The IUCN Species Survival Commission

Conservation and Development Interventions at the Wildlife/Livestock Interface

Implications for Wildlife, Livestock and Human Health

Edited and compiled by Steven A. Osofsky

Associate Editors: Sarah Cleaveland, William B. Karesh, Michael D. Kock, Philip J. Nyhus, Lisa Starr and Angela Yang

Occasional Paper of the IUCN Species Survival Commission No. 30

IUCN
The World Conservation Union

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Contents

Acknowledgements vii

Abbreviations and Acronyms ix

Introduction

Looking *AHEAD* While Looking Back xiii
Steve Osofsky

World Parks Congress *AHEAD* Agenda xv

Abstracts xix

What is this Infamous "Wildlife/Livestock Interface?" A Review of Current Knowledge . . . xix
Richard Kock

Transfrontier Conservation Area Initiatives in Sub-Saharan Africa: Some Animal Health Challenges xix
Roy G. Bengis

Diseases of Importance at the Wildlife/Livestock Interface in Kenya xx
Elizabeth Wambwa

Relevance of the ROSELT/OSS Programme in Maintaining the Ecological Integrity of Protected Areas and Surrounding Lands xx
Jesse Njoka

The Influence of Veterinary Control Fences on Certain Wild Large Mammal Species in the Caprivi Strip, Namibia xxi
Rowan B. Martin

Wildlife, Livestock and Food Security in the South East Lowveld of Zimbabwe. xxii
David H.M. Cumming

Tuberculosis – What Makes it an Ideal Disease for the Interface? xxii
Anita L. Michel

Bovine Tuberculosis in the African Buffalo: The Role of Population Models xxiii
Wayne M. Getz, Paul C. Cross, Anna E. Jolles, James O. Lloyd-Smith, Sadie J. Ryan, Peter W.J. Baxter, Justine Bowers, Craig T. Hay, Christiane Knechtel, Craig J. Tambling, Wendy C. Turner and J.T. du Toit

Experiences and Challenges of Wildlife Health Management in the National Parks of Tanzania xxiii
Titus Mlengeya and Vitalis Lyaruu

Control Options for Human Sleeping Sickness in Relation to the Animal Reservoir of Disease . . . xxiii
Susan C. Welburn, K. Picozzi, J. Fyfe, E. Fèvre, M. Odiit, M.C. Eisler and P.G. Coleman

Rinderpest Surveillance in Uganda National Parks xxiv
Chris S. Rutebarika

Virus Topotypes and the Role of Wildlife in Foot and Mouth Disease in Africa xxiv
Wilna Vosloo, A.D.S. Bastos, M. Sahle, O. Sangare and R.M. Dwarka

The Impact of Disease on Endangered Carnivores xxiv
Craig Packer

Veterinary Challenges Regarding the Utilization of the Kafue Lechwe (*Kobus leche kafuensis*) in Zambia xxv
Victor M. Siamudaala, J.B. Muma, H.M. Munang'andu and M. Mulumba

The Health Paradigm and Disease Control: Consideration of the Health of Ecosystems and Impacts on Human Health and Rural Livelihoods xxv
Michael D. Kock

Conservancies: Integrating Wildlife Land-Use Options into the Livelihood, Development and Conservation Strategies of Namibian Communities xxv
Chris Weaver

"Counting Sheep": The Comparative Advantages of Wildlife and Livestock – A Community Perspective xxvi
Michael J. Murphree

Foot and Mouth Disease Management and Land-Use Implications in the Zimbabwean Lowveld: the Rationale for Creating a Biosphere Reserve. . . . xxvi
Raoul du Toit

Protected Areas, Human Livelihoods and Healthy Animals: Ideas for Improvements in Conservation and Development Interventions. xxvii
Gladys Kalema-Zikusoka

Impact and Value of Wildlife in Pastoral Livestock Production Systems in Kenya xxvii
Fumi Mizutani and Elizabeth Muthiani

A Regional/Community Approach to Conservation and Development Interventions at the Livestock/ Wildlife Interface xxviii
George Gitau

Complementarity Between Community-Based Animal Health Delivery Systems and Community-Based Wildlife Management? An Analysis of Experiences Linking Animal Health to Conflict Management in Pastoralist Areas of the Horn of Africa xxviii
Tim Leyland and Richard Grahn

Introduction of Foot and Mouth Disease-Infected Buffalo into the Save Valley Conservancy in Zimbabwe: Success or Failure? xxix
Chris Foggin and G. Connear

The Disease-Free Buffalo Breeding Project of the State Veterinary Services and South African National Parks xxix
Markus Hofmeyr

Control of Domestic Dog Diseases in Protected Area Management and the Conservation of Endangered Carnivores xxx
Karen Laurenson, Titus Mlengeya, Fekadu Shiferaw and Sarah Cleaveland

Impacts of Wildlife Infections on Human and Livestock Health with Special Reference to Tanzania: Implications for Protected Area Management . . . xxx
Sarah Cleaveland, Karen Laurenson and Titus Mlengeya

Synergies Between Livestock Husbandry and Wildlife Conservation in Southern Province, Zambia . . . xxxi
Dale Lewis

Map of national parks and other major conservation areas of East and southern Africa xxxii
Sara Zeigler and Philip Nyhus

Full Papers

1. What is this Infamous "Wildlife/Livestock Disease Interface?" A Review of Current Knowledge for the African Continent 1
R. A. Kock
2. Transfrontier Conservation Area Initiatives in Sub-Saharan Africa: Some Animal Health Challenges 15
Roy G. Bengis
3. Diseases of Importance at the Wildlife/Livestock Interface in Kenya 21
Elizabeth Wambwa
4. The Influence of Veterinary Control Fences on Certain Wild Large Mammal Species in the Caprivi, Namibia 27
Rowan B. Martin
5. Wildlife, Livestock and Food Security in the South East Lowveld of Zimbabwe 41
David H.M. Cumming
6. Tuberculosis – What Makes it a Significant Player at the Wildlife/Livestock/Human Interface? 47
Anita L. Michel
7. Experiences with and the Challenges of Wildlife Health Management in the National Parks of Tanzania 51
T. Mlengeya and V. Lyaruu
8. Control Options for Human Sleeping Sickness in Relation to the Animal Reservoir of Disease 55
S.C. Welburn, K. Picozzi, M. Kaare, E.M. Fèvre, P.G. Coleman and T. Mlengeya
9. Rinderpest Surveillance in Uganda National Parks 1998–2003 63
C.S. Rutebarika, N. Nantima, R.O. Ademun, J. Okori, G. Kalema and R. Kock
10. Virus Topotypes and the Role of Wildlife in Foot and Mouth Disease in Africa 67
W. Vosloo, A.D.S. Bastos, M. Sahle, O. Sangare and R.M. Dwarka
11. Disease Challenges Concerning the Utilization of the Kafue Lechwe (*Kobus leche kafuensis*) in Zambia 75
V. M. Siamudaala, J.B. Muma, H.M. Munang'andu and M. Mulumba
12. The Health Paradigm and Protected Areas: Linkages Between People and Their Livelihoods, Ecosystems and Natural Communities, Health and Disease . . . 81
Michael D. Kock
13. Conservancies: Integrating Wildlife Land-Use Options into the Livelihood, Development and Conservation Strategies of Namibian Communities 89
Larrye Chris Weaver and Patricia Skyer
14. "Counting Sheep": The Comparative Advantages of Wildlife and Livestock – A Community Perspective 105
Michael J. Murphree
15. Foot and Mouth Disease Management and Land-Use Implications in the Zimbabwean Lowveld: the Rationale for Creating a Biosphere Reserve 109
Raoul du Toit
16. Protected Areas, Human Livelihoods and Healthy Animals: Ideas for Improvements in Conservation and Development Interventions 113
Gladys Kalema-Zikusoka
17. Impact and Value of Wildlife in Pastoral Livestock Production Systems in Kenya: Possibilities for Healthy Ecosystem Conservation and Livestock Development for the Poor 121
Fumi Mizutani, Elizabeth Muthiani, Patti Kristjanson and Helga Recke
18. Complementarity Between Community-Based Animal Health Delivery Systems and Community-Based Wildlife Management? An Analysis of Experiences Linking Animal Health to Conflict Management in Pastoralist Areas of the Horn of Africa 133
Richard Grahn and Tim Leyland
19. Approaches to Disease Control in Domestic Canids for the Conservation of Endangered Wild Carnivores 141
M. K. Laurenson, T. Mlengeya, F. Shiferaw and S. Cleaveland
20. Impacts of Wildlife Infections on Human and Livestock Health with Special Reference to Tanzania: Implications for Protected Area Management . . . 147
Sarah Cleaveland, Karen Laurenson and Titus Mlengeya
21. Synergies Between Animal Husbandry and Wildlife Conservation: Perspectives from Zambia 153
Dale Lewis

Appendices 157

Vth World Parks Congress: Emerging Issues – Official Document 159

Original *AHEAD* Invitation 169

AHEAD Working Group notes 175

Biosketches of *AHEAD* Launch Invited Participants 205

Acknowledgements

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AHEAD invitees (or a good portion of them!) – Vth World Parks Congress – Durban, South Africa, September 2003

Angela Yang. Sincere apologies to anyone we may have inadvertently missed!

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Sincerely,

Steve Osofsky, DVM
Wildlife Conservation Society – Field Veterinary Program
Senior Policy Advisor, Wildlife Health

Abbreviations and Acronyms

AAAS	American Association for the Advancement of Science
ADMADE	Administrative Management Design for Game Management Areas
AE	adult equivalent
AGID	agar-gel immunodiffusion
AHEAD	Animal Health for the Environment And Development
AIDS	acquired immune deficiency syndrome
ASAL	arid and semi-arid lands
ASF	African swine fever
AU/CTTBD	African Union/Centre for Ticks and Tick-Borne Diseases
AU/IBAR	African Union/Interafrican Bureau for Animal Resources
AWF	African Wildlife Foundation
AZA	American Zoo and Aquarium Association
BIIT	blood infectivity incubation test
BINP	Bwindi Impenetrable National Park
BTB	bovine tuberculosis
CAHS	Community-based Animal Health Systems
CAHW	Community-based Animal Health Workers
CAMPFIRE	Communal Areas Management Program For Indigenous Resources
CAPE	Community-based Animal Health and Participatory Epidemiology
CBNRM	Community-Based Natural Resource Management
CBPP	contagious bovine pleuropneumonia
CCPP	contagious caprine pleuropneumonia
CI	Conservation International
CIRAD	Centre de coopération internationale en recherche agronomique pour le développement
CITES	Convention on International Trade in Endangered Species
CONASA	Community-based Natural Resource Management and Sustainable Agriculture
CRB	Community Resource Board
DFID	Department For International Development
DNPWM	Department of National Parks and Wildlife Management
DRC	Democratic Republic of Congo
EAC	East African Community
ECF	East Coast fever (theileriasis)
EDD	Exotic Diseases Division
EIA	environmental impact assessment
EU	European Union
FAO	Food and Agriculture Organization (of the United Nations)
FEWS	Famine Early Warning System
FMD	foot and mouth disease
FVP	Field Veterinary Program
GATT	General Agreement on Tariffs and Trade
GDP	gross domestic product
GEF	Global Environment Facility
GIS	Geographic Information Systems

GLTFCA	Great Limpopo Transfrontier Conservation Area
GLTFP	Great Limpopo Transfrontier Park
GMA	Game Management Area
GR	Game Reserve
GREP	Global Rinderpest Eradication Programme
GTZ	Gesellschaft für Technische Zusammenarbeit
ha	hectare
HIV	human immunodeficiency virus
HUP	Hluhluwe-Umfolozi Park
ILRI	International Livestock Research Institute
IRDNC	Integrated Rural Development and Nature Conservation
IUCN	World Conservation Union (International Union for Conservation of Nature and Natural Resources)
JMB	Joint Management Board
KARI	Kenya Agricultural Research Institute
KEMRI	Kenya Medical Research Institute
KNP	Kruger National Park
KWS	Kenya Wildlife Service
LIFE	Living In a Finite Environment
LPEC	Livestock Production Efficiency Calculator
LSU	large stock unit
MAWRD	Ministry of Agriculture, Water, and Rural Development
MCF	malignant catarrhal fever
MET	Ministry of Environment and Tourism
MGE	mobile genetic elements
MOLD	Ministry of Livestock Development
NCAA	Ngorongoro Conservation Area Authority
NGO	nongovernmental organization
NIMR	Naval Institute of Medical Research (Tanzania)
NNF	Namibia Nature Foundation
NP	National Park
NSF	National Science Foundation
OAU	African Union (previously Organization of African Unity)
ODA	Overseas Development Administration
OIE	Office International des Epizooties, *also* World Organisation for Animal Health
OSS	Observatoire du Sahara et du Sahel
PACE	Pan African Programme for the Control of Epizootics
PARC	Pan African Rinderpest Campaign
PCR	polymerase chain reaction
PPR	peste des petits ruminants
RFLP	restriction fragment length polymorphism
ROSELT	Réseau d'Observatoires de Surveillance Ecologique à Long Terme
RP	rinderpest
RT-PCR	reverse transcription polymerase chain reaction
RVF	Rift Valley fever
SADC	Southern African Development Community
SANParks	South African National Parks

SARS	severe acute respiratory syndrome
SASUSG	Southern Africa Sustainable Use Specialist Group
SAT	South African Territories
SAVA	South African Veterinary Association
SEATIP	South East Africa Tourism Investment Program
SEL	South East Lowveld
SRA	serum-resistance associated (gene)
SSC	Species Survival Commission
SUA	Sokoine University of Agriculture
TANAPA	Tanzania National Parks
TAWIRI	Tanzania Wildlife Research Institute
TB	tuberculosis
TBD	tick-borne disease
TFCA	Transfrontier Conservation Area
TLU	tropical livestock unit
TPN3	Thematic Programme Network 3
TRAFFIC	Trade Records Analysis of Fauna and Flora In Commerce
TREP	Tropical Resource Ecology Programme
UAE	United Arab Emirates
UK	United Kingdom
UNCCD	United Nations Convention to Combat Desertification
UNEP-GEF	United Nations Environment Programme-Global Environment Facility
UNESCO	United Nations Educational, Scientific, and Cultural Organization
US	United States
US$	United States dollars
USAID	United States Agency for International Development
USDA	United States Department of Agriculture
UWA	Uganda Wildlife Authority
WCS	Wildlife Conservation Society
WHO	World Health Organization
WHS	Wildlife Health Sciences
WTO	World Trade Organization
WWF	World Wide Fund for Nature (World Wildlife Fund)
ZSL	Zoological Society of London

Introduction

Looking *AHEAD* While Looking Back

Steve Osofsky, DVM, Wildlife Conservation Society, Field Veterinary Program

The "Southern and East African Experts Panel on Designing Successful Conservation and Development Interventions at the Wildlife/Livestock Interface: Implications for Wildlife, Livestock and Human Health" forum brought together nearly 80 veterinarians, ecologists, economists, wildlife managers, and other experts from Botswana, Kenya, Malawi, Mozambique, Namibia, South Africa, Tanzania, Uganda, Zambia, Zimbabwe, France, the United States, and the United Kingdom to develop ways to tackle the immense health-related conservation and development challenges at the wildlife/domestic animal/human interface facing Africa today, and tomorrow. This volume attempts to capture invitees' uniquely grounded insights, and their ideas for making the long-overdue "one health" perspective a reality in practice.

In planning this forum, one of the Wildlife Conservation Society's main objectives was to help facilitate collaborative work among a diverse array of highly skilled partners to bring sound science to bear on natural resource management decisions that directly affect the livelihoods and cultures of Africa's people, including those decisions that impact the future of Africa's protected areas and wildlife resources. Since the September 2003 forum, we have already seen strengthened as well as new partnerships, expanding circles of synergy and collaboration. The esteemed group assembled for this panel generated an impressive array of ideas for solving some of today's most critical problems at the interface between wildlife health, domestic animal health, and human health and well-being. Some of these ideas are already being implemented, meeting the Wildlife Conservation Society's hopes that this would indeed prove to be more than "just another meeting," that it would be catalytic and positive for Africa.

This forum represented the launch of the Wildlife Conservation Society's Animal Health for the Environment And Development (***AHEAD***) initiative, a program developed by WCS's Field Veterinary Program in response to the growing recognition of the critical role of animal health in both conservation and development. Throughout the world, domestic and wild animals are coming into ever-more intimate contact. Without adequate scientific knowledge and planning, the consequences can be detrimental on one or both sides of the proverbial fence. But with the right mix of expertise armed with the tools that the animal health sciences provide, conservation and development objectives have a much greater chance of being realized – particularly at the critical wildlife/livestock interface where conservation and agricultural interests meet head-on. The ***AHEAD*** initiative focuses on several themes of critical importance to the future of animal agriculture, wildlife, and, of course, people: competition over grazing and water resources, disease mitigation, local and global food security, zoonoses, and other potential sources of conflict related to the overall challenges of land-use planning and the pervasive reality of resource constraints. To date, neither nongovernmental organizations, nor aid agencies, nor academia have holistically addressed the landscape-level nexus represented by the wildlife health/domestic animal health/human health triangle.

WCS believes that "win-win" solutions to health, land-use, and broader socioeconomic challenges are attainable. ***AHEAD***, created to foster a sharing of ideas that will lead to concrete and creative initiatives addressing conservation and development challenges at the livestock/wildlife/human health interface, can help catalyze these solutions. By bringing regional expertise together to compare lessons learned, fostering communications networks that are often lacking even among practitioners in relatively close proximity, and by bringing a global perspective to problems that can benefit from the experiences of other regions, this initiative can pay dividends for protected areas as well as buffer zone communities, for core areas as well as conservancies and corridors – the places where tensions and challenges at the livestock/wildlife interface are greatest. Conflicts between livestock and natural resources must be dealt with if there is to be any hope for peaceful coexistence between the two sectors upon which so many people's livelihoods depend. The papers in this ***Proceedings*** make this quite clear.

There is probably no region on earth where animal health policies and their downstream consequences have had as tangible an effect upon the biotic landscape as in Africa, southern Africa in particular. In many parts of the world, land-use choices are often driven by government (domestic and/or foreign) incentives or subsidies that can favor unsustainable agricultural practices over more ecologically sound natural resource management schemes. Of course, livestock will remain critically important both culturally and economically in much of the region. But provided with a better understanding of disease epidemiology and grasslands ecology, land-use planners can begin to take the true costs associated with both disease control schemes and environmental degradation related to livestock management practices not well-suited to a particular ecosystem into account, and therefore more often favor a return to natural production systems. For example, in semi-arid parts of southern Africa, foot and mouth disease control programs, implemented to support beef production for an export market, may not be as profitable or as environmentally sustainable as a return to multi-use natural systems emphasizing endemic wildlife species (consumptively and non-consumptively). When it comes to animal health programs and policies in transboundary landscapes, where domestic as well as wild

animals have opportunities to cross international borders, making the right decisions becomes even more critical. Launching ***AHEAD*** with a focus on southern and East Africa, particularly with the World Parks Congress being hosted by South Africa, was indeed a very logical decision for us.

The benefits of a more holistic land-use management perspective also extend to pastoralists, people who derive the bulk of their subsistence directly from livestock – people who are often marginalized in African economies and political systems. By recognizing the ecological and economic significance of pastoralist land-use practices, conservation and development programs can lead to improved livelihoods via more strategic and efficient mechanisms for animal (and human) health care delivery, and for disease surveillance. Of course the extraordinary benefits of sound management at the wildlife/livestock/human interface reach well beyond pastoral communities. One need only look at global travails with SARS or avian influenza, foot and mouth disease, or "mad cow," to see the tremendous social and economic importance of these issues.

