Estimating Dung Density

Strip transects are not suitable for dung counts in forest because the visibility of dung-piles falls rapidly with distance from the centre line of the transect. Line transects give estimates that are less biased and have a lower standard error than strip transects (Burnham *et al*, 1985). A comprehensive description of the line transect method is provided by Burnham *et al* (1980), while a concise summary is given by Krebs (1989: pages 113-121). A new tome (Buckland *et al*, 1993) will soon become the standard reference work. Field methods are simple and are described by Buraham *etal* (1980), Barnes & Jensen (1987), and Dawson & Dekker (1992). Methods of analysis are more complicated. A user-friendly computer programme intended for field workers has been written by Dekker & Dawson (1992), while Laake (1991) has produced a more complex package offering a choice of models. Up to now the Fourier series model has been used for forest elephant dung counts because it is a robust all-purpose model. However, other models, such as those discussed by Buckland (1985) and Buckland *et al* (1993), need to be tested with dung data. For example, White (1992) used the hazard-rate model.

## Converting Dung-Piles to Elephants

If a steady-state is assumed, then one can estimate the numbers of elephants (E) using estimates of three variables; dung-pile density (Y), elephant defaecation rate (D), and dung decay rate (r) (McClanahan, 1986; Barnes & Jensen, 1987):

$$E = \frac{Y.r}{D} \quad (1)$$

However, the steady state assumption does not always hold. Hiby & Lovell (1991) have devised an alternative method which does not require a steady state. The practical drawback of their method is that dung-piles need to be located two months or more before the transects are cut.

Before starting the process of estimating defaecation and decay rates, one should pause to reflect upon the goals of the survey. Is an estimate of elephant numbers really necessary? For many purposes, e.g. estimating trends or distribution, an index of abundance will suffice. Converting dung-piles to elephants is fraught with so many complications and potential errors that

it should be avoided unless it is essential to know the number of elephants.

Defaecation rates can be estimated by observing elephants for long periods (e.g. Tchamba, 1992). Decay rates are estimated by monitoring dung-piles until they “disappear”, i.e. until they pass from morphological stage D to stage E (Barnes & Jensen, 1987). Some droppings will disappear quickly while others may last for months. At first dung decomposition was assumed to be a random process similar to radioactive decay and so it was logical to apply a negative exponential model (Short, 1983; Merz, 1986; McClanahan, 1986; Barnes & Jensen, 1987). However, observations on much larger samples (Grimshaw & Foley, 1990; Reuling, 1991; Dawson, 1990; and L.J.T. White, pers. comm.) showed that a period of slow decay precedes the exponential phase, resulting in a reverse sigmoid curve (Figure 3). Some methods for calculating decay rates are described by Barnes & Barnes (1992).

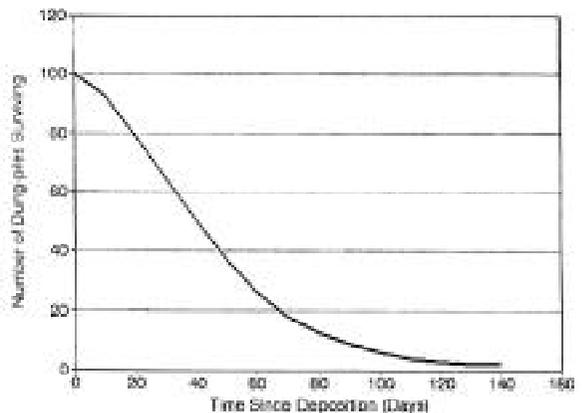


Figure 3 : An example of a survival curve for forest elephant droppings, adapted from Barnes & Barnes (1992)

It is useful to distinguish between the proximate and ultimate factors governing decay rates. The proximate factors are: (a) mammals which rummage through dung-piles in search of seeds (e.g. bushpigs, duikers, mandrills, apes); (b) invertebrates like termites and dung beetles; (c) the rest of the decomposer community, such as fungi and bacteria. Dung beetles probably play a minor role in the lowland equatorial forest compared with the savanna. The activity of these organisms (except perhaps the mammals) is

determined by rainfall, temperature, and relative humidity, which are therefore the ultimate factors. Microclimatic variations caused by soil, drainage, slope, aspect, and canopy cover are also important.

## Calculating Confidence Limits for E

Elephant estimates based on dung counts will always have wide confidence limits. This is because the estimates of Y, r, and D each have their own standard error (SE) which will contribute to the SE of elephant numbers. There are three methods for estimating the variance in the final estimate of E. The first requires calculating the variance of a product and a ratio. The variance of a product is (Goodman, 1960):

$$\text{var}(Y.r) = \text{var}(Y).\text{var}(r) + Y^2.\text{var}(r) \pm r^2.\text{var}(Y) \quad (2)$$

where  $\text{var}(Y)$  is the variance of Y, etc. The variance of the ratio  $(Y.r)/D$  is (Rice, 1988):

$$\text{var}(E) = \text{var}(D). \frac{(Y.r)^2}{D^4} + \frac{\text{var}(Y.r)}{D^2} \quad (3)$$

Second, an approximate value can be estimated using the expression:-

$$CV^2(E) = CV^2(Y) \pm CV^2(r) \pm CV^2(D) \quad (4)$$

where the CV is the coefficient of variation ( $CV = SE/\text{mean}$ ).

The third method is a Monte Carlo technique, combining replicate estimates of r and Y from bootstraps (e.g. Barnes & Barnes, 1992) with estimates of D. For example, one might have a series of estimates of Y, a series of estimates of r, and a series of estimates of D (such as those from Table 1 in Tchamba, 1992). A value of each variable is selected at random with replacement. The estimate of E is calculated  $E = Y.r/D$ . Then this repeated say 1000 times to give 1000 independent estimates of E. Because E is the result of a product it will be lognormally distributed and therefore the confidence limits will be asymmetrical.

## Sources of Error

The recent estimates of forest elephant numbers have been criticised, partly because the critics have not troubled to read the methods (e.g. Pfeffer, 1990), and

partly because people cannot accept dung counts as a valid census method. How much credence can we give to counts of excrement as a means of estimating animal numbers? Dung counts have the advantage that the distribution of dung at any one moment represents the accumulated distribution of elephants over the preceding one or two months. In contrast, a direct count of elephants records the instantaneous distribution and is more prone to sample error (Jachmann, 1991). Dung counts have long been used in the USA as a means of assessing deer abundance. In Australia they have been shown to be an accurate means of assessing wallaby densities (Johnson & Jarman, 1987). As for elephants, Jachmann & Bell (1984) established that dropping counts gave an estimate close to that from an aerial survey. Dawson (1990) used dung counts to estimate that there were 1.77 elephants per  $\text{km}^2$  in the Mudumalai Wildlife Sanctuary in India. Elephant sightings from a vehicle using the line transect method gave estimates of 1.75 and 1.56 per  $\text{km}^2$ , and total counts gave 1.39 and 1.25 per  $\text{km}^2$  (Sukumar et al, 1991). Finally, Jachmann (1991) tested different methods of counting elephants on the Nazinga Game Ranch, including direct sample counts from the air and from the ground. He found that a dropping count using the steady state assumption gave both the most accurate and most precise estimate. Thus dung counts are indeed a valid method for estimating animal numbers.

Nevertheless, there are several potential or perceived sources of error. The first five points below refer to deriving the index of abundance (i.e. dung-piles per  $\text{km}^2$ ) while the last two are concerned with turning the index into an estimate of elephant numbers.

**1. Dung-pile visibility** The visibility of a dung-pile depends upon its shape or stage of decomposition. However, Barnes *et al* (1988) found no difference in visibility between between two categories of dung-pile, those where all or some of the boli retained their shape (morphological stages A to C2), and those where all the boli had broken down to the cow-pat form (stage D).

**2. Observer efficiency** Barnes *et al* (1988) used a computer simulation to test estimates of dung-pile density from good and poor observers using the line transect method. They found that poor observers produced surprisingly good estimates. This is because the smaller number of dung-piles recorded by the poor

observers was counter-balanced by narrower effective strip width resulting from the steeper probability density curve. In other words, variations caused by differences in observer efficiency or the undergrowth may not have a marked effect on the dung-pile estimate.

**3. One dung or two?** Often an elephant defaecates when walking. Because dung-pile in the forest break down quickly into a cow-pat shape, it is difficult to tell whether two adjacent cow-pats represent two separate defaecations or one defaecation by a moving animal.

**4. Cut-off point** There is a stage beyond which dung-piles rapidly become invisible (stage E). The boundary between stage D (visible) and stage E has to be clearly defined at the beginning of a census. It is sometimes difficult to decide whether a border-line dung-pile is a late D or early E. This potential error can be minimised by carrying reference photographs.

**5. “What if an elephant has diarrhoea?”**

This is the most common question posed by civil servants and foresters. Defaecation rates, like most physiological processes, will be normally distributed and therefore a few high or low values are to be expected.

**6. Steady state** If the system is not in a steady state - e.g. if rainfall is irregular or if the census zone is small and elephants are moving in and out - then one of the principal assumptions is violated and the subsequent estimate of E will be wrong. Violation of the steady state assumption is probably the greatest source of error in calculating elephant numbers from dung counts.

**7. Biases in Y, r, and D** Any biases in estimating dung-pile density, defaecation or decay rates will be reflected in the final estimate of elephant numbers. Biases in Y, r, and D are additive and will give a biased estimate of E (Barnes & Jensen, 1987).

**A Universal Theory of Defaecation and Decay**

It is in estimating defaecation and dung decay rates that the most work needs to be done to improve the accuracy of elephant estimates of dung counts. Can general equations be developed which will predict

rates of dung decay or defaecation for a given set of conditions? The most practical predictors of these rates are the ultimate factors. Thus dung decay rate (r) is probably a function of rainfall (R), temperature (T), and humidity (H). So in any particular habitat type,

$$r = f(R) + f(T) + f(H) \tag{5}$$

Similarly, defaecation rate is likely to depend upon food quality which is dependent upon rainfall, so defaecation rate D may be some function of rainfall in the current month (R<sub>t</sub>) and possibly in the preceding month (R<sub>t-1</sub>) too:-

$$D_t = f(R_t) \pm f(R_{t-1}) \tag{6}$$

Note, however, that Tchamba (1992) did not detect any seasonal variations in defaecation rate.

The points from different habitats may all lie on the same line, or perhaps on parallel lines. Multivariate models for both dung decay and defaecation rate could be constructed from data collected by the various dung surveys being conducted in both Africa and Asia. Then a dung surveyor going into a new area need not undertake decay or defaecation measurements. Instead he would measure mean R, T, and H during his survey to estimate the values of r and D from the appropriate equations.

**Other Methods for Counting Forest Elephants**

Can we use infra-sound calls as an indirect census method? Elephants have passed much of their evolutionary history in the forest and the phenomenon of infra-sound communication probably evolved as a means of communicating in forest. There will have to be major advances in technology before the necessary equipment is small enough to carry in the forest. Then there will be the problem of translating calls received per unit time into elephant densities. It will be a long time before the accuracy of infra-sound counts approaches that of dung counts.

Another possibility is infra-red. However, Prinzivalli's (1992) theoretical calculations and experiments with live elephants suggest infra-red will not work in the forest.

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## Conclusion

Estimating abundance and distribution is only the first step in elephant management. The estimates now available for elephants in the forest zone are not yet of the quality necessary to provide the basis for elephant management. More work needs to be done to improve the methods. We need to:

(a) Study the distribution of elephants in relation to human pressures and then work out the optimum sampling design. We need to improve geographic information systems for stratifying the forest to account for vegetation types, management practices such as logging, and the gradient of declining human disturbance with distance from roads.

(b) Investigate the optimum probability density models to fit to the dung-pile data recorded in the transects.

(c) Examine the assumptions of the steady state, and how deviations bias estimates of E.

(d) Elucidate the factors determining defaecation and decay rates and develop general equations.

Improving estimates of dung-pile density is relatively simple compared to the problem of grappling with defaecation and decay rates and the steady state assumption. In many cases it is not necessary to do so, for an immense amount of information about elephants can be gleaned just from the distribution of their dung-piles (e.g. *Barnes et al*, 1991).

It took many years for the methods of aerial survey to be worked out in the savanna zone, yet AESG members continue the struggle to improve them. The methods of counting elephants in forests are only now beginning the same evolutionary process. There is still a long way to go.

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# Working Group Discussion Two

## Ground Survey Working Group

Dr. Raman Sukumar, from the Asian Elephant Specialist Group, chaired the ground survey working group of about 10 persons through nearly two days of discussions. It should be noted that the recommendations formulated during the discussions are preliminary. They are currently undergoing careful review by the data review taskforce which was appointed by Dr. Holly Dublin at the close of the AESG meeting.

### Terms of reference

#### Goals:

To critically assess the methods of ground census and indirect techniques for estimating elephant numbers and densities. Determine the strengths and weaknesses of the methodologies currently employed. Develop methods for more precise population estimates to allow better comparisons between and within populations over time.

#### Focal Topics for Discussion:

- \* Assess the differences between the studies undertaken in central African forests and east African montane/coastal forests. Compare these with lessons learned from Asian elephant research.
  - \* Identify the limitations of using dung counts as a means to estimate numbers/densities of forest elephants.
  - \* Critique the common assumptions regarding the following:
    - i) Defaecation rates: the differences between seasonal forest foraging and year-round forest use;
    - ii) Effect of seasonal movement of elephants in to and out of forests on dung density estimates;
    - iii) Differential decay rates along precipitation, slope, temperature and altitude gradients;
  - iv) Effects of decomposers, such as dung beetles, on decomposition rates;
  - v) Validity of using distance from roads and rivers to set densities and thereby, estimate population size.
  - \* Assess data quality and categorising of data for input to national, regional or continental databases.
  - \* Identify the best means to analyse these data.
  - \* Define how data decreases in value with time since last census (ageing). Should old (guess) estimates be discarded or revised?
  - \* Using revised census methods, is there an acceptable way to review and revise previous estimates to allow for valid trend analyses.
  - \* Define the best means to provide data to the African Elephant Database:
    - i) How different quality data should be managed?
    - ii) The frequency of updating numbers;
    - iii) The shedding of data which does not meet the present scientific standards;
    - iv) Revising the historical numbers to include updated estimates produced by employing new techniques.
    - v) Re-introduction of revised data into the database?
  - \* Discuss the role of the African Elephant Database: What can range states or individuals provide towards this facility, and what can they expect in return from this tool?
- Others topics that are considered relevant to the discussion.

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## Discussion Summary

This group began their deliberations by summarizing the differences between East, Central & West African ground surveys. Basically, surveys in Central Africa have been conducted in vast areas of contiguous lowland forest, whereas in East Africa, there is a wide variety of forest types in small isolated areas from which elephants can move in and out. West Africa tends to be more like East Africa.

It was pointed out that human populations in Central African forests are sparse and are distributed along roads and therefore elephant densities increase with distance from roads. In contrast, human activities in West and East African forests are ubiquitous and there is probably no gradient of human pressures which relates to elephant density.

The group listed a number of important decision making steps which are useful to take before embarking on ground surveys. These steps relate specifically to information needs (i.e. what are the management authorities, donors and technical experts aiming to produce information on?); survey design (i.e. what is the method under consideration designed to produce?); resources (i.e. what funds, time and skills are needed?); and the level of accuracy and precision required (i.e. what sort of results are expected from the survey and what are the limitations of the survey?). It was stressed that both donors and managers must be clear about their objectives when planning research on forest elephants.

In a critique of the current survey methods used (which were aptly reviewed in the plenary presentation by R. Barnes) the group noted the conclusions made by Jachmann (1991) from his comparative survey of four methods of estimating elephant density: that the dung seen on a transect is an accumulated index of elephant abundance over the previous month or two. Direct counts of elephants (aerial and ground), which record instantaneous distribution, might not give as accurate estimates as dung transect counts.

It was agreed that in order to account for elephant movements, *either* (i) the whole range must be sampled if the survey is conducted in only one season *or* (ii) a survey must be conducted in both seasons. When planning a time frame for a survey, it should

also be borne in mind that it takes about 2 months for the system to reach a new steady state after transition from one season to another.

The steady state assumption is central to ground survey theory and practice. Inaccurate estimates will result when the steady state assumption is violated. However, when the transects cover a large area and span a long time period, deviations from the steady state are probably evened out.

The group emphasised the urgent need for more data on the relationship between dung decay and rainfall and the possible relationship between defaecation rates and rainfall, before any effects of violations of the steady state assumption can be simulated.

The members of the working group agreed that much work remains to be done on the factors influencing dung-decay rates. They proposed that a wide-scale study of dung-decay rates was required and suggested 15 sites in India, Kenya, Congo, CAR, Malawi, Ghana, Cameroon, Congo and Gabon, where such studies could be conducted. It was decided that a proposal for these studies should be drawn up.

Various factors which could be studied within such a proposal were discussed. The point was made that either one conducts an ecosystem study including *all* factors that might influence dung decay, or one keeps the study as simple and as practical as possible. For example, rainfall influences decay rates directly and also indirectly through determining dung-beetle activity. Thus the simplest procedure might be to relate rainfall to dung-beetles.

The group made substantial suggestions for refining *data quality* of ground surveys for inputting into the AED. It was strongly felt that there should be two scales, one for aerial and one for ground surveys. The new data quality categories for ground surveys were proposed as follows, subject to further discussion:

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**High:** \*Confidence Limits (CLS) for mean elephant density less than 30% and *one* of the following:

- (a) Decay rate measured on site for >50 dung-piles
- (b) Defaecation rate measured on site
- (c) CLS for dung density estimate <20%
- (d) Sampling is done for both wet and dry seasons  
*OR* Any 3 of the above 4 conditions (a) -(d)

**Medium** CLS for elephant density < 50 *OR* Any two out of the three following conditions:

- (a) Decay rate measures on site for > 30 dung piles
- (b) Defaecation rate measured for target population
- (c) CLS for dung density <30%

**Low** When the conditions for HIGH and MEDIUM are not fulfilled.

\* In this discussion CLS are 95% confidence limits expressed as a percentage of the mean. The group

specified that data would be assumed to be valid for the date of the survey, and dung counts made in the past would be updated as new data on defaecation and decay rates become available. For trend analysis not less than 5 consecutive estimates over time are required. A significance level of 90% would be acceptable.

In general, the group felt that the AED is a valuable tool for stratification and for planning ground surveys. It was pointed out that the value of the database is likely to grow as more data for the forested regions are collected. Updating estimates once every 3 years was felt to be adequate.

## Reference

Jachmann, H. Evaluation of four survey methods for estimating elephant densities. *African Journal of Ecology* 1991. 29:188-195.

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# Plenary Paper Three

## Elephants and Habitats: the Need for Clear Objectives

Keith Lindsay

### Abstract

In all places where elephants have been managed, the relevant authorities have expressed concern over elephant impact on vegetation and the risk of irreversible habitat change. However, in many cases, management objectives have not been clearly defined, or where objectives are clear, their basis may be not entirely logical.

Management plans for protected areas often include the preservation of “biological diversity” and occasionally even ecological processes as high level objectives. However, in many cases in southern Africa for example, the ecological process of elephant/habitat interaction has been regarded as a special case. Extensive woodlands have been chosen as the desirable habitat condition, and the management target or “carrying capacity” for elephants has been set - and maintained by culling - at such a low density that their use of these habitats will have little effect on trees or on other species, either positively or negatively. An alternative view slowly gaining acceptance is that episodic change is an essential feature of African ecosystems and that attempting to maintain a single fixed state - even one of high biodiversity - over the entire range of a population could result in loss of species and habitat instability. Under this view, the use of the term “carrying capacity” is not appropriate, since it prescribes constant conditions selected by the value judgements of the managers. The latter are often not acknowledged or are poorly defined.

Appropriate management can be guided by information from research, but in turn habitat research must be guided by clear management objectives. There should be at least conceptual, if not numerical, models of the elephant/habitat interaction, the regulation of elephant and tree populations, and the influence of other environmental factors.

Management actions should avoid being “reactive” and instead provide data to test or refine the conceptual models. The ecological processes which move the system from one state to another and the requirements of plant and animal species which are affected by the elephant-tree interaction should be key areas of study.

### Introduction

Managers of areas which contain elephants are faced with an apparent dilemma: they wish to keep elephants in the system, but are often concerned that the considerable impact elephants may exert on habitat structure may have undesirable, possibly irreversible, consequences for the plant and animal communities in their range. Because both elephants and trees are long-lived, the interaction may take decades to unfold. The causes of present-day conditions may lie many years in the past and the outcome some time in the future.

Such long term dynamics make it difficult for researchers to get answers of immediate use to managers, and although much research has been undertaken, there are very few examples where the ecological processes at work are well understood. However, in all cases management authorities must formulate action plans in the present, even when good data are lacking. This “management with uncertainty” has left considerable room for argument, particularly when political, ethical and emotive values enter the equation.

In much of eastern Africa, the central issues of elephant management have changed through time. In the 1960s, there were many reports of elephant “overpopulation” in different parks and concern over habitat change - reviewed for example by Laws (1970) - with considerable debate over the appropriate management action. Then in the 1970s and 1980s,

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the accelerated, uncontrolled ivory trade changed “the elephant problem” to one of decline and local extinction through overhunting. Decisions on how to manage elephant habitats have been postponed, but authorities in east Africa have recognised that the issue, while remote at the moment, must be faced in the future (Poole *et al* 1992).

Meanwhile, most of southern Africa remained relatively free of intensive poaching, and the question of elephant-habitat interaction has been faced for a longer period of time. Managers in several southern African countries have formulated policies on elephant and habitat management, derived in part, it seems, from an agricultural background of strict control over nature. Generally, the problem is that elephants threaten to alter the woodlands which were found in the area in the early part of the century (Pienaar 1969, Martin & Conybeare 1992). These woodlands have been viewed as the pristine condition of habitat and the solution is to cull elephants to keep their densities and habitat impact low. However, some workers (e.g. Viljoen 1988) have recently suggested that tree densities in parks like Kruger may have “increased abnormally” when elephants were eliminated by hunters in the early 1900s, and that tree loss may have been a “natural process of elimination” when they began to recolonize the area.