With rapidly expanding trade through SADC (the Southern African Development Community), COMESA (the Common Market for Eastern and Southern Africa), and ongoing globalization trends, these issues will increasingly affect the development trajectories of many African countries. Clearly, animal health issues – and their implications for human health and livelihoods – must be addressed by any regional agricultural or natural resources management strategies, including those adopted by national parks authorities, if they are to succeed.

As we look around the world, impacts from interactions between livestock and wildlife (and habitat) are often profound. The issues at this interface represent an unfortunately all-too-often neglected sector of critical importance to the long-term ecological and sociopolitical security of protected areas and grazing lands worldwide. Whether we are talking about the ongoing tuberculosis crisis in and around South Africa's Kruger National Park, or Yellowstone National Park's brucellosis saga costing U.S. authorities millions of dollars to manage, these issues merit more proactive attention than they have received to date. With its initial focus on southern and East Africa and their diverse land-use mosaics, we hope that the WCS's ***AHEAD*** initiative is poised to make a difference.

Part of the reason we convened this forum at the World Parks Congress was to help give animal health, and the health sciences in general, a seat at the conservation table. By raising the profile of the management (and research) implications of the impacts of infectious diseases on the ecosecurity of East and southern African protected areas at the World Parks Congress, we hope we have also helped sensitize the donor community to the importance of this type of work. (Please see the appendix of this volume or www.iucn.org/themes/wcpa/wpc2003/english/outputs/durban/eissues.htm for the official IUCN World Parks Congress: Emerging Issues resolution on the subject.) The fact that IUCN encouraged us to hold this forum as part of the World Parks Congress tells me we are making some headway, *pole pole,* in terms of helping the broader conservation and development communities understand the core relevance of our work and expertise to their overall objectives. As socioeconomic progress demands sustained improvements in health for people, their domestic animals, and the environment, we hope we've been successful in drawing attention to the need to move towards a "one health" perspective – an approach that was the foundation of our discussions in Durban, and a theme pervading this ***Proceedings***. We hope that conservation and development colleagues from within and, as importantly, *outside of* the health science professions will find this volume thought-provoking, insightful, practical, and applicable to their daily work.

My colleagues responsible for the contents of this exciting volume are true conservation heroes, working in the face of daunting obstacles, more often than not without adequate resources or adequate political support. I hope the "Southern and East African Experts Panel on Designing Successful Conservation and Development Interventions at the Wildlife/Livestock Interface: Implications for Wildlife, Livestock and Human Health," these ***Proceedings***, and the ***A***nimal ***H***ealth for the ***E***nvironment ***A***nd ***D***evelopment concept behind them, will continue to foster positive change for the places and people we all care so much about.

Note: The entry point to the WCS ***AHEAD*** website is at www.wcs-ahead.org. It includes the complete agenda from the World Parks Congress (Durban) ***AHEAD*** launch, abstracts of presentations, the presentation slide sets, biographical sketches and contact details for most of the invitees, as well as a range of downloadable video and audio clips from the meeting. It also includes materials on ***AHEAD*** programs that were conceived in Durban and have continued to develop since the 2003 World Parks Congress.

AGENDA

Sunday September 14th, Monday September 15th

"Southern and East African Experts Panel on Designing Successful Conservation and Development Interventions at the Wildlife/Livestock Interface: Implications for Wildlife, Livestock and Human Health"

Durban International Convention Center (ICC)-Room 3C

Associated with the "Building Broader Support for Protected Areas " Stream, World Parks Congress

PLEASE make sure you register and collect your security passes from World Parks Congress officials at the Durban Exhibition Center (DEC) before the 14th or early on the morning of the 14th so as not to miss our 9AM start.

SUNDAY September 14th

Overview of Challenges to Conservation and Development at the Livestock /Wildlife Interface :

9:00 AM Welcome/Introduction-Why Are We Here? (10 min): Steve Osofsky, Billy Karesh (WCS Field Veterinary Program and IUCN SSC Veterinary Specialist Group) and Mike Kock (IUCN SSC Southern Africa Sustainable Use Specialist Group and WCS Field Veterinary Program)

9:10 **Brief Self-Introductions, and Day 1 Guidelines** (10 min) :'Round the Room': Susie Ellis, Facilitator (CI)

9:20 **Opening Address** (20 min): Richard Kock (PACE/OAU-IBAR, and IUCN SSC Veterinary Specialist Group) "What is this Infamous 'Wildlife /Livestock Interface?'– A Review of Current Knowledge on the Subject"

9:40 Invited presentations begin (10 min each)

The State of Play

9:40 "Transfrontier Parks in Southern Africa: Animal Health Challenges" (Roy Bengis)

9:50 "Diseases of Importance at the Wildlife/Livestock Interface in Kenya" (Elizabeth Wambwa)

10:00 "Relevance of the ROSELT/OSS Programme in Maintaining the Ecological Integrity of Protected Areas and Surrounding Lands" (Jesse Njoka)

10:10 "The Influence of Veterinary Control Fences on Certain Wild Large Mammal Species in the Caprivi Strip, Namibia" (Rowan Martin)

10:20 "Wildlife, Livestock and Food Security in the South-East Lowveld of Zimbabwe" (David Cumming)

10:30–10:50 TEA BREAK #1

Perspectives on Pathogens

10:50 "Tuberculosis – What Makes it an Ideal Disease for the Interface?" (Anita Michel)

11:00 "Bovine Tuberculosis in the African Buffalo: The Role of Population Models" (Wayne Getz)

11:10 “Experiences with and the Challenges of Wildlife Health Management in National Parks of Tanzania” (Titus Mlengeya and Vitalis Lyaruu)

11:20 “Control Options for Human Sleeping Sickness in Relation to the Animal Reservoir of Disease” (Susan Welburn *et al*.)
11:30 “Rinderpest Surveillance in Uganda National Parks” (Chris Rutebarika)

11:40 “Virus Topotypes and the Role of Wildlife in Foot and Mouth Disease in Africa” (Wilna Vosloo)

11:50 “The Impact of Disease on Endangered Carnivores” (Craig Packer)

12:00 “Veterinary Challenges Regarding the Utilization of the Kafue Lechwe (*Kobus leche kafuensis*) in Zambia” (Victor Siamudaala)

12:10–12:25 QUESTIONS & ANSWERS

12:30–1:30 LUNCH (Group Facilitators and Recorders meet with Susie Ellis over lunch.)

Challenges and Opportunities-Within and Out of the Box

1:30 “The Health Paradigm and Disease Control: Consideration of the Health of Ecosystems and Impacts on Human Health and Rural Livelihoods” (Mike Kock)

1:40 “Conservancies: Integrating Wildlife Land-Use Options into the Livelihood, Development and Conservation Strategies of Namibian Communities” (Chris Weaver)

1:50 “‘Counting Sheep’: The Comparative Advantages of Wildlife and Livestock – A Community Perspective” (Michael Murphree)

2:00 “Foot and Mouth Disease Management and Land-Use Implications in the Zimbabwean Lowveld: the Rationale for Creating a Biosphere Reserve” (Raoul du Toit)

2:10 “Protected Areas, Human Livelihoods and Healthy Animals: Ideas for Improvements in Conservation and Development Interventions” (Gladys Kalema-Zikusoka)

2:20–2:35 QUESTIONS & ANSWERS

2:35 “Impacts and Value of Wildlife in Pastoral Livestock Production Systems in Kenya” (Fumi Mizutani, Elizabeth Muthiani)

2:45 “A Regional/Community Approach to Conservation and Development Interventions at the Livestock/Wildlife Interface” (George Gitau)

2:55 “Complementarity Between Community-Based Animal Health Delivery Systems and Community-Based Wildlife Management? An Analysis of Experiences Linking Animal Health to Conflict Management in Pastoralist Areas of the Horn of Africa” (Tim Leyland and Richard Grahn)

3:05 “Community-Based Animal Health Care – An Opportunity to Help Overcome the Sometimes Conflicting Interests of Rural Communities and Conservationists at the Wildlife/Livestock Interface – Challenges and Research Needs” (John Woodford)

3:15–3:30 QUESTIONS & ANSWERS

3:30-3:50 TEA BREAK #2

3:50 “Introduction of Foot and Mouth Disease-Infected Buffalo into the Save Valley Conservancy in Zimbabwe: Success or Failure?” (Chris Foggin and G. Connear)

4:00 “The Disease-Free Buffalo Breeding Project of the State Veterinary Services and South African National Parks” (Markus Hofmeyr)

4:10 “Control of Domestic Dog Diseases in Protected Area Management and the Conservation of Endangered Carnivores” (Karen Laurenson with S. Cleaveland *et al.*)

4:20 “Impacts of Wildlife Infections on Human and Livestock Health with Special Reference to Tanzania: Implications for Protected Area Management” (Sarah Cleaveland with T. Mlengeya *et al.*)

4:30 “Synergies Between Livestock Husbandry and Wildlife Conservation in Southern Province, Zambia” (Dale Lewis)

4:40–4:50 QUESTIONS & ANSWERS

4:50–5:00 WORKING GROUPS IDENTIFIED AND INSTRUCTIONS PROVIDED (Susie Ellis, Steve Osofsky)

A maximum of 5 total Working Groups are suggested as follows (names in **bold** are the suggested Working Group Facilitators; *italicized* names are the suggested Recorders). If you feel you’ve been assigned to the ‘wrong’ group or role, please let the facilitator know before the session begins:

(1) Botswana/Namibia/Zimbabwe – Guy Freeland, **Mike Kock**, Neo Mapitse, Gary Mullins, Chris Weaver, Michael Murphree, David Cumming, Raoul du Toit, Chris Foggin, Rowan Martin, *Robert Cook,* Steve Osofsky, Mark Eisler, Delphine Purves

(2) Kenya – George Gitau, Agi Kiss, **Richard Kock**, Fumi Mizutani, Elizabeth Muthiani, Jacob Mwanzia, Jesse Njoka, *Elizabeth Wambwa*, Helga Recke, Kenneth Waithiru

(3) Malawi/Mozambique/Zambia – Misheck Mulumba, *Rod de Vletter*, Simon Munthali, Bartolomeu Soto, Dale Lewis,Victor Siamudaala, Tim Leyland, **Laurel Neme**

(4) South Africa – **Roy Bengis**, Koos Coetzer, Jacques Flamand, Wayne Getz, Markus Hofmeyr, Nick Kriek, Woody Meltzer, Anita Michel, *Philip Nyhus*, Cobus Raath, Wilna Vosloo, Banie Penzhorn

(5) Tanzania/Uganda – Gladys Kalema-Zikusoka, Chris Rutebarika, Innocent Rwego, Michael Woodford, Philippe Chardonnet, Sarah Cleaveland, Robert Fyumagwa, **William Karesh**, *Karen Laurenson*, Titus Mlengeya, Pete Morkel, Craig Packer, Susan Welburn, John Woodford, Mary Phillips

5:00–? WORKING GROUPS SESSION 1.

1. Brainstorm to produce a list of priority protected areas in your Working Group's region, including those that are/could become transboundary.

2. Identify the 2–3 highest priority protected areas.

3. Define (list) the major health-related challenges/threats for each priority area.

– End of Day One Working Sessions –

Don't forget tonight's Group Dinner at the Protea Hotel Edward!

MONDAY, September 15th

New Working Groups formed as needed based on highest-priority protected areas as indicated by Day 1 outputs/ priorities.

Overview – Moderated Working Groups outline project concepts they think can practically address the health-related challenges discussed yesterday. Working Groups are to be landscape-focused so that the proposal outlines that are developed are geo-referenced to places (which include core protected areas of some type) of conservation interest (specific landscapes of focus will likely depend on representation at the meeting). The emphasis should be on projects that can and should be developed and implemented soon. Concepts emphasizing further research must justify that the proposed research is critical to improved management practices on the ground.

8:00–8:30 AM PLENARY SESSION.
Review of yesterday's outputs/priorities, new Working Group assignments and instructions (Susie Ellis and Steve Osofsky).

8:30–10:00 WORKING GROUP SESSION 2.

1. Prioritize health-related challenges for the top 1–3 priority protected areas identified within each group.
2. Begin defining 2–3 pilot projects (including transboundary endeavors) that can address the 2–3 highest priority health-related challenges for each area (*what are the most important things to do to address these challenges – why, who, what, how, when?*) Please see worksheets to be provided.

10:00–10:30 TEA BREAK #1

10:30–12:00 WORKING GROUP SESSION 3.
Continue working to flesh-out 2–3 pilot projects (including transboundary endeavors) that can address the 2–3 highest priority health-related challenges for each area (*what are the most important things to do to address these challenges?)*

12:00–1:00 LUNCH (**Working lunch** – One to two representatives from each Working Group volunteer to convene to delineate "measures of success" – what criteria should these conservation and development interventions be measured by? A suggested list of indicators of success relevant to goals at the livestock/wildlife interface should be outlined. This outline is to be distributed to all participants as the afternoon Working Groups get underway.)

1:00–2:15 WORKING GROUP SESSION 4.
Finalize 2–3 pilot projects (including transboundary endeavors) that can address the 2–3 highest priority health-related challenges for each area (*what are the most important things to do to address these challenges?)*

2:15–3:45 PLENARY:WORKING GROUP REPORTS (10 MINUTES EACH, AND 5 MINUTES QUESTIONS/ DISCUSSION PER GROUP)

3:45–4:00 TEA BREAK #2

4:00–4:45 WORKING GROUP SESSION 5.
Refine/finalize pilot projects based on feedback from plenary session. Groups should reference how identified or modified "measures of success" may help them monitor conservation/development results in their landscapes. HAND IN FINAL ELECTRONIC AND HARD COPY VERSIONS TO FACILITATOR.

4:45–5:15 GROUP DISCUSSION/REFLECTION

5:15–5:30 **Closing Address** (15 min): Billy Karesh, Richard Kock (Co-Chairs, IUCN SSC Veterinary Specialist Group) Key Themes Emerging from this Forum

5:30–5:45 **Meeting Conclusion** (15 min): Steve Osofsky (WCS) and Mike Kock (SASUSG/WCS) Thanks, and Next Steps.

– End of Meeting –

Follow-up: One product of the meeting will be proceedings of the papers presented on Day 1, and a written summary of the outlines for envisioned future work produced by Day 2's Working Groups. Longer term, WCS would like to work with interested participants from the various Working Groups to help them more fully develop the outlines into full proposals for eventual donor consideration. Obviously this will involve broader consultation within the regions of focus with a wider range of stakeholders than could be accommodated at this initial forum.

Abstracts

What is this Infamous "Wildlife/Livestock Interface?" A Review of Current Knowledge

Richard Kock

With the exponential growth of human populations in Africa over the last century, the inevitable decline in wildlife habitat and populations has been rapid. The loss has been primarily in areas of human settlement and agriculture, as here, the habitat loss is extreme. Wildlife survives increasingly in pockets of land peripheral to these areas as a result of the establishment of protected area systems (parks, reserves, and sanctuaries) or in the remaining forests, wetlands, and vast arid rangelands of Africa, which have not been settled or exploited. Africa is now a mosaic from developed landscapes to relatively unchanged habitats that recall pre-ice age communities. Probably the most stable systems over the last centuries, where the habitats have remained relatively intact, are the dry rangelands. These areas are less attractive to human settlement as the environment and climate are harsh, and agriculture is limited by low rainfall and nutrient-poor soils. Consequently, these are areas with a lower human density, and the livelihoods are often based on pastoral livestock and now, rarely, hunter-gatherer systems. Ironically, due to lack of political empowerment and cash poverty, these traditional communities are considered backwards and unproductive by urban society, whereas they should be praised for their more environmentally sustainable land-use practices, and means sought to enhance their incomes without destroying their way of life.

When considering the "wildlife/livestock interface," the understanding for this paper is that the wildlife component comprises the large mammals, which in one way or another interact with the livestock population and, more specifically, herbivores. It is here in particular that the scene is changing and novel problems are arising. This does not mean the remaining animals – carnivores, reptiles, and so on – are not important. The impact of predation and the prevalence of snakebites on livestock might be examples! These subjects are best dealt with in other fora.

A major impact of the changing landscape has been increasing competition for the finite resources, and it is here that the interface has become more apparent and contact more frequent. In summary, the wildlife/livestock interface has become more intense in certain areas, whilst it is no longer an issue in many others.

The interface can present itself in many different ways, and a better definition of the interface is needed in which it has a real impact economically or in terms of health on either the livestock or wildlife populations. This will help clarify the issues and focus research and management efforts appropriately. The subject is large, and this paper will review only the more important animal health issues at the interface:

- Diseases of importance that pass between wild and domestic animals at the physical interface with a focus on infections impacting trade in animals.
- Diseases that are transmitted through vectors between livestock and wildlife and the influence each community has on the overall prevalence and impact of the disease.
- Contact rates in relation to the competition for the resources shared between wildlife and livestock – forage and water.

See full paper on p.1.

Transfrontier Conservation Area Initiatives in Sub-Saharan Africa: Some Animal Health Challenges

Roy G. Bengis

As Africa's conservation areas come under increasing pressure from expanding human resource needs, the transfrontier conservation area (TFCA) initiatives are a welcome breath of fresh air from a biodiversity conservation point of view. In addition, the integration of land across international borders, as well as the consolidation of state and privately/communally owned land in joint ventures, may have major positive economic potential for the specific region. These initiatives are strongly supported by conservationists, ecotourism enterprises, and the public at large, because they are the first tangible moves that may reverse the current encroachment experienced by existing and established conservation and wilderness areas, as expanding local communities battle to survive the onslaughts of nature's climatic fluctuations and plagues that threaten their food security. The TFCA vision explores the possibility that changing land-use practices, from subsistence farming on marginal land to community participation in ecotourism-based enterprises, may have sustainable economic and ecological benefits for all. In the Southern African Development Community (SADC) region, there are currently seven TFCAs involving land from two or more participating countries that have already been established or are in the process and have political support with international agreements at various stages of develop-

ment and planning. A further 15 potential TFCAs have been identified by the Peace Parks Foundation in the SADC sub-region.

It is definitely not the intention of this paper to portray these environmental conservation initiatives in a negative light. The message that needs to be conveyed however, is that all parties involved should enter these initiatives with their eyes wide open, forewarned of the potential animal health implications and challenges that may be expected when increasing the currently existing geographic range of certain animal pathogens and disease vectors. Without international boundary barrier fences and with biological bridges being formed by contiguous wildlife populations, any contagious/infectious disease or vector present in any one of the participating countries or areas will predictably spread throughout the entire TFCA. Potentially problematic infections should be identified early by surveillance and monitoring, and joint containment and control measures should be established proactively when and where necessary.

These animal disease issues may also be compounded by the enlarging wildlife/livestock interface, which may negatively impact on adjoining communities. This paper deals with some of the more problematic animal infections and disease vectors that have been identified in certain TFCAs.

See full paper on p.15.

Diseases of Importance at the Wildlife/Livestock Interface in Kenya

Elizabeth Wambwa

The rangelands of Kenya occupy 74% of the country's land area and are largely inhabited by nomadic or transhumant pastoralists who comprise less than 15% of the total population. This extensive production system allows a greater interface between domestic and wild animals. This interface also occurs on large-scale private or community ranches, and with communities that border the protected areas (national parks and game reserves) around the country. With livestock and wildlife sharing the same ecosystems, several diseases can be transmitted among them. The resurgence of some livestock and wildlife diseases in Kenya that were previously controlled is of serious concern and can be attributed to several factors. The uncontrolled or illegal movements of livestock by pastoralists within the country and across national borders in search of grazing, markets, or following cattle rustling is a major factor in the spread of diseases. Seasonal wildlife movements result in constant interactions with livestock and also increase the possibility of occurrence of transboundary diseases.