This paper is intended to promote discussion on the subject of elephant - habitat interactions. I start with a review of management plans from different countries, mainly in southern Africa. I follow with discussions of process-oriented management in wildlife conservation, the use and misuse of the term “carrying capacity”, and some models which have been used to approximate elephant, tree and interaction dynamics.

## Management Objectives

Management objectives of any given area should depend on its form of land use. In national parks (NPs), game reserves (GRs) and other protected areas, the objectives are primarily nature conservation. In this section I will review some management plans for protected areas in southern Africa. My sources were the documents available to me at the time of writing and in many cases they were draft plans in typescript form which may have already been superseded by improved versions. I would ask that no one be offended if I have included items which

are now out of date. Some examples will also be given for other areas where the primary objective is commercial tourism or animal production.

Within parks in southern Africa, the general emphasis appears to be the conservation of animal and plant species, recently termed “biological diversity”. This has been noted as the primary objective or policy in Etosha NP, Namibia (Anon 1985), Hwange NP, Zimbabwe (Anon 1990), Kruger NP (Joubert 1986) and Natal Parks (Grobler 1983) in South Africa and as a secondary objective in the Botswana elephant range (Anon 1991). Some of the local authorities also include the conservation of ecological processes (Hwange), “essential life support systems” (Botswana) or “dynamic interactions” (Kruger) as a secondary objective. In the latter it was noted that the park ecosystems are affected by outside influences and that, within a policy of minimum interference, management should seek to “simulate natural conditions”.

In Etosha, “optimal stocking rate/ratios” for elephants and other species are invoked but “optimal” is not defined. In Kruger, the elephant and buffalo populations are to be kept “well below the peaks... of the potential carrying capacity”, although this term is also not defined. The condition of woodlands when the Park was created in 1926 is the target, with the earliest aerial photos being available from the 1940s. In Zimbabwe, it has been estimated, though not yet established empirically, that elephant densities greater than 1/km<sup>2</sup> will have unsustainable and undesirable impacts on mature canopy woodlands. The woodland cover visible in aerial photos of 1959 was the chosen baseline.

The determination of limits of acceptable (=permissible) change in the state of habitats (Bell 1983) was noted as an important goal in Hwange and Etosha NPs and a comprehensive exercise of zoning the parks for management treatments has been undertaken. In Hwange, fairly narrow numerical limits to such factors as bare soil and tree canopy cover have been set, while in Etosha these limits are still under review.

Thus, while conservation of ecological processes is given some importance in these areas, the authorities primarily wish to maintain a catalogue of existing species and habitats. The ideal condition for woodland

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habitats is that which was found in the early to mid parts of the century, regarded as the pristine natural state, or at an least aesthetically pleasing one (Martin & Conybeare 1992). Since these trees flourished when elephants had been reduced or removed by hunters, an upper limit has been set on elephant abundance in order to achieve the goal of preserving the woodlands and associated species. The impact of elephants on habitats is now seen as a threat to their own survival as well as other species of concern (Hall-Martin 1990, Martin & Conybeare 1992), although no data have been presented to confirm that this would happen.

clearly stated (Ferrar 1990). Ecological processes do not appear to be an issue here and limits are set on all wildlife species.

On cattle ranches which are open to elephant use, it would appear that moderate elephant densities are beneficial to ranchers. As noted by van Wijngaarden (1985), ranchers adjacent to Tsavo East National Park in Kenya found that elephants helped to keep rangelands clear of bush, which improved the grazing opportunities for livestock. When elephant densities were reduced through poaching, bush cover began to

Photo by: Ralph Klumpp



In Botswana, the elephant population had grown large and woodland change had already taken place by the time a management policy was written. The 1990 elephant population size was set as an arbitrary interim target with the intention of preventing further change in the remaining woodlands while research and policy review takes place. However, since elephant numbers were already high, simply holding them constant is unlikely to succeed in preventing change.

In Pilansberg GR, which is a wildlife viewing area reconstructed from farmland, the primary goal of maintaining a representative range of wildlife species for the enjoyment of tourists and other visitors was

increase, to the detriment of livestock.

### **“Carrying Capacity”**

Many managers of elephant populations continue to use the term “carrying capacity” as if it has an objective meaning grounded in ecological reality. The view that there is a self-defined carrying capacity for an area which is “ecologically correct”, the one animal density which will popular account of wildlife management principles, yet it blandly assumes a single value system when in fact there are a great variety, each of which sets its own limits of acceptability for the density of plants and animals.

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More than a decade ago Caughley (1979) pointed out that the definition of “carrying capacity” depends on the goals of the manager. He noted that many wildlife managers tend to borrow the approach of range management as applied to commercial livestock production, that of maximum economic return from cattle herds at moderate densities. The population level returning maximum sustainable yield was described by Caughley as “economic carrying capacity”. However, animals left to their own devices are likely to reach “ecological carrying capacity”, which is set by the habitat’s ability to sustain life. This would be a higher population level, and because of greater use by the herbivores, the plant community would appear to be “overutilised” to the cattle fanner, but not necessarily to the manager of a protected area.

Caughley’s point was reviewed and extended by Bell (1985b, p.153), who concluded that “the only embracing definition of carrying capacity is: ‘That density of animals and plants that allows the manager to get what he wants out of the system’.” Bell noted there are no “natural” points on the isocline of plant-herbivore equilibrium, independent of human values. The manager’s target species or communities, the densities of the other species which will interact with these targets and other factors which could affect from the interaction must all be included in his personal definition of “carrying capacity”.

Behnke & Scoones (1992) illustrated the point clearly with examples of a few definitions from the range of possibilities. A reserve manager wishing to provide a high density of certain animals for tourists to see would set a “camera carrying capacity” at a higher level than “economic carrying capacity” and lower than or equal to “ecological carrying capacity”. A game rancher intent on meat or hide production would set a target more in the area of “economic carrying capacity”. with fewer animals amid more, or different, vegetation from that in a game viewing area. And a manager keen to preserve certain animal or plant species which are sensitive to the habitat change induced by a given herbivore would set an even lower “species preservation carrying capacity” for that forager.

When there are so many different ways of defining a term, its meaning becomes lost. With such potential for abuse, it would appear best to give “carrying

capacity” a rest and focus instead on management objectives and the densities of animals and plants they dictate. A second and perhaps more important problem with the concept of a single target “carrying capacity” is that it describes an ideal equilibrium state for a system which is unlikely to be at or even close to equilibrium for much of the time. As I note in the following section, most African ecosystems are characterised by great variability in climate and other factors, which affects the interactions between herbivores and their habitats. For a manager, any single set of conditions, unless it has broad limits of acceptable change, is likely to be an elusive goal.

## Ecological Processes

Walker (1989) reviewed the literature on ecosystem diversity and stability in relation to conservation. He noted that there has been confusion over interpretation of the theory, with the term “constancy” equated with “good”. He pointed out that in fact the conservation goal of achieving persistence of a high richness of species depends on complex systems remaining *nonconstant* and *unstable*, with fluctuations and disturbance allowing the coexistence of many species through time and a space. Management has often been aimed at stabilising the system - dampening fluctuations in numbers, spreading animals evenly over the landscape (Hall-Martin 1990) - in the short term, but these activities are likely to reduce species diversity over the longer term. In the case of elephant - tree systems, Martin & Conybeare (1992) cautioned that there is a risk in allowing elephants to carry the system across what may (or may not) be a boundary from woodlands to more open habitats, and that this risk is unacceptable. Walker (1989) would argue that there is equally a risk of loss of species if the dense woodland equilibrium condition is maintained indefinitely over the whole wildlife estate.

Episodic events such as fire, frost, drought, changes in hydrology, and animal population eruptions and crashes are known to be common

features of savanna ecosystems (Walker 1989; Berry & Siegfried 1991). Since many of these factors, particularly the abiotic ones, are beyond the control of managers, and since they may exert major influences on ecosystem structure, they should be a focus of management thinking, rather than the more common concern over maintaining stable numbers of a relatively few animal species.

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Westoby *et al* (1989), echoed by Behnke & Scoones (1992), proposed a shift in approach to management of rangelands, including wildlife areas, from attempting to maintain systems in or close to a single, fixed equilibrium state. Instead they advocated process-oriented management; the identification of key processes which could shift the system from one state to another, for example woodland to grassland. It would need to be determined if the shifts between states are continuous or if there is an abrupt change across a boundary to an alternative "stable state", where a new factor takes over control of the state of the system. If the system has such boundaries and "multiple stable states", the manager must know when and how to take advantage of conditions which would allow a shift back towards the preferred state. Westoby *et al* (1989) termed this approach "opportunistic management", and emphasized the importance of working with ecological processes, rather than forcing the system to sit at an arbitrary equilibrium.

## Models of Population Dynamics and Habitat Interaction

Part of the problem managers face in managing "natural" ecological dynamics is in the definition of "natural"; managers need a formal description of the hypothesized "natural" mechanisms for comparison against observations. Logical description and exploration of interactive systems is best done through models; when data from the real world are available, parameter estimates can then be inserted to see how they affect the projected outcome. This section contains a brief, and consequently inadequate, review of some of the modelling approaches to elephant - habitat interactions.

Some models have dealt with elephant population dynamics on their own. Spinage (1990) attempted to fit a logistic curve to a limited dataset from Botswana; his only reference to habitat was the suggestion that by reaching  $K$  on the curve, the elephants would have reduced the Chobe woodlands to bare sand, leaving the definition of  $K$  (which should be "ecological carrying capacity") in a theoretical muddle. Croze *et al* (1981) included more demographic detail and avoided the pitfalls of the logistic equation in their transition matrix model, but "habitat" was represented only by a cyclic mathematical function.

Some models have been developed to explore the consequences of different elephant management

regimes. Barnes (1983) looked at the possible trajectory of different tree population dynamics with given fixed elephant densities in Ruaha NP, Tanzania. Craig (1992) predicted equilibrium woodland canopy cover at different elephant densities for Zimbabwe parks. Norton-Griffiths (1979) and Pellew (1983) looked at the influence of fire and other browsers on tree dynamics in the southern Serengeti. The concepts of single v multiple stable states were examined by Dublin *et al* (1990) in models which simulated tree population dynamics at fixed elephant densities and fire regimes in the northern Serengeti/Mara.

Relatively few attempts have been made to examine the dynamics of freely interacting elephant and tree populations. Caughley (1976) used simple logistic models to show how stable limit cycles could occur under certain specific circumstances. Van Wijngaarden (1985) employed a basic systems model to explore the possible dynamics of elephants, trees and other herbivore species. At the broader conceptual level, Bell (1985a) proposed a framework for understanding how soil nutrients and infiltration capacity may interact with the abundance of large herbivores such as elephants to produce stable or unstable system dynamics.

Many authorities assume that dispersal, rather than *in situ* food limitation, is the important mechanism in elephant population regulation and that a significant disturbance which humans have introduced is the blocking of dispersal routes. This influence on population dynamics was explored theoretically by Owen-Smith (1983) amid Craig (in press) but more work and data are needed before conclusions can be drawn.

While these initial efforts have provided some insight into possible outcomes of the elephant habitat interaction, there is a clear need for the development of more comprehensive models which incorporate the dynamics of both elephant and tree populations and the interaction between them. An element of spatial heterogeneity should also be included. Progress in this field need not involve the building of ever more complex systems models. The approach of "rule-based" modeling (Starfield & Bleloch 1986), which avoids strict adherence to specific mathematical equations such as the logistic, makes use of little, large or increasing datasets, and incorporates both predictable and episodic events, is most promising.

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## Conclusions

Most wildlife managers agree that conservation of a high diversity of plant and animal species should be the goal of their protected areas, and some have stated that ecological processes should also be preserved. However, in many cases, there is a view that particular woodland habitats must be maintained in much the same state as they were found at a specific point in time. The fear is that if elephant - habitat interactions are allowed to proceed unchecked there will be unacceptable change in habitats and loss of species diversity. Since there are few definitive data or models to go on, the fear of risking irreversible change may be justified. On the other hand, there may be an equal risk in attempting to hold ecosystems at fixed equilibrium in the face of ecological processes. This contradiction in risk assessment is reflected in some of the contradictions in the stated goals of park authorities in southern Africa.

The approach of "adaptive management", where actions are designed to provide information on the state and function of the ecosystem under management, has been advocated (Bell 1983, 1985; Martin & Conybeare 1992) but rarely practiced by essentially conservative wildlife managers. A more confident approach to management and research along the lines proposed by Westoby *et al* (1989) and Walker (1989), coupled with improved models and a genuine interest in finding out how systems work, would appear to be the way forward. This could best be achieved by avoiding such concepts as fixed equilibria, embodied by the obsolete term "carrying capacity", and giving greater scope to ecological processes within at least some part of elephant ranges.

Variety in management strategies would generate spatial and temporal heterogeneity, allowing greater species diversity and providing the possibility of experimental treatment blocks. Research on other components of elephant - habitat systems, such as the habitat requirements and vulnerabilities of other animal and plant species and on the influence of fire and other episodic disturbance factors should be undertaken.

Whatever the approach adopted, management should have clear goals and objectives which do not conflict. Measureable objectives, such as limits of acceptable change - broad or narrow - should be identified so that

research can have a target, and management can be informed on the progress or otherwise towards its goals.

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Footnote: The terms of reference and discussion summary for the elephant-habitat working group will be published in the next issue of *Pachyderm*.

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# Regional Report Summaries

The following reports are direct summaries of the minutes of the 3 regional working groups, which were arranged as fairly informal discussions. It should be noted that these summaries do not reflect final decisions on any of the issues raised. In fact, 2 of the groups were in the process of organizing separate meetings in their respective regions, during the first half of 1993. A meeting of the Southern African region had already taken place in September 1992.

## 1. Central/Western Africa

### Population Updates

The group was able to make revisions of elephant range data, particularly for Congo, Guinea, Ghana, Senegal, Liberia and Sierra Leone, after examining the 1:1,000,000 UNEP-based African Elephant Database maps. Modifications of previous elephant population estimates were also made based on analysis of ground survey data from Cameroon, Central African Republic, Congo, Equatorial Guinea, Senegal and Zaire. The group noted the need for obtaining real numbers rather than estimates.

Several key elephant populations were listed for which conservation projects should be prioritized. At the same time it was recognized that local human populations would have to be integrated into any such projects. The key populations are:

### Central Africa

**Cameroon:** Nki, Lobeke, Boumba-bek, Korup, Waza

**Gabon:** Gamba Complex, Minkebe, Lope

**Central African Republic:** Dzanga-Sangha, Manovo-Gounda-Saint Floris

**Zaire:** Salonga, Garamba, Ituri, Manko, Kahuzi-Biega

**Congo:** Nouabale-Ndoki, Odzala (& possible extension areas) Lefini (& areas in savannah where elephants are discovered) Conkouati

**Equatorial Guinea:** Mt Alen

**Chad:** Zakouma

### West Africa

**Ivory Coast:** Tai

**Senegal:** Niokolo-Koba

**Ghana:** Bia Park, Enkasa Park

**Liberia:** Sapou NP, Grebo NF

### Attitudes Towards a Continental and Regional Database

The group felt that there was a need for a "low-tech" regional database, with a modest infrastructure in the 2 sub-regions (Central and West), which would act as a repository for database information. At the same time it was felt necessary for each country to submit data to a central repository (the African Elephant Database at IJNEP in Nairobi). It was agreed that each country's Elephant Action Plan be updated every 2 to 3 years, thereby acting as the main vehicle for dissemination of information.

### Pros and Cons of Regional Conservation Efforts

It was felt that West and Central regions should be discussed separately in future as the problems arising from each are so different.

It was suggested that a regional plan would be advantageous for managing migrating cross-border populations, for addressing the problem of relict populations, and for finding solutions to problems stemming from broadly similar ecological and political systems.

At the same time the group recognized the sovereignty of each nation, with a resulting diversity of legislation, land-use management and planning priorities. The group felt that the problem of coordination between countries in the region is a real one which is not likely to improve soon.

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## Summary of Regional Initiatives and Country Priorities

Several suggestions for action at a regional level were noted including the necessity for a regional census, identification of cross-border projects (including anti-poaching protocols and initiatives), input of appropriately trained individuals to lead in country management strategies, and the establishment of a regional database. In general the group deplored the current paucity of regional coordination and absence of political will to deal with natural resources management. The wildlife management tradition needs to be developed on a country-by-country basis with promotion of relevant training.

The group applauded the 1989 CITES ban on trade in African elephant products. However, it also felt that this "stop gap" measure would have to be eventually replaced by a medium-term solution. Any future solution would have to ensure that countries are able to manage their own elephant populations and that poaching does not reach pre-ban levels.

### The Role of the AESG

The group discussed the regional role of the AESG and concluded that it was very important for (i) ensuring the development of relevant management and conservation techniques, (ii) the coordination of scientific research on elephant conservation, (iii) the sharing of knowledge within and beyond the region, and (iv) the regional monitoring (through TRAFFIC) of illegal trade.

### Other Issues of Concern

The group concluded their discussions by recognizing that the increasing problems of human-elephant conflict need to be seriously addressed. Each group member was urged to prepare a report on the situation in their respective countries for further discussion at the forthcoming regional meetings in 1993.

## 2. Southern Africa

### Population Updates

The group decided to distinguish national and regional baseline elephant populations. While national populations were confirmed for Zimbabwe, S. Africa, Namibia, Malawi, Zambia and Botswana, the following were agreed upon as belonging to the regional category:

1. Upper Zambezi/Cubango (Angola/Namibia/Zambia/Botswana/Zimbabwe)
2. Kunene/Namibe (Namibia/Angola)
3. Luangwa Valley (Zambia/Malawi)
4. Middle Zambezi (Malawi/Zambia/Mozambique/Zimbabwe)
5. Save/Limpopo (Mozambique/Zimbabwe)

### Attitudes Towards a Continental and Regional Database

The group reported that at the Southern African Elephant Range States Regional (SACIM) meeting (Etosha, September 1992), a proposal had been developed for a database network which would be coordinated by SACIM (irrespective of SACIM's membership and policy).

The group agreed that a continental database had its value but felt that this was limited where the southern African states were concerned basically because of the coarseness of the data. Further information about the running costs of the continental database was requested and it was suggested that more attention be given to data quality and definitions of range boundaries for mapping. It was also felt that there should be more peer review of the data.

### Summary of Regional Initiatives and Country Priorities

Key issues for regional action which had already been discussed at the Southern African regional meeting, included the initiation of ELESMA (Elephant Survey and Monitoring Action Programme), expansion of tracking VHF and satellite programmes, law enforcement, training (in relevant languages) and management of cross-border parks. Within ELESMA, each country developed a national survey programme based on coordinated timing and consistent methodology, with the aim of establishing a source of accurate information on elephant status throughout the region.

### Pros and Cons of Regional Conservation Efforts

The group realised that a substantial amount of conservation action, training and security measures are more feasibly undertaken at a national or bilateral level. The regional approach would be most important for cross-border population management, security and monitoring.

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## The Role of the AESG

The group agreed that the “AESG was an important forum for sharing regional and continental expertise”. Regional issues such as those developed at Etosha would benefit from AESG support. It was also felt that there was a need to emphasise the management and conservation terms-of-reference of the AESG in the light of changing conservation priorities. The group thought that the AESG should also look at the costs of protected area management versus conservation of elephants as an integral part of rural development.

## Other Issues of Concern

A major topic of increasing regional concern is poaching. Issues to be addressed include security, investigation and cross border controls, the need to maintain ivory trade studies (and all their ramifications) and the need to coordinate statistics on regional poaching, trade and intelligence data.

## 3. Eastern Africa

### Population Updates

The group added new data on elephant populations for only the countries represented: Kenya, Tanzania and Uganda. Priority projects for support in Uganda were identified as the Queen Elizabeth (QE) National Park, the QE elephant study, and forest studies. In Tanzania, preference was given to forest studies, pocket populations and elephant range studies.

The group felt that previous AERSG baseline populations were no longer relevant as each country now has its own management priorities. Regional populations for support were identified as follows:

**Kenya/Tanzania:** Amboseli/Kilimanjaro corridor; Meru to Longido ecosystem.

**Kenya/Uganda/Sudan:** Kidepo/Northern Kenya/Sudan/Ethiopia

**Tanzania/Mozambique:** Ruvuma

**Tanzania/Uganda:** Sango Bay

## Attitudes Towards a Continental and Regional Database

There was a general agreement that the continental database should continue but it was suggested that it would have more value if maps with a finer scale were used. The group felt that it would be helpful to centralize regional data, and suggested having a regional coordinator for inputting data.

## Pros and Cons of Regional Conservation Efforts

The advantages of a regional conservation effort were listed as (i) enabling the monitoring of cross border areas, (ii) leading to improved security and control of illegal trade, and (iii) generating a forum to discuss issues of common concern, such as the approach leading up to CITES meetings. Practical problems such as lack of finances and poor communication were seen as definite disadvantages to regional efforts.

## Summary of Regional Initiatives and Country Priorities

Priorities for the 3 countries represented were categorized as law enforcement, (anti-poaching, ivory trade and intelligence), surveys and monitoring, research, elephant/community problems (including fencing) and training. Further regional priorities included ivory trade monitoring, surveys to detect elephant population trends, training, and improved communication leading to sharing of ideas. As a first initiative, a regional meeting in Tanzania is already planned for the first half of 1993.

## The Role of the AESG

The AESG's role was seen by the group as being primarily technical, with emphasis on helping to compare methods and ideas, and monitoring overall status and trends across the continent.

## Other Issues of Concern

In conclusion it was noted that elephants face a wide array of threats that must be responded to on an individual basis with regard to the area and country. Issues related to management of increased human-elephant conflict need to be highlighted.

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# SCIENTIFIC PRESENTATIONS

## Current Elephant Range and Status in Mozambique

Mateus Chambal

### Abstract

This report gives a general overview of the range and status of the African elephant (*Loxodonta africana*) in Mozambique. There are 3 main populations: southern, central and northern. The central population appears to be the most promising in the long-term, followed by the northern populations (Rovuma and Lugenda areas) in the provinces of Niassa and Cabo Delgado, and lastly the populations of southern Mozambique (from the Save River down to the Ponta de Ouro).

### Introduction

The Republic of Mozambique, with a human population of approximately 15 million, covers a total land surface area of about 800,000 km<sup>2</sup>, of which 13,000 km<sup>2</sup> is made up of inland waters (rivers and lakes) with 6,880 km<sup>2</sup> belonging to Lake Niassa alone. About 14% of the country has been set aside as conservation areas of which 2% are National Parks, 2.5% are Game/Especial Reserves and 9.5% are designated as multiple land use areas/hunting areas, commonly known as "coutadas". About 70% of the total land surface is still covered by natural forest, while approximately 75% is infested by the tsetse fly (*Glossina sp.*), the vector of trypanosomiasis, which renders livestock production economically unviable and ecologically unjustifiable. Large parts of the interior of Mozambique are virtually uninhabited by humans. As a result of the prolonged civil war, many people moved into the towns. A large proportion live in the south and along the coast.

In 1945 the elephant population of Mozambique was estimated at not less than 120,000 (Rosinha, J.A., personal communication). From 1947 to 1969, a continuous campaign against trypanosomiasis was undertaken with the aim of encouraging animal husbandry, farming and human settlement. In the south, this campaign consisted of indiscriminate killing of all types of game including elephant and rhinoceros, while in the northern and central regions, vegetation was cleared with the opening of wide roads. By 1969 an

estimated 233,513 game animals of all species had been killed.

There have been no country-wide systematic studies in Mozambique on animal distribution and movement. In 1978, following a fortnight's visit, Iain Douglas-Hamilton estimated the elephant population at not less than 57,000. However, more recent surveys by the author, from 1985 - 1992, indicate that the animal population in the south has been especially affected by both the trypanosomiasis campaign and by indiscriminate hunting during the civil war.

### Methodology

The following methods were used for the collection of data in the 1985 - 1992 surveys:

#### **A - Questionnaires**

Questionnaires were prepared and data collected by a direct approach. The questions were read out verbally to the field wildlife staff, regional wildlife officers, mine prospectors, farmers, ranchers, military personnel, villagers and other people knowledgeable of wildlife. The answers were immediately recorded on relevant questionnaire forms. The individuals questioned were selected at random in the three regions surveyed: southern, central and northern. This method was simple, less time consuming and eliminated the problems of illiteracy, loss of questionnaire forms and improper answers.

#### **B - Interview and Discussions**

To supplement the data obtained by direct questioning, interviews and discussions were conducted with safari operators, game scouts, trackers, mine prospectors, farmers and elders from various villages within the three regions. In certain localities it was difficult to communicate with village elders due to language limitations. Notwithstanding this method added more useful information which otherwise would have been omitted from the questionnaires. In addition, monthly and annual regional reports were read thoroughly and analyzed.

### C - Direct and Indirect Field Observation

This methodology involved the use of light aircraft (a CESSNA 185 and a CESSNA 206 highwing), a helicopter, a vehicle, or field walking - depending on the nature of the terrain and the presence of guerilla activities.

Aeronautical maps (1:50000, 1:250000, 1:1000000 and 1:2000000) were used for flying. The areas for survey were selected randomly within the country and a combination of block counting and sampling counting was applied.

The combined methodology provided data on animal distribution (including cross-border populations) and numbers, as well as identification of land utilization patterns, agricultural and other human activities. Information on vegetation status and the effects of animals on habitat were also noted.

### Results

The bulk of Mozambique's elephant (and black rhino) populations are to be found in the central and northern regions, where human population pressure is very low.

The total population of the African elephant in Mozambique is estimated at between 15,000 and 20,000, as seen in Table 1. The survey results suggest that the central and northern populations are the most abundant, particularly in Tete, Niassa, Sofala and Cabo Delgado provinces. Apart from the populations in the Gorongosa National Park, the Marrameu Wildlife Complex in Sofala province and Niassa Game Reserve in Niassa province, the remaining elephants occur outside protected areas. In Tete province, groups numbering 150-200 animals are not uncommon. In the dry season (September/October)

Table 1: Estimated population of elephant in Mozambique in different provinces

PROVINCES	1978	1992 - LOWEST ESTIMATE	1992 - HIGHEST ESTIMATE
<b>Southern</b>			
Maputo	500	187.5	250
Gaza	8500	1500	2000
Inhambane	8000	1312.5	1750
<b>Central</b>			
Sofala	12000	2625	3500
Manica	7000	750	1000
Tete	8000	3375	4500
Zambezia	2000	1425	1900
<b>Northern</b>			
Cabo Delgado	5000	1500	2000
Niassa	8000	2250	3000
Nampula	?	75	100
<b>TOTAL</b>	<b>57000</b>	<b>15000</b>	<b>20000</b>

NB. Reports from Nampula revealed that elephant populations do cross the provincial border between Zambezia and Nampula provinces at Ligonha river, causing crop destruction.

Table 2: Estimated range of elephants in Mozambique in km<sup>2</sup>

REGION TOTAL	LAND SURFACE (km <sup>2</sup> )	LAND SURFACE INHABITED BY THE ELEPHANT (km <sup>2</sup> )	LAND SURFACE INHABITED BY THE ELEPHANT (%)
Northern	280,137	103,461	13.1
Central	341,339	122,888	15.6
Southern	167,335	35,359	4.5
<b>TOTAL</b>	<b>788,811*</b>	<b>261,708</b>	<b>33.2</b>

\* excludes inland waters

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several hundred elephants can be seen along the Cahora Bassa plains and Panhame rivers. In this area, it is evident that there is already some destruction of the mopane woodlands.

In the southern region, the Gonarhezou National Park and surrounding areas in Gaza province still support a healthy population of elephants.

Table 2 shows the estimated range of the elephant in km<sup>2</sup> and as a percentage of the total land surface of Mozambique. The current elephant range is also displayed on the map in Figure 1.

## Conclusions and Recommendations

The 1985-1992 survey revealed that a healthy elephant population can still be found in the central and northern regions of Mozambique.

It is important to consider the creation of conservation areas in Tete and Cabo Delgado provinces, where significant elephant populations exist outside the few protected areas. This is especially important with the expectation that up to 1.3 million people may return to Mozambique following the end of the war. Unless there is proper planning for human settlements, there will be an inevitable increase in human/animal conflict in the central and northern regions.

It is also suggested that an International Park be created to protect the southern elephant population

which crosses the borders between Mozambique and Zimbabwe. A final recommendation is to upgrade the Zambezi Valley ecosystem from its present status of a Game Reserve, to a World Site Heritage combined with the Gorongosa ecosystem.

## Acknowledgments

The author would like to thank the owners of Benguela Holdings Ltd., namely Kim and Trevor Landreys, for their invaluable assistance in money and two aircraft without which this seven years work would not have been possible; to Tim Otto who financed the aerial census of the upper Limpopo Region in southern Mozambique; Piet Hougaard who financed a ground and aerial survey of Rovuma and Lugenda areas in northern Mozambique and that of Tete and Sofala Provinces in the Central Region; to Dr. Boaventura Cuamba of the Department of Physics at Eduardo Mondlane University for his valuable comments and assistance during the write up of this paper; to Miss Fran Michelmore, IJNEP GIS Specialist, for her encouragement and help to produce an update map of elephant distribution in Mozambique. And last but not least, my warmest thanks to all those who directly or indirectly have contributed in many way to the success of this work.

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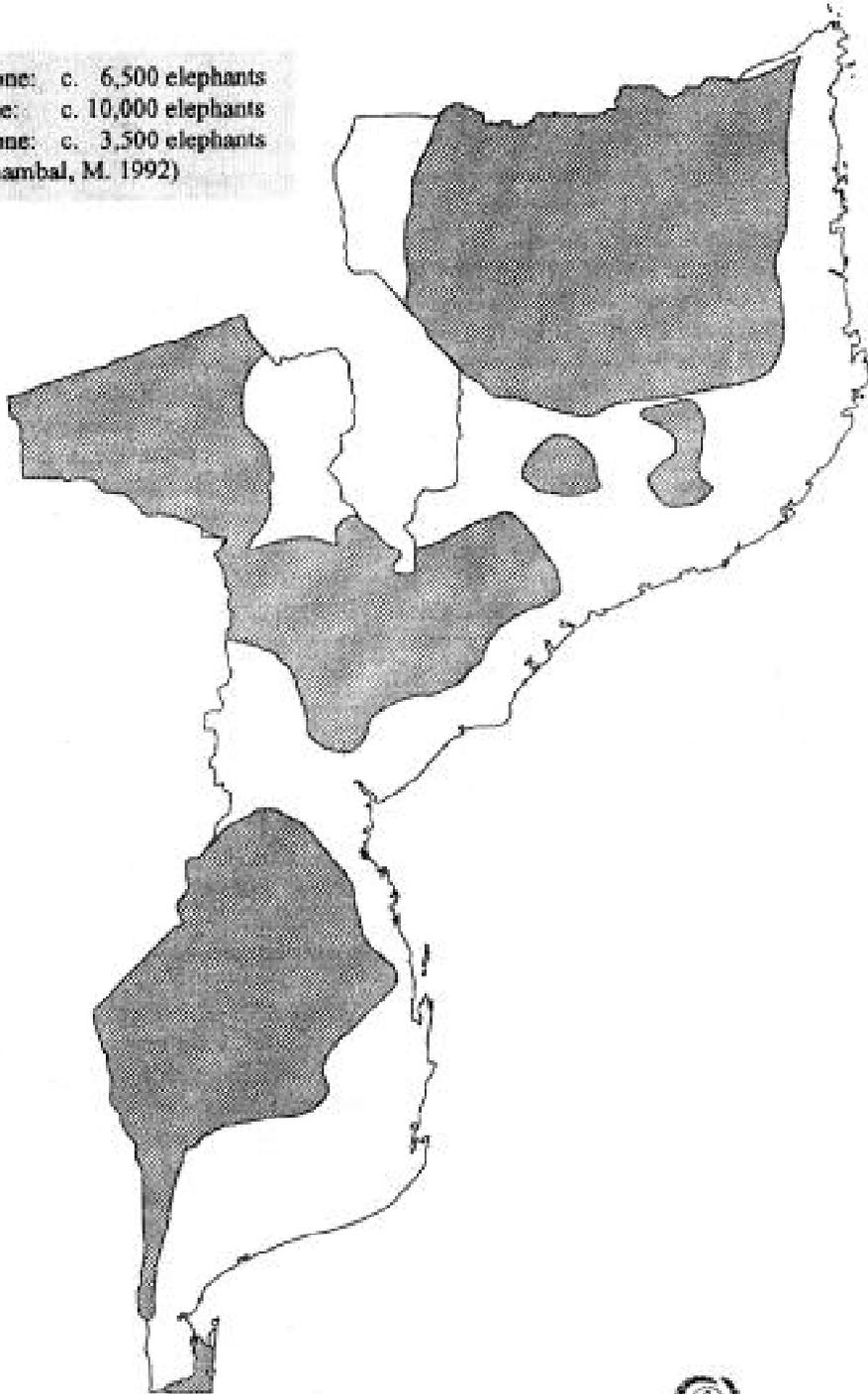
Photo by: Nina Marshall



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## Mozambique - Current Elephant Range Distribution, 1992

Northern Zone: c. 6,500 elephants  
Central Zone: c. 10,000 elephants  
Southern Zone: c. 3,500 elephants  
(source: Chambal, M. 1992)



**African Elephant database Project** in collaboration with *UNEP/GEMS/GRID*,  
*African Elephant Specialist Group*, and *WCMC*.



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# The Status of Elephant on the Zambian Bank of the Middle Zambezi Valley

Glory Chanda\* and Ackim Tembo

## Introduction

Historically, the elephant population in the Middle Zambezi has been one of the most heavily affected by hunting in Central Africa. Since the 15th century when the Portuguese plundered for ivory, elephants have never fully recovered from the impact of legal and illegal hunting. The impact of hunting for ivory was more prominent during the difficult years of European advance into the interior of Central Africa in the early part of the 19th century. In 1876 alone 18 tonnes of ivory were traded on the Zambezi, representing about 850 elephants. Since the late 19th century, the middle Zambezi Valley has been neglected by successive administrations. As a result of ineffective management, few historical numbers are available. The first record of game estimates for the Middle Zambezi in 1960 suggested a total of 1,000 elephants for the north bank. In May 1970, the first aerial census of wildlife on the north bank was carried out covering a total of 760 km<sup>2</sup> of valley floor (Bell, 1972). The results gave an estimate of 647 elephants.

Between Bells's census and the present time, the Zambezi valley has come under sharp focus of various international and local conservation concerns because of escalating cross-border illegal hunting of rhino and elephant. The current decline of Black rhino and elephant population in Zambia is alarming.

Therefore, the purpose of this study was to determine the current status of the elephant population in the area. Specific objectives were to determine: 1) the abundance and distribution of elephants, and 2) the extent of illegal hunting of elephant, as evidenced by elephant carcasses.

## Study Area

The study area is located between the Zambezi/ Kafue confluence in the west and that of the Zambezi/ Chongwe to the east. The floor of the valley varies in altitude from 350 m to 640 m above sea level and the escarpment rises to 1,200 m. above sea level.

The average annual rainfall at Chirubdu is 628 mm. Rainfall usually occurs between November and March. Mean temperatures vary between 6.5 C (July) and 40 C (October). The vegetation is predominantly composed of *Acacia/ combretum* woodlands, *Colophospermum mopane* woodland, mixed scrub and riparian woodland along the Zambezi River. On the alluvial floor-plain, *Acacia albida* becomes very common sometimes occurring in pure stands.

## Methods

Systematic sampling was used throughout the survey in order to map the distribution of animals and resources.

The survey of Chiawa Game Management Area (GMA), covering elephant and illegal elephant hunting was carried out on the 25th July 1991 for 2 hours 15 minutes. The Lower Zambezi National Park (NP) survey was covered on the next day for about 4 hours. A total of 790 km<sup>2</sup> of the GMA and 580 km<sup>2</sup> of the NP valley floor was covered in this survey.

The survey was done by a crew of four, comprising a pilot, a navigator and two observers on opposite sides of a Cessna 182 aircraft flown at a ground speed of approximately 80 knots (145 km/ h). An average height of 120 m was maintained over the GMA and 92 m for the NP with strip width of 500 m for the former and 250 m for the latter.

The strip maintained by streamers fixed to the wing-struts of the aircraft was determined by geometric calculation.

All observations were made from systematic transects oriented by a north-south direction and spaced at 2.4 km intervals. The recording intervals (or sampling units) were kept at 25 seconds, a long each transect for the GMA and one minute each for the NP area. At the stated survey speed, these intervals translated into distances of 1 km for the GMA and 2.4 km for the NP sampling units. Most transects were flown from the

north bank of the Zambezi or the Kafue to the foot of the escarpment except in the case of a few whose southern boundary was a range of hills in the upper reaches of the Munsenshi river. The extent of illegal elephant hunting was recorded as the numbers of tuskless elephant carcasses observed.

The result of the game transect counts were analysed using the procedure recommended by Caughley (1973) and Kaweche et al. (1987) for the Luangwa Valley elephant survey.

## Results

### **Abundance and Distribution of Elephant**

A total of 31 elephants were estimated for Chiawa GMA (Table 1) and 328 elephants for the Lower Zambezi NP (Table 2).

Elephant densities were much higher in the NP than in the GMA at this time of the year (mid dry season). All the elephants observed were within 2-3 km<sup>s</sup> of the Zambezi alluvial floodplain. The GMA population concentrated in the area near Nyamangwe river (Figure 1). In the NP, all elephants were recorded between the Chongwe and Chakwenga rivers (Figure 2) save for the one herd of about 70 animals sighted outside the counting strips in the upper Musensenshi Valley.

### **Illegal Elephant Hunting**

Only one elephant carcass with skin and no tusks was seen in the GMA near the confluence of the Munyameshi and the Zambezi but it fell outside the counting strips. A total of 10 elephant carcasses were sighted within the Lower Zambezi NP giving an

estimate of 52 carcasses for the whole park suggesting an excessively high illegal offtake. All carcasses sighted in the NP were tuskless skeletons widely scattered on the valley floor.

## Discussion

### **Abundance and Distribution of Elephant**

It is likely that the number of elephants especially in the NP is underestimated. For instance, reports from wildlife field officers and safari hunting operators indicate the existence of a large elephant population in the area between the upper Musensenshi and Rufunsa valleys, an area that was only partially covered in the survey. This is the area in which a herd of about 70 elephants was sighted outside the counting strips and during the survey. Elephants are also known to exist in the hilly region above the main perennial rivers such as the Chongwe, Chakwenga, Musangashi and Musensenshi.

A comparison between the last census in 1970 (Bell, 1972) with the present one shows elephant numbers appear to have been depressed to almost half of the 1970 number probably due to illegal hunting and migration to the safer south bank. Elephant, like many other species are attracted to the flood-plain areas on account of year round availability of shade, water and food. *Acacia albida* is of particular importance in this regard. It is also possible that the islands on the plains offer some good measure of protection from poachers.

### **Illegal Elephant Hunting**

The current pressure of illegal elephant hunting in the area suggests that the total number cited in the present study is under estimated. This is likely to have happened

Table 1. The abundance of elephant in Chiawa GMA.

Species	Estimated Numbers	Density km <sup>2</sup>	Sampling Intensity %	S.E	S.E %	95% C.I
Elephant	31	.04	18	58		36

Table 2. The abundance of elephant in Lower Zambezi NP.

Species	Estimated Numbers	Density km <sup>2</sup>	Sampling Intensity %	S.E	S.E %	95% C.I
Elephant	328	.06	18	121	37	242

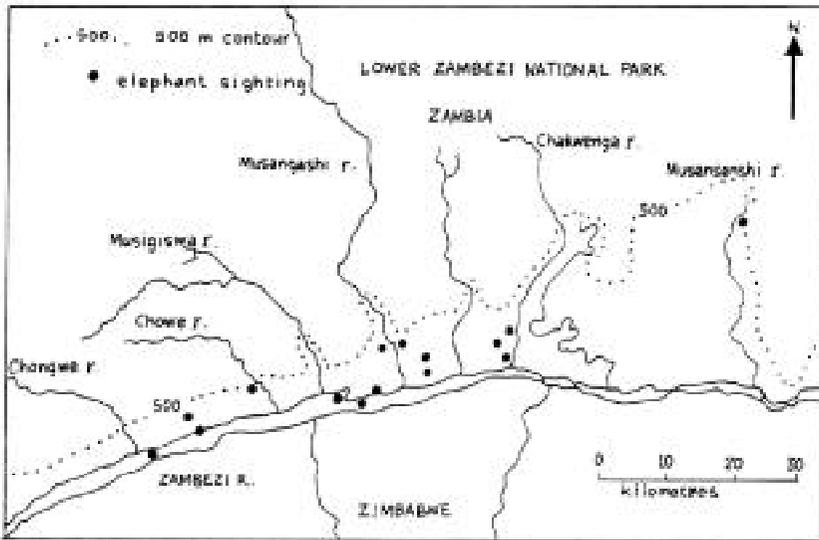


Figure 1: Distribution of elephant in Lower Zambezi NP, 1992

given the problem of locating elephant carcasses from the air. Nevertheless, the carcass to live elephant ratio of (about 13%) is extremely high indicating an excessive high illegal offtake and inadequate policing by wildlife authorities in the area. Under natural conditions the ratio of dead to live animals should be less than 9%.

## Recommendations

There is a need to continue monitoring herds of elephant population and other important species of the Lower Zambezi NP and Chiawa GMA as well as the escarpment region of the Middle Zambezi.

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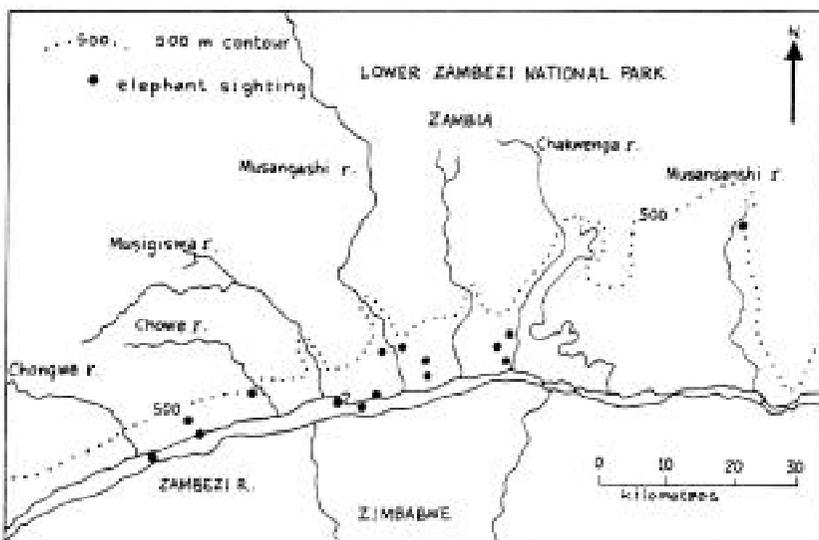


Figure 2: Distribution of elephant in Chiawa, GMA, 1992

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# Elephants and Ivory in the Congo since the Ban: The Lull before the Storm?

J. Michael Fay and Marcellin Agnagna

## Abstract

On average, the raw ivory from between 2,011 and 3,788 elephants was exported with documentation from the Congo every year from 1979 to 1988. The actual amount that left Congo is unknown, but it was undoubtedly much more than the official figure. There was also an active trade in worked ivory for which there is little documentation. It is evident that the Congo was an active participant in the rather anarchical ivory trade which resulted in a dramatic decrease in elephant populations almost throughout their range in the 1980s. Since the CITES decision to ban the trade in ivory in 1989 and subsequent collapse of the ivory market, we have seen significant decreases in both poaching and the ivory trade in Congo. This is due almost exclusively to the decrease in the price of ivory and the difficulty of export. The

Congo has made significant advances in the domain of conservation in the past two years which has resulted in positive results in elephant protection in some areas. It is our opinion that if the trade were opened again and a consequent increase in demand occurred, the situation in Congo, both on the poaching and trade fronts, would quickly revert to that before the ban, except perhaps in a few newly-created islands of protection.