The most prevalent and economically important diseases in Kenya include those caused by viruses such as rinderpest, Rift Valley fever, foot and mouth disease, African swine fever, malignant catarrhal fever, and rabies. Bacterial diseases include anthrax, brucellosis, and contagious bovine pleuropneumonia. Protozoal diseases, such as trypanosomiasis and theileriosis, and numerous ectoparasites and helminths are also prevalent. The presence of some important transboundary diseases has greatly reduced Kenya's export of wildlife, livestock, and their products to lucrative international markets. This is due to stringent requirements in sanitary standards for international trade in animals and animal products established by the Office International des Épizooties (OIE) that are a prerequisite for exporting products.

New and innovative approaches to disease control are needed, as the human/livestock/wildlife situation in Africa is highly dynamic, and current knowledge and veterinary skills should be applied at the interface. Government policy needs to focus strongly on improvement of disease control and marketing of livestock, wildlife, and their products. There is need for regional integration within East Africa to allow for free trade in animals and animal products.

This paper briefly describes the wildlife/livestock interface in Kenya with emphasis on the important diseases at this interface. It suggests measures to enhance disease control and improve trade in wildlife, livestock, and their products.

See full paper on p.21.

Relevance of the ROSELT/OSS Programme in Maintaining the Ecological Integrity of Protected Areas and Surrounding Lands

Jesse Njoka

The ecological changes taking place in protected areas are both due to natural processes and human activities. In the absence of long-term monitoring data from the protected areas, it is difficult to distinguish these two types of changes. Various initiatives to monitor these changes using modern technologies such as remote sensing devices (among others) are being tested in an uncoordinated fashion. There is a need for establishing long-term ecological observatories at the local level to monitor the ecological integrity of protected areas and the adjacent buffer zones to obtain sound scientific data on the interaction of the local human population and the natural resources, especially with respect to those within the protected areas. The goal of the Réseau d'Observatoires de Surveillance Ecologique à Long Terme (ROSELT) programme is to monitor these changes on a

long-term basis to generate scientific information for decision-making in development and for conservation of ecological integrity.

The ROSELT programme also seeks to identify management indicators at the local observatory level. Each observatory includes both the protected areas and systems altered through agriculture or urban development. The programme involves several countries participating as member countries of OSS (Observatoire du Sahara et du Sahel).

To assess how the natural system is changing with time, ROSELT seeks to establish a baseline map/state of the area under each observatory against which changes can be monitored in the future. The programme has identified several observatories that are representative of the important ecological zones in the drylands. The baseline study involves compilation of existing information from previous studies and selection of the minimum data set to be collected on a regular basis at the lowest cost. Selection of indicators, which will assist decision-makers to assess trends in the ecological integrity of protected areas as well as areas under agriculture, will be an important output of this programme. These indicators will monitor changes in the ecological, social, economic, and management trends of protected areas and surrounding areas. A well-designed monitoring and evaluation model will be able to detect threatening processes such as those related to invasive species, poaching, natural resources conflicts, and unsustainable exploitation of natural resources.

Because the pilot observatories in each participating country are certified in terms of the quality of scientific data that are collected, this certification process can be extended to protected area systems as well as to areas beyond the boundaries of protected areas. The ROSELT programme is relevant at the local level for each observatory, but several observatories at the national level will scale up the ability to detect problems that imply the need for policy change. This approach will also scale up interpretation of information at sub-regional and regional levels.

The Influence of Veterinary Control Fences on Certain Wild Large Mammal Species in the Caprivi Strip, Namibia

Rowan B. Martin

This paper is based on consultancies conducted for the Ministry of Environment and Tourism, Namibia, from October 2002 to April 2003, to develop management plans for southern savanna buffalo (*Syncerus caffer caffer*), roan antelope (*Hippotragus equinus*), sable antelope (*Hippotragus niger niger*), and tsessebe (*Damaliscus lunatus lunatus*).

Rainfall is ultimately the factor limiting the distribution and abundance of these species in southern African savannas. Prior to the great rinderpest epidemic at the turn of the 19th century, the range of buffalo extended to all parts of southern Africa that had an annual rainfall exceeding 250mm. Rainfall determines not only the final carrying capacity of the range for buffalo but also the age of first conception and fecundity of females. Roan, sable, and tsessebe do not occur naturally in areas where annual rainfall is less than 400mm, and their numbers are strongly correlated with the long-term cumulative surpluses and deficits above and below the mean annual rainfall.

The Caprivi is the only part of Namibia that enjoys an annual rainfall above 500mm, and it is to be expected that the area would carry populations of all of these species at densities of the order of 1–2/km^2. In northern Botswana in the area contiguous with the Caprivi, buffalo numbers may be as high as 100,000 and there are substantial populations of roan (1,500), sable (3,000), and tsessebe (10,000). Immediately across the international boundary, the abundance of these species decreases drastically and the populations are fragmented into isolated subpopulations.

A range of potentially limiting factors was examined to assess the primary causes of the species' poor conservation status. In the eastern Caprivi, poor land-use planning may be the primary factor limiting wild species. The ad hoc westward expansion of people and domestic livestock threatens the integrity of the range for all wild species. Wedges of human settlement are fragmenting the range and, in several places, continuity of species populations can be maintained only through spatial links with northern Botswana. Any ill- considered placement of veterinary fences in this area would likely result in the total isolation of a number of small sub-populations and, ultimately, their demise. In the western Caprivi (the Caprivi Strip), the present location of veterinary fences has caused the isolation of Mahango and Khaudum National Parks and effectively broken all linkages not only between the east and west Caprivi but also between Botswana and Namibia. At a time when there are high expectations for transfrontier conservation areas, this is a retrogressive development. Various alternative configurations and mitigating measures for veterinary fences were recently proposed in a major study commissioned by the Botswana Government but, as yet, no decisions have been reached that alter the status quo.

These conservation issues may be secondary to the long-term development potential for the Caprivi and northern Botswana based on wildlife management as the primary form of land use. The financial and economic values offered by wildlife far exceed those possible from domestic livestock.

See full paper on p.27.

Wildlife, Livestock, and Food Security in the South East Lowveld of Zimbabwe

David H.M. Cumming

The South East Lowveld (SEL) of Zimbabwe covers an area of approximately 50,000km^2 and is characterised by high temperatures, low rainfall (less than 400mm per year), and periodic severe droughts. It is also an endemic foot and mouth disease area. Apart from a high potential for irrigation in limited areas, the SEL is best suited to extensive wildlife and livestock production. Subsistence dry land cropping fails in most years because the growing season is too short and unreliable. With the advent of game ranching in the 1950s, there has been an increasing shift from cattle ranching to wildlife and tourism. The current land reform programme has adversely affected the wildlife/tourism sector and resulted in an increase in area under subsistence agropastoralism. Food security is a key issue for the region because cereal production from dry land cropping in the communal farming sector areas falls well below household requirements in most years, resulting in a high dependence on food aid.

Wildlife tourism is ecologically and economically the most suitable form of extensive land use for most of the region, and there are currently major moves to extend this through the development of transfrontier conservation areas. However, the question of food security and the role of livestock vis-à-vis wildlife in rural livelihood strategies remains unresolved and contentious. Key biophysical and resource management constraints, arising largely from conservative policies on agriculture, land use, and resource access rights, are examined, and strategies for achieving resilient and sustainable multispecies production systems are explored.

See full paper on p.41.

Tuberculosis – What Makes it an Ideal Disease for the Interface?

Anita L. Michel

In recent years, it has become evident that the role of wildlife in the epidemiology of bovine tuberculosis (BTB) has been greatly underestimated, both in developing countries as well as in the developed world. With the breakdown of traditional control programmes and a lack of an effective vaccine, it is almost impossible for affected countries to eradicate or even prevent the further spread of this chronic disease.

Compared with the effects in developed countries, where economic losses in the livestock production sector represent the most serious effect of *M. bovis* infection at the wildlife/livestock interface, the range of implications can be much broader in developing countries.

In South Africa's two largest protected areas, Kruger National Park (KNP) and Hluhluwe-Umfolozi Park (HUP), BTB has become endemic after spilling over from domestic cattle during the second half of the 20th century if not earlier. African buffalo (*Syncerus caffer*) are the main reservoir in both cases, but other species have recently shown potential to serve as maintenance hosts. Apart from the impact of this disease on the conservation of endangered species, on the genetic diversity within infected species, and with regard to international trade, tuberculosis caused by *M. bovis* poses a direct health threat to people and livestock in communities along the border of infected ecosystems. The prevalence of BTB in communal cattle is currently unknown for most of the areas, but the risk of *M. bovis* transmission from wildlife is rapidly increasing as exceedingly high herd prevalences are reached in buffalo and as the spectrum of affected wild animal species becomes broader. Against the generally proclaimed reduced susceptibility of humans to *M. bovis*, the human/livestock interface in this particular case should be considered a favourable environment for zoonotic tuberculosis because immunosuppression due to infection with HIV/AIDS can pave the way for infectious agents otherwise unable to cause disease on their own.

Along the borders of KNP and HUP, an estimated 165,000 people are living in close contact with and consume products from cattle with an unknown BTB status, but which form part of the wildlife/livestock/human triangle.

See full paper on p.47.

Bovine Tuberculosis in the African Buffalo: The Role of Population Models

Wayne M. Getz, Paul C. Cross, Anna E. Jolles, James O. Lloyd-Smith, Sadie J. Ryan, Peter W. J. Baxter, Justine Bowers, Craig T. Hay, Christiane Knechtel, Craig J. Tambling, Wendy C. Turner and J.T. du Toit

The spread of bovine tuberculosis (*Mycobacterium bovis*, BTB) in wild populations of African buffalo (*Syncerus caffer*) can be modeled at various levels of complexity, including components that *inter alia* deal with: basic and refined demographic and epidemiological processes; behavior as it relates to herd organization and the movement patterns of individuals among herds; ecological factors that focus on buffalo-vegetation, buffalo-lion, and buffalo-other grazer interactions; environmental effects, particularly the influence of rainfall and the distribution of water; BTB reservoirs in other species, as well as BTB transmission between buffalo and other species, including domestic cattle and people; and finally, the effects of various management actions in controlling BTB in natural populations. To avoid getting embroiled in details, models should be only sufficiently complex to answer the question at hand. Here we evaluate the form and utility of various modeling components in addressing different kinds of basic and applied questions regarding the spread of BTB in populations typified by herds in Kruger National Park, Hluhluwe-Umfolozi National Park, and Klaserie Private Game Reserve, all in South Africa.

Experiences and Challenges of Wildlife Health Management in the National Parks of Tanzania

Titus Mlengeya and Vitalis Lyaruu

Wildlife populations and the natural lands they inhabit are the world's foremost heritage. Tanzania is one of the countries that has abundant biological diversity and a "high megafauna" wildlife population. Wildlife species receive a high level of protection in over 28% of the country's land area in the form of national parks, game reserves, game-controlled areas, and forestry reserves. Through gradual development of tourism, wildlife is foreseen to have an important and growing economic role in poverty eradication for Tanzania. Wildlife species have been able to tolerate natural disasters, and their populations are known to rebound when the ecosystems are not disturbed. However, with increasing human population pressure and activities around protected areas, the impacts on natural ecosystems are great and the well-being of animals is compromised. Risks for disease transmission between wildlife, livestock, and people have increased significantly. Among the most challenging conditions include a giraffe ear disease, sexually transmitted disease in baboons, skin infection in giraffe, human-related diseases in chimpanzees, and other human/livestock/wildlife conflicts.

For the last seven years, Tanzania National Parks (TANAPA) has been developing a Wildlife Veterinary Unit to address the numerous emerging wildlife health challenges. However, considering the expanse of the area and the diversity of species, the ability of the Unit to address relevant issues is limited. This is because of the small number of veterinary staff, inadequate skills, insufficient funding and equipment, and low awareness of the impact of diseases on wildlife systems among decisionmakers. Because most of the emerging diseases affect large ecosystems or even cross international boundaries, there is a need to strengthen local capacity to detect and identify disease threats, launch efficient reporting mechanisms, and foster concerted efforts to manage and mitigate the impacts of disease.

See full paper on p.51.

Control Options for Human Sleeping Sickness in Relation to the Animal Reservoir of Disease

Susan C. Welburn, K. Picozzi, J. Fyfe, E. Fèvre, M. Odiit, M.C. Eisler and P.G. Coleman

To our knowledge, sleeping sickness has existed in southeast Uganda for more than 100 years, but little effort or resources have been applied to controlling the reservoir of the disease in domestic livestock or in wildlife. Control options have instead focused on controlling tsetse flies. Considering that the spot prevalence of *Trypanosoma brucei rhodesiense*, the human-infective parasite in cattle, can be up to 18% in cattle in southeast Uganda, while less than 1 in 1,000 tsetse flies are similarly infected, it would seem appropriate to target interventions towards controlling the animal reservoir of disease. A recent survey in this region has shown 100% of village cattle positive for *T. brucei* over an 18-month period of surveillance. Because this parasite appears relatively nonpathogenic to Zebu cattle, the implications of cattle-keeping for human health in this setting are serious.

See full paper on p.55.

Rinderpest Surveillance in Uganda National Parks

Chris S. Rutebarika

Rinderpest continues to pose a potential threat to both the wild and domestic ungulates in eastern Africa. In Uganda, livestock and wildlife are very closely associated. Vaccination against rinderpest in livestock ceased in 2001. Because the wildlife has never been vaccinated, serosurveillance of wildlife in this ecosystem is a very useful tool being used by the member states under PACE programmes.

In addition, passive data are collected on a regular basis by the staff of Uganda Wildlife Authority and local government veterinary services. "Suspected outbreaks" and rumours in both livestock and wildlife are investigated fully.

The rinderpest high-risk areas are located in the eastern and northeastern parts of Uganda, and the data collected from wildlife surveillance will augment data from livestock surveillance and support the implementation of the OIE pathway.

Understanding the circulation and distribution of rinderpest virus in wildlife is an essential component of rinderpest eradication and wildlife conservation programmes in Uganda.

See full paper on p.63.

Virus Topotypes and the Role of Wildlife in Foot and Mouth Disease in Africa

Wilna Vosloo, A.D.S. Bastos, M. Sahle, O. Sangare and R.M. Dwarka

The epidemiology of foot and mouth disease (FMD) on the African continent is influenced by two different patterns, viz, a cycle in which wildlife plays a role in maintaining and spreading the disease to other susceptible domestic animals and wild ungulates, and a cycle that is maintained within domestic animals. In southern Africa, the former cycle predominates due to the presence of African buffalo (*Syncerus caffer*), the only wildlife species for which long-term maintenance of FMD has been described. In East Africa, both cycles probably occur, while in West Africa, due to the absence of sufficient numbers of wildlife hosts, the disease is maintained largely in domestic animals.

Foot and mouth disease is endemic in most countries in sub-Saharan Africa, except in southern Africa, where a number of countries have been able to control FMD by separating infected buffalo and other wildlife species from livestock using fences. Vaccination is used on a limited scale in domestic animals in close proximity of the potential infectious hosts. In other parts of the sub-continent, control of FMD is surpassed by more urgent needs such as poverty and famine. However, FMD is one of the diseases that needs to be controlled if countries want to access international agricultural export markets. FMD cannot be eradicated from Africa unless all infected buffalo are removed, which is untenable from an ecological and ethical point of view.

A better understanding of the epidemiology of FMD could aid in planning control strategies. Molecular epidemiological studies have been very useful in this regard by highlighting historical and current patterns of spread across borders and by demonstrating the presence of viral topotypes that occur in both cycles of spread. Geographic clustering of virus strains into topotypes has been demonstrated for all six serotypes occurring on the continent, and genetic variation is such that topotype distribution should be considered when vaccination efforts for control of FMD are undertaken.

See full paper on p.67.

The Impact of Disease on Endangered Carnivores

Craig Packer

The potential for frequent, virulent disease outbreaks has increased as human populations have come into closer contact with wildlife. The risk to people from wildlife disease is widely recognized (e.g., Ebola, anthrax, and possibly SARS), but less attention has been paid to the risk to wildlife from domesticated animals. Wild dogs and Simien foxes have been decimated by rabies, and lions by canine distemper; both diseases originated from unvaccinated domestic dogs. Similar threats clearly endanger small isolated populations of wild carnivores that, by themselves, could never sustain deadly viruses. This presentation emphasizes the impact of multihost pathogens on long-term population trends in the Serengeti lions, and outlines the techniques we are using to measure the effectiveness of a large-scale dog vaccination program on the health of wild carnivores.

Veterinary Challenges Regarding the Utilization of the Kafue Lechwe (*Kobus leche kafuensis*) in Zambia

Victor M. Siamudaala, J.B. Muma, H.M Munang'andu and M. Mulumba

The Kafue lechwe (*Kobus leche kafuensis*), which is endemic to the Kafue Flats of Zambia, has immense ecological and socioeconomic importance. The species is important in the maintenance of the fertility of the Kafue Flats and fisheries, where fish are the major food source for aquatic birds. Economically, the lechwe is an important tourist attraction and is hunted for meat, hides, and trophies. Its ecological and socioeconomic importance is, however, progressively coming under threat from infectious diseases. A number of diseases have been isolated in the Kafue lechwe. Some of these diseases, such as brucellosis and bovine tuberculosis (BTB), pose serious conservation and public health challenges. The lechwe population has steadily declined from an estimated 80,000 in the 1970s to 41,000 in the mid-1980s. Infectious diseases, poaching, and increased grazing pressure are considered the major factors responsible for the population decline. The translocation of the lechwe to game ranches adjacent to cattle farms increases opportunities for the transmission of diseases from cattle to lechwe and from lechwe to cattle. A number of diseases, including brucellosis and BTB, have been diagnosed in lechwes on game ranches. The lechwe is now considered the sylvatic host for BTB and brucellosis, thereby complicating control of these diseases in livestock that share the same grazing pasture on the Kafue Flats. In addition, the lack of veterinary certification of wildlife products in the country places people at risk of contracting zoonotic diseases.

See full paper on p.75.

The Health Paradigm and Disease Control: Consideration of the Health of Ecosystems and Impacts on Human Health and Rural Livelihoods

Michael D. Kock

Historically, when considering disease control methods, authorities in Africa have paid scant attention to the impact these methods might have on ecosystems, the flora and fauna that reside therein, or on livelihoods in communities that might rely on these resources. Healthy ecosystems contribute to sustainable development and human well-being, and provide a diverse resource base that can be utilized on a sustainable basis to address poverty.

Ecosystems should not be viewed purely as "wildlife" or "natural community" based; rather, they should be seen to support the myriad activities of people and animals that occur on a daily basis, including livestock production. Recognition of the many ecosystems (both natural and human-derived, i.e., altered but healthy systems) that exist over a landscape and how they are interconnected is essential in developing a holistic approach to managing diseases and protecting biodiversity. Veterinarians need to move away from a "reductionist" approach to disease control and begin to recognize the value of a "one medicine, many ecosystems" approach to protecting livelihoods and addressing poverty and environmental issues.

Ecosystem health can be assessed by adopting a biomedical approach. For example, the development of ecological health or condition monitoring criteria that are linked to health monitoring of communities and their livestock would form a critical component of an ecosystem health approach. This would allow the monitoring of the overall condition of the ecosystem and its components in an "umbrella" fashion contributing towards the well-being of people, livestock, wildlife, and the environment. Monitoring should be done across landscapes, be multidisciplinary and complementary, detect (diagnose) problems, and lead to the generation of solutions (treatment).

See full paper on p.81.

Conservancies: Integrating Wildlife Land-Use Options into the Livelihood, Development and Conservation Strategies of Namibian Communities

Chris Weaver

Namibia is a large, sparsely populated southern African country. Since its independence in 1990, the Government of the Republic of Namibia has introduced an innovative conservancy formation strategy that has engaged more than 150,000 rural communal area residents in a national conservation movement. The passage of the conservancy legislation in 1996 has resulted in the registration of 29 communal conservancies, which encompass more than 74,000km^2 of wildlife habitat. Seventeen of these conservancies are immediately adjacent to state-protected areas, and cumulatively, increase the buffer and corridor areas around and between the existing protected areas by more than 42%. The groundswell of support for conservancies is being generated by an escalating flow of benefits that has doubled during three of the

past four years, reaching more than US $1.1 million in 2002. The conservancy movement has markedly changed the attitudes of communal area residents, and communities are now integrating wildlife and tourism enterprises into their livelihood strategies. As a consequence, land-use patterns across Namibia's arid and semi-arid communal areas are changing towards more environmentally appropriate and sustainable forms of game production, which concomitantly, enhances the viability of Namibia's extensive protected area network. Though conservancies are already producing significant environmental, social, and economic gains, it is believed that most of today's highly successful conservancies (e.g., the Nyae Nyae Conservancy) still have massive upside potential to increase income and benefits to their membership. However, in order to capitalize on such conservancies' growing populations of rare and valuable game, there is a need to address veterinary concerns and restrictions that severely inhibit the ability of conservancies north of Namibia's veterinary "Red Line" to market their valuable game resources.

See full paper on p.89.

"Counting Sheep": The Comparative Advantages of Wildlife and Livestock – A Community Perspective

Michael J. Murphree

Community wildlife management programmes across Africa have strived to encourage wildlife management over livestock production by small-scale rural farmers. However, despite data that indicate a higher return per km^2 and improved habitat management in areas under wildlife management systems, small-scale farmers in communal situations favour livestock over wildlife in almost all cases.

Why?

Several factors determine the comparative advantages of livestock and wildlife, including tenure, policy/legislation, and the fugitive nature of the wildlife resource. These factors have traditionally worked against wildlife as an attractive and viable land-use option by small-scale farmers in communal tenure regimes. However, wildlife has advantages of its own, such as resistance to drought and disease, cultural and traditional values, and high economic returns (in certain circumstances), as well as most often being the "meat" of preference. Where are we in this balancing act of choices? With over 20 years of community wildlife management experience in southern Africa, what are the current trends? Will community wildlife management programmes even out the advantages and disadvantages? Does southern Africa have lessons to learn from other parts of Africa? This paper will examine these issues and questions from the perspective of a small-scale communal farmer.

See full paper on p.105.

Foot and Mouth Disease Management and Land-Use Implications in the Zimbabwean Lowveld: the Rationale for Creating a Biosphere Reserve

Raoul du Toit

The Lowveld region of Zimbabwe is the semi-arid south-eastern sector of the country, in which mean annual rainfall is 300–600mm per year. This region is about 200,000km^2 and comprises 20% of Zimbabwe. It includes state land (notably the Gonarezhou National Park), Communal Lands (subsistence production), and commercial ranching areas that until recent political unrest in Zimbabwe were converting rapidly into wildlife production as the primary land-use in place of cattle ranching. These commercial ranching areas contain approximately 260 black rhinos, which constitute about half of Zimbabwe's total black rhino population. In addition, the Lowveld contains significant populations of wild dog, elephants, cheetah, white rhino, etc. The initiation of the Great Limpopo Transfrontier Conservation Area can and should lead to the inclusion of wildlife-producing areas of the Lowveld within a massive regional wildlife complex.

Although land-use patterns in the Lowveld have recently been disrupted by land invasions and by associated problems during a period of economic and political instability, the future of the area clearly lies in the comparative ecological and economic advantage that has been demonstrated in wildlife-based land-uses, regardless of who owns the land. There is an urgent need now to initiate planning and dialogue between stakeholders to maximize the wildlife potential of the Lowveld, as Zimbabwe emerges from its current instability. This may best be achieved through the initiation of a Lowveld Biosphere Programme, for which international funding and technical support must be secured. This programme would have to be strongly linked to the re-establishment of control measures for foot and mouth disease, which must become a priority for future development assistance to Zimbabwe, owing to the impacts of this disease not only on Zimbabwe's beef industry but also on the economies of adjacent countries (South Africa and Botswana).

See full paper on p.109.

Protected Areas, Human Livelihoods and Healthy Animals: Ideas for Improvements in Conservation and Development Interventions

Gladys Kalema-Zikusoka

Effective protected-area management is undermined by disease transmission at the wildlife, human, and livestock interface. The poorest people in developing countries tend to live at the borders of protected areas where the value of land is often reduced because of the threat of "problem" wildlife. Additionally, most protected areas are found in remote locations with limited access to adequate health facilities both for people and their animals, leading to a persistence of preventable diseases. Zoonotic diseases can be transmitted between wildlife, people, and domestic animals in close contact, especially if they are closely related. This can potentially have devastating consequences for public health, wildlife conservation, and ecotourism. In certain instances, all three sectors can be affected.

An ideal example is the association between people and habituated great apes. In Uganda, scabies skin disease outbreaks in a tourist group of mountain gorillas (*Gorilla gorilla beringei*) resulted in morbidity and mortality. These outbreaks are thought to have been associated with the relatively high incidence of scabies in the local community. Further scabies outbreaks in another habituated group of mountain gorillas is one of the factors delaying the start of tourism to this group. Ecotourism provides employment for surrounding communities and revenue that is shared for community development. Not only are people's livelihoods improved, but so is their attitude towards wildlife conservation. This particular case is one in which disease prevention measures in wildlife can be effective only if public health is improved. Tuberculosis and brucellosis are zoonotic diseases that can be transmitted between cattle and people. Around protected areas, cattle frequently mix with closely related wildlife, such as buffalo *(Syncerus caffer)*, providing an opportunity for disease transmission. This case is one in which preventing disease in people can be done effectively only by controlling disease in cattle and wildlife. In both these cases, health education to improve hygiene including boiling milk (tuberculosis and brucellosis) and washing clothes (scabies) is necessary.

An integrated approach could be more cost effective in preventing and controlling diseases around protected areas. This could be limited to close collaboration such as sharing knowledge and health information between medical, veterinary, and wildlife departments, or could be fully integrated by combining health programs for wildlife, people, and their domestic animals. Although most protected areas are in remote locations, some protected areas have relatively good infrastructure for wildlife conservation and ecotourism activities. People in the wildlife and tourism community can improve the situation by extending their resources to improve health service delivery for people and their domestic animals, such as transportation of medication to people in remote areas. To achieve a great impact, multidisciplinary teams from wildlife, medical, veterinary, and information and communications technology sectors should be created to combine expertise in education and health programmes. Mutual training programs in wildlife, domestic animal, and human health monitoring, as well as sharing of laboratory facilities for disease diagnosis, could help to maximize the use of limited resources while building local capacity and being more sustainable. Research on interrelated conservation and public health issues should be encouraged and results shared with policymakers. Finally, funds from health donors could be given to wildlife conservation where it directly affects public health and, similarly, funds from conservation donors could be given to public health when it directly affects wildlife conservation. Close collaboration between governments, NGOs, the private sector, universities, and schools would be needed to develop efficient and effective programs.

See full paper on p.113.

Impact and Value of Wildlife in Pastoral Livestock Production Systems in Kenya

Fumi Mizutani and Elizabeth Muthiani

Four Kenyan pastoral communities in semi-arid areas of Laikipia and Amboseli participated in an in-depth socio-economic household survey corresponding to 1-year periods within the March 2001 to March 2003 time frame. One hundred households were selected randomly from the geographic clusters within each community to compare characteristics of different communities. The year surveyed was considered, by the communities, an average/good year for Laikipia and a bad year for Amboseli.

Laikipia communities had fewer cattle than the Amboseli community and derived less net profit proportionately. However, the wildlife-based enterprise benefited every level of the community in poorer pastoral communities – more than in wealthier ones – compared with the benefits derived from livestock production.

Reductions in communities' livestock production caused by predation and major diseases have been calculated using the Livestock Production Efficiency Calculator. This paper includes an examination of variables such as group ranch size, rainfall, soil fertility, and progress in community-based wildlife utilisation.

See full paper on p.121.

A Regional/Community Approach to Conservation and Development Interventions at the Livestock/Wildlife Interface

George Gitau

Conflicts between people, livestock, wildlife, and the environment have remained a sensitive issue in many parts of Africa, especially in East Africa. These conflicts arise from the use of shared natural resources that have been increasingly dwindling during the last few years. The latter is associated with an increasing human population, changes in land-tenure systems, and land use moving increasingly towards agro-pastoralism and sedentarisation of formally migratory groups of pastoralists. In addition, there has been an increased uncontrolled encroachment of national parks and private ranches by the pastoralists in search of grazing resources.

The United Nations Convention to Combat Desertification (UNCCD) selected the African Union/Interafrican Bureau for Animal Resources (AU/IBAR) as one of its focal points. The UNCCD mandated AU/IBAR to address the Thematic Programme Network 3 (TPN3) that focuses on the theme area of "rational use of rangelands and fodder conservation." To address the above theme, AU/IBAR has initiated a cluster of stakeholder meetings in 2002 comprising local, regional and international institutions with interest or currently working at the livestock/wildlife/environment interface. After a series of meetings between AU/IBAR and the partners, existing gaps were identified in the understanding of the socioeconomic, political, and institutional drivers for environmental change and degradation at the interface between the livestock within pastoral systems and wildlife and the environment. A proposal has been developed for funding and is currently receiving positive consideration by UNEP-GEF.

The main objectives of the project proposal are 1) to develop models and approaches to stabilize livestock/wildlife populations for sustainable livelihoods, biodiversity conservation, and reduced land degradation; and 2) to enhance capacity for management at the livestock/wildlife interface for economics and/or food security in Africa. This will be achieved through community and regional approaches via compilation of a database from available information from other studies and from pilot activities set up by the project, and by enhancement of capacity for dissemination of the livestock/wildlife/environment interface model through the TPN3 in Africa.

Complementarity Between Community-Based Animal Health Delivery Systems and Community-Based Wildlife Management? An Analysis of Experiences Linking Animal Health to Conflict Management in Pastoralist Areas of the Horn of Africa

Tim Leyland and Richard Grahn

Community-based animal health delivery systems have been developing since the early 1980s across all continents. They are now accepted as viable mechanisms for bringing services to remote, marginalised, and under-served livestock-keeping communities. In recent years, there has been a concerted drive in the pastoralist areas of the Horn of Africa to make these systems sustainable through privatisation, supported by enabling policies and legislation. This process has forced advocates for these delivery systems to confront core non-animal health problems, such as access to markets, political marginalisation of pastoralist communities, and conflict. This paper briefly describes how successful community-based animal health delivery systems function. It gives examples of the positive impact these projects have had on the livelihoods of livestock owners. They have also proved vital in gaining the confidence of pastoralists and assisting the pastoralists themselves to manage local conflicts such as livestock raiding. The authors note that whilst much progress has been made at the community level in conflict management, sustainable peace and improved economic outcomes require policy and legislative change by responsible governments, based on a fuller understanding of pastoralist problems. This understanding will have to come from pastoralist communities themselves through their attainment of a voice and ability to advocate for improvements.

During the course of animal health-linked conflict management work in pastoralist areas, the weak management of wildlife resources has emerged as a community concern. Opinion leaders in pastoralist communities are advocating increased efforts from communities and other stakeholders to address the massive wildlife depletion that has taken place in pastoralist areas of the Horn of Africa over the past 30 years, primarily through game meat off-take. Some of the local leaders' suggestions are presented. The authors note that pastoralists are more likely to address issues of wildlife and habitat destruction once their more crucial livelihood problems (particularly animal health and conflict) are being solved.

Given the geographic closeness of wildlife and pastoralist grazing lands in the Horn of Africa, the paper examines community involvement in wildlife conservation and management around protected areas. It asks whether some of the lessons learned from community animal health programmes and their links with conflict prevention could be utilised to

improve wildlife conservation and management in pastoralist communities. The authors conclude that there is an opportunity to add value to community-based wildlife management schemes by linking them with community-based animal health initiatives. Such linkages require more dialogue and collaboration between conservationists, veterinary practitioners, and pastoralists.

See full paper on p.133.

Introduction of Foot and Mouth Disease-Infected Buffalo into the Save Valley Conservancy in Zimbabwe: Success or Failure?

Chris Foggin and G. Connear

A total of 618 buffalo *(Syncerus caffer),* known to be carrying foot and mouth disease (FMD) and originating from the west and southern regions of Zimbabwe, were released into the Save Valley Conservancy in the southeast region of Zimbabwe between 1995 and 2002. This Conservancy consists of 24 different title deeds with multiple ownership. It is 3,420km^2 in area and is stocked with numerous other species of wildlife. On veterinary instructions to facilitate the buffalo release, all livestock was removed, and an electrified, double fence was constructed around the 312km perimeter of the Conservancy (the inner fence was 1.2m high with six strands, and the outer fence 1.8m high with 12 to 14 strands). Despite careful fence maintenance, an outbreak of FMD occurred in cattle adjacent to the Conservancy within two years of the initial release. Subsequent to that, a further four outbreaks of the disease have occurred within 10km of the outside of the perimeter fence, although not all of them appear to have originated within the Conservancy. Ongoing serosurveys of wildlife indicate that FMD virus circulates widely in eight species of antelope, and especially greater kudu (*Tragelaphus strepsiceros*), which have shown 34% seroprevalence. Since the year 2000, the continuing land crisis in Zimbabwe has further facilitated spread of this disease with some 22% of the Conservancy being occupied against the owners' wishes, resulting in the destruction of 80km of the perimeter fence. There are presently over 5,000 cattle within the Conservancy, and many wildlife animals have been illegally killed. It is concluded that, to date, this buffalo introduction has had more failures than successes.

The Disease-Free Buffalo Breeding Project of the State Veterinary Services and South African National Parks

Markus Hofmeyr

The African buffalo *(Syncerus caffer)* is one of the more important wildlife species, ecologically and economically, in Africa. It occurred historically in large herds throughout South Africa, and played an important ecological role as a bulk grazer. Extensive over-hunting, the rinderpest epidemic of the late 19th century and, lately, its role as a carrier of economically important diseases have restricted the range and resurgence of this species back into its former habitat in South Africa.

The Department of Agriculture's Veterinary Services in Kruger National Park has done extensive studies on the dynamics and epidemiology of the economically important diseases carried by buffalo such as foot and mouth disease, corridor disease (theileriosis), bovine tuberculosis, and brucellosis. This research has allowed the innovative "disease-free" buffalo-breeding project to be initiated by the veterinary staff of South African National Parks (SANParks) in Kruger National Park. The driving force for this project is SANParks' need to reintroduce buffalo into newly established national parks within its former range.

This presentation describes how, through collaboration between the State Veterinary Services and SANParks, a breeding project has been developed that rids buffalo of the economically important diseases (foot and mouth disease, corridor disease, bovine tuberculosis, and bovine brucellosis) so that reintroduction into former range can be undertaken without risk to neighbouring farming communities.

Control of Domestic Dog Diseases in Protected Area Management and the Conservation of Endangered Carnivores

Karen Laurenson, Titus Mlengeya, Fekadu Shiferaw and Sarah Cleaveland

Disease is an increasing threat to many of the world's endangered carnivores, from those in North America to those in Africa. To date, rabies and canine distemper have given the greatest concern, causing severe declines in and local extirpations of a range of species, including the black-footed ferret, Channel Island foxes, Ethiopian wolves, African wild dogs, and lions. In many of these examples, particularly in Africa, outbreaks in wildlife have occurred when pathogens have spilled over from a surrounding reservoir of domestic dogs. With dog populations and thus risk of spillover constantly increasing, many protected area managers are taking measures to reduce this disease risk to endangered carnivores. The range of approaches available includes reducing disease in target species, reducing disease incidence in the reservoir dog population, and preventing contact between the target and reservoir species. Reducing disease risk in endangered carnivores can be effected by directly vaccinating or treating endangered individuals. This approach has been tried for black-footed ferrets, African wild dogs, and Channel Island foxes, but has been limited by logistical and technical constraints such as the availability of safe and efficacious vaccines. Reducing disease incidence in reservoir dogs has been tried by directly vaccinating or treating or indirectly through reducing the size of the dog population by culling or limiting reproduction. Dog vaccination has been carried out around several protected areas in Tanzania such as the Serengeti National Park (NP), Ruaha NP, and Udzungwa NP, and in Ethiopia, particularly the Bale Mountains NP, to protect the Ethiopian wolf. If done with sufficient scale and commitment, this approach has been effective. Culling and limiting the size of dog populations face considerable cultural challenges. Education campaigns to encourage responsible dog ownership have been conducted in Ethiopia, although with limited effect. Future work to reduce the need for dogs in Ethiopia is planned. Contact could be reduced through fencing or other physical barriers, restraining dogs, or through reducing human and thus dog movements in wildlife habitat. Fences are common in protected areas in South Africa but have not always prevented rabies outbreaks, particularly when small carnivores may be a vector from reservoir dogs or a component of the reservoir themselves. Encouraging owners to tie dogs has had limited success in Ethiopia. Overall, wildlife managers are ill-equipped to reduce disease threats to endangered carnivores. Conducting successful campaigns will require currently available approaches to be tailored to the specifics of the situation.

See full paper on p.141.

Impacts of Wildlife Infections on Human and Livestock Health with Special Reference to Tanzania: Implications for Protected Area Management

Sarah Cleaveland, Karen Laurenson and Titus Mlengeya

Microbial pathogens are integral components of natural ecosystems and play an important role in the evolution and ecology of host communities. However, the growth of the human population and expansion of associated activities have affected contact and transmission patterns between human and animal populations, leading to the emergence of several major diseases that affect human health, livestock economies, and wildlife conservation.

Zoonotic pathogens, particularly those that infect wildlife, pose a particular risk for human disease emergence (relative risk for zoonoses = 1.97; for pathogens infecting wildlife = 2.44). Zoonotic diseases associated with wildlife, such as sleeping sickness and anthrax, also pose a potential threat to the tourist sector, which is a major source of foreign exchange in many African countries. Wild animal populations are often implicated as reservoirs of emerging zoonoses, but we have little knowledge of the infection dynamics of these diseases in wildlife, which limits the options and effectiveness of disease control.

Infections in wildlife also have major implications for livestock development in areas adjacent to wildlife (protected) areas. Most livestock pathogens (54%) can also co-infect wildlife. Where wildlife populations are the source of disease for livestock, land-use conflicts invariably arise, typified by problems associated with malignant catarrhal fever in East Africa and foot and mouth disease in southern Africa. Malignant catarrhal fever has been a major factor contributing to the decline in livestock production in pastoralist communities living in and around protected areas of East Africa, leading to a growing demand for cultivation, a form of land use generally incompatible with wildlife conservation. In other resource-poor communities, a deteriorating livestock production base, exacerbated by diseases transmitted from wildlife, has also fuelled a growth in illegal wildlife hunting to meet growing demands for both dietary protein and cash income.

Options to control infection in wildlife are limited, and current strategies, such as culling and movement restriction, have major negative repercussions on wild populations. Engaging wildlife managers in issues relating to both public health and livestock development is therefore crucial in order to develop effective and appropriate strategies for disease control.