## Background

As were most countries in central Africa, Congo was heavily involved in the ivory trade before the ban in late 1989. There is a considerable discrepancy between the figures furnished by the Direction de la Conservation de la Faune (DCF) and the Wildlife Trade Monitoring Unit (WTMU). According to DCF

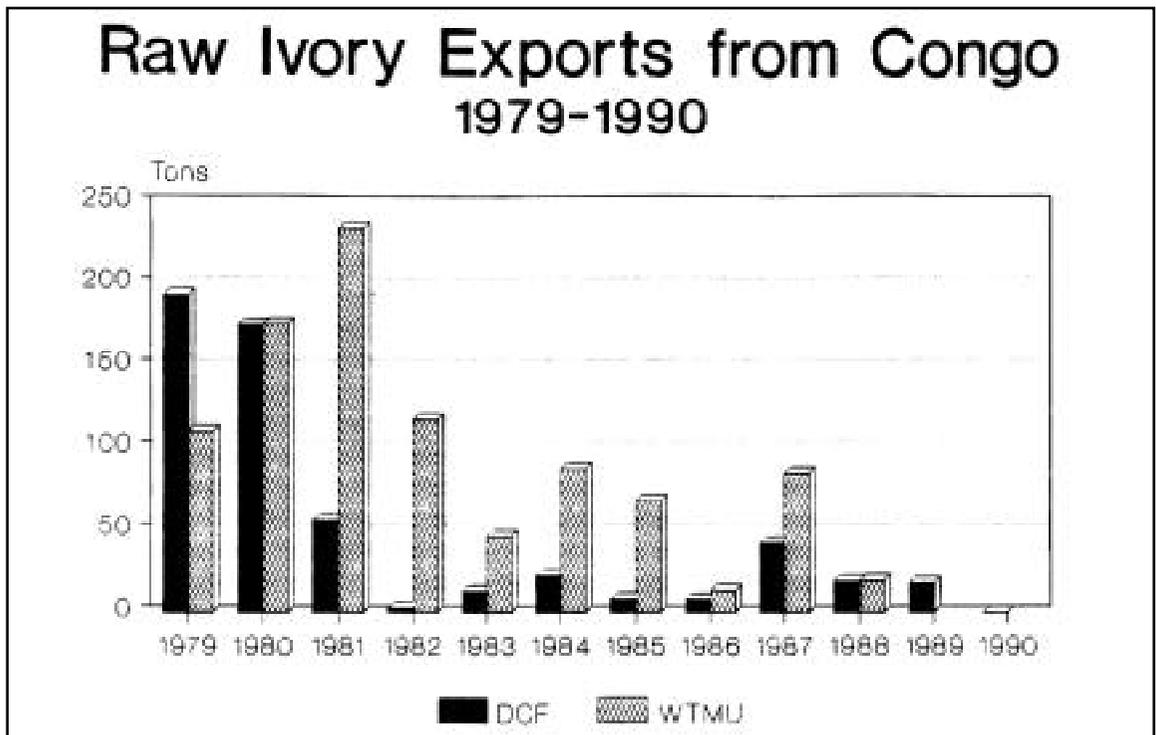


Figure 1: Raw ivory exports from the Republic of Congo between the years of 1979 and 1990 is recorded by the Direction of the Conservation of Fauna in Congo and the Wildlife Trade Monitoring Unit

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the legal raw ivory trade averaged 50,679 kg (S.D. 67,979 kg) per annum for the period between 1979 to 1989. The WTMU estimated that the amount averaged 95,475 kg (S.D. 68,466 kg) per annum (Figure 1). For ivory sold between 1986 and 1988 the mean weight was 12.6 kg (Barnes 1989). Extrapolating from this mean weight, the ivory of from 2,011-3,788 elephants worth of ivory was exported from the Congo with some kind of documentation every year for at least ten years. This represents 20,000-30,000 elephants. In addition, it is likely that considerable amount of raw ivory left the country which was not accounted for in export figures. It is impossible to estimate the amount that was smuggled out of the country with no trace that it originated in Congo.

The most likely explanation for the gaping discrepancy noted in the DCF vs WTMU figures above ( $r=0.48$ , on an annual basis) is the failure of the government to properly monitor and control the trade. The ivory market offered such potential for enormous profits that many people enthusiastically became involved in the trade ranging from the traditional peoples of the forests to highly-placed individuals in large cities. The network enabled tusks to pass easily from forest to exporters with enough profit for several middlemen.

In 1989 there were 80 ivory carvers in Congo. They produced sculptures, jewelry and other items. In principle their activities were controlled by the DCF. Each artisan was required to maintain a register of the certificates of origin and measurements for ivory worked, weights in and out of the workshop, as well as the characteristics of finished products. Subsequently all pieces of art were to be stamped by the Ministry of Forest Economy. In practice not a single step in this process was followed. In addition, because it was so difficult to obtain tusks from official sources, and because there was virtually no control, all of the ivory worked by artisans was illegal. Most of the tusks used by the artisans were small-tusks that were of little interest to the raw ivory exporters (Ndinga 1991). The amount of ivory that was worked and subsequently exported is unknown. One estimate put it at 2.5-3.0 tons per year (Ndinga 1991) but it could have easily been considerably more.

It is difficult to precisely determine what percentage of the ivory that was officially exported from Congo, or unofficially but traceable to Congo, actually originated in the country. The Republic of Congo

shares a 1,500 km long border with Zaire. It is downstream of the Central African Republic (CAR) and shares large borders with Cameroon and Gabon. Add to that the possibility of smuggling to and from Angola. All of its neighbors were major ivory producers during the 1980's. The Oubangui and Congo Rivers, which form the border with Zaire, were notorious crossing points for ivory. Much Zairian ivory found its way to Congo and was collected in Dongou, Impfondo, Moussaka and Brazzaville. The main impetus for this movement is that the Congo is in the CFA franc zone, a convertible currency. One village, Ndjondo, was particularly renowned. It is on the Oubangui River just upstream of the confluence of this river and the Kasai which drains much of central Zaire. It is said that Ndjondo was the major collection point for central Congo basin ivory. In addition to stationary buying points, there is an entire fleet of floating markets that travel up and down the rivers. The river boats are inhabited by merchants, and much of the ivory coming from Zaire was traded right from dugout canoes to the barges *en route* to Brazzaville. The trade was vigorous - one can only guess how much "Congolese" ivory came into the country this way.

Trade across borders was common throughout the region. The official export records for the CAR, nestled to the north of Zaire and Congo, revealed that in the early 1980s only 9% of the ivory exported from that country originated there. The certificates of origin for the rest originated from Zaire (65%), Sudan (6%), Chad (16%) and Congo (4%). It is thought though that in fact 70% to 90% percent of this ivory actually originated in the CAR (Froment 1985). This, of course, represented only the ivory legally exported. When the level of exports between 1976 and 1979 exceeded 450 tons, and after the fall of Bokassa, the trade in the CAR was shut down between 1980 and 1981. But during these two years 1-long Kong and Japan imported 263 tons of ivory originating in the Central African Republic. During the same period it is estimated that between 3,000 and 4,000 tusks entered the (Congo from the CAR (Froment 1985). Because the government found it impossible to control the trade and was receiving no revenue from illicit exports, it reopened the trade. CAR was able to produce official exports of 309 tons of ivory in the two years following the resumption of the trade (Froment 1985). Between 1971 and 1984 the CAR officially exported ca. 33,000 elephants' worth of tusks. It is estimated that in order for the CAR to

maintain the levels of official exportation that it achieved from 1982 to 1984 that it needed a population of 300,000-350,000 elephants. It is difficult to imagine how many tusks actually reached the world market and almost impossible to know their origin. This ignores all of the “objets d’art” which were exported with little or no control. The CAR also had a large complement of carvers.

A conservative estimate of 30,000-40,000 elephants’ worth of ivory were exported from Congo in the period from 1980 to 1989. In the same period Congo issued 1,312 big game hunting licences (Ndinga 1991). Each hunter was allowed a quota of two elephants. This would account for just over 2,624 elephants, assuming that all hunters obtained their quota. It becomes evident that over 90% of the elephants killed in Congo were poached. The figure was considerably higher in the Central African Republic.

This introduction is to remind us of the total anarchy that existed in the ivory trade which resulted in significant population decreases in much of the range of the elephant in the 1980s. It should not be forgotten that most states in Africa were not only incapable of controlling the unsustainable trade and poaching, but in most cases were active partners in it officially, officiously and/or covertly.

In 1989 the world community shut down the ivory trade using two strategies. CITES placed the African elephant on Appendix I, and the media and a number of conservation organizations and governments mounted an intensive campaign to make ivory undesirable. Our colleagues from southern Africa look back on this as the end to an era of good game management for the region. To those of us living in central Africa it seemed the only chance for the elephants, even if common sense

economics would have never supported such a ban (Anon. 1989).

## Elephant Population and Poaching Levels in Congo before the Ban

In January of 1989 the European Community (EC) and Wildlife Conservation International (WCI), undertook a survey of elephant populations in northern Congo (Fay and Agnagna 1992). Four sites were censused from east to west, from the Likouala swamps to the hills bordering Gabon. The major criterion of the study was to obtain data from a wide range of habitats with a stratification based on human population density. This survey, which included 401 km of line transects, revealed the presence

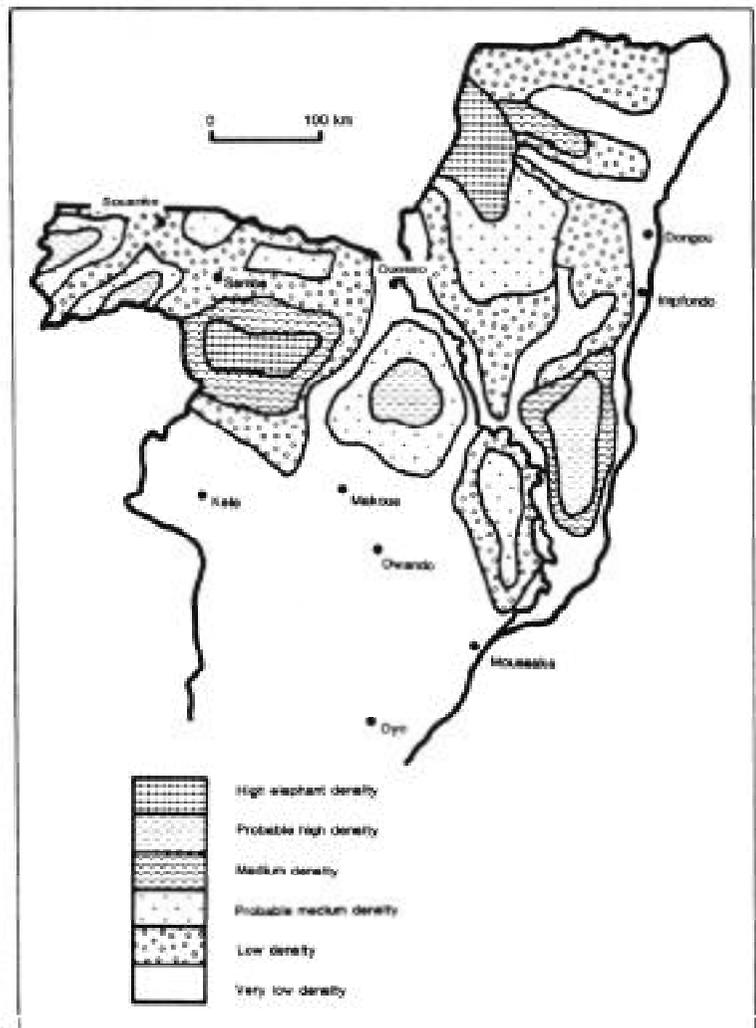


Figure 2: Known and putative elephant populations in Northern Congo (from *African J. of Ecology* 29:1 77-187)

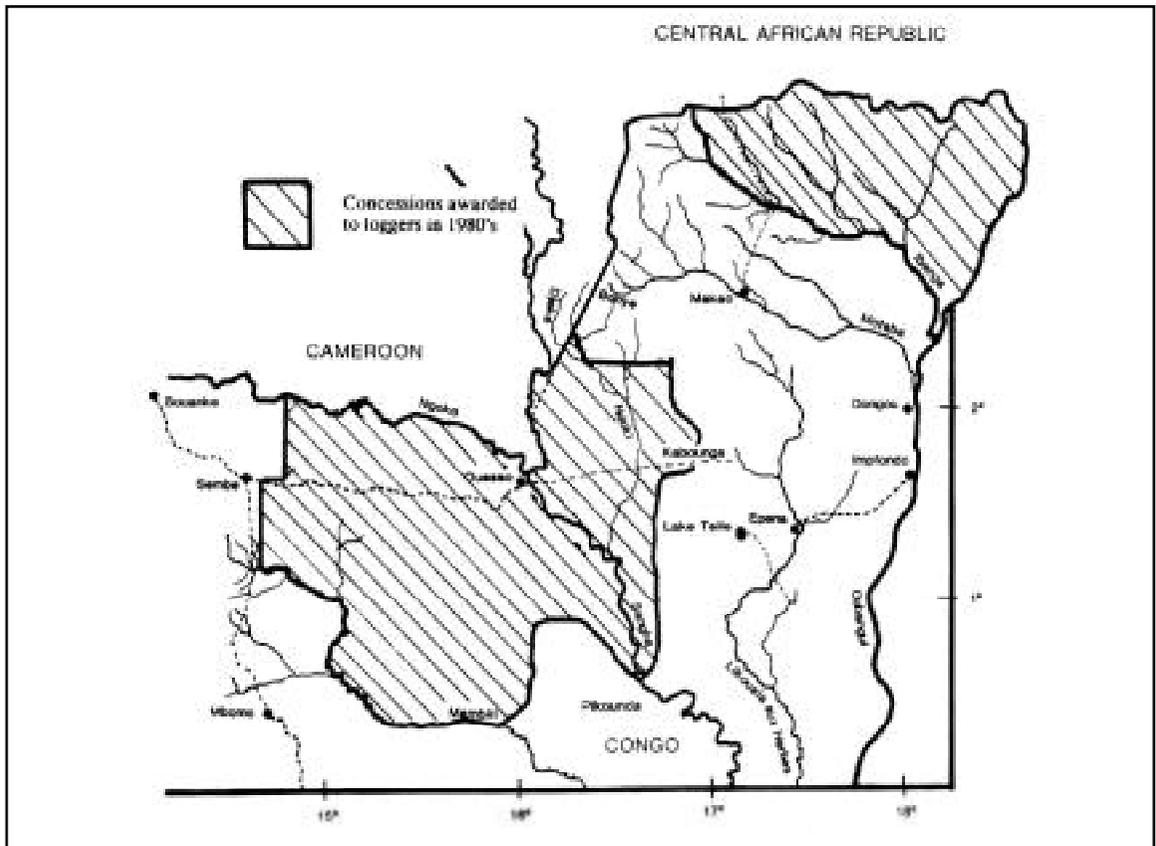


Figure 3: Forest area of Northern Congo awarded to logging companies in the 1980s

of high densities of elephants in two sites, one north of the present Parc National d'Odzala and the other in the proposed Nouabale-Ndoki Park. In addition medium and low densities were discovered in other sites. It was shown clearly that the density of elephants was correlated with the distance from the nearest village ( $r=0.83$ ). Based on this correlation a hypothetical map of elephant density in northern Congo was produced (Figure 2).

The study also revealed, from interviews with local government officials, Moslem traders, resident expatriates, poachers and local villagers, that elephant poaching was proceeding on a large scale throughout the range of the species in northern Congo. Only those areas that were far from human populations were relatively undisturbed.

During the 1980s there was a number of large development projects in the north of the country. Often the employees of these projects had access to

chartered planes and boats which made the illegal export of ivory very easy. Two major road projects, the Dongou to Epena built by the Brazilians and that which linked Owando and Ouessou built by the French, appeared to have major impacts on the elephant populations in these areas. Also during this time more than half of the exploitable forest was awarded to logging companies (Figure 3). The dense network of roads and transportation infrastructure put in place by these companies greatly facilitated poaching and transport of elephant ivory.

In 1990 and 1991 several other sites in the south, the Lefini Reserve in the large savannah area called the Plateau, and a fifth site in the north were surveyed. About two thirds of the forests in the south (Mayombe and Chaillu) are devoid of elephants and elsewhere in the more isolated parts of the forested region of the south, in particular along the Gabonese border, low densities of elephants were found. This is the result of decades of development projects, such as

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the construction of the railroad (CFCO), intensive logging and a relatively high human population density (Agnagna *et al.* 1991).

The savannah block of the country, which represents about 30% of the land surface is practically devoid of elephants (World Bank 1991a),

The results from the site in the NW followed the basic premise of the original correlation of human population density, but this turned out to be quite different from what was predicted by the hypothetical map (World Bank 1991). As a result of gold mining there are large numbers of people in the forests of the northwest, Survey results revealed that the density of elephants was extremely high in the not too distant past, based on scars on the trunks of trees, This population, according to numerous informants, was severely depleted in the late eighties for the ivory market, The major perpetrators were said to be the Bangombe Pygmies working in complicity with Moslem traders, Apparently a very efficient means of killing was discovered, Boards with large spikes through them are placed on an elephant trails, Elephants step on these and are immobilized waiting for the hunter to come along to "check his traps" and shoot the elephants.

## **The Ivory and Hunting Situation in Congo after the Ban**

In the conclusion to the paper resulting from our 1989 survey, which was submitted in 1990, it was stated: "The CITES ban on the trade in African ivory and subsequent price decreases have had a limited dissuasive impact on the level of poaching in the forests of northern Congo (Fay and Agnagna 1992)." An economic argument was presented for why the ban had not worked totally . Elephants were free to poachers in the Congo because there was a negligible chance of being sanctioned for the traffic of illegal ivory. Many people had guns which were still perfectly functional and which represented considerable capitol investment, and people were still paying for ivory. At the same time the country was in the troughs of a terrible economic slump thus profit margins on any activity could be very low and still have participants. The recommendation in the conclusion was as follows: "In order for poaching to decrease, even further profits must disappear. This will take place if the bottom falls out of the ivory market and/or with dramatic increases in the all but

non-existent antipoaching effort to control the trade. This, in economic terms, will add a cost factor to the poachers for the elephants being killed. Profit margins since the CITES ban have decreased significantly. Added effort in controlling the trade and massive antipoaching effort throughout Africa will go a long way toward slowing the rate of poaching."

The overall impression that we have today from "the forest, the smallest village, the middlemen, right up to the major players in the market is that poaching has slowed considerably and that the market for ivory has diminished to a very low level. The price of ivory to producers for tusks in the 8-10 kg range in the field has gone, in some areas, from about 48.00 USD/kg down to 8.00 USD/kg (Fay and Agnagna 1991, Fay 1991). This means that the actual shooters, who are often Pygmies that do not own guns, now get some of the meat whereas before they got radios, clothing, shoes, etc. The price to the buyer in Brazzaville is down to 24.00 USD/kg for tusks in the 10-15kg range. There is absolutely no doubt that the differences in prices for raw ivory are due to the ban. This has led to a lackluster market which has resulted in significant decreases in poaching. This does not mean by any means that the trade in ivory, or the hunting of elephants, has stopped, but only slowed considerably.

Information that we have obtained from five levels in the trade in September and October of this year illustrate this.

In September we undertook the first crossing of the proposed Nouabale-Ndoki Reserve. We traversed 200 km of forest from the Sangha basin to the Oubangui basin. The general trend in elephant populations along the walk, while truncated, followed the trend of increase away from human population (Fay 1992). In 1989 we surveyed the western area of the proposed reserve and discovered four elephant carcasses in a cursory search around the main forest clearing there, including one large elephant that had been killed only a few days previously. This year we found no recent carcasses, yet there has been a great deal of elephant activity around the saline. This is a very positive indication that poaching activity has slowed significantly. Throughout the trip we discovered no elephant carcasses. On the eastern boundary of the reserve elephant dung density decreased precipitously. This is because we entered the hunting range of the village of Makao.

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In 1989, when we visited Makao, which is 225 km from the nearest town, there were at least 5 west African merchants based there. The atmosphere of the village was one of a frontier boomtown. There were many strangers and one could purchase beer, radios, guns, shells, .458 and .375 ammunition, and an abundance of other consumer goods. At least one motorized dugout arrived daily from the regional capital. One of these was named "La flèche de Makao" (the arrow of Makao) and was owned by one of the biggest ivory dealers in the area. In the forest within 30 km of Makao we found a number of poaching camps, many of which we were told had been inhabited not only by Bantu and Pygmy hunters but Moslem buyers. The majority were for hunting ivory. The general impression was of a village experiencing the euphoria of the ivory boom. Upon our arrival in September of 1992 we discovered a completely different place. The Moslem merchants were all gone except one. He stayed on because he was out of money and had married and had children in Makao. He had no goods for sale. The village was very quiet and empty of strangers, even the most basic of consumer goods such as kerosene and cigarettes were unavailable. Motorized pirogues were a thing of the past. The village now gave the impression of precipitous decline. A merchant showed up on the only boat that had arrived in village in the past month. He had great difficulty peddling his soap and salt, the ultimate basics. A man while we were there had to send someone downstream to buy shotgun shells, they were no longer available in Makao. The boat which normally would have carried thousands of shells of all descriptions previously had brought none. Elephants were still being hunted, however. We found out about two elephants which had been killed in the previous couple of weeks in the area. Our impression that these were being killed primarily for meat. Elephant meat was readily available in the village. When we traveled down the river on the boat, however, only a few pieces were loaded on board. There was no evidence of traffic of either elephant meat or tusks on this boat. Three years previously we encountered a very large cargo of elephant meat coming down the river to Dongou. On a recent visit to Pikounda, on the Sangha River, in August 1992 Mokoko Ikonga, one of our collaborators and ex-Directeur of DCF, met with an ivory trader/hunter whom he knew from the days of the trade. Pikounda, a PCA capital, at the height of the ivory trade was

one of the primary locations where large amounts of ivory from the entire Sangha basin was bought and sold. This trader/hunter said that he was still engaged in hunting and was now stock-piling the product. He admitted that the market had dried up and that it was now difficult to get rid of the tusks at a reasonable price. His collection/hunting strategy had gone from an all out blitz to get as much as possible in as short amount of time, to very selective hunting and buying. This individual said that he was optimistic that the trade would open back up and that he would be in a good position to enter the market with a stock of quality ivory. It is not out of the question that he is currently selling some ivory.