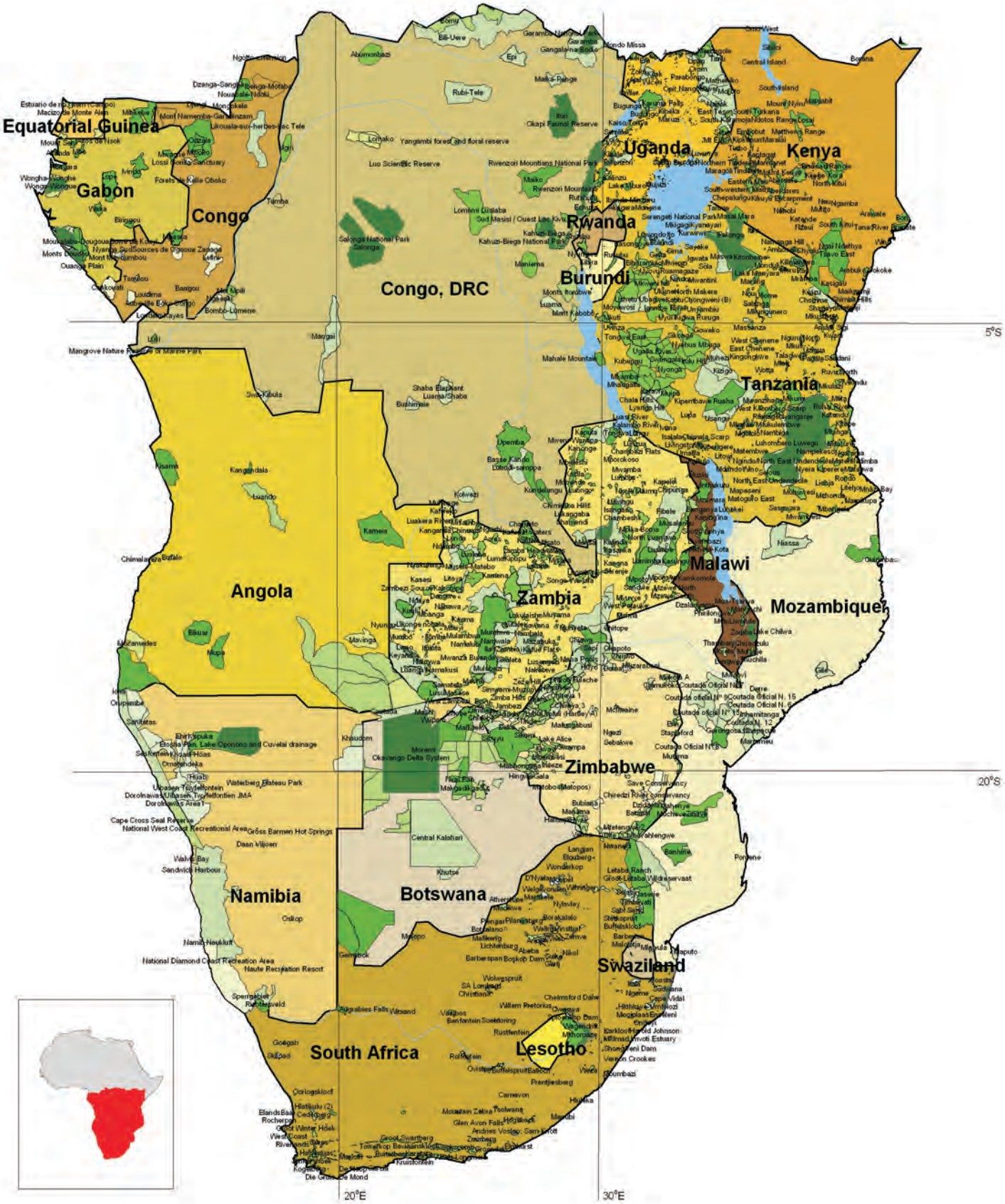
See full paper on p.147.

Synergies between Livestock Husbandry and Wildlife Conservation in Southern Province, Zambia

Dale Lewis

Wildlife conservation solutions in rural areas surrounding protected areas are often hidden in a complex web of livelihood constraints and needs that increase the risks for wildlife/human conflicts. Most wildlife managers are not trained to look for such relationships, and rural development specialists generally do not adapt their rural livelihood solutions to conservation. This paper illustrates the critical importance of building conservation programmes around such relationships for wildlife areas where the potential for human/wildlife conflict exists. Such conflicts are especially exacerbated when human populations suffer hardships of food shortages and low income. Two real-life examples in Zambia are described in which disease of domestic species (cattle and poultry) plays an important role in influencing poaching rates. Pilot studies show how appropriate interventions that enhance the synergy between wildlife conservation and human livelihoods through applied animal husbandry can lead to relatively low cost solutions to wildlife conservation challenges.

See full paper on p.153.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Zimbabwe
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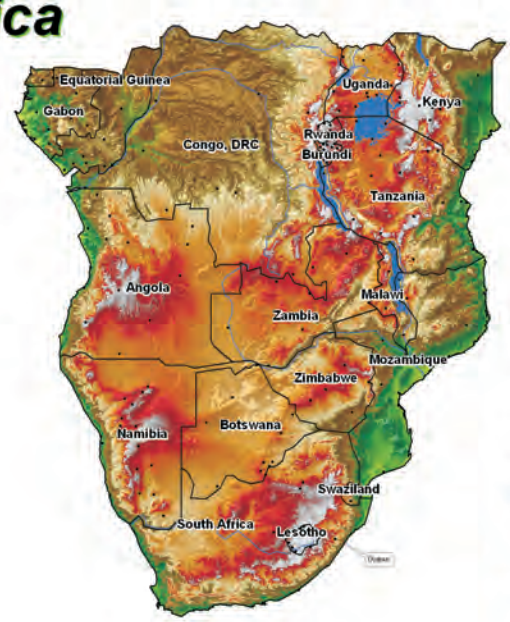
National Parks and Other Major Conservation Areas of East and Southern Africa



Topography

- Country Boundaries
- Major Cities
- Major Rivers
- Major Lakes

Altitude (m)

5825

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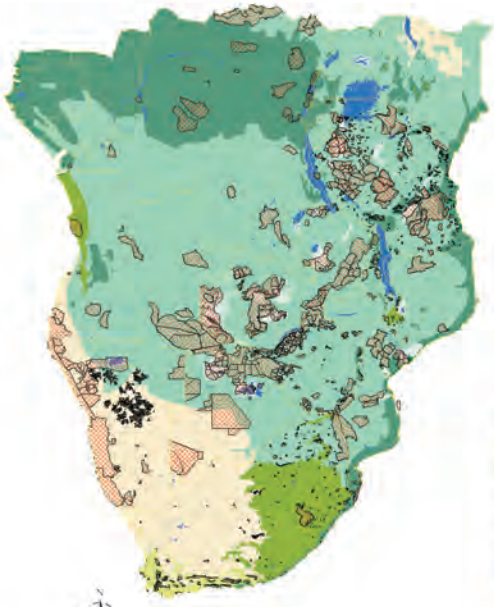

Protected Areas

- International Protected Areas
- National Parks, Reserves
- State Forests, Reserves
- Forest Reserves
- Nature, Wilderness, Wildlife Reserves and Management Areas
- Conservation Areas, Conservancies
- Generic Parks, Reserves, and Protected Areas
- Other Forests, Reserves and Sanctuaries
- Recreation Parks, Areas
- Games, Safari, Hunting, and Private Reserves
- Marine and Wetland Reserves, Parks and Sanctuaries
- Not Protected, Production Forest, Unknown
- Major Lakes
- Major Rivers

Ecoregions

- Country Boundaries
- Deserts and xeric shrublands
- Flooded grasslands
- Mangroves
- Mediterranean scrub
- Montane grasslands
- Tropical and subtropical dry broadleaf forests
- Tropical and subtropical grasslands
- Tropical and subtropical moist broadleaf forests
- Water
- Protected Areas

0 125 250 500 750 1,000 Km

Created by Sara Zeigler and Philip Nyhus, Franklin and Marshall College
July 2003

Protected area data provided by United Nations Environment Programme - World Conservation Monitoring Centre (UNEP-WCMC)
WCPA, May 2003
Country boundary, river, lake, and city data from ESRI
GTO0)30 topographical data from United States Geologic Survey (USGS)

Projection: Africa Albers Equal Area Conic
Central Meridian 25.0
Standard Parallel 1: 20.0
Standard Parallel 2: - 23.0
GCS WGS 1984

Errors related to any political or conservation boundaries or any omissions of sites remain those of the authors and do not reflect the official opinions of Franklin and Marshall College or any other organization involved in the AHEAD forum.

Developed for the Southern and East African Experts Panel on Designing Successful Conservation and Development Interventions at the Wildlife/Livestock Interface: Implications for Wildlife, Livestock, and Human Health, World Parks Congress, Durban, South Africa, 2003.

Chapter 1

What is this Infamous "Wildlife/Livestock Disease Interface?" A Review of Current Knowledge for the African Continent[1]

R.A. Kock, ZSL Conservation Programmes, Regent's Park, London, and PACE Epidemiology Unit, AU/IBAR, Nairobi, Kenya

Introduction

The wildlife/livestock interface means different things to different people. Impressions vary from images of wild bird contact with intensive pig operations along the avian migration routes of North America to dusty scenes of thirsty and hungry cattle trudging through protected areas of Africa in search of drought-depleted resources. The many facets to the interface, such as health, conservation, environment, culture, and economics, have been issues since livestock became an integral part of the landscape. There are positive and negative aspects to the interface and it has been a source of conflict in many areas, often as a result of misunderstanding and polarisation of opinion between ecocentric and anthropocentric forces in society. To review all aspects of the interface is beyond the scope of this article, and other texts provide useful data (Boyd *et al*. 1999) for those wishing a more comprehensive view. Attention here is given to those elements relevant to the health of the large-mammal communities and is focused on Africa, where currently there is an urgent need to find solutions to the problems of abject poverty, poor health status for people and animals, and threats to the environment and biodiversity.

The African rural context

Africa is a continent with great natural richness, particularly in terms of human culture and natural resources. This is especially so in dry-land pastoral systems, where livestock and people share resources with the most diverse array of wild ungulates on earth (R. Kock *et al*. 2002). With improvements in human health care, the population is growing exponentially but the economies of most countries are not growing correspondingly. Poverty is widespread, with significant portions of the continent's people living on less than US$1 per day (FAO/UNEP/CGIAR 2004). Communities are often food insecure, especially where land degradation is prevalent and social systems have broken down, which often happens during times of war or other unrest. Consequently, there is considerable international pressure to accelerate development and alleviate poverty (Thrupp and Megateli 1999). With rapid economic development, environmental change and loss of biodiversity can be expected; indeed, this has been the experience in many countries. One form of poverty is thus replaced by another.

Eighty percent of the population is rural, and the majority of these people are dependent on livestock; 70 million people are wholly dependent with no alternative source of food or wealth (AU/IBAR 2002). Yet, Africa accounts for only 2% of the total value of world trade in livestock and livestock products and imports twice as much as it exports with the net imports increasing at 4% per year (Thambi 2003). Taking this into account, one way to alleviate poverty in Africa is through improved livestock (and agricultural) economics, as well as through the development of alternative rural livelihoods based on natural resources. Urbanisation and industrialisation are not an answer as the energy, human resources, skills, and infrastructure needed to compete globally are lacking. Since the first warnings of a need for a shift in wealth distribution from the North to the South (Brandt 1980), there has been no sign that this will occur. Developed nations continue to unsustainably utilise dwindling resources, which they control and need in order to maintain their own positive economic growth (Pyle 2003). Under these conditions, Africa has little choice but to concentrate on utilising its natural resources and exploiting the agricultural potential of the land.

Health constraints and the market

The single most important constraint on the African livestock export trade is the "Sanitary and Phytosanitary Measures" of the World Trade Organisation (WTO) (OIE 2003); i.e., the status of endemic disease(s) in many African countries is a barrier to trade and this is a key concern of policymakers. This is despite the fact that the impact of these trade-sensitive diseases is minimal within Africa, especially amongst pastoral livestock and poor farmers (Perry *et al*. 2002). As the maintenance of these extensive livestock systems, and to some extent the close association between wildlife and livestock, is the main reason for the current disease status, pressure is building amongst certain political elements in Africa for change and this is threatening the existence of traditional pastoral society and also wildlife resources (R. Kock *et al*. 2002). These WTO rules are set up by the developed nations, essentially in their own self-interest, and African nations have not been able to influence

[1]See abstract on p.xix.

changes in these regulations to their own advantage (Thambi 2003). This barrier to Africa's entry into lucrative markets is ironic, given the rhetoric from the developed world on achieving poverty reduction in Africa.

However, the situation is not simple because, even if changes were possible, under current conditions the resulting trade is likely to directly benefit only a small sector of people – those running commercial enterprises – so its relevance to many of the poor people on the continent is questionable. In Kenya, for example, only 3% of the meat trade is supplied by the commercial livestock ranching sector, a likely beneficiary of the export trade, whilst 67% of the available meat is from pastoral communities, which could not easily benefit (EU 2003). There are examples of African livestock export success stories, such as in Botswana, where cooperative systems and well-developed livestock movement procedures and other disease control measures ensure a profitable trade and benefits to livestock keepers, although the role of government support (subsidies) and the sustainability thereof cannot be ignored. In most African countries, measures taken at the international level will need to be matched at the local level with initiatives that more obviously connect pastoralists with the global economy before the export trade can benefit the majority of livestock owners. Nevertheless, as long as this disease "pariah" status exists, it will be an incentive for countries to seek ways to comply rather than seek changes to the rules, which will continue to isolate remote and politically disenfranchised pastoral communities, which suffer endemic diseases that cannot easily be controlled.

Misconceptions at the wildlife/ livestock interface

There is a perception amongst African intellectuals and others that there is a link between the desire of the international community to conserve Africa's wildlife as a world heritage and a reluctance to support livestock development and people (Bourn and Blench 1999). This comes from the idea, still commonly held outside of Africa, that livestock is a major factor in land degradation and loss of wildlife. This view has been shown to be overly simplistic; positive environmental benefits can be attributed to livestock systems as much as "overstocking" can lead to soil impaction and loss of vegetation (Mace 1991). There is also a tendency for livestock-induced degradation to be associated with subhumid and humid zones, especially at the periphery of agricultural areas. Even here, livestock are only part of the picture in terms of the trend towards a general fragmentation of habitats and disruption of the natural ecology, including the disappearance of large mammal wildlife across much of its historic range. The arid and semi-arid lands do not fall so neatly into this category.

Contemporary studies have shown that pastoralists' strategies are optimal for sustaining the communities and the resources and that they are a force, as well, in conserving the environment to the benefit of wild species (Roth 1996, Scoones 1994). The most compelling evidence for this is the fact that the last significant, unrestricted, wild ungulate populations surviving in Africa (East 1999) are associated with pastoral systems. Improvements in livestock production systems, health, and marketing in pastoral society, along with sustainable exploitation of wildlife resources, are likely to lead to a *reduction in domestic animal herd sizes,* which are currently high primarily to insure against drought and disease. This improvement will lead to healthier ecosystems.

Parallel to the improved understanding of the role of livestock in dry lands, there is an increasing awareness of a new potential value of the wildlife resource through community-based ecotourism and other forms of utilisation, with wildlife industries becoming increasingly important in the economics of African countries (Chardonnet *et al*. 2002, Jansen *et al*. 1992, Cumming and Bond 1991). To further support this, studies of mixed systems indicate considerable environmental benefit as well as economic ones (Western 1994). It can be argued that one of Africa's main advantages (perhaps the only one in economic terms) over the rest of the world is its extensive and diverse wildlife resource, which is so attractive to tourism. This is not to say that livestock are not important on the continent but, to put it into context, Chile and Argentina taken together currently have a larger livestock industry than all the countries of Africa put together (FAO 2003). So to sacrifice wildlife in favour of developing a competitive commercial livestock sector has little justification, but to develop both wildlife and commercial livestock concerns mutually (not defaulting to one or the other exclusively) is a key to utilisation of available resources.

Given the increasing economic benefits from wildlife, health issues are an increasing concern in this field especially where epidemics and chronic disease problems occur as a result of introduced disease. A review of the coexistence of livestock and wildlife (Bourn and Blench 1999) concluded that wildlife disease was not a constraint, but lack of information on diseases in the field make this a risky assumption. Disease can adversely affect animal population dynamics in the short and long term (Hudson and Dobson 1989, Rodwell *et al*. 2001, Jolles 2003, Lankester 2003, Hwang 2003) and increases the risk of the extinction of rare species (Andanje 2002). The initial impacts of exotic disease can be devastating and depress population growth for decades (Mack 1970, Plowright 1982, Kock *et al*. 1999); conversely, control or eradication of these pathogens can lead to dramatic recovery of populations (Sinclair 1970). The more subtle effects of disease are to make the population more susceptible to other impacts, such as predation, and effectively depress the numbers well below the limitations of the food resource available (Joly 2003). The decision on what to accept as a natural or an acceptable disease dynamic within a biological system may well in the end be a value judgement, but in terms of resource use, consumptive or otherwise, depressed populations will limit the options.

With this background, the important reasons for enhancing understanding of the wildlife/livestock interface in terms of disease are clear: to alleviate fears or concerns about the impact of disease at the interface and ensure that appropriate policies and control measures are implemented. This will improve livestock production and support healthy ecosystems.

Veterinary intervention at the interface

Policy and practice in Africa on interface disease issues have often been controversial. Examples are the wildlife eradication policies for the control of tsetse fly and trypanosomiasis (Austen 1907, Sidney 1965), some approaches to buffalo management and control of foot and mouth disease (FMD) (R. Kock *et al*. 2002, M. Kock *et al.* 2002), and contagious bovine pleuropneumonia control using fencing (Owen and Owen 1980, Taylor and Martin 1987, Scott Wilson 2000). With wildlife abundant during the earlier part of the last century, it is perhaps understandable that farming communities and veterinarians attempted broad-brush approaches on the path to establishing a livestock economy. The natural resources seemed endless and wild animals were considered to some degree to be pests. The concerns over wildlife as a source of infection were sometimes justified as efforts to establish commercial livestock industries were frequently failing or constrained as a result of disease outbreaks, some of which could be attributed to contact with wildlife. FMD was a good example of this. In fact, strict land-use policies, animal movement controls, and fencing largely resolved the problem of FMD in southern Africa (Thomson 1995). The impact of wildlife disease has also been a concern to traditional livestock keepers, e.g., the Maasai communities of the greater Serengeti ecosystem, where malignant catarrhal fever (MCF) causes significant cattle mortality and reduces the ability of livestock to exploit pasture resources (CSU 1999, Rwambo *et al.* 1999).

The understanding of wildlife/livestock diseases globally is improving and better tools for researching health issues now exist, mainly due to the progression in the science of molecular biology. This, coupled with improved techniques of monitoring the environment with remote sensing and the application of easily comprehended reporting systems using GIS, make it theoretically possible for decisionmakers to promote better policies for sustainable resource use and animal health management. Unfortunately, even though the technology makes it easier to interpret information, it has the disadvantage that unless data are scientifically sound and balanced a false picture can be made entirely believable.

One problem in Africa is a lack of basic field data on the interactions at the wildlife/livestock/environment interface in relation to disease. There are some data from southern Africa, but here the interface is much more limited than elsewhere due to fencing and landscaping. Historical data on wildlife disease in eastern Africa have been mainly from laboratory-based activities with few epidemiological studies. The outputs of wildlife disease research in the region have been reviewed (Grootenhuis 1999). Attempts were made more recently to gather information in pastoral systems such as the Greater Serengeti ecosystem (CSU 1999, Rwambo *et al.* 1999) to fill this gap but sufficient hard data are still lacking, with relatively superficial results based mainly on questionnaire surveys from relatively few areas. The emphasis was on livestock diseases, of which East Coast fever (ECF), MCF, anthrax, and anaplasmosis were reported as priorities. Buffalo were not associated by the Maasai with ECF outbreaks, and the recent die-off in the Ngorongoro crater of buffalo (25%), lion (50%), and rhinoceros (40%) associated with increases in ticks, biting flies, and blood parasites (R. Kock, personal observation 2001) was not predicted by this assessment. It may well be that there are numerous disease associations in this region at the interface but that they have been overlooked.

A fundamental issue in this field in Africa is a lack of effective institutions to do field research and act on any information. Even with the current knowledge of what matters and on what interventions are needed to maintain healthy ecosystems, few countries are currently able to do anything meaningful to stop the decline in animal populations and parallel degradation of land and other natural resources.

One certainty is the increasing need for veterinary input in the fields of wildlife disease and human public health, in recognition of the growing intensity of the human/wildlife/livestock interface and the emergence of diseases that either originate in wildlife or have wildlife reservoirs. An example is the recent global phenomenon of severe acute respiratory syndrome (SARS), a well-documented threat to public health believed to have originated in captive wildlife. This human-infective coronavirus disease emerged most probably from a species of civet cat after a massive mixing of indigenous and exotic animals with people in crowded urban markets in China. Human immunodeficiency virus (HIV), Ebola virus, West Nile virus, and monkey pox are all documented to have emerged in humans through an association with wildlife, with pathogens' species-jumping being associated with, for example, bush meat consumption or the exotic pet trade or insect vectors, with these viruses achieving notoriety due to their association with human mortality within Africa and beyond (WCS 2003). There has also been an increasing incidence of wildlife/livestock interface diseases reported over the last decade (bovine tuberculosis [BTB], rinderpest, anthrax, FMD) (Bengis *et al*. 2002).

This apparent emergence of disease is partly a result of the expansion of human and livestock populations into wildlife areas, with dramatically disturbed habitats and novel interactions, but also a result simply of increased awareness. Ironically, there is also now a belief in some philosophical circles that human and natural landscapes should not be separated (Paquet, personal communication 2003). Much of this is based on the thought that packaging nature (e.g., in National Parks and Reserves) separate from man will not maintain biodiversity and associated essential ecological and evolutionary processes. In some parts of the world, this concept has led to reduced persecution and the recovery of wildlife populations in some agricultural, urban, and suburban environments with dramatic results. For example, in North America there are now an estimated 39 million deer living in a highly modified environment, some restricted in farms and fed artificial diets but the majority free ranging. Interestingly, chronic wasting disease appears to have emerged under these conditions (Williams and Miller 2002, Powers 2003).

This trend towards establishing larger more integrated wildlife systems is also occurring in Africa, e.g., through

Table 1. African wildlife species associated with diseases of economic importance in wildlife/ livestock systems and their epidemiological role

Wild Animals Concerned	Diseases	Epidemiological Role	Predicted Mortality (wildlife)
Ungulates (notable species)			
Kudu, impala	Anthrax	Multiplier epidemic hosts	High
Buffalo	Brucellosis	Epidemic host	Low
Buffalo, kudu	BTB	Epidemic hosts	Moderate
Eland, buffalo, impala	Ticks and TBDs	Multiplier endemic hosts	Low
Grazing ungulates	Internal parasites	Multiplier endemic hosts	Low
Gerenuk, others	Rift Valley fever	Multiplier epidemic hosts	High in epidemics
Buffalo, impala, kudu, wildebeest, sable	FMD	Epidemic hosts	Low
Eland, kudu, giraffe, impala, bushbuck, buffalo	Rinderpest	Epidemic hosts	High
Wild bovine, hippotragine, caprine species	MCF	Epidemic hosts	Negligible
Kudu	Rabies	Epidemic host	High
Eland, springbuck, lechwe, sitatunga	Heartwater	Endemic hosts	None
Bushbuck and others	Trypanosomiasis	Multiplier endemic hosts	None
Gazelles, oryx, ibex	PPR	Epidemic hosts	Moderate
Important species-specific associations			
Buffalo	BTB	Maintenance host	Moderate
	Rinderpest	Multiplier epidemic host	High
	FMD	Maintenance host	Negligible
	Corridor disease	Endemic host	None
Bushbuck	Bovine petechial fever	Endemic host	None
Warthog	ASF	Endemic host	None
Wildebeest	MCF	Endemic host	None

transfrontier parks (Gelderblom *et al*. 1996): extension of wildlife management areas into communities, conservancies, and wildlife corridors (IIED 1994, Hulme and Murphree 1999). Clearly, to conserve wildlife there is a need to find a more integrated approach and yet we cannot recreate Eden; there will be costs. These initiatives will inevitably be a compromise with other land-use practices and will result in complex disease phenomena (Rosenzweig 2003) that will need novel solutions and interventions. This is the contemporary challenge to the veterinary community, disease biologists, and wildlife managers alike.

Definition of the wildlife/livestock interface

Here, an attempt is made to define this interface in Africa, in relation to pathogenic infections and economically important diseases and the species that, based on current knowledge, have some epidemiological significance to these infections (Table 1), as well as to illustrate what the interface amounts to, in a physical sense, and how this relates to transmission of the concerned diseases.

Contact – The physical interface and disease transmission

Defining the interface in a physical sense, which is critical to understanding transmission dynamics, is complicated by an almost total lack of published observations of contact between livestock and wildlife species. This is more the realm of experience of the goat herder than of the scientist. Some published studies (Dobson 1995, Kock *et al*. 1999) and ethological texts (Kingdon 1997, Estes 1991) on wildlife across the African continent allow for some generalisations, but there are remarkably few studies that relate to observations of diseased populations.

The species most often reported in wildlife/livestock disease outbreaks come from the ungulate group and are mainly from the family Bovidae, of which the buffalo and bovine antelope are most prominent. This is perhaps not surprising given their relatively close phylogenetic relationship to ancestral (wild) cattle. These species live in spatially discrete small family groups or in larger herds (up to many thousands), with intraspecific fusion-fission herd dynamics (Prins 1987). Herds are usually made up of related animals, which maintain close contact with each other but occasionally split or come together according to social or environmental factors (e.g., rain, drought, formation of bachelor groups, breeding, migration), which clearly have epidemiological implications; i.e., opportunities for contact and transmission of infection are frequent but variable, within and between herds of a given species. Mixing, or contact, between animals or herds of different species occur but are less often observed. It is more common in open habitats and with plains species, e.g., during mass migrations of wildebeest, topi, zebra, and gazelles in the greater Serengeti system of East Africa. Bush, woodland, or forest species are usually more cryptic and even less likely to come into direct contact with other species. In all cases and especially under conditions of drought, contact increases at watering points or locations with key forage resources. When wild species mix, the separation distance can be a matter of a few feet, certainly close enough for transmission of most aerosol-borne infections, for pathogen transmission through contamination of grazing, or via water/bodily fluids. However, the typical and predictable behaviour of species can be disrupted by disease and ill health, e.g., rinderpest, in which the animal can exhibit bizarre behaviour such as losing fear of man, chasing other species aggressively, or seeking contact with other animals, having been rejected by its own herd members (Kock *et al.* 1999, Rossiter 2001).

The behaviour between wildlife and livestock is somewhat different. Wildlife usually avoids livestock and human contact spatially and temporally unless habituated. Whether this is instinct or learned behaviour is not clear. An example of this is seen at shared water points or grazing areas. Buffalo and other wildlife will be seen at night and early in the morning watering and grazing at these locations, purposively moving off sometimes only minutes before livestock arrive from their night bomas (secure pens constructed of brush or thornbush adjacent to temporary human shelter). The daily distance moved by wildlife to and from these key resources can be less than 100m if thick protective vegetation is adjacent to the point, or many kilometres to safe havens when there is regular aggressive contact with livestock owners or hunters. So the disease interface between wildlife and livestock is not usually a direct physical interaction or even sharing of the same space at the same time but an indirect contact; through the soil, forage, and water with which another animal has recently been in contact and has left bodily discharges, such as faeces, urine, saliva, or ocular or nasal discharge, or through shared insect vectors or intermediate hosts (Fenner 1982).

Infective agents survive for different periods in the environment depending on a number of factors, both intrinsic (e.g., cell structure of the organism, adaptation to vectors or intermediate hosts) and extrinsic (climate and season, temperature and humidity), surviving for a period of seconds or minutes (many viruses) to up to 200 years (some bacteria, such as anthrax) (Hugh-Jones and de Vos 2002). This in part explains why major wildlife/livestock disease epidemics that have been observed (Kock *et al*. 1999) are associated with drought, when the contact rate between animals, a fundamental driver, particularly for epidemics from microparasitic infections, increases (Anderson 1982). As much as animal disease can vary with seasonally determined environmental factors, temporally distinct animal cycles such as seasonal calving can have an important role in disease transmission, e.g., MCF in wildebeest (Rossiter 1983).

Another basic concept in transmission dynamics is the immune status of the population to a particular disease agent at the time of the epidemic. This can be described as the number of animals in a population that are susceptible to disease and indicates the likelihood that contact between infected animals and unexposed animals will lead to further multiplication of the organism and transmission (greater than 20% susceptible in a population are considered necessary for an epidemic of an infectious disease to occur [Thrusfield 1997]). In a stable biological system, the disease dynamic tends towards endemism with little or no clinical manifestation, and the host and parasite are described to be in balance (Allison 1982). There is a coevolution of host and parasite. This concept has also tended to convince many wildlife managers to consider all disease(s) in the protected areas as natural, and this historically has discouraged interest or intervention in parks and reserves in relation to disease outbreaks. This would be valid in "Eden," perhaps, or in a truly natural ecosystem, but this state is historical, if it ever existed.

The situation has changed significantly over the past century, with many examples of transcontinental disease introductions (rinderpest, BTB) causing persistent problems in wildlife and livestock populations. The wild species were never exposed to these agents over millennia, there had been no coevolution, and the consequences were serious and persistent (Bengis *et al*. 2002, de Lisle *et al*. 2002). Besides these initial introductions of major diseases through importation of livestock to the continent, the coexistence of humans and their livestock with wildlife is still not governed by natural mechanisms; at best they are only partially integrated, especially in pastoral systems when contact may occur seasonally or only in drought years. Thus, endemism is disturbed and this is another reason the interface deserves close attention.

Diseases at the interface

Trade-sensitive diseases

The main diseases of concern to trade in Africa are FMD, Rift Valley fever (RVF), rinderpest (eastern Africa), peste des petits ruminants (PPR) (western Africa), and African swine fever (ASF).

Foot and mouth disease

FMD is the single most important disease influencing global livestock trade. The role of wildlife species in FMD was extensively reviewed (Thomson *et al.* 2003), but there are a number of important points in relation to the interface that are highlighted here. African buffalo are the only wildlife species confirmed to be a long-term maintenance host and this is exclusively for South African Territories (SAT) types of the virus (Condy *et al.* 1985). Natural infection has been reported in a wide host range but appears to be self limiting, and in most areas where FMD has been controlled the disease has disappeared in wildlife. Buffalo herds act as a reservoir for future outbreaks, transmitting infection to cattle directly or through other species, which have contracted the infection from the buffalo (Sutmoller *et al*. 2000, Bastos *et al*. 2000). As FMD is a highly infectious virus, transmitted in most instances by aerosol over short distances, it requires a relatively close contact situation between buffalo, other wildlife species, and cattle herds for interspecific transmission. In fact, how the transmission occurred in historical outbreaks is still uncertain, but it has been possible to confirm the connection through genetic sequencing and comparison of virus isolated from cattle and buffalo during outbreaks. Transmission is likely through mechanisms discussed above and may even involve venereal transmission, as virus has been isolated from semen and sheath washings and buffalo-cow mating has been observed in the field.

So the interface becomes an issue only when the disease is controlled in livestock, which is the case in a number of southern African countries. It is also becoming a concern in other regions as commercialisation of the livestock sector is planned and wildlife and particularly buffalo populations exist. Countries reporting FMD currently are Ethiopia, Kenya, Uganda, Tanzania, Zimbabwe, Mozambique, Chad, Niger, Burkina Faso, Senegal, Ghana, Togo, Benin, and Mali, all supporting buffalo populations except Niger and Mali (AU/IBAR 2003). Probably many more outbreaks in other countries have gone unreported. The only effective control measure at the interface where there are infected buffalo herds has been separation of this species from cattle and, in the case of South Africa, this includes vaccination of buffer livestock populations around the source of virus. There have also been some initiatives involving the establishment of disease-free buffalo herds, allowing for integration of this species into game-ranching enterprises in FMD-free areas (Foggin and Taylor 1996).

In countries where the extensive wildlife populations are integrated with pastoral systems, there is no possibility of effective separation. In these locations, the proposed solution is the creation of small export zones from which wildlife is excluded. Effectively, this means the creation of "protected areas" for livestock. This approach could resolve the conflict and provide the opportunity for commercial livestock development without much affecting the important wildlife resources in these parts of Africa. This would also support the culture and traditions of the pastoral peoples. The concept does not exclude the opportunity for links between the pastoral communities and the export zones, although a system of quarantine and mechanisms for this will need to be explored. As the loss of key grazing resources has been a factor in the decline of pastoralism, this potential reconnection with what would amount to fattening areas could strengthen the overall livestock economy and reduce pressure on national parks, which are frequently used for this purpose. This will also enable traditional peoples to benefit from a mixed-species system and develop wildlife-related livelihoods in addition to their livestock, while bypassing the veterinary restrictions, which have been a constraint on local trade.

Rift Valley fever

In the case of RVF, wildlife and livestock are epidemic hosts, whilst the mosquito is the maintenance host that also acts as the vector for virus infection in mammals (Swanepoel and Coetzer 1994, Garcan *et al*. 1988). Epidemics occur when conditions of high rainfall lead to extension of the range of infected mosquitoes, and nonimmune animals become exposed. Wildlife plays a role in the epidemiology through general amplification of virus in the environment, but the interface is not important to the trade or human/livestock health issues. RVF outbreaks are highly sporadic spatially and temporally, and the main emphasis for disease control is on early warning and timely vaccination of livestock. From this perspective, there is a possible sentinel role for wildlife, which, if monitored, may show signs well before the epidemics reach human and livestock concentration areas, allowing for more timely and effective control measures to be put in place. In northern Kenya, for example, the first species affected during the last major epidemic in 1997 after an El Niño event were gerenuk followed by small livestock (R. Kock, personal observation 1997).

Rinderpest

Rinderpest is the focus of a global eradication campaign and, after over a century of applying control measures, the virus is currently restricted to one last focus, in the so-called Somali ecosystem of Kenya and Somalia, where a single strain persists. The presence of the virus was confirmed through virus isolation techniques or by reverse transcription polymerase chain reaction (RT-PCR) from buffalo, eland, and kudu (Barrett *et al.* 1998). The process of verification of the absence of rinderpest virus from most countries in Africa (OIE 1998) will take some years, but the most important contemporary issue is the presumed persistence of a mild form of rinderpest in cattle. Although a cattle syndrome has been reported and confirmed by agar-gel immunodiffusion (AGID) during wildlife outbreaks (Rossiter 1997), no virus has yet been isolated from cattle to confirm its

association with the wildlife disease. Experimental infection with wildlife virus isolates produces a very mild syndrome in indigenous cattle, although quite severe disease was reported in exotic breeds. This finding supports the hypothesis that the virus is circulating cryptically in livestock. The current thinking is that the virus occasionally "spills" from cattle herds, causing sporadic outbreaks amongst mainly buffalo and other susceptible wildlife species, with disease of varying severity (Kock *et al.* 1999).

With this last pocket of infection, the threat remains of recurrence and spread of this potentially devastating disease back to currently free areas in the region and to other continents worldwide. There is also the threat that the virus will revert to virulence given changing epidemiological conditions, and this is now a major risk given the cessation of vaccination in all cattle populations in Africa by the end of 2003. The current economic impact is minimal in livestock, but regular outbreaks in wildlife in Kenya have had an inevitable cost. The last major epizootic in 1994–1997 caused over 60% mortality in buffalo in Tsavo and mortality was estimated to be even higher in kudu (approximately 90%), with two further smaller epidemics occurring since then in the region. The depressive effect on these populations is both dramatic and persistent. In the two largest protected area systems in Kenya, Tsavo and Meru National Parks, the loss of visible wildlife species such as buffalo has contributed to a significant decline in visitors and related income.

In all the epidemics reported, there was circumstantial evidence that the origin of virus was cattle (Kock *et al.* 1999, R. Kock 2002), but in no instance was this proved. There is evidence from buffalo epidemics that the virus spreads to virtually all members of a contiguous population after the index case in the species, and the infection might or might not subsequently transmit interspecifically (R. Kock 2002, Rossiter 2001). Where there is multiple species involvement, these seem to be separate independent epidemics, which may occur simultaneously from similar or different point origins and with different rates of spread.

In all wildlife species there is evidence that the disease does not persist at a herd or population level. Interspecific transmission of infection is probably a rare event, dependent on chance contact, which is therefore increased where there are large numbers of infected wild animals present in the ecosystem, with seasonally determined contact patterns playing a role. Should the transmission dynamic have been more fluid between species, wildlife might have played a more significant role in maintenance of the virus, but fortunately this appears not to be the case. The infection in buffalo herds of approximately 300 animals lasts 2–3 months and in an ecosystem of approximately 50,000km^2 can persist for 3–4 years and can affect all animals. Reinfection of partially immune populations leads to focal epidemics, which can be very localised and the disease may not affect all animals, although in any single infected herd (of buffalo) all eligible animals will be involved.

The significance of the interface for rinderpest is that since the disease does not persist in wildlife, its existence in cattle is essential for recurrence of wildlife epidemics. The chance of transmission from wildlife back to cattle is proved experimentally but not reported under natural conditions. In theory, transmission from wildlife back to cattle can occur and this would mean wildlife could have a greater role in the epidemiology (and not just as a dead-end host). This role is perhaps best described as that of a vector, multiplying the virus in the environment and spreading it spatially for a limited period of time. During the extensive blanket vaccination campaigns of cattle in the region over recent years, this aspect may have been underestimated as a contribution to persistence. Virus may have remained in the environment (in wildlife) for a period of years with reinfection of young cattle a possibility, although the epidemiological data available do not suggest this is in fact the case. The fact that this persisting virus appears to be of low virulence in cattle and may be reaching some sort of host-parasite equilibrium is a major concern to the eradication strategy, as this creates considerable obstacles to surveillance and application of control measures.

The clinical expression in wildlife provides a sentinel but, unless improved techniques are determined for identifying the virus in cattle populations, the ultimate goal may remain elusive. The fact that the virus still appears capable of high virulence in wildlife is also of concern as this indicates a different trend to that seen in cattle after a century of exposure to the virus. If eradication is not achieved, this will create a considerable problem for the region in relation to trade, which is already restricted in a number of countries due to common borders with infected countries. The means of spread of the disease between cattle and buffalo (or other species) in nature is not known for certain but probably is through aerosol and contamination of pasture and water points. As sick buffalo, with profuse diarrhoea and ocular and nasal discharges, frequently remain and die around water points, this is probably the area where transmission takes place, intra- and interspecifically. Whilst this disease persists, development of commercial export livestock systems will be constrained in affected regions, and unless rinderpest is eradicated it might become necessary to isolate cattle from wildlife in a similar manner as for FMD.

Peste des petits ruminants

The epidemiology and clinical picture of PPR, another morbillivirus, is similar to that of rinderpest but it affects (clinically) only small ruminants. The incidence and role of PPR in free-ranging wildlife is not known, as epidemics have not been reported except in captive or semi-captive conditions. The severity of the disease in wildlife, with up to 95% mortality in gazelles (Mwanzia 2002), suggests it may well have been a problem and have affected natural populations, although there is no proof for this. Since the virus appears restricted to West and central Africa and Ethiopia, it is interesting to correlate the presence of the virus over the last 40 years with the decline and even extinction of gazelle from many areas within this zone, with robust populations surviving in the rest of East Africa, where the virus is absent. Other wildlife species can provide a sentinel role through serology for the presence of this virus, and antibody has been detected in a number of species, such as buffalo.