On the 8th of October 1992 Fay visited Ndjondo, the famous ivory trading post on the Oubangui River. This again is a village in precipitous decline. The makeshift bars, of which there were about five, all with paved dancing pads and electric wires and different colored fluorescent bulbs were idle and had fallen into disrepair. The three thousand people on the boat that we were on disembarked more as a curiosity, certainly not to cut deals. While it is impossible to know the past and present levels of ivory traded through this village, it is very obvious that its economy has folded and this is entirely due to the crash in the ivory market. We can only assume that the amount of ivory passing through Ndjondo has plummeted.

On the 11th of October 1992 Fay interviewed Mr. Frank Ebatha, who held the largest ivory quota issued by the government. In 1989, before the ban and closure of elephant hunting in Congo, Mr. Ebatha held a quota of 562 tusks. During the trade, Mr. Ebatha only traded heavy tusks, averaging between 10 and 15 kg with many in the 20 kg range, and a few in the 30 kg range. He said because he only had a limited number it was much better for him to only purchase the best of the product. At the height of the trade he paid anywhere from 100-150 USD/kg for ivory. He then had to pay the service of DCF 20.00 USD/kg and customs the same. He indicated that his average profit was about 30.00 USD/kg of ivory. If we take an average weight of 12 kg we can estimate that Mr. Ebatha was making over 200,000 USD a year on legal ivory. There is no way to verify if he exceeded his limit through the illicit trade. Given the ease of illicit trade before the ban, and his very good position in the business, this is quite likely. Since the ban came into place Mr.

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Ebatha says that he is no longer in the trade. His evidence is that he has all the tusks, 10 tons worth, that he bought for the 1989 campaign sitting in the house. He estimates that there are currently about 40 tons of ivory stockpiled in Brazzaville waiting for a buyer.

The last of the levels of the circuit is a discussion that we held with one of the larger volume carvers in Brazzaville. Before the ban this individual operated out of the hotels and his home and had a monthly volume of about 8,000 USD. Post ban times have been extremely bad for business. He still does some carving but only gets the occasional client, mostly French. Otherwise he has now gone back to fishing which was his occupation before he took up carving. He says that his income has decreased precipitously and does not have much hope that the trade will open up again. All of his colleagues, he says, have gone on to other endeavors.

While the efficiency of the DCF has not increased, conservation is on the upswing in Congo. In 1991 there were only 28 official game guards in the entire country or 10,000 km<sup>2</sup> of elephant range per guard. In 1990 the budget for the entire game department, to manage all game reserves, and enforce hunting regulations and the trade in wildlife products was 35,900USD (Ndinga 1991), or about 10 cents per k.m<sup>2</sup>. Needless to say the game department did not possess a single vehicle. At the present time there are several projects afoot. In particular in the past year two conservation projects have started in the north of the country. The Nouabale-Ndoki Reserve project funded by WCI and the United States Agency for International Development (USAID) and the Odzala National Park project funded by the European Community. It has become evident that it is totally feasible to put in place an infrastructure, in protected areas, which adds a cost to hunting elephants. In the Nouabale-Ndoki forest we have realized that only a minimum of protection has been needed to make it too expensive for poachers to hunt in the area. In the next year or so the German government and the World Bank, through the Global Environment Facility, will contribute to conservation in Congo. Once these two organizations are in place we will have gone from an annual budget for game and reserve management in the country of 35,900 USD to ca. 4 million USD, an increase of two orders

of magnitude. While it is far from sufficient, it will certainly help to bring us closer to the point where key elephant populations will be afforded protection.

## Conclusion

How has our economic argument for continued poaching and trade in ivory held up since we last wrote about it in 1990 (Fay and Agnagna 1991)? Since that time profit margins have continued to deteriorate. The export market, while there is still the possibility to export to west Africa and there is a small amount of ivory that leaves as carved products, has largely collapsed. Poaching continues for three reasons:

- 1) Elephant meat is still a highly prized, and pricey commodity in Congo. This is still an important incentive for people to kill elephants. In isolated areas the costs of getting the meat out—exceed that paid for the meat so meat poachers do not reach extremely isolated areas.
- 2) There are a certain number of speculators who are optimistic that the trade will open up again. These people are stockpiling, but are very selective in what they buy.
- 3) The price of an elephant to a poacher is still only the very minimal costs of shells, portorage, etc. The system of protection is still not in place that would add a significant cost to an elephant, except in isolated areas such as Odzala and Nouabale-Ndoki where there are now conservation projects. Because of the very deteriorated economy in Congo people are willing to work now at very low profit margins, significantly lower than in 1990.

## Prognosis for the Future

Congo is in the fortunate position to have exported mostly other people's ivory during the boom years, especially that of Zaire. The elephants of Congo are also naturally protected by the forest where it is very difficult to kill herds of elephants. This has left the country with a significant elephant population. This is in contrast to the CAR which lost most of its elephants during the late seventies and early eighties. If the ban is maintained, and prices remain low, it is doubtful that the hysteria which once dominated the

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market will recommence. If the significant progress that has been made in the domain of conservation in Congo in the past year continues until there is a viable system of reserves, as well as stepped up control of poaching in general, the cost of killing an elephant will continue to rise. The end result, even in the short term, may be increasing elephant populations in Congo.

If the trade is resumed in the short term or relatively short term and it becomes acceptable to buy ivory again we would probably see a rapid return to pre-ban poaching and trading levels.—The trade ban though is not a long term solution. The long term solution will ultimately be to make elephants an economically viable commodity through whatever means: photo tourism, hunting safari, meat, ivory, or even for traction. Elephants must also be an integral part of land use management planning, and a proper management infrastructure must be in place that would permit rational exploitation of the resource.

The current reality of central Africa is very far from the ideal. It is very doubtful that these countries will put in place proper land use management practices with proper control structures even in the medium term. More likely we will continue to see deterioration in the state of the economies, law and order, and land use management in the region. On the regional level this leaves us with no option other than to continue with an inadequate short term solution. This does not bode well for a unified front on elephant management in Africa. Ultimately countries capable of management, such as Zimbabwe, will refuse to carry the burden of mismanagement elsewhere. When this happens central African elephants will most likely

face a new onslaught of poaching. We can only hope that before the short term solution is no longer effective that we will reach a sufficiently sophisticated level of management in central Africa to exploit what could be a significant economic resource for the region. This will take considerable investment in land use management, including the creation of protected reserves, training and education.

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# Status of Elephants and Poaching for Ivory in Malawi: A Case Study in Liwonde and Kasungu National Parks

Francis X. Mkanda

## Abstract

An assessment of elephant distribution, numbers, and mortality was undertaken in November 1991 in Malawi. Elephants occupy three recognizable ranges totaling about 10,480 km<sup>2</sup>. Two of the ranges cross international borders, into Zambia and Mozambique, while the last one is fragmented within Malawi. Within these ranges the elephants occupy five major habitat types.

Data from Liwonde National Park show that the elephant population has remained stable since 1978. The population in Kasungu has most probably declined due to crop protection shooting and poaching.

## Introduction

Poaching for ivory appears to have increased in Malawi during the ivory trade post ban period (Dublin and Jachmann 1991). The increase was in spite of a 20% increase in the budget, and a constant mean area coverage per vehicle. The increase in poaching was of concern as 65% of the population estimates were educated guesses, while 30.5% were from outdated surveys (Anon., 1991), and therefore it was necessary to conduct surveys to assess elephant numbers and the extent of poaching.

Funds from the US Fish and Wildlife Service enabled us to conduct the survey in November 1991. The funds were, however, not adequate to conduct surveys in all nine protected areas. Therefore we limited coverage to 6 national parks and game reserves that harboured elephants in 1987. We used different methods to assess the numbers depending on the terrain and sizes of the study area (Douglas-Hamilton, 1992). For example we used aerial sample counts in Kasungu and Vwaza Marsh. In Liwonde National Park we used a total count, and in Nyika, Nkhotakota and Majete we conducted dung counts. We collected mortality data from ledgers kept in each area.

Most of the data are still being analysed. Therefore this report considers elephant numbers and mortality due to poaching in Kasungu and Liwonde National Parks only. A full report will be available in due course.

## Distribution of Elephants in Malawi

The elephant population in Malawi most probably occurs in protected areas only. Two ranges cross international boundaries. In the west, the range extends into the Luangwa Valley in Zambia, and includes the population of Vwaza Game Reserve. In the south, the Namizimu, Mangochi and Liwonde elephant populations are probably part of the range that spans eastward into Mozambique. There is also a fragmented range within the country inhabited by the population of Majete, Phirilongwe, Thuma and Nkhotakota.

By 1989 the elephant range in Malawi covered an area of 10,480 km<sup>2</sup> traversing 5 different habitat types. These are: the alluvial plains, open canopy woodland of hills and scarp *Brachystegia* species, open canopy woodlands of the plateaux (*Brachystegia/ Julbernardia/ Isoberlinia*), mixed . thicket/ woodland of drier upland areas, and woodland/savanna .(mixed species). The 1991 survey suggests a similar distribution in terms of habitat types. The area occupied presently by elephants is not known as we excluded forest reserves in the present survey. Little poaching has been reported in these areas since 1991, and it is therefore likely that forest reserves still contain elephant populations, but these areas need to be surveyed to confirm this optimism.

## Population Status

The 1992 counts show a total of 354 elephants in Liwonde and 926 elephants in Kasungu (Table 1). The trend in Liwonde shows little change between 1978 and 1992 (Figure 1). In contrast, elephants in Kasungu appear to have recovered from a population low recorded in 1987, to numbers close to those

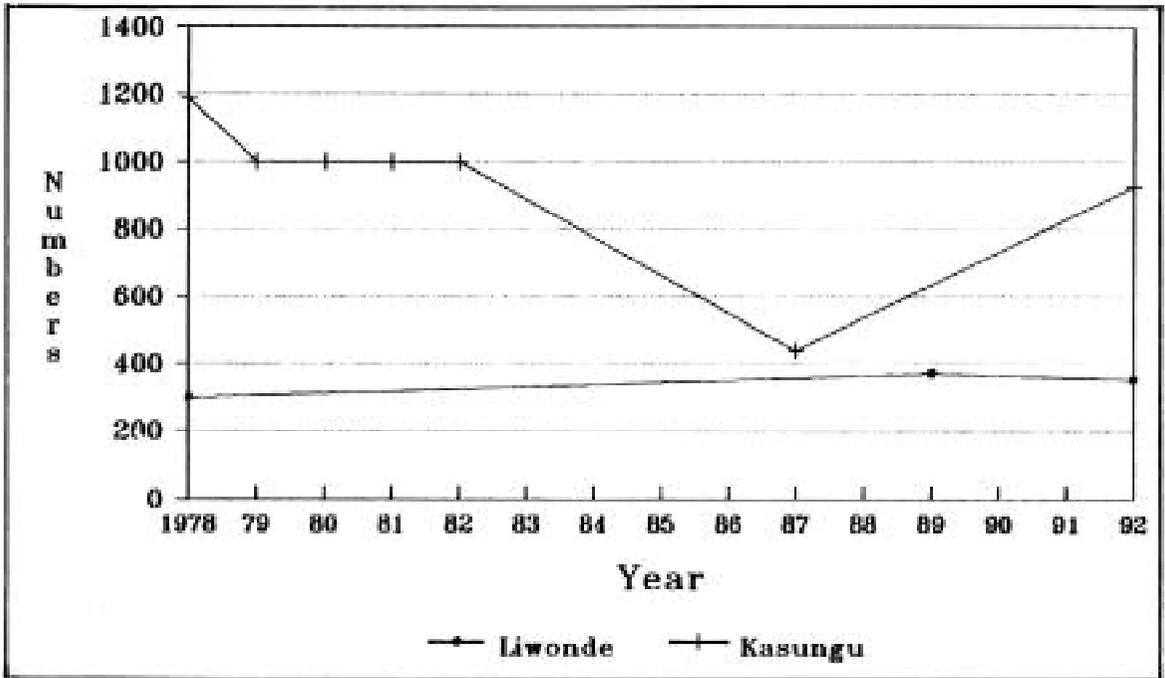


Figure 1: Elephant population trend in Liwonde and Kasungu National Parks in Malawi

recorded in 1978-82 (Table 1, Figure 1). However, the decline and rise of the elephant population in Kasungu between 1987 and 1992 (Figure 1) should be treated with caution. The apparent decline in 1987 was because of under sampling (Mkanda and Mphande, unpublished data). In 1987 we sampled only 12% of the park while in 1992 the sample size was about 38%.

Table 1: Elephant population estimates, Liwonde and Kasungu National Parks

Year	Liwonde	Kasungu
1978	300	1189
1979-82	-	1000
1983-86	-	-
1987	-	440
1988	-	-
1989	371	-
1990-91	-	-
1992	354	926

A larger number of elephant carcasses were found in Kasungu than in Liwonde from 1985 - 1992 (Table 2). However, this could be due to a variety of factors including differences in the size of the elephant populations in the two areas or differences in patrolling efficiencies. Given observed trends in the two elephant populations, it would appear that poaching is higher in Kasungu than Liwonde. This

Table 2: Elephant mortality due to poaching, Liwonde and Kasungu National Parks

Year	Liwonde				Kasungu			
	M	F	Un	Total	M	F	Un	Total
1985	0	0	3	3	6	3	6	15
1986	1	0	0	1	6	5	26	37
1987	1	0	4	5	2	0	7	9
1988	1	0	25	26	5	4	7	16
1989	0	0	0	1	5	6	15	26
1990	1	1	7	9	9	11	13	33
1991	4	1	0	5	12	13	1	26
1992	2	0	1	3	4	0	1	5
	10	2	40	48	49	42	76	167

M = male, F = female, Un = sex unknown

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differences could be because of the socio-cultural and economic setting of the two parks. Liwonde is surrounded by Muslim communities who prefer poaching for fish than meat or ivory, while Kasungu National Park is surrounded by subsistence and commercial farmers, for whom poaching helps recover their loans for agricultural inputs (Bell 1984).

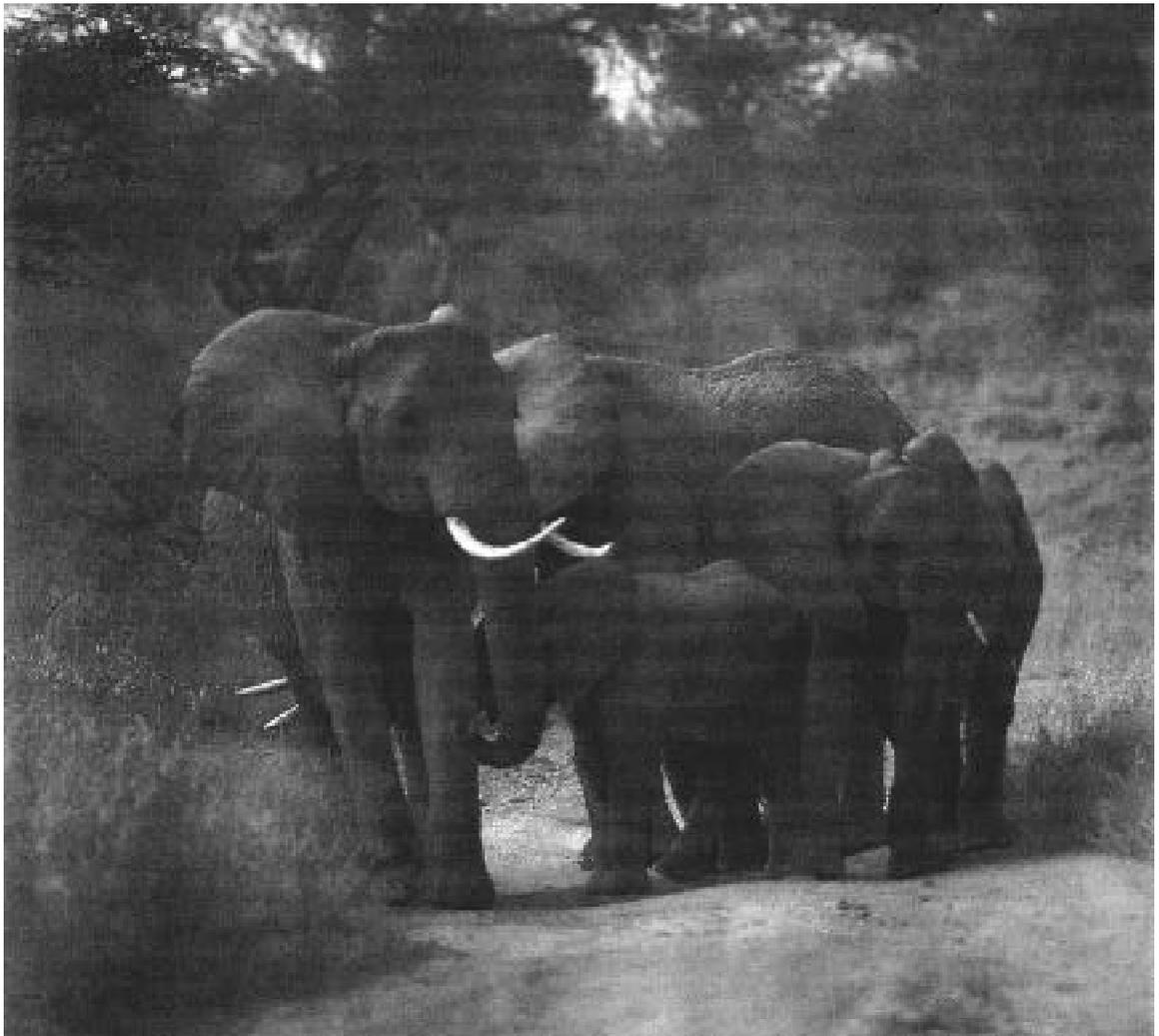
## Conclusion

As part of a nationwide survey of elephants, data from two parks in Malawi show that elephant numbers have remained stable in Liwonde, but have most probably declined slightly in Kasungu due to poaching and crop control. The results from the full nationwide survey are still being analysed.

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Photo by: Ralph Klumpp



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# Kenya's Initiatives in Elephant Fertility Regulation and Population Control Techniques

Joyce H. Poole

## Abstract

During the last two decades, Kenya's elephant population was reduced by poaching from some 170,000 to 24,000 individuals. As a result of the 1989 ivory trade ban and increased protection efforts by Kenya Wildlife Service, the illegal killing of elephants has now essentially stopped. As the country's elephant population gradually recovers from the years of poaching, some populations, and particularly those that are fenced, may eventually need to be regulated. The Kenya Wildlife Service is opposed to the culling of elephants, except where absolutely necessary, for several reasons including: ethical considerations; the negative impact that killing elephants in our protected areas would have on tourism; and the destabilising effect that culling would have on population dynamics. We are, therefore, embarking on a programme of research and development to produce humane methods of elephant population control. The Kenya Wildlife Service is looking into a range of new technologies including abortion, contraceptive vaccines and steroid implants or solutions. In evaluating the different options we will pursue methods that are both practical and feasible and ensure that we develop a programme that will not cause undue stress to the elephants nor disrupt social behaviour.

## Introduction

Between 1973 and 1989 Kenya's elephant population was reduced by poaching for the ivory trade from some 170,000 to 24,000 individuals (Poole *et al.*, 1992). As a result of the 1989 ban and increased protection efforts by Kenya Wildlife Service (KWS), the illegal killing has essentially stopped (KWS elephant mortality database). As Kenya's elephant population gradually recovers from the years of poaching, some populations may eventually need to be regulated. While Kenya's elephant population is now a mere fraction of what it was twenty years ago, there are pockets that are approaching a situation of "too many" elephants.

For example, *in* some areas of the country, elephants sought refuge from poaching by concentrating in parks and reserves thus creating compression and localised habitat destruction (eg: Amboseli National park; Maasai Mara Game Reserve). Other areas outside parks that were previously inhabited by elephants have now been turned over to agriculture. Since the cessation of poaching elephants have started to return to their former range and in doing so they have come into conflict with a newly settled and expanding human population (eg. in Taita Taveta District near Tsavo; across Laikipia District). In other parts of the country, formerly pastoral peoples are being encouraged to settle and are turning to agriculture, thus creating conflict between elephants and people where they were formerly compatible (eg. the Maasai in Narok and Kajiado Districts; the Pokot and Turkana near Nasolot and S. Turkana Reserves, the Samburu near the towns of Isiolo and Maralal; the Rendille and Boran around Marsabit Reserve). In still other parts of the country, the Government has degazetted segments of forests to provide land for the landless creating "island farms" in the middle of elephant habitat or "forest peninsulas" surrounded by farms, thus providing a perfect situation for crop raiding to thrive (eg. around Mt. Kenya Forest; Aberdare Forest; the Mau Forest; on the Siria Escarpment). Finally, from recent surveys undertaken by KWS during the last two years, it is clear that elephants living in forests survived the years of poaching better than savanna dwelling elephants. It is also around the forests of Kenya that the best arable land is found and thus conflict between elephants and people in these areas is intense (eg. Shimba Hills Reserve; Mt. Kenya Forest, Aberdares Forest).

To reduce the injury and damage to human life and property and to ensure support for wildlife conservation in general, KWS has decided to fence several parks, reserves and forests (eg. Shimba Hills Aberdares Forest Mt Kenya Forest. Mwea Reserve). The concern is that in solving one problem we may be creating another. Once fences are erected, the concentration of elephants in one area may lead to

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habitat destruction and loss of biodiversity. KWS will be initiating studies in several of these areas to monitor the impact of elephant density on high and low rainfall habitat from savanna bush to forest.

In some of these areas, particularly savanna habitats, it is expected that some form of elephant population control will eventually be required to prevent “undesired” loss of habitat. In some areas of Africa, this problem has been dealt with through culling schemes. KWS considers this solution to be unacceptable for several reasons including: ethical considerations, the negative impact that culling would have on the behaviours of elephants and thus on tourism and the destabilising effect that it would have on population dynamics. KWS has therefore resolved to embark on an immediate programme of research and development to produce humane methods of elephant population control. The overall programme objective is to develop a method of elephant fertility regulation that is a humane alternative to culling.

## Potential Contraceptive Methods and Population Models

The concept of regulating the fertility of non-human animal species is not new. In recent years techniques for fertility regulation of domestic and wild species have made considerable advances. Fertility regulation has been successfully carried out in animals ranging from dogs, cats, racoon, white tailed deer, elephant seals, and domestic and feral horses. Thus, the concept of fertility regulation (or “family planning” as it has been dubbed), for elephants is not as alien as it may initially seem. However, elephants do present particular problems (they are large, dangerous, highly mobile, intractable, and have a not altogether typical reproductive system), and even if a suitable, practical method is developed, it is recognised that in some environments no fertility regulation approach will be possible or applicable (Poole, 1992).

Fertility regulation approaches will be targeted at females rather than at males. There presently are no “male” approaches that have a likelihood of maintaining or reducing existing populations. Behavioural data suggest that even if a large number of males were removed from the population and only a few reproductively intact bulls remained, a high number of pregnancies would still result. The programme will therefore investigate several different

approaches to contraception for female elephants including pregnancy termination, immunocontraception and steroids. It will be necessary to develop techniques that do not require anaesthesia for contraceptive delivery since immobilisation would be disruptive to elephant behaviour and would be expensive as well as dangerous to personnel and the targeted elephants. However, occasional anaesthesia will be necessary during the developmental studies for assuring the delivery of certain compounds, collecting biological materials and for assessing the impact of new delivery darts.

KWS is considering several different techniques including pregnancy termination using a compound known as RU 486, immunocontraception, and a steroid approach. We are collaborating with a number of different institutions and individuals to develop the different methods and to model their effects on elephant populations. Each of the different approaches has its own particular advantages and drawbacks (Poole, 1992).

For example, while pregnancy termination using RU 486 (which is now used widely by women) could be ready for testing within a few months and could increase the interbirth interval by two years, it would have to be fed to an individual elephant, making it impractical for use except in small populations where habituated individuals could be trained to take the drug embedded in a piece of fruit.

Steroid hormones, on the other hand, can be delivered orally, injected or implanted. But the potential problems of a steroidal approach include delivery, health effects and incorporating sufficient steroid into implants to suppress reproduction in a species as large as the elephant (Brown *et al.* 1992). It may prove difficult to produce an implant of acceptable size and shape for remote delivery of steroids for use in elephants. Elephants produce low circulating concentrations of progesterone, therefore, it is possible that the species is hypersensitive to exogenous progestin, and a relatively small dose may well suppress ovarian activity. Since routine anesthesia is not acceptable, this approach must rely on the development of a new dart implant. The first study will be to develop a technologically efficient dart for the intramuscular administration of a chemical delivery implant. Additional studies will determine 1) the ideal steroid for suppressing reproductive

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activity in elephants, and 2) the technical feasibility of incorporating sufficient steroid into a silastic implant that could be delivered within the technical limitations of the implant dart.

Contraceptive vaccines have the advantage that they can be either reversible or permanent, depending upon the nature of the immunological approach and the immunogen which is used for immunisation (Dunbar, 1992). Immuno-contraception has been successfully used in a number of wild species and is seen as being the most likely to succeed in the longer term. However, the development of an appropriate contraceptive vaccine for use on wild elephant populations will undoubtedly require five to ten years of research. The first phase of the study will involve captive animals and will aim to determine the feasibility of injections into skin versus muscle, the presence of adverse tissue reaction to delivery and if antigen injection elicits an immune response. The second phase will be a field study with the aim of determining whether the vaccine induces short or long-term infertility.

The efficacy of any fertility control technique is dependent upon the numbers and ages of individual elephants treated. In most areas of Kenya we would be aiming to maintain elephant numbers at their present level. We are thus primarily concerned with reducing rates of population growth. Two general strategies may be pursued to achieve this, one is to increase the age at first reproduction, the other is to increase inter-birth interval. In some areas it may be possible to apply techniques that lead to decreases in fecundity through increases in both inter-birth interval and age at first reproduction.

Preliminary calculations based on demographic parameters derived from the well studied Amboseli population (Dobson, 1992; Moss 1992), suggest that increasing the average age of reproduction by two years (from 13 to 15 years old), and increasing inter-birth interval from four to six years, would be sufficient to hold most populations at a constant size.

Techniques that induce abortion at around 12 months of pregnancy should produce an increase in interbirth interval from four to six years in individual females. In any population each female would need to be treated only once every six years, so in a population of around one thousand elephants, sixty to eighty mature females would be treated each year. In contrast, if an immunocontraceptive is developed that leads to female sterility, the eventual treatment of thirty percent of mature females should be sufficient to hold a population at a constant level. These numbers may be reduced if a significant proportion of young females are induced to abort their first calf.

Although fertility control may reduce the size of elephant populations, their rate of decline will be determined by their overall mortality rate; thus, even if births are halted completely it may take twenty-five to thirty years for the population to decline by fifty per cent (Dobson, 1992). This calculation emphasises the importance of developing a fertility control technique that may be applied as soon as possible.

## Discussion

Contrary to recent accounts in the press, Kenya is not suddenly suffering from an overpopulation of elephants. Our concern is that over the course of the next few years we will have several elephant populations enclosed by fences. Under this circumstance, it is likely that in the longer term we will face a problem of habitat loss caused by high densities and restricted movement of elephants. Our interest in developing a programme of elephant fertility regulation comes from a belief that there are better ways to deal with the problem of "too many elephants" than to repeatedly kill off a proportion of the population. Developing a feasible and humane method of elephant fertility control will require a number of years and dedicated teamwork. We welcome the collaboration of others who are interested in achieving a similar objective.

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Photo by: Jared Crawford



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# Number and Migration Patterns of Savanna Elephants (*Loxodonta africana africana*) in Northern Cameroon

Martin N Tchamba

## Abstract

The Sudanian region of Cameroon covers about 198,000 km<sup>2</sup> and comprises two major domains: the sahelian and the sudanian. The Waza-Logone floodplain lies in the sahelian domain and contains one of the largest elephant populations of the soudano-sahelian region of West and Central Africa (1,100 elephants). In the dry season elephants stay in Waza and Kalamaloué National Parks because of water availability, and move out during the rains when there is also less perennial grass available inside the parks. A sub-population of elephants migrates between Waza and Kalamaloué. In the dry season they are in Kalamaloué and in the wet season they move back towards Waza. The prolonged stay of an increasing number of elephants is having deleterious effects on the vegetation in Kalamaloué Park.

There is another major population of elephants located in the band of sudanian vegetation which lies north of the Adamawa Plateau and south of the sahelian domain (1,620 elephants). The three national parks of Faro, Bénoué and Boubandjida lie in this zone. Seasonal movements again appear to be correlated with water and food availability, but are limited.

Recently a herd of more than 320 elephants has entered the Kaélé region (70 km south of Maroua) near the Chadian border. Their origin is unknown, but it appears that they have crossed into Cameroon from Chad. The origin of these elephants and the causes of their migrations need to be urgently determined if measures have to be taken to prevent further crop damages (estimated at more than \$ 200,000) and humans lost (3 dead) from immigrants.

Elephant migrations in northern Cameroon are cause for concern to farmers, local authorities and conservationists. Elephants are killed, farms are

damaged and crops lost. Elephants might loose the battle unless the sources of conflict are removed.

## Introduction

The vast majority of Cameroon's elephant live in the dense forest zone, and most of them stay outside of the country's protected area system. There are populations, particularly of the savanna elephants, living inside the protected area system, most notably the Waza-Logone flood-plain, but their seasonal migration has become a serious concern to farmers, economists and project designers.

The situation in Northern Cameroon is different from that in Southern Cameroon, Central, Eastern and Southern Africa, in that the elephants in the north are under far greater pressure from human populations competing for space and altering natural habitat.

Northern Cameroon comprises two major domains: the sahel domain and the sudanian domain. Historically, elephants were rare in the sudanian domain in 1933 (Flizot, 1948). There were small numbers (20) in Boubandjida and the Vina valley, south of Ngaoundéré, but they were not known to occur in the Benoué and Faro Reserves until 1946 and 1947. Since then the number of elephants in the region has continued to increase. Flizot (1968) believed that many of the elephants moving into the Benoue region came from Nigeria, where the British Authorities were less interested in game conservation.

The sahel domain in which the Waza - Logone floodplain is located was devoid of elephants until 1947 when the first ones crossed the Logone near Kousseri and took up residence in the Kalamaloué Reserve. Since then their numbers have grown steadily as shown by Flizot's estimates: 250 in 1961, 400 in 1964, and over 600 in 1969 (Flizot, 1969).

Most of this increase was due to immigration from Chad.

A first attempt to assemble all existing information on elephants in northern Cameroon and to determine their conservation status was made within the framework of the National Plan for Elephant Conservation (Tchamba *et al*, 1991). The present investigation is based on this plan, but it is adding much historical and more detailed local information collected since 1990 by the elephant project of the Center for Environmental Studies and Development in Cameroon.

## Study Area

The sahel domain of northern Cameroon extends from lake Chad southwards as far as  $10^{\circ}$  and covers 36,000 km<sup>2</sup>. It includes two distinct vegetational communities: thorny grasslands with *Acacia spp.*, *Balanites aegyptiaca*, *Tamarindus indica*, *Calotropis procera*, *Ziziphus spp.*, and periodically flooded grasslands of the Logone-Chari and lake Chad floodplains with *Echinochloa pyramidalis*, *Hyparrhenia rufa*, *Oryza longistaminata* and *Pennisetum ramosum*. Waza and Kalamaloué National Parks are located in this domain (Figure 1). The rainfall is about 1,000 mm per year in the south diminishing to less than 350mm in the north. The dry season lasts 6-8 months. The expansion of agricultural farm lands and wood cutting activities in the Waza-Logone floodplain have led to human-elephant conflicts and to changes in migration patterns.

The sudanian domain extends south from  $10^{\circ}$  N as far as the 800m contour on the southern slopes. of the Adamawa plateau and covers about 162,000 km<sup>2</sup>. Faro, BÈnouÈ and Boubanjidah National Parks are the only protected areas of this domain (Figure 1). This domain is covered with savanna woodland in which *Terminalia laxiflora*, *Isobertia doka*, *Monotes keatingii* and *Anogeissus leiocarpus* are the common species interspersed with fire resistant trees like *Daniella olivieri*, *Lophira*

*lancoelata*, *Borassus aethiopicum*. The rainfall is between 1,000 and 1,500mm per year with a dry season of 3 to 6 months. This ecological domain is very important for savanna elephants.

## Methods

There are few recent accurate counts of elephants in Northern Cameroon. The most accurate are for the Waza-Logone floodplain (including the parks of Kalamaloué and Waza). Data on elephant numbers were obtained by reviewing several reports: Esser and Van Lavieren (1979), Van Lavieren and Esser (1979), Eijs and Ekobo (1987), Steehouwer and Kouahou (1988), Mahamat (1991). Because no elephant surveys have been conducted in BÈnouÈ and Boubandjidah National Parks since 1979, the present estimates are basically guesses. An aerial census of elephants of the Waza-Logone floodplain was carried out in September 1991 and May 1992 (Tchamba and Elkam, 1992).



Figure 1: Location of the study area (1-Kalamaloué National Park, 2-Waza, 3-Boubandjidah, 4-BÈnouÈ, 5-Faro)

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Elephant movements were studied by recording footprints left in the mud and examining the perimeter roads for sign of elephants crossing to areas outside the parks. Observations on elephant movements were also made during aerial surveys. Eight trips were made to areas surrounding the protected areas of the Waza-Logone floodplain to inquire about recent or former movements of elephants. Two trips were made to villages north of KalamalouË park, three to villages north of Waza park, and three others to villages south of Waza. Arrangements were made with game wardens and local agricultural officers for systematic keeping of records of elephants movements in the area (date of arrival, number of elephants, sex and age structure of the group, date of departure, direction of travel).

## Results

Van Lavieren and Esser (1979) estimated the elephant population of Boubandjida National Park at 232 and 150-300 by aerial and ground sample counts respectively. Tchamba *et al.* (1991) gave an estimate of 660 and 540 elephants for Boubandjida and BËnouË National Parks respectively. These estimates were based on an educated guess of 0.3 elephant per km<sup>2</sup> in the region. The same authors estimated the elephant population outside of the protected areas in the sudanian domain at 360. The elephant population of Faro National Park is evaluated at 60 individuals (Tia Esaie, conservator, personal communication) which gives a total of about 1,620 elephants in the sudanian domain of northern Cameroon.

The Waza - Logone floodplain of the sahel domain is one of the last elephant refuges of the soudano-sahelian region. Esser and Van Lavieren (1979) estimated the elephant population in Waza National Park at 465 individuals. Dry season counts at permanent waterponds inside the park mentioned figures of about 750 elephants (Eijs and Ekobo, 1987 ; Steehouwer and Kouahou, 1988). Mahamat (1991) made a total count in KalamalouË during the dry season (the only time when elephants are found in KalamalouË) and found 384 elephants. Aerial census conducted in the Waza - Logone gave an estimate of 1,100 elephants (Tchamba and Elkam, 1992). The total elephant population of northern Cameroon could be estimated at 2,720 individuals. In July 1992, a herd of more than 320 elephants entered the KaËËË region near the Chadian border and increased the number of elephants in the region.

## Migration patterns

There has been no recent observations of elephant migrations in the sudanian domain. Elephants reside permanently in Faro, BËnouË and Boubandjida National Parks. The elephant populations of these parks occasionally forage outside the protected areas. These short distance movements are done at night in the beginning of the dry season when crops are ripe.

Waza National Park is the core area for elephant migrations in the sahel domain of northern Cameroon. Elephants spill out of this protected area and disperse throughout the region on a seasonal basis.

Three elephant sub-populations have been identified in Waza Park. The first sub-population resides in the northern part of the park. At the beginning of the dry season (December-January), this sub-population moves north to KalamalouË Park (Figure 2) traveling about 120 km. Because the floodplain is still flooded these elephants migrate along the eastern part of the floodplain 5 to 10km from the paved road "Waza"- "Kousseri", following a corridor dominated by *Acacia seyal*. They stay 5 to 6 months in KalamalouË with frequent night incursions into farms as far as Goulfey (6 km from the park). At the beginning of the wet season (May - June) this sub-population moves back to Waza following a corridor on the western part of the floodplain, 10 km from the Logone river. This corridor goes through the villages of Kalakafra, Oulouf, logone Birni, Khalkoussam, HinalË, Kaoussen and BËËË (Figure 2).

The second sub-population is made of resident elephants of Waza National Park. They stay in the park year-round. In the wet and early dry seasons (May to November) they use the southern and eastern parts of the park. This region is covered with woodland savanna dominated by *Sclerocarya birrea*, *Anogeissus leiocarpus* and *Lannea lumilis*. In December, January and February (mid-dry season) they move to the floodplain and *Acacia seyal* woodland. At the end of the dry season (March - April), the resident elephants concentrate in the *Acacia seyal* zone.

The third sub-population of Waza uses the southern and central part of park (forest and *Acacia* zone) in the dry season (December-January to May - June). At the onset of the rains the elephants spill out of the park, enter and eat the rich patches of food that

constitute plantations of millet, corn, peanuts and beans. These elephants could be divided into two groups. The first group goes out of the park through Andirni, then passes Alagarno, Fadare and Doubbel. The second group crosses the park boundary towards BandalarÈ, then goes to PettÈ and Doubbel. The village of Doubbel seems to be the elephants' meeting point during their departure and return to Waza.

A few individuals stay around Doubbel with trips to Wolorde. Most of the elephants continue their journey southward, going through Balaza alcali, Djoulgouf, YoldÈo, Ourozangui and Mindif. The elephants of this sub-population migrate up to 100 km from Waza. They return to the park only in December.

A new elephant population has appeared in the KaÈÈÈ region since July 1992. Investigations made along the Maroun-Bogo-Maga road (mandatory crossing for elephants moving south from Waza) indicate that such a number of elephants (more than 320) have not passed through that area. These elephants have probably migrated northward either from south west of Chad or from Boubandjidah National Park located only about 150 km south of the region. At the time of this study it was not possible to visit these two areas because of inaccessibility (wet season) and lack of authorization from Chadian authorities.

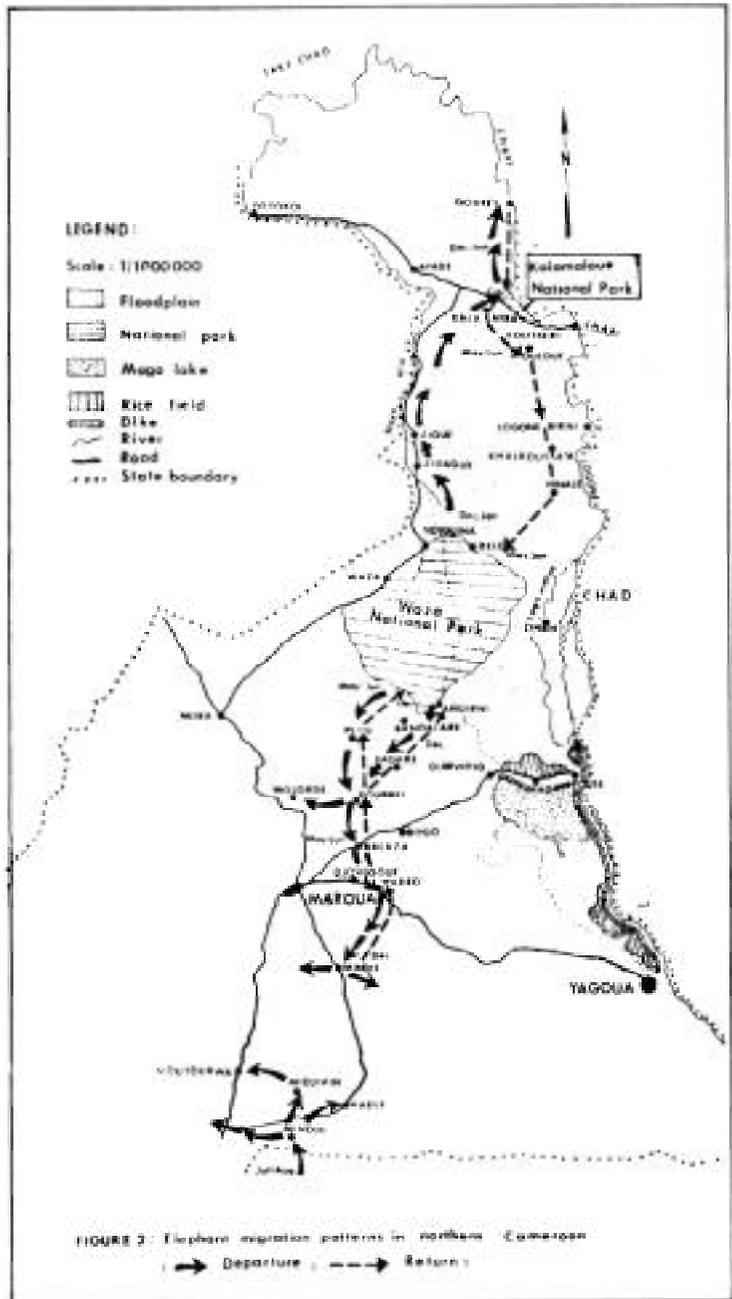


Figure 2: Elephant migration patterns in northern Cameroon

## Discussion

Since about 40 years ago the elephant population has continued to increase in northern Cameroon. Most of this increase is due to immigration from Chad and Nigeria but observations indicate that considerable breeding is taking place. The elephant of northern Cameroon generally carries small tusks rarely exceeding 25 kg each side, a factor which has doubtlessly weighed in their favour. In order to

determine the conservation status of elephants in the sudanian domain of northern Cameroon, it is necessary to investigate the population size in each protected area (BÈnouÈ, Faro, Boubandjidah), degree of isolation and possible interchange with neighbouring elephant populations.

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In the Waza-Logone floodplain elephants show two distinct migration patterns. When one sub-population leaves Waza Park in December-January and travels north to KalamalouË Park, another sub-population returns to Waza after spending the wet season raiding crops south of Waza. The reasons for these migrations are probably similar. Water is available during the dry season only in the two artificial waterholes of Waza and in the Logone river bordering KalamalouË Park. To avoid competition for limited food and water in Waza, part of the elephants move to KalamalouË where there is more water and more diverse savanna woodland. These elephants are replaced by elephants confining themselves to within 10km foraging radius of the artificial waterholes.

Migration often starts a few hours after the first rains, long before vegetation has responded to it, further supporting the hypothesis that water restricts the movements of migrants during the dry season. Support to this argument is given by the observation that elephants stay longer in the Mindif area where boreholes were sunk in 1985 for livestock.

Seasonal migrations and habitat selection have been reported for many elephant populations (Laws et al. 1975, Eltringham, 1977 ; Caughley and Goddard, 1975, Western, 1975 ; Short, 1983; Jachman, 1983 and 1988; Butynski, 1986; Merz, 1986 ; Roth and Douglas - Hamilton, 1991). The movements appear to coincide with changes in food and water availability. Water availability (pull factor) alone cannot fully explain the migration patterns of Waza elephants. Forage requirements (push factor) also contribute to their leaving Waza Park. The reduction of the flooded area of the Waza-Logone floodplain has led to the replacement of perennial grasses by annual grasses which cannot produce nutritive regrowth for wildlife and cattle (Oijen and Kemdo, 1986).