African swine fever

Another disease of importance to trade of pigs and pig products is ASF. Currently it is a problem in West Africa and parts of East and southern Africa (AU/IBAR 2003). Wildlife does not appear to be involved in the epidemiology of the disease in West Africa, with the viral transmission cycle occurring within the free-ranging (village) pig population, which is difficult to control by conventional methods. In East Africa, in contrast, the disease is often associated with warthog, in which the disease is endemic and associated with the maintenance host, an ornithodorus tick (Plowright *et al*. 1969, Plowright *et al*. 1974). This tick lives in warthog burrows and feeds on warthog, infecting young pigs as they are born (Thomson 1985). This interface issue has been a factor in preventing the development of pig farming in the East African region.

Summary

There are relatively few diseases of concern to international trade associated with the interface, and few species of epidemiological significance (primarily buffalo). If commercial export systems for livestock are to be developed under the current trade rules, in countries where presently trade is only local or at best regional, the exclusion of buffalo and pastoral livestock will be necessary to control the important diseases (e.g., through export zones). This approach will reduce the burden on government veterinary departments, ensuring realisable targets in epizootic disease control, and allow for the development of improved animal health services in the pastoral communities which are more relevant to the local disease concerns.

Non-trade-sensitive high-impact diseases at the interface

Of the trade-sensitive diseases mentioned above, only rinderpest currently impacts wildlife population dynamics, and this is only in certain wildlife species, in relatively few locations. There are more widespread infections that can cause high mortalities, and these are discussed in this section.

Anthrax

Anthrax is considered natural to the African continent, and epidemics in wildlife are probably as old as the origin of the species themselves (Hugh-Jones and de Vos 2002). Certain species have been more associated with outbreaks and these include kudu, wildebeest, buffalo, and impala, probably more a result of their relative abundance than any species-specific susceptibility. The manner in which anthrax survives is highly effective, which is why this ancient disease has not changed much over generations. After entering a host it multiplies, usually killing the animal and, after exposure to air, produces billions of spores. These are released into the environment, where they persist for years – under ideal conditions, for hundreds of years.

Infection is dose dependent and occurs at the soil level in most instances, although leaf contamination from vulture faeces has been associated with disease in browsers, particularly kudu (Lindeque and Turnbull 1994). Certain ecological and geographical conditions favour the persistence of the bacteria, and these have been documented for some wildlife populations (de Vos and Bryden 1996). In these cases, the presence or absence of cattle does not necessarily affect the cycle of disease. Nevertheless there have been associations of anthrax epidemics in wildlife with cattle infections, and no doubt this association can work in both directions. Once an epidemic reaches areas where livestock and cattle mix, the chance of crossover between domestic animals and wildlife increases. If there are high concentrations of cattle on the periphery of wildlife concentration areas and there is a general water run-off from one area to the other, transmission can occur through indirect exposure mechanisms. Essentially, the water carries the spores to a water sink and there concentration takes place, leading to an increased probability of infection of the animals feeding or watering at that point.

The main implications of this disease to the wildlife/livestock interface are that control measures may necessarily include certain restrictions involving the extent of the interface to reduce contamination levels at key points. Vaccination is also possible for livestock and this can help to reduce the overall environmental load. At the time of epidemics, further measures can be taken and these ideally involve burning of the intact carcass (with coal as fuel if possible) to reduce spread of the bacteria by scavengers and local contamination (Nishi 2003, Hugh-Jones and de Vos 2002).

Tuberculosis

Tuberculosis, for the purposes of considering its impact at the interface, is considered to mean bovine tuberculosis (BTB). This infection was introduced to the continent, arriving with imported livestock and subsequently spilling into wildlife populations in southern and eastern Africa in particular. BTB is not only a concern to the African wildlife/livestock interface but is also a particular problem in the United Kingdom (badger–cattle), New Zealand (opossum–cattle/deer), and North America (deer/bison-cattle). It has been prominent in Africa in the higher-density wildlife systems in South Africa, Uganda (Woodford 1982a, 1982b), and Tanzania.

The disease is chronic, and transmission between livestock and wildlife probably occurs sporadically through direct contact, but the organism is able to establish in some species, which then become a maintenance host. This is the case with buffalo, and once this has occurred the disease can spill back into cattle as well as to a number of other species including kudu, lion, and baboon, to mention a few (Keet *et al*. 1996). In low-density ecological systems (often pastoral arid systems), despite the considerable mixing of wildlife and livestock, the disease is rarely observed and probably here does not play an important role. However, in the sites with higher densities of wildlife, the disease does appear to depress population growth rates and make species more vulnerable to other regulating factors such as predation; its net effect will depend on the extent of environmental variation the population is exposed to (Jolles 2003). Since BTB is difficult to control in free-ranging populations, once it is established in wildlife and wildlife becomes a potential source, this is likely to lead to the need for separation of

wildlife and livestock by fencing to ensure that control measures in cattle are not frustrated. The approach to or need for or indeed feasibility of controlling BTB in wildlife systems remains a current debate and focus of research (de Vos *et al*. 2001).

Brucellosis

Brucellosis, although present in livestock, has been demonstrated as a clinical entity only rarely in wildlife in Africa (Gradwell *et al*. 1977) and the evidence is mainly serological (Grootenhuis 1999, de Vos and van Niekerk 1969). The significance of African wildlife in the epidemiology of brucellosis is not well understood and appears minimal, which is likely to remain the case until perhaps the disease is controlled in livestock.

Malignant catarrhal fever

MCF virus is of considerable concern to pastoral livestock keepers as it is usually fatal in cattle. This herpes virus (Alcelaphine herpes virus 1) is maintained in wildebeest and transmitted to cattle by the young calves (2–4 months of age) through contamination of pasture from nasal secretions (Mushi *et al*. 1980). Generally, the livestock keepers will avoid calving grounds, but when they have no choice the grazing strategy of the pastoralists shows considerable understanding of the epidemiology of the disease. The virus is highly sensitive to drying, heat, and ultraviolet light, so under natural conditions the pastoralists have learned that since wildebeest calve at night, by 10:00 a.m. the pasture is sterile (in terms of MCF) and infection can be avoided.

Rabies

Rabies virus infection in livestock is rarely contracted from wildlife, through bites from sylvatic hosts (mongoose, foxes, jackals). This is a sporadic and dispersed problem through Africa and is not necessarily associated with the more intensive interface areas. Since the domestic dog plays the more significant role in the maintenance of this infection, it will not be considered in more detail here.

Macroparasites and the interface

Internal and external parasites can play a significant disease role in wildlife and livestock populations, and there are certain infections that are particularly important at the interface. The most significant of these is trypanosomiasis (Morrison *et al*. 1981). This blood parasite is maintained in a variety of wildlife species and has led to the virtual exclusion of cattle from large tracts of African bush. Due to the susceptibility of cattle to infection, with high morbidity and mortality, considerable investment has been made to control the disease through eradication or control of the tsetse fly, which acts as the vector. Few of these efforts have been sustained, and the disease remains a significant moderator of the interface between wildlife and livestock in many areas of Africa. The other major impact of this disease at the interface is in the negative attitude of livestock communities to wildlife and their natural habitat that harbours the fly. Some approaches such as the use of drugs and field insecticide targets and traps have helped to reduce the impact but it remains a problem. In these areas, more diverse livelihood approaches are needed to mitigate the problem; otherwise, destruction of wildlife and their habitat is likely.

The other broad disease grouping, which is important at the community level, is tick-borne diseases (TBDs), which perhaps are more important to the ordinary African livestock keeper than any other. Here, the interface is important due to the reservoir status and the multiplier effects of numerous host species. Normally a problem of livestock, with wildlife showing tolerance, TBDs can under certain conditions be a problem to both, e.g., with wildlife translocation, which leads to novel exposure of source or recipient populations of wildlife/livestock to new parasites for which there is no immunity. Losses can be high.

One of the most important TBDs is theileriosis, which causes corridor disease in cattle (Neitz 1955). Buffalo carry the parasite *Theileria parva (lawrencei)* and only in the presence of a particular tick, *Rhipicephalus appendiculatus*, does one see cattle mortalities. The parasite is not able to survive in cattle, which act as a dead-end host, literally, as cattle die before the piroplasm stage develops (Grootenhuis 1999). As with the other vector-borne infections, direct contact is not necessary and sharing the range is all that is required for transmission of the parasite between wildlife and livestock through the tick. There is growing molecular-based evidence that the buffalo-derived parasite is indeed different from the cattle parasite *T. parva*, with which it can be confused. The cattle *T. parva* also causes disease, namely East Coast fever, which occurs when nonimmune cattle are exposed, again with a tick vector. *T. parva* from cattle will not infect buffalo. Another parasite found in livestock and wildlife species, often confused with *T. parva*, is *T. taurotragi,* which occasionally causes clinical disease in eland.

Heartwater caused by the rickettsial parasite *Cowdria ruminantium* is another important TBD of livestock, with at least three species of *Ambylomma* tick involved. There are many possible wildlife reservoir hosts, the most important of which are probably buffalo, giraffe, and eland.

Helminth parasites (nematodes, cestodes) are numerous and can locally be of considerable importance to both livestock and wildlife, but there is little or no evidence that wildlife acts as a true reservoir for livestock or vice versa even though some helminth species have multiple hosts and each can act as amplifiers. Haemonchosis is the most important nematode disease of small livestock; gazelle can be carriers (Grootenhuis 1999). The pathogenicity of the parasite usually depends on whether the individual has had prior exposure and on its nutritional state. Seasonal factors can be important including heavy rain, which supports egg survival and increases challenge from infective larvae on the pasture, and drought, during which animals suffer malnutrition and show poor resistance. These organisms have coevolved with the host, so under natural conditions there is a balance (Fowler 2001). Seasonal movements and sporadic contact at the interface between livestock and wildlife can be a source of novel parasite infestations and disease.

The most important external parasite in wildlife is sarcoptic mange, caused by *Sarcoptes scabiei*. Although the disease can cause devastating short-term mortality in African species of great ape, cat, and antelope, an epizootic does not generally affect long-term population dynamics, although endangered or threatened species are vulnerable to its effects (Pence and Ueckermann 2002). The origin of the parasite in wildlife populations is thought to be man and his domestic animals, and interspecies infection appears to occur.

Conclusions

There are many situations when protected-area managers and communities have come to tolerate the problems of disease at the livestock/wildlife interface, usually where the impacts are cryptic or difficult to quantify. A number of superficial reviews of the interface were carried out in the 1990s, and no new disease issues could be identified. However, the situation is rapidly changing as land becomes more developed and the interface more intense. There is already some indication of re-emergence of serious infectious diseases and emergence of new diseases on or from the continent. As this process of change continues, the situation will need to be addressed. When high-impact diseases occur, the implications are not only devastating to communities, but the financial implications can be disastrous, particularly for developing nations but also for the economies of developed nations.

Disease is becoming an important issue in conflicts between national parks authorities and adjacent communities. These frequently poor interface communities increasingly perceive wildlife negatively, especially when they have no stake in the management or use of that wildlife resource. Under these circumstances, disease outbreaks can be the trigger to conflict, and politics dictate that interventions by public health and (agriculturally oriented) state veterinary services take priority: this usually impacts negatively on the wildlife resource. On the other hand, those same poor communities and livestock are seen as a threat to many protected areas as they compete with wildlife for resources and also because of a history of disease introductions. This situation is counterproductive for all concerned and cannot lead to better decisions being made for healthier ecosystems or human environments. To reduce the conflict, the risks and impacts of disease, in particular at the interface between wildlife and livestock but also at the interface with people, will need to be better understood amongst all the stakeholders. More research is needed, as are new philosophies and attitudes, and new approaches to livelihoods and resource use. New practical measures must be introduced in order to improve animal and human health. This will be beneficial to community development and biodiversity conservation alike. The lack of investment and of trained personnel in this field in Africa are major constraints that, if not addressed, will affect overall development and conservation goals for the continent.

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Chapter 2

Transfrontier Conservation Area Initiatives in Sub-Saharan Africa: Some Animal Health Challenges[1]

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Introduction

As Africa's conservation areas come under increasing pressure by expanding human resource needs, the transfrontier conservation area (TFCA) initiatives, from a biodiversity conservation point of view, are a welcome new perspective. In addition, the integration of land across international borders, as well as the consolidation of state and privately/communally owned land in joint ventures, may generate positive economic benefits for specific regions. These initiatives are strongly supported by conservationists, ecotourism enterprises, and the public at large because they are the first tangible moves that may reverse the current encroachment being experienced by existing and established conservation areas. This encroachment has occurred when local communities have expanded their struggle to survive the onslaughts of nature's climatic fluctuations and plagues that threaten their food security. The TFCA vision explores the possibility that changing land-use practices from subsistence farming on marginal land to community participation in ecotourism-based enterprises may have sustainable economic and ecological benefits for all.

In the Southern African Development Community (SADC) region, there are currently seven TFCAs, each involving land from two or more participating countries, that have already been established (or are in the process of being established) and have political support, with international agreements currently being developed or already ratified. A further 15 potential TFCAs have been identified by the Peace Parks Foundation in the SADC subregion (Fig. 1).

It is definitely not the intention of this paper to portray these environmental conservation initiatives in a negative light. The message, however, that needs to be conveyed, is that all parties involved should enter these initiatives fully informed and forewarned of the potential animal health implications and challenges that may be expected when increasing the current geographic range of certain animal pathogens and disease vectors. Without barriers on international boundaries, and with biological bridges being formed by contiguous wildlife populations, any contagious/infectious agent or vector present in any one of the participating countries or areas will predictably eventually spread throughout the entire TFCA.

Potentially problematic infections should be identified at an early stage through surveillance and monitoring, and proactive joint containment and control measures should be established as necessary. These animal disease issues may be compounded as a result of the enlarging wildlife/livestock interface, and this may have a negative impact on adjoining communities (Bengis *et al.* 2004). This concept paper discusses some of the risk factors and identifies some of the potential animal infections and disease vectors that may become problematic in certain African TFCAs.

Risk factors

Several important animal disease risk factors have been identified with regard to the development of TFCAs. These include the following:

Environmental factors

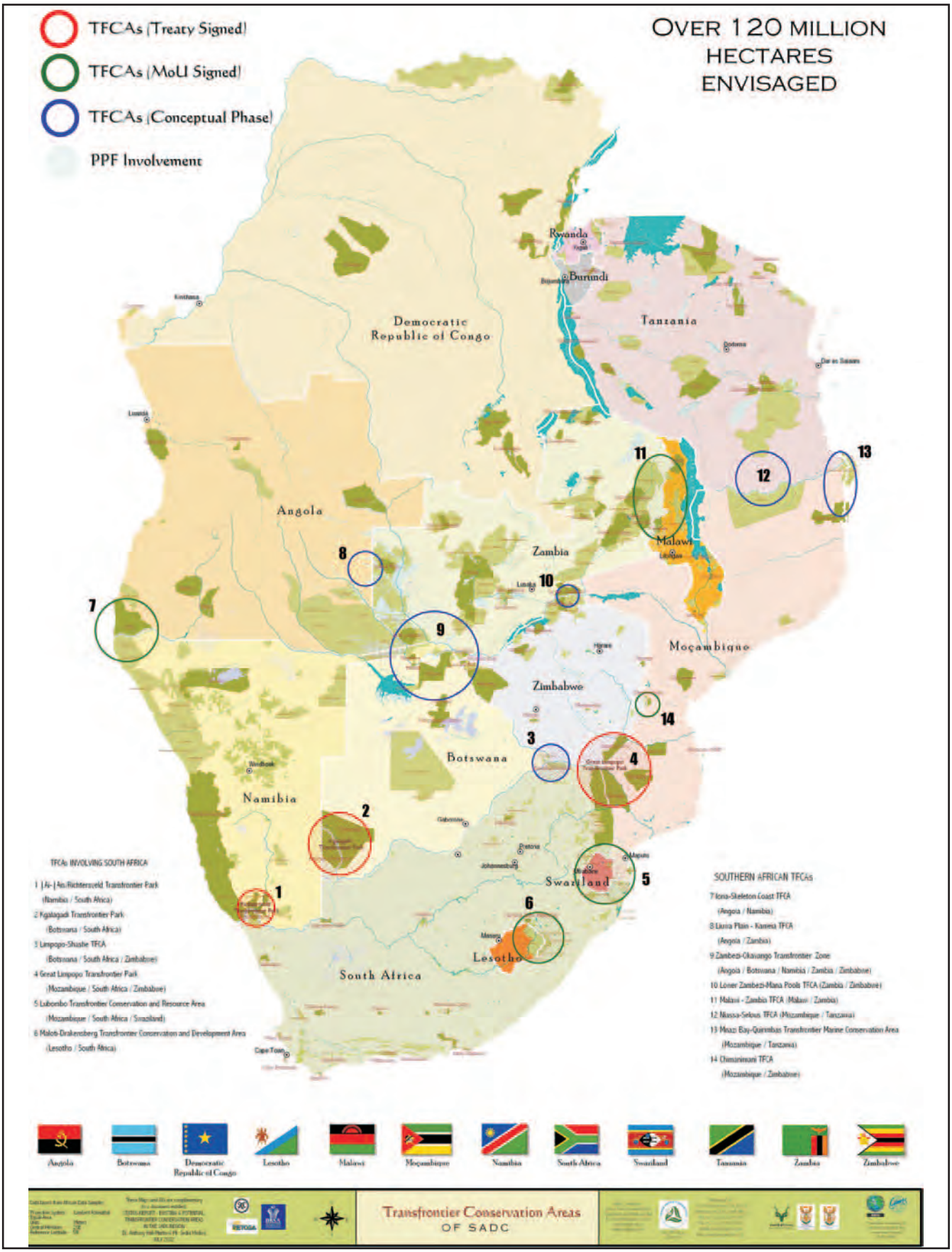
Certain environmental factors, usually associated with geographic location and climate, such as mean temperature, rainfall, and altitude, and the resultant habitat and landscape types may be important considerations when assessing animal disease risks for an existing or potential TFCA. For example, it is probably the savannah ecosystems, with their enormous botanical and mammalian biodiversity and heterogeneity, that support the greatest variety of associated macro- and microparasites and vectors. In contrast, in very arid ecosystems with relatively low densities of specialised species, most contagious or vector-borne infections are unlikely to be maintained. Similarly, high-altitude montane habitats, which are cyclically subjected to freezing temperatures, are only seasonally – at most – suitable for certain vectors and parasites. Between these extremes, the African tropical rainforests, with their high rainfall, reduced sunlight, and canopy-bound nutrients, support only certain niche-adapted species and their parasites.

Animal species

The mix of animal species seen in the participating land areas of the TFCA may also give insight into the animal disease risk. In sub-Saharan Africa, certain key mammalian species

[1]See abstract on p.xix.

Fig. 1. Transfrontier conservation areas
Courtesy of Peace Parks Foundation.



have been identified as maintenance hosts or reservoirs of certain infectious agents and are therefore of epidemiological importance. For example, the role of the African buffalo in the maintenance of foot and mouth disease (Hedger 1972) and theileriosis (Irvin and Cunningham 1981) has been well documented, as has the association of wildebeest with alcelaphine malignant catarrhal fever (Plowright *et al.* 1960). Epidemiological links have been made between wild porcines and argasid ticks in the maintenance of African swine fever (Plowright *et al.* 1994) and between bushbuck and ixodid ticks in the epidemiology of bovine petechial fever (Snodgrass *et al.* 1975). Zebra and certain dung-breeding midges are linked to the dry-season cycling of African horse sickness (Barnard 1993). Although these infections are generally "silent" in their traditional hosts, these animals should be considered high-disease–risk species under certain interface conditions with livestock (Bengis *et al.* 2002). Similarly, certain wildlife species such as the spiral-horned antelope (tragelaphids), wild porcines, buffalo, black rhino, and elephant are preferred hosts for certain savannah and riverine tsetse flies (Morrison *et al.* 1981).

Disease status

Disease status of domestic animals adjacent to the TFCA is a major risk factor for wildlife within the area. For example, the presence of foreign animal diseases such as bovine tuberculosis (BTB) (de Vos *et al.* 2001, Rodwell *et al*. 2001) or rinderpest (Mack 1970, Kock *et al.* 1999) in adjacent cattle populations places the wildlife in the TFCA at risk. Similarly, the presence of canine distemper or rabies in domestic or feral dogs at the interface may threaten wild carnivores, especially the social species (Alexander and Appel 1994, Roelke-Parker *et al*. 1996).

Interface type

The extent and type of the interface with adjoining domestic livestock herds is also an important animal disease risk factor. The interface may be linear, as along a fence line, or patchy, reflecting habitat preferences of a disease host. It may be focal at a shared water point, or diffuse, where range and resources are shared, as in savannah pastoral societies. A diffuse interface has the greatest risk for animal disease transmission. Animal disease transmission at these interfaces may be bidirectional, with diseases traditionally seen in livestock entering wildlife populations, or indigenous wildlife infections crossing over into livestock. Both scenarios have potentially serious implications.

The Great Limpopo Transfrontier Park – a potential case study

The Great Limpopo Transfrontier Park will incorporate the Kruger National Park (KNP) in the Republic of South Africa, Gonarezhou National Park in Zimbabwe, and the Limpopo National Park in Mozambique (Fig. 2). A ratified treaty has been signed by the three participating countries, and a joint management board with supporting committees in the fields of safety and security, finances and human resources, and tourism and conservation are in place. Fences have not yet been dropped, but over 2000 head of plains game (including zebra, wildebeest, impala, waterbuck, giraffe) as well as some 75 elephant and two white rhinos have been translocated to a fenced 30,000-ha core sanctuary area near Massingiri dam in the Limpopo National Park.

Animal disease risks in this TFCA are moderate to high for a number of reasons. This TFCA lies in a low-veld savannah ecosytem. Disease is endemic in the species mix that includes maintenance hosts and reservoir species such as buffalo, wildebeest, zebra, wild porcines, and tampans. All the indigenous disease agents have also been detected in one or more of the contributing parks.

The eastern side of the proposed TFCA is unfenced, which would create a diffuse interface between wildlife and domestic livestock, while the western side of the TFCA is fenced, creating a linear interface. The disease status of domestic animals on some of the boundaries of the TFCA is largely unknown, but rabies outbreaks in domestic dogs have been recorded in the Pafuri region of Mozambique.

In addition, buffalo, kudu, and warthog in regions of the KNP compartment are infected with BTB – a foreign animal disease (de Vos *et al.* 2001, Bengis *et al*. 2001). These three species are all potential maintenance hosts of this contagious bacterial infection, and BTB has already spilled over into at least six additional incidental hosts. The BTB status of cattle and wildlife in Mozambique is unknown, but Zimbabwe currently appears to be free of BTB in cattle, based on abattoir surveillance.

A tsetse fly incursion has recently been detected in the northern part of the Gonarezhou National Park in Zimbabwe. Tsetse flies also are found north of the Savé River in Mozambique. The KNP has been free of tsetse flies for over a century, and the Limpopo National Park appears to be currently free of these nagana vectors.

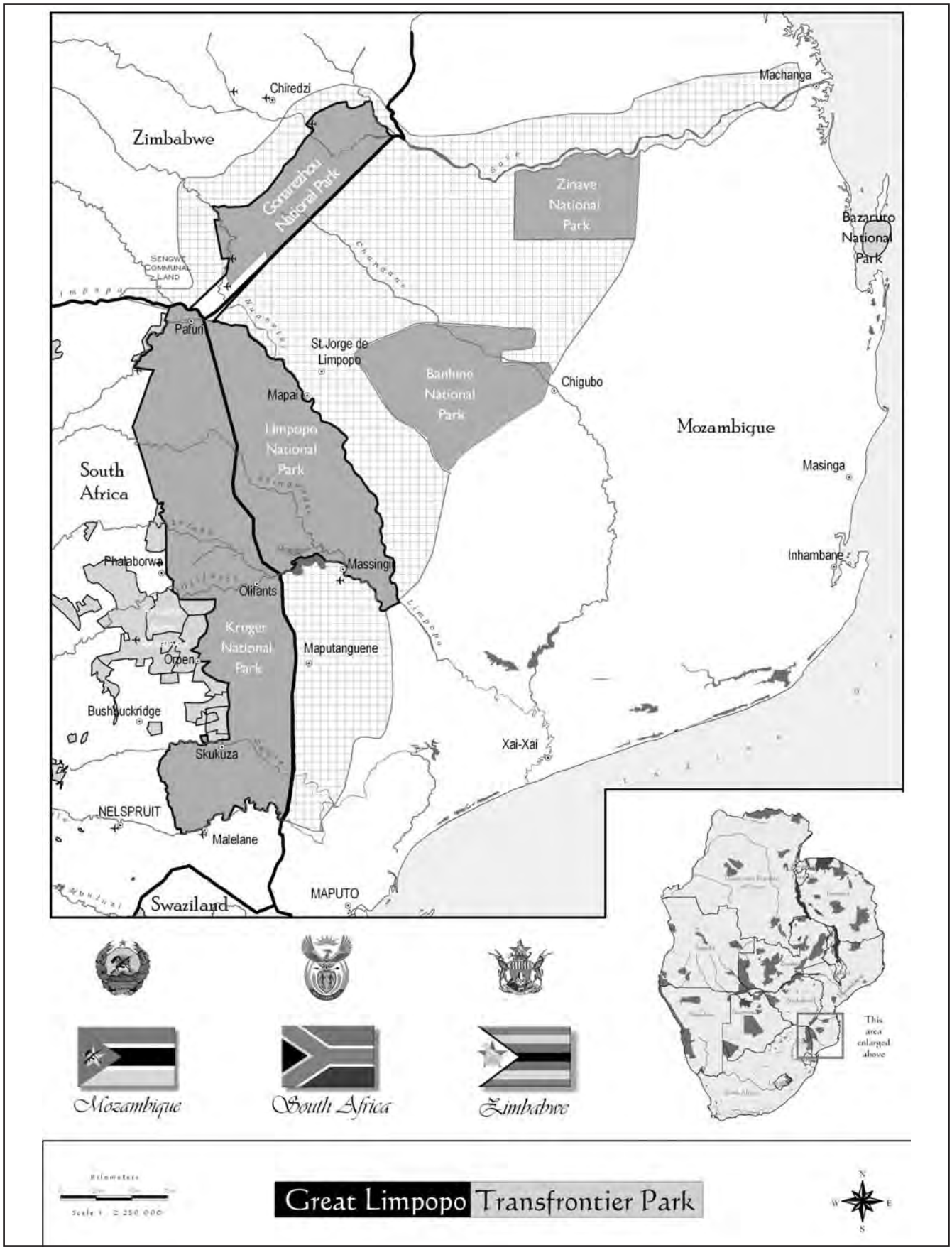
During the past decade, buffalo were introduced from Hwange National Park in western Zimbabwe into Gonarezhou National Park in the east to address a possible genetic bottleneck. These buffalo carry different topotypes of FMD virus to the local resident buffalo. New topotypes may require the use of different vaccine strains for protective coverage in vaccinated buffer zones.

Finally, rabies outbreaks have been detected in domestic dogs in the Pafuri area of Mozambique. Rabies has never been detected in wildlife in the KNP.

Conclusions

The formation of TFCAs has great potential benefits for biodiversity conservation and ecotourism, with associated regional economic "spin-offs." This land-use practice may have sustainable ecological and economic benefits for all. Participating nations should, however, be aware of the po-

Fig. 2. The Great Limpopo Transfrontier Park incorporates five anchor protected areas
Courtesy of Peace Parks Foundation.



tential animal health challenges that may arise out of these initiatives. Appropriate planning and disease management strategies should be proactively put in place, in both the TFCA and adjoining communal farming areas, as deemed necessary.

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Chapter 3

Diseases of Importance at the Wildlife/Livestock Interface in Kenya[1]

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Introduction

Wildlife and livestock contribute significantly to the economies of most sub-Saharan African countries. The wildlife sector in Africa is worth US $7 billion with an annual growth rate of 5%. It is thus a major contributor to the continental gross domestic product (GDP). In East and southern African countries, the consumptive and nonconsumptive utilization of wildlife is a significant foreign exchange earner. In Kenya, tourism accounts for 30% of foreign exchange earnings (Kock *et al*. 2002).

The livestock subsector contributes over 30% of the agricultural GDP and employs more than 50% of the agricultural labor force. Dairy and livestock farming accounts for utilization of 30% of the high-to-medium-potential land and of 81% of the arid and semi-arid lands and is crucial for promoting rural development and reducing poverty (Kock *et al*. 2002).

The rangelands of Kenya comprise 74% of the country's land area and are largely inhabited by nomadic or transhumant pastoralists who comprise 25% of the total population and are principally dependent on livestock (Bourn and Blench 1999). Most of Kenya's livestock and most wildlife are found in the rangeland districts of Kajiado, Laikipia, Narok, and Taita Taveta (Bourn and Blench 1999), and this extensive traditional production system allows a greater interface between domestic and wild animals.

The resurgence of some livestock and wildlife diseases in Kenya that were previously controlled is of serious concern. The recent incursion of rinderpest virus in Kenyan wildlife populations, associated with cattle in the Somali ecosystem, is one example (Wambwa 2002). Major factors in the spread of disease are the uncontrolled or illegal movements of livestock by pastoralists within the country and across national borders in search of grazing or markets, or as a result of cattle rustling. The cross-border livestock trade involves approximately 400,000 head of cattle per year. Seasonal wildlife movements result in frequent interactions with livestock, which also increases the possibility of disease spread across boundaries (Wambwa 2002). In addition, most of these rangelands have a poor infrastructure and are remote, making it difficult to provide adequate veterinary services.

The diseases of major concern to livestock trade presently include contagious bovine pleuropneumonia, contagious caprine pleuropneumonia, African swine fever, foot and mouth disease, Rift Valley fever, rinderpest, and peste des petits ruminants (Grootenhuis 1999). Other diseases of economic and public health importance in Kenya include viral diseases such as malignant catarrhal fever and rabies (Karstad 1986, Kock *et al*. 2002), bacterial diseases such as anthrax and brucellosis (Karstad 1986), protozoal diseases such as trypanosomiasis and theileriosis, and ectoparasite and helminth infestations (Grootenhuis 1986).

The presence of transboundary diseases has greatly reduced Kenya's export of wildlife, livestock, and their products to lucrative international markets as a result of the stringent requirements in sanitary standards for international trade in animals and animal products established by the World Organisation for Animal Health (OIE).

This paper briefly describes the wildlife/livestock interface in Kenya, with emphasis on the important animal diseases at this interface. It suggests measures to enhance disease control and improve trade in wildlife, livestock, and their products.

The wildlife/livestock interface

The wildlife/livestock interface in Kenya is largely influenced by the livestock production systems present in the country. There are two major systems at the interface:

Ranching (cattle/wildlife) system

These are extensive commercial beef or dairy systems in which domestic livestock and wildlife share the same range. They are usually fenced. The management approach aims at selecting livestock breeds that are resistant to disease to establish endemic stability and to regulate stocking densities to ensure optimal nutrition and environmental stability. Income is generated mainly from the sale of livestock and livestock products, and additional income on some ranches is derived from wildlife cropping and tourism. Due to the presence of important diseases such as foot and mouth disease, some export-related income is lost. Disease control measures are specific to the disease in question (Grootenhuis 1999).

Pastoralism and agropastoralism

Nomadic and transhumance pastoralism is found in the rangeland districts of Kenya. Rangelands are treated as

[1]See abstract on p.xx.

common property resources by pastoralists and shelter a great diversity of free-ranging wildlife species that often mix with their livestock (Bourn and Blench 1999). Pastoralists keep indigenous breeds of livestock that are more resistant to pathogens and that are well adapted to these environments. However, land-use pressure and conflict between pastoralists and wildlife have been increasing, resulting in a growing risk of disease transmission between livestock and wildlife and increasing competition for grazing and water resources (Kock *et al*. 2002). Most pastoralists survive at subsistence level and have limited access to veterinary services. Disease control measures usually rely on ethnoveterinary practices, based on traditional knowledge of livestock diseases.

Factors affecting disease trends at the wildlife/livestock interface

Several traders are involved in cross-border trade and sell their cattle all the way from the Somali border to major cities in Kenya, including Nairobi and Mombasa. The dynamic state created by this animal movement results in frequent contact between livestock and wildlife, and a high incidence of pathogen transmission and transboundary diseases (Kock *et al*. 2002). The near cessation of export trade to the lucrative markets of Europe and the Middle East has had a negative impact on livestock production (Grootenhuis 1999).

In Kenya, between 1974 and 1996, wildlife in the rangelands declined by 33% and livestock by approximately 10%, while the human population continued to rise (Bourn and Blench 1999). Pastoralists are becoming more sedentary in the higher-potential rangelands. This has led to the destruction of flora and fauna in these areas due to excessive use of available resources. The resultant ecological changes have created an environment more conducive for development of diseases.

Types of diseases at the wildlife/livestock interface

The most important diseases at the interface are classified by the Office International des Épizooties (OIE) under List A. List A diseases are defined as "transmissible diseases which have a potential for very serious and rapid spread, irrespective of national borders, which are of serious socio-economic or public health consequence and which are of major importance in the international trade of animals and animal products."

At the household level, the effects include inadequate food and income; at the national level, vital export earnings are lost as a result of trade restrictions, and foreign exchange reserves become depleted when livestock food products must be imported (Kock *et al*. 2002). Control needs to be coordinated at both national and international levels. Examples of List A diseases include rinderpest, foot and mouth disease, Rift Valley fever, and African swine fever (Table 1).

Local breeds of livestock and wildlife have developed a degree of endemic stability to some of the pathogens that are constantly present and cycle between livestock and wildlife populations. Many endemic infectious agents do not cause clinical disease in newly infected hosts under normal circum-

Table 1. Transboundary diseases transmitted between wildlife and livestock in Kenya that have national and international importance

Disease and causative agent	Domestic/wildlife association	Status
Rinderpest Morbillivirus	Wide domestic and wild host range in ruminants and suids. Wildlife species are poor maintenance hosts; those most affected are buffalo, kudu, eland, and warthog. Acute disease seen in cattle, wild ruminants, and pigs.	Currently restricted to Somali ecosystem at Kenya/Somali border with occasional epidemics.
Peste des petits ruminants Morbillivirus	Wild/domestic small ruminants are the hosts. Disease cycles endemically in nomadic herds, and transhumance introduces it to native populations.	Serological evidence in sheep and goats in Kenya, 2001. Significant due to importance of sheep and goats for food security.
Rift Valley fever Phlebovirus	Many species of *Culex* and *Aedes* mosquitoes can transmit the disease. No vertebrate reservoir host identified. Reservoir is drought-resistant eggs of *Aedes*.	Disease agent endemic in East Africa and causes sporadic epidemics after long inter-epidemic periods. A pathogenic zoonosis.
Foot and mouth disease Aphthovirus	Wildlife species are not reservoirs except buffalo, which are persistent carriers of SAT1 and SAT2 serotypes. Highly contagious and spreads rapidly. Cattle, pigs, sheep, goats and wildlife (e.g., wildebeest in Serengeti) affected. Types A, O, C, SAT1, and SAT2 have been isolated in Kenya.	Widespread and endemic in cattle and wildlife. Major epizootic potential. Livestock movement control and vaccination are priorities for control.
African swine fever African swine fever virus	Disease of domestic and wild pigs. Maintenance hosts are argasid ticks (*Ornithodorus* spp); secondary role played by free-ranging porcine hosts (warthogs are asymptomatic carriers of the virus).	Has major epizootic potential. First reported in 1921. Reappeared after 30 years and involved movement of pigs.
Contagious bovine pleuropneumonia *Mycoplasma mycoides mycoides* S.c.	Closely associated with livestock movement and not dependent on a wildlife reservoir. Sources of new outbreaks are chronic livestock carriers.	Endemic in northeastern Kenya, newly infected districts in central Kenya. Rest of the country at risk of infection through uncontrolled movement of livestock. Vaccination critical to control spread.

stances of transmission and infection (immunocompetent host exposed to low dose). Disease is most often the result of the disruption of this relationship (e.g., high infectious dose, stressed host, failure of passive transfer). These include vector-borne blood parasites, helminth diseases, enteric bacterial diseases, and a variety of reproductive diseases. The negative impacts of these diseases are mainly experienced at the community level and as such they receive less attention than do epidemic diseases in terms of when control measures are instituted nationally or regionally. However, when the losses at various community levels are consolidated, they are significant enough to result in a national loss. Some endemic diseases have major epizootic potential under certain epidemiological conditions. For example, highly contagious viral diseases such as foot and mouth disease and African swine fever tend to occur as epidemics in livestock but are maintained as stable endemic infections in wildlife. The epizootic potential of a pathogen is related to various epidemiological determinants such as the causative organism, climatic and environmental factors, presence or absence of maintenance hosts, seasonal abundance of vectors, mode of transmission, and presence of a susceptible population (Table 2).

Many zoonotic diseases affect the productivity of both wildlife and livestock. These include diseases such as the meat-borne helminth diseases, and bacterial diseases such as anthrax, brucellosis, tuberculosis, salmonellosis, and clostridial infections. Viral diseases include rabies and Rift Valley fever, and protozoal diseases include toxoplasmosis, sarcosporidiosis, and trypanosomiasis. Both wildlife and livestock could be potential hosts or sources of infection for people. The major concern from zoonotic diseases relates to human disease and suffering (but decreased productivity of animals also has a major impact on livelihoods, welfare, and food security).

Although many diseases can infect wildlife hosts, most wildlife species are generally not involved to any significant extent in the transmission of disease to livestock. However, a few key wildlife species are linked with transmission of major livestock diseases (Table 1). For example, buffalo *(Syncerus caffer)* are a source of a particularly virulent form

Table 2. Diseases transmitted between wildlife and livestock in Kenya that have national and community-level importance

Disease and causative agent	Wildlife/livestock interaction	Status
Malignant catarrhal fever Alcelaphine herpesvirus-1	All wildebeest species are reservoirs. Cattle infected when exposed to cell-free form of the virus from nasal secretions of wildebeest calves. Disease is fatal in cattle and limited to areas where cattle and wildebeest interact (e.g., Maasailand). Cattle are dead-end hosts.	Risk period of contracting this disease is greatest over four months in the wildebeest calving period. Morbidity low but case-fatality rate high, with up to 10% losses of the herd.
African horse sickness Orbivirus	Endemic in zebra, the wild maintenance host, and cycles throughout year. Prevalence rate of antibodies in elephants is high, but role of elephants as maintenance host seems unlikely. An important disease in horses.	Moderate epizootic potential. Transmitted by midges of *Culicoides* species.
Rabies Lyssavirus	Sylvatic rabies has been diagnosed in 33 carnivorous and 23 herbivorous species in sub-Saharan Africa, including jackals, honey badger, mongoose, bat-eared fox, and civet cat in Kenya. Transmitted from wildlife to livestock and vice versa, but domestic dogs thought to be principal reservoir in Kenya. Fatal in all mammalian species. Rabies outbreaks partially responsible for near extinction of endangered wild dogs in the Maasai Mara-Serengeti ecosystem.	Incidence increasing over past 30 years. Most cases reported