The expansion of agricultural land and wood cutting activities coupled with the construction of the Maga dyke (Figure 2) has resulted in an apparent maldistribution of people with respect to elephants, and changes of migration patterns. Farmers continually face the threat of extensive elephant damage on crops and elephants are subsequently killed to protect people and crops. Elephant crop damages in the KaËË region were estimated at more than 200,000 US dollars between July and October

1992 (Thouless and Tchamba, 1992). Three persons were reported killed by elephants in the same period.

Elephant migrations also have an impact on the natural vegetation. (Tchamba and Mahamat 1992) observed that the "elephant problem" in KalamalouË National Park was significant. They noted large scale killing of mature trees and serious damages on the regeneration of vegetation, and concluded that the habitat would not remain in equilibrium with regeneration not balancing the losses.

A good understanding of elephant movement patterns is necessary for a better management of protected areas to the benefit of both elephant and man. A study is currently being conducted to determine the natural factors (vegetation composition, structure productivity, digestibility and succulence, phenology, water availability) and human factors (crop presence, forms of disturbance and distance to them, poaching) which influence movements and the most important ones in time and space. Radio/satellite telemetry is also being conducted to determine elephant home ranges. The ultimate goal of this study is to propose solutions that would allow the coexistence of the presently opposing domains of agricultural development and conservation in northern Cameroon.

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# The Movement Patterns of Elephant in the Kruger National Park in Response to Culling and Environmental Stimuli

Ian Whyte

## Introduction

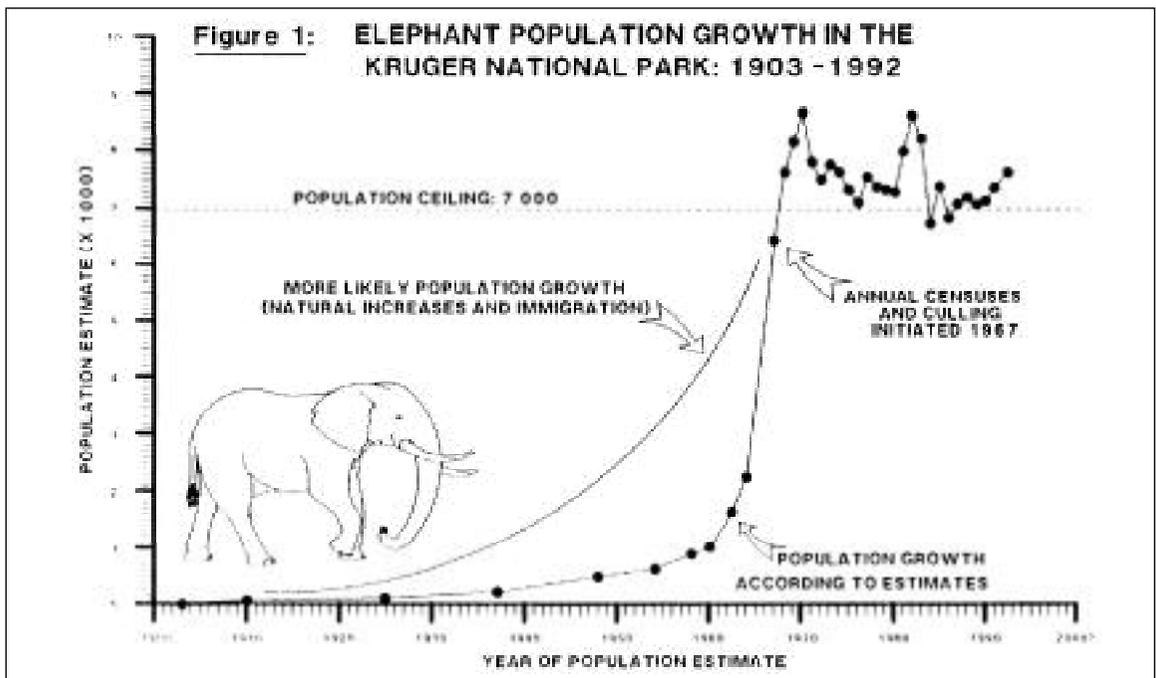
The elephant population of the area now comprising the Kruger National Park (KNP) was almost extirpated before the proclamation of the area as a game reserve in 1903. The population then grew gradually through both immigration from Zimbabwe (then Rhodesia) and Mozambique, and through natural increases until 1967 when the decision was taken to restrict the population (through culling) to a level around 7,000. This policy has been successfully applied since then and the most recent census of the population in September 1992 indicated a total of 7,632 animals (Figure 1). The philosophy behind this policy has been discussed by Pienaar (1983) and defined by Joubert (1986).

The elephant population is censused annually in August/September using a Bell "Jet Ranger" 206 helicopter. The standardised method (Joubert, 1983)

has delivered a total of between -4,4% and +7,9% of the expected result since 1982 (Whyte & Wood, 1993).

Elephant culling is conducted from a Bell 206 "Jet Ranger" helicopter. Animals to be culled are darted using "Scoline" (Succinylcholine chloride) and are brain shot as soon as they become recumbent to prevent the inhumane effects of suffocation caused by the Scoline (de Vos *et al*, 1983). Younger, more tractable animals are immobilised using M99 (Etorphine hydrochloride) for translocation to other conservation areas. Approximately 360 animals are culled annually - 310 from breeding groups and 50 adult bulls.

It has been suspected for some time that some form of disturbance results from such culling operations, as reports are received from field staff engaged in culling operations that the elephants had









**Figure 4: RESPONSES OF AN ELEPHANT COW (No 01)  
TO CULLING AND RAINFALL (See text for explanation)**

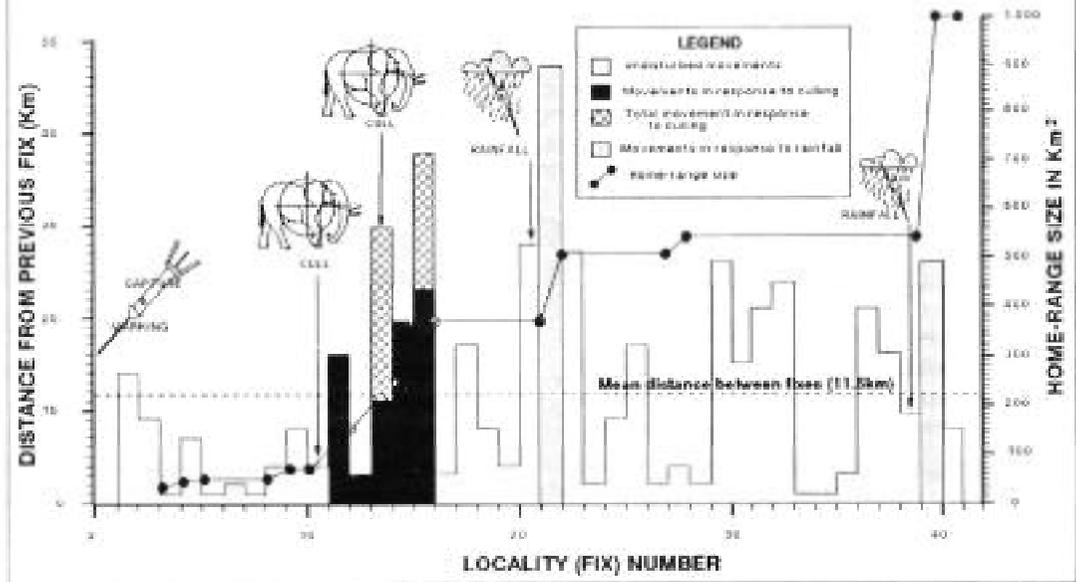
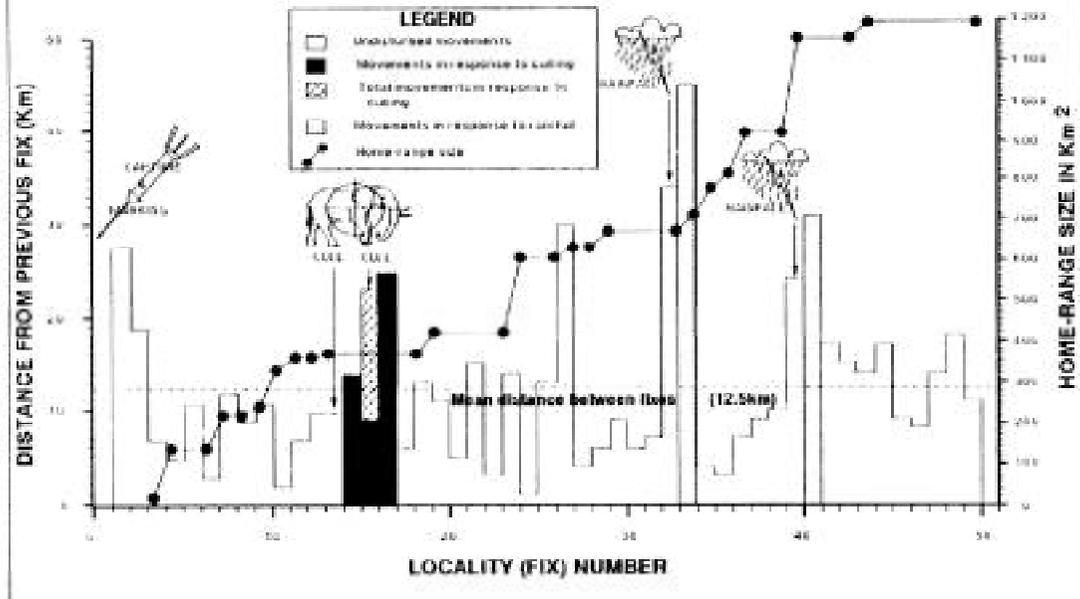
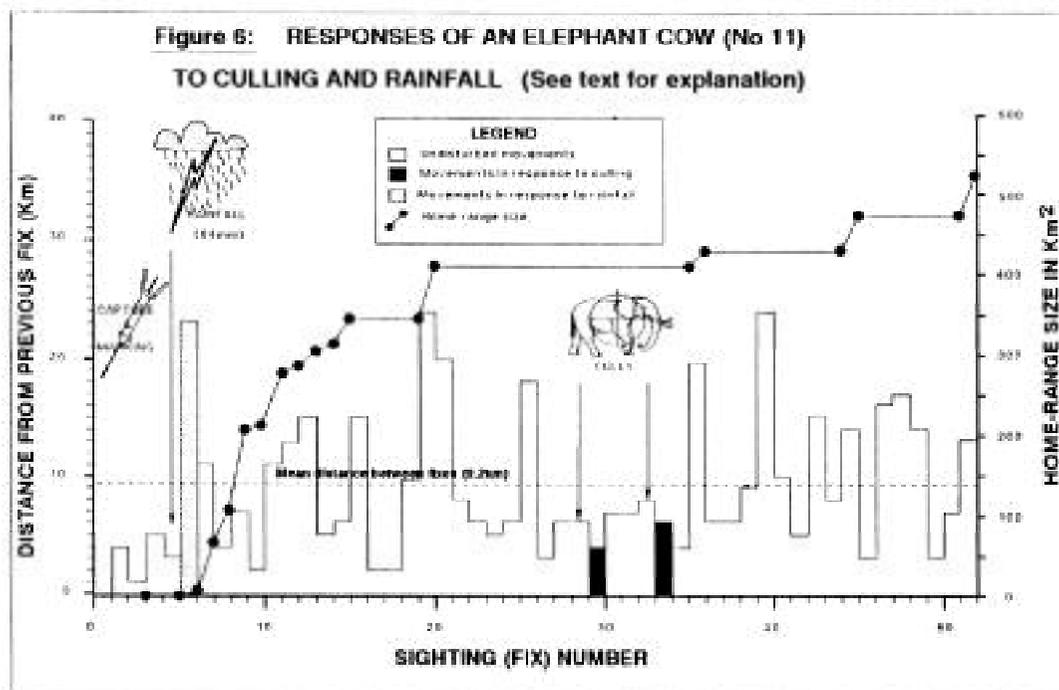


Figure 4 shows how elephant cow 01 responded to two culling operations by significant movements. After each cull her movements resulted in an increase in her recorded home-range. The first cull was conducted approximately 7km from her location in spite of which she responded

by a significant movement of 30km in a straight line over two days (it would seem that “infra sound” (Langbauer *et al*, 1991) must have played some role in the communication of the animals being culled and the radio-collared group as 7km is a long way for the sounds of the helicopter and

**Figure 5: RESPONSES OF AN ELEPHANT COW (No 06)  
TO CULLING AND RAINFALL (See text for explanation)**





rifle to have been such a disturbing factors). The second cull was conducted very close by (<1km) which resulted in movements of 38km over a period of eight days. On two subsequent occasions, she again undertook significant movements in response to a localised rain showers which also resulted in an increase in her recorded home-range. In the second case, the movement took her way out of her “normal” home-range which nearly doubled its area. In this animal’s case, the movements in response to rainfall were far more significant than to those in response to culling both in terms of distance between successive fixes and increase in recorded home-range size.

The responses of elephant cow 06 to culling are illustrated in Figure 5. Culling was conducted out of a herd of 57 animals of which she formed part. She responded by moving 23km over the next two days. This herd had by then been joined by others and was 85 strong and was then culled again. She responded by moving all the way back almost to the previous culling site - 25km overnight. Although these movements were significant in terms of distance between successive fixes, it can be seen in Figure 5 that there were no concomitant increase in home-range size. In this animal’s case,

rainfall again induced movements which were significant in terms of distance and home-range size increase. In contrast to the above two cases, Figure 6 shows that elephant cow 11 showed a response to rainfall which resulted in only a small increase in home-range size (this was because all of the fixes obtained up to that time fell almost on a straight line). She was then exposed to two culls. In the first case she was located three kilometres from the cull while in the second, her immediate family group were culled. Culling of her group was actually under way when the pilot saw that she was carrying a collar and the culling for the day was stopped. She and four others (ages and sexes uncertain) were left. In spite of the trauma that this must have caused, her responses to both of these culls were very slight - 4km and 6km respectively, and neither of these resulted in home-range size increases.

3. *Long-term stability of home-ranges* A radio-telemetry study of the movements of breeding herd elephants in the Kruger National Park in the early 1980’s was conducted by Hall-Martin (1984). The comparison of the results of his work with those of the present study suggest that clans may show a high degree of fidelity to home-ranges over a considerable period (10 years or more). Figures

7a & 7b illustrate the home-ranges he recorded overlaid with those of the present study. It is not known whether the animals he studied are definitely from the same clans as those presently under study, but this, with minor differences, would certainly seem to be the case. The home-range sizes recorded by me appear to be larger than those by Hall-Martin (1984) which may be related to the extreme drought conditions which have prevailed during most of the present study.

## Discussion

As with other studies, the analyses of home-range and movement have not been entirely satisfactory as there are limitations to these kinds of data. The major limitations during this study were that:

1. Collared animals could not be tracked regularly. This makes the comparison of the distances between fixes difficult or even superfluous as periods between tracking varied from hours to weeks
2. Minimum convex polygons do not give an accurate idea of the actual area important to the collared animal. They give an indication of the total area that the animal may use but this tells nothing of how the range is utilised.

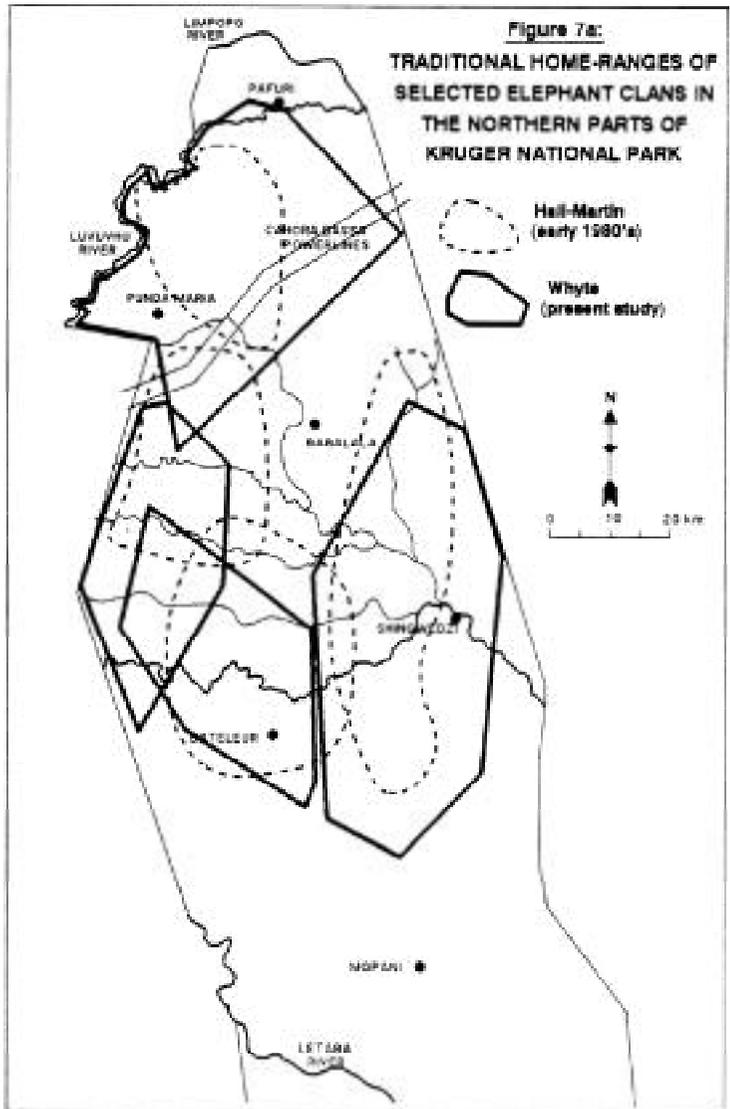
Given these two shortcomings, there is still some useful information that has emerged.

### 1. Home-range size

It becomes apparent that home-ranges can never be satisfactorily determined when studied in this manner. The area of the home-range increases with time after collaring and the number of fixes. From Table I it is clear that the longer an animal is tracked, the larger will be its recorded home range. This continues to a point where it looks as if the picture is complete when suddenly a movement occurs in response to some stimulus which takes

the animal outside of its previously recorded home-range and adds significantly to its area. Figure 4 illustrates this well. After fix 28 up to fix 39 it seemed as if the limits of the home-range had been determined. This was from 11 to 29 months after collaring when suddenly the area of the home-range increased by 87% in response to rainfall. The movement undertaken to achieve this increase was not particularly large (26km) considering the largest recorded by her was 47km.

Home-range sizes differed considerably even though the animals had been collared for the same

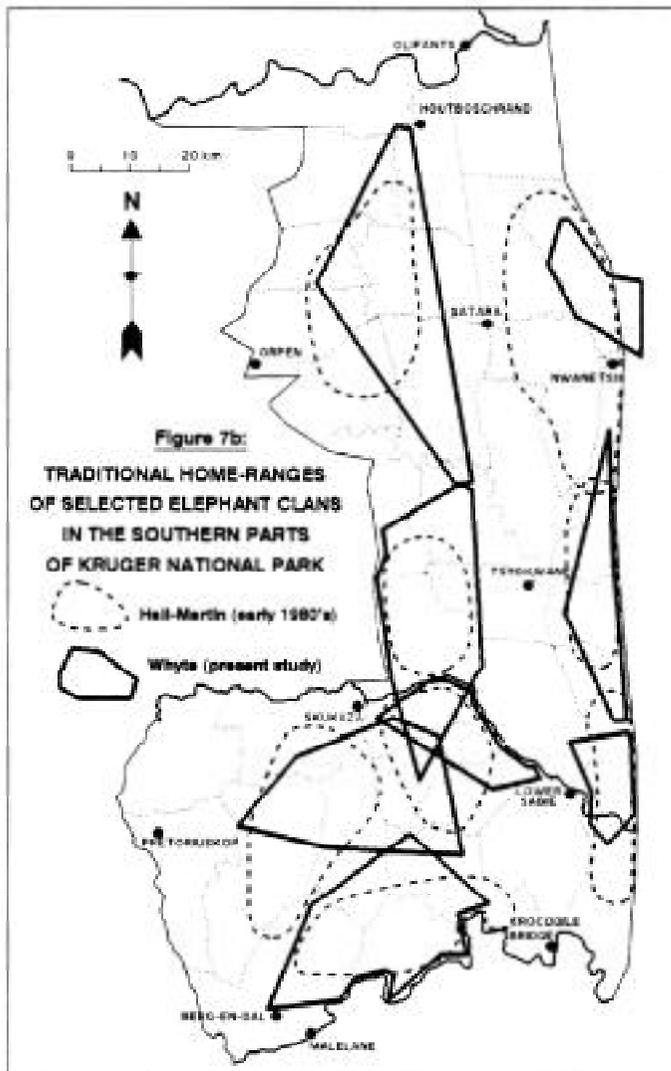


period of time and had been tracked the same number of times. This must be related to the “quality” of the home-range in terms of its ability to provide all of the requirements of the elephant clan. No data are available on this aspect however.

2. *Reaction to culling*

The culling operation clearly instigated movements in some of the collared elephants - some of which took them outside of their previously determined home-ranges. This was mainly due to the short period of time since these animals had been collared. Subsequent to culling and with further study, all of these animals returned to areas in the vicinity of where culling

had taken place and also back again into the areas into which they had “fled” from the culling operation. This suggests that the stress and/or trauma of the cull was not a sufficient stimulus to induce them to leave their home-ranges. Rainfall on the other hand induced some of the longest movements recorded and in the case of elephant cow 01 (Figure 4) appears to have provided a stimulus sufficient to induce her to leave her “normal” home-range. At the last fix she was still in the area added to her home-range by this movement. It may be that time will show that she repeatedly returns to this area when conditions are right and that it does in fact constitute part of her home-range.



**Figure 7b:**  
**TRADITIONAL HOME-RANGES**  
**OF SELECTED ELEPHANT CLANS**  
**IN THE SOUTHERN PARTS**  
**OF KRUGER NATIONAL PARK**

The inconsistency in the results of determining the responses of collared elephants to culling has made the interpretation difficult. It is clear that the response is not predictable and this must have to do with factors which may not be measurable. It may be, for instance that if the matriarch of a group is not

culled, she may lead the remainder away from “danger” to other parts of the home-range. If she was one of those culled however, it may be that the younger animals are directionless without her leadership and thus remain in the area of the culling operation. These are unknown and unmeasurable factors which will always affect responses and which will remain factors in the culling of elephants.

3. *Long-term stability of home-ranges*

The home-ranges of collared elephants studied by Hall-Martin have as yet received only cursory analyses (Hall-Martin, 1984). They suggest however, that there is considerable conformity between them and those of the present study. This is entirely to be expected as elephants are long-lived intelligent animals who must get to know their respective home-ranges very well. Such knowledge would be learned by subsequent generations of calves, and having acquired familiarity with these home-ranges, would no doubt be reluctant to leave.

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There is some degree of nonconformity however, and this begs the questions:

- \* Are the differences that have been recorded due to conditions prevailing during the two periods of study or to insufficient time spent and/or fixes obtained of the respective collared animals?
- \* Are “clans” discrete units each with their respective home-ranges or does each kinship group have its own favoured area which may overlap considerably with those of other kinship groups?
- \* If this latter should be the case, is the “clan” concept valid? A more intensive study of the individual adult animals constituting so-called clans may resolve the question.

## Conclusions

1. Significant movements may or may not be induced in response to culling.
2. In terms of movement, radio-collared elephants showed a greater response to localised showers of rain and resultant vegetation “flushes” than to the trauma of culling.
3. Movements in response to a cull do not seem to take animals out of their normal home-ranges, while those in response to rainfall may do so. Longer term home-range studies may show that these areas used in response to rainfall may in fact form part of clan’s normal home range.
4. Distance of the animals from the cull site does not appear to be a factor determining the response of the animals to the cull, as animals up to 7km from the cull showed a marked response while others who had had members of their immediate kinship group culled showed no response at all. The factors affecting this response may be social and may not be measurable or else only by long-term social studies of family groups and a subsequent experimental evaluation of the responses to specific culls.

An investigation into infra sound vocalisations from elephants being culled, the distance that such vocalisations are audible to other elephants, and the effects on other elephants within hearing range would likely be a fruitful field of study.

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## Acknowledgements

I would like to acknowledge the role of the National Parks Board of South Africa in promoting and supporting this research. The field assistance of Messrs Steven Whitfield and Obert Mathebula is gratefully acknowledged as is the financial support given by the Rhino and Elephant Foundation and “Time Shoppe Sales”.

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# Group size and Ranging Patterns of Queen Elizabeth National Park Elephants

Eve Abe

Like elsewhere in Africa, the elephants of Queen Elizabeth National Park (QENP) suffered a drastic decline in numbers in the 1970's. The major cause was the illegal killing of elephants for the sale of ivory. It was noted that elephant groups had become fewer in the park but one large group had formed. In 1989, therefore, it was found necessary to investigate what effect this critical reduction in numbers had on the ecology of the QENP elephants. This paper, which forms a part of that work, tries to examine the effect of critical reduction on the group size and ranging patterns of the remaining elephants.

Smaller groups of elephants are now very frequent, suggesting that the large semi-permanent groups

may be starting to split up. A group of about 200 individuals which range on the northern side of Kazinga Channel were, at the beginning of the study, encountered only in the areas of Hamukungu and Kasenyi. Now two years later they are frequenting the Crater regions and Mweya Peninsula. A second group of about 60 whose movement is more parallel to the Kazinga Channel have also of late been encountered in the Chambura Game Reserve. The areas least frequently used were undoubtedly where mass massacres took place in the 1970's. It is therefore possible that some of these individuals survived from these regions. Bulls in musth are known to cross the Channel to seek mates.

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## Illegal Activities and Law Enforcement in the Central Luangwa Valley, Zambia, from 1979 to 1992

R.H.V. Bell, H. Jachmann, D.M. Chimbali and E.Y. Mulonda

1. Data on illegal activity and law enforcement from the central Luangwa Valley, Zambia, are analysed for two time periods, the first 1979-82, when the National Parks and Wildlife Service was supported by the Save the Rhino Trust (SRT), the second (1988-92), when it was supported by the Luangwa Integrated Resource Development Project (LIRDIP). Data on the intervening period are not currently available.
2. Prior to 1979, there was effectively no law enforcement in the area which was subject to extremely heavy illegal offtake of elephant, rhino and other species. During the SRT period, there were up to 22 effective wildlife scouts engaged in law enforcement, with an operating budget estimated at US\$1 5/km<sup>2</sup>/year. This was sufficient to reduce but not halt the decline of elephant and rhino populations.
3. The LIRDIP period was supported by major funding from the Norwegian Agency for Development Cooperation, NORAD, which was used for an integrated rural development programme. The wildlife management component was allocated about US\$65/km<sup>2</sup>/year; this led to the increase of scouts to 285 by 1991 and comparable increase in law enforcement effort.
4. Between 1988-92, illegal offtake of elephant was reduced by a factor of 88% to an acceptable level estimated at about 10% of the sustainable yield

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of the population. At the same time, indices of all other classes of illegal activity were reduced by between 75 and 90%.

5. Analysis of the relationships between indices of illegal activity and various law enforcement parameters demonstrates logarithmic relationships indicative of diminishing returns on law enforcement effort and expenditure at low levels.
6. This result leads to the conclusion that, for most wildlife management purposes, including the conservation of elephant, acceptable levels of illegal offtake can be achieved for about US\$ 70/km<sup>2</sup>/year, that is considerably less than the amounts recommended by other authors. It is noted however, that this result was achieved in the context of the LIRD community participation programme. Moreover, it implies a significant increase in staff efficiency, requiring in turn a focus on staff quality at all levels.
7. The proposed scenario is probably not effective for rhino, which are both more attractive to illegal hunters and have lower sustainable yields than elephants.
8. The analysis provides no evidence that the 1990 CITES ban on ivory trading has had an influence on the rate of illegal offtake of elephants.

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## The African Elephant Database

Iain Douglas-Hamilton

The African Elephant Database is a repository of information on numbers and range of the species arranged on a country-by-country basis. Each record of elephant numbers is accompanied by a map showing the specific area to which the estimate refers. Each record is clearly labeled with its own numerical code. Computer-generated maps can be related to accompanying tables that give details such as name of the census zone, date of estimate, counting method, quality of estimate and source of data. The geographical information is digitized from maps of varying scales into a computer where it is stored for further use. In this way, data from different populations or countries can be combined to make maps or produce data overviews on a country, regional or continental scale. Currently the database holds three different layers of geographical information: elephant range, estimates of elephant numbers and distribution of protected areas. However, in our earlier attempts to construct a continental population estimate many more data layers were entered from existing continental datasets such as human population, rainfall, habitat type, various economic indicators at a country level, even tsetse fly distribution. These data were analysed by multiple regression to identify which factors were significantly associated with elephant density. Of all the factors analysed protected

status was most positively associated with elephant density (Burrill and Douglas-Hamilton 1987).

### Uses of the database

Once these data are entered, the computer has great powers of analysis and presentation. It can generate areas from its internal maps and calculate elephant range based on different factors such as country, region, protected status, or the quality of Input data. It thus allows overviews to be constructed at a variety of levels.

While the technique of multiple regression has been valuable in creating a continental overview, it could be even more useful on a country or regional basis where the datasets are of far higher quality and better resolution. For example, a field-derived relationship between elephant densities and the distances from roads or rivers, a GIS technique, coupled with the database, was used to calculate elephant estimates for some Central African forest areas (Michelmore *et al*, in press). The database also has far greater analytical potential which has yet to be tapped. For example, two additional factors that may be strongly associated with elephant densities on the continent are land use and investment in law enforcement within protected areas. The database allows the juxtaposition of these

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and any other existing data sets to assess the factors providing the most predictive powers for the estimation of elephant numbers, densities and trends.

## **Some controversial aspects of the database**

### ***Data Quality***

The quality of data is a controversial topic, because it harks back to the debate over the actual methods used for censusing elephants. For example aerial counting of elephants, although widely accepted, has several different methods each with its own adherents and detractors. The relative merits and demerits of sample versus total counting could fruitfully be discussed to establish which should be the preferred technique for different situations. The need for reporting of confidence limits or other indicators of variance should be discussed also. As things now stand, many of the estimates in the database are not even based on numerical surveys. One person's "informed estimate" may be regarded as another's "unsubstantiated speculation".

The database imposes a challenge to informants to prepare data in a standardised and rigorous way. Its value hinges on the reliability of these estimates. At best, estimates are derived from well-executed elephant censuses. At worst, informants may be tempted to invent data to fill in blank spaces on posted questionnaires. However, variability in the quality of data is a fact of life and it is necessary to classify all data in the database according to reliability. The role of classifying these data has traditionally been asked of the African Elephant Specialist Group. The end result, however imperfect, should be an agreed set of data within the limitations of what is possible. In the past, interpretation of these data has been carried out by many different individuals with differing goals and in some cases, this has created controversy.

The history of variability in data quality has not been all bad. In fact, it has in some cases served to establish where good data are lacking and as an aid to those planning new censuses. Governments may have to choose between maintaining limited but good coverage or improving deficiencies in the extent of census coverage to date. The provision of standardized

data quality indices provide the necessary information to formulate these decisions.

This AESG meeting will hopefully accept the challenge to propose and develop new ideas as to how we might improve the classification of data on elephant numbers. In addition we should try to look critically at the definitions of elephant range versus distribution and to reach a group consensus over a common definition to be used in future. This may also enable us to go back in time and reanalyze historical data in a productive and mutually acceptable way.

### ***Trend Analysis***

Given the variability of data can one compare earlier versions of the database with later ones in order to calculate trends? For a continental dataset of variable quality this is a risky enterprise, but it has been done. For some populations there are consistent data-sets of high quality where such comparisons are generally accepted as valid, although there are few for which a rigorous trend analysis has been performed. In any event there is no general agreement as to how these different data-sets could or even if they should be combined into a regional or continental picture .

### ***Conclusions***

Given the importance of elephant numbers and trends in the conservation and management of the species we cannot walk away from estimating them. Numerous models have been produced, it is our challenge to come up with a mutually agreeable formula for interpreting and presenting data on the African elephant for ourselves and outside audiences. This meeting would do well to explore how better data can be obtained and what acceptable norms can be used for trend analysis. We must also clarify our thinking on the end product, its value for end-users, and who and where these users are.

These issues are open for discussion. There are no prescriptive solutions but I would suggest we should openly discuss these sometimes controversial issues. In so doing we may finally reach some useful definitions of range and distribution, reconcile different types of data gathering and the resulting population estimates, address the problems of analysing population trends over time, and provide a satisfactory product for end-users.

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# The Status of Forest Elephants in the South East of the Republic of Cameroon

Atanga Ekobo

A chronic lack of data made it difficult to appraise the impact of logging activities and ivory poaching on forest elephants in the South East of Cameroon. In response to this situation, Wildlife Conservation International and the World Wildlife Fund, sponsored by the European Economic Community, undertook a series of surveys in the region in 1990 and 1991. An area of 5,594km<sup>2</sup> was studied in three different sites: Lac Lobeke, Mangokele and Boumba-Bek. A total of 290 km of non randomly distributed line transects measuring 5.0km in length and 4.0 x 10<sup>-3</sup> km in width was surveyed. An additional 117 km of logging roads were also studied incidental to moving between

transects. A full description of the study area, methodology and preliminary results is given by Stromayer & Ekobo (1992). The final results of these surveys suggest that the Lac Lobeke, with 4.65 elephants per km<sup>2</sup>, holds the highest density of forest-dwelling elephants yet surveyed in Africa. A total population of 18,163 elephants was estimated in these three areas. Regardless of the ivory poaching and logging activities, these populations still appear both large and healthy and promise excellent and perhaps unparalleled conservation potential. The following table presents an update of the results presented by Stromayer & Ekobo . (1992).

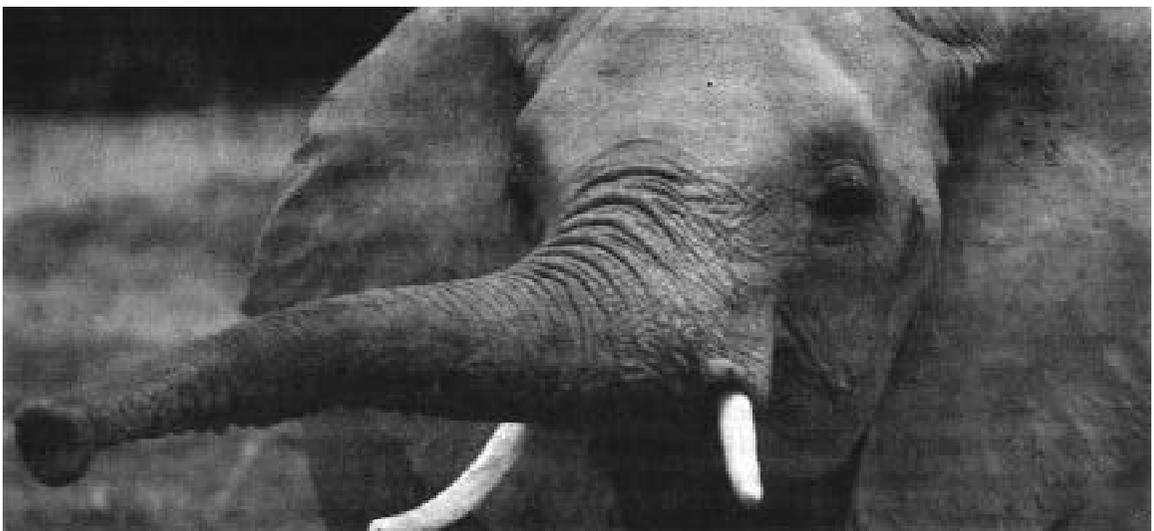
Table 1: Summary of results from the survey in three sites of Cameroon's tropical rain forest

SITE	TOTAL AREA(km <sup>2</sup> )	NO. OF TRANSECTS	AREA SAMPLED (km <sup>2</sup> )	(DUNG PER km <sup>2</sup> )	ELEPHANT PER km <sup>2</sup>	NUMBER OF ELEPHANTS
LAC LOBEKE	2,414	28	0.56	3318.11	4.65	11,225
MONGOKELE	850	10	0.2	3126.50	4.38	3,723
BOUMBABEK	2,330	20	0.4	984.20	1.38	3,215

## Reference

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Photo by: Jared Crawford



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# The Cost of Conserving Elephants

Nigel Leader-Williams

African elephants attract a variety of economic values, whether actual or potential. Furthermore, elephants, to varying degrees in different range states, live both within and outside protected areas. In both situations, elephants are usually in conflict with man. Consequently range states have to expend funds if elephants are to be protected throughout their range. As a general rule, it was necessary to spend around US\$200 per km<sup>2</sup> of protected area in 1981 to prevent the decline of elephants from severe commercial

poaching for their ivory. Following the ban on trade in ivory in 1989, it is imperative that costs of conserving elephants in and out of protected areas in different range states are quantified. Given that ensuring the success of law enforcement efforts is probably the most important management objective for the future conservation of elephants, and given the amount of less relevant research undertaken on elephants, greater emphasis needs to be placed upon collecting and analysing data on this topic.

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## Elephant Management in Nyaminyami District, Zimbabwe: Turning a Liability into an Asset

Russel D. Taylor

In Nyaminyami District, on the southern shores of Lake Kariba, in excess of 20,000 inhabitants share Omay Communal Land, an area of nearly 3,000km<sup>2</sup>, with some 2,000 elephants and arrange of other large wild mammals. Elephants are a major source of conflict between wildlife and people in Omay, largely on account of damage inflicted upon crops and property and injury or death to human life. Under the CAMPFIRE programme the management of elephants in Omay is presently being directed towards:

(i) reducing conflict through combining problem elephant control with sustainable trophy hunting

of elephants; electrified fencing to protect arable fields and homes from the depredations of elephant; zonation of land use for tourism development and agricultural planning at ward and village level:

(ii) increasing tolerance towards elephants through revenues earned from safari hunting and other wildlife management activities, and wildlife—based tourism ventures with private-sector operators. The relative merits or otherwise of these various approaches are described and discussed.

**The full paper will be published in the next issue of *Pachyderm*.**

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# Long-distance Movements of an Unprotected Population on the Laikipia Plateau, Kenya

Chris Thouless

The Laikipia-Samburu elephant population of approximately 3,000 animals, is the largest surviving population in Kenya outside protected areas. The southern part of their range is in Laikipia District, which consists of large-scale private ranches and small-scale farming settlement schemes. The northern part of their range is in Samburu District, consisting of low lying pastoralist areas and forested mountains. In the 19th and early 20th centuries there were many elephants in Samburu and almost none in Laikipia, which was gradually colonized by them during the late 1960's onwards. This southwards movement was accelerated by the heavy poaching in Samburu during the 1970's and 1980's, while Laikipia ranches provided greater security.

Radiotracking of 20 elephants during the past two years by the Laikipia Elephant Project has shown that there are now 4 main subpopulations.

- (1) Laikipia residents with home ranges of about 100 km<sup>2</sup>
- (2) Itinerant Laikipia elephants moving around

- ranches and settlement areas, which are the main crop-raiders
- (3) Forest elephants, moving onto the plains after rain
- (4) Long distance migrants, moving twice yearly between Laikipia and Samburu, during the long and short rainy seasons, a distance of more than 100km, giving total home ranges in excess of 3,000 km<sup>2</sup>

The regularity of this movement gives the appearance of a traditional migration, but it cannot have occurred for more than 20 years and older elephants will once have been residents in Samburu. It appears that the reason for the return to Laikipia during the dry season, even though poaching is now at a very low level, is a result of increasing human populations in pastoralist areas. As temporary rain pools dry up, elephants are forced to use dams and rivers where they compete with herders for access to water, and are vulnerable to spearing. In contrast Laikipia ranches have abundant permanent water and there is an attitude of tolerance towards elephants.

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# The Impact of Elephant Density on Biodiversity in Different Eco-climatic Zones in Kenya

John Waitaha

Poaching pressure and habitat fragmentation in Kenya, coupled with an unprecedented demand for land from an ever increasing human population, have brought about the compression of elephants into few refuge areas. The same forces have caused loss of this species from many areas that previously constituted their natural range. The direct consequence of concentrating elephants into a few areas is the creation of artificially high elephant densities which may cause undesirable changes in woodlands, bushes, swamp vegetation and other existing habitats. On the other hand, extermination of elephants from their

natural habitats removes a species that plays a central role in determining the rate, scale and direction of habitat change. Available information *suggests* that the disappearance of the elephant will reduce biological diversity and increase species extinction rates.

The aim of this study was to quantify the role of elephant density in the restructuring of habitats. The first objective was to determine whether there have been major vegetation changes over the years in areas with adequate information on trends in elephant numbers. Secondly, the study undertook to investigate

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the ecological impact of elephant density on habitat and how this impact varies in different eco-climatic zones (defined by rainfall). Thirdly, the study sought to establish the extent to which elephant impact affected the abundance of other mammalian species and to detect, from past and present records, any changes in browser-grazer biomass.

Three areas were selected for the study: the Aberdares National Park which receives rainfall in excess of 1,000mm per annum, the Laikipia Plateau which receives up to 850mm, and Tsavo, which is a semi-arid area and receives between 250 and 500mm of rain annually.

Sampling sites in Tsavo and Laikipia were chosen in areas where human land-use practices provided distinct boundaries separating different densities of elephants. In the Aberdares National Park, sampling was done along an elephant-density gradient which was established using the dung-count technique.

The role of elephants in creating gaps in forests and promoting patch dynamics was determined within selected forest sites in the Aberdares. Their role as seed dispersal agents was also investigated both in the Aberdares and Tsavo National Parks.

Vegetational parameters such as height, density, species composition and biomass were measured using appropriate techniques for different life forms. The PCQ (Point-Centre-Quarter) and Pin Frame were used for sampling trees/shrubs and herbs respectively.

Aerial photographs were used to detect any vegetational changes in areas where the history of elephant numbers and distribution was known. In these areas, the changes in animal species composition, particularly the trend in grazer-browser biomass ratios, was investigated.

The overall trends established so far are summarised as:

**i) *Changes in Landscape***

In the Aberdares National Park, the open area under grass around Treetops lodge has increased from one hectare in 1953 to more than 50 hectares in 1992.

There has been a decrease in large trees and an increase in low bushes making the lower part of the park more open than it was 40 years ago.

**ii) *Trees And Shrubs: Height, Density and Biomass***

In Tsavo East & West, these parameters are greater outside parks than inside; a similar trend is apparent in Laikipia ranches without elephants compared to those with elephants. In the Aberdares, there is a significant increase of the same variables along a decreasing elephant density-gradient.

**iii) *Grass Cover and Biomass***

Grass cover and biomass were consistently higher inside Tsavo Park than outside; higher in Laikipia ranches that tolerate elephants than in those that fence them off, and in the Aberdares, higher in areas of intermediate elephant densities than in those with extreme densities.

**iv) *Seed Dispersal***

It was evident that elephants act as agents of seed dispersal for certain plant species; more plant species were dispersed by elephants in areas of higher rainfall (Aberdares) than in areas with low rainfall (Tsavo).

**v) *Animals***

In the Aberdares, the bongo disappeared from the area around Treetops lodge in the early 1970's. In general, browser species have decreased significantly while there has been a remarkable increase in the grazer species such as buffalo, water-buck and warthog.

In conclusion, the results analyzed so far show that elephants have a strong habitat modifying role which is potentially of great importance to livestock economies as they reduce bush cover and increase grass cover. At the appropriate densities, elephants enhance biological diversity in parks, a fact that in itself provides a strong basis for promoting tourism. The results also indicate that the expansion of elephant range to cover areas beyond parks and reserves should be encouraged, in order to ease elephant compression and the associated ecological and economic impacts.

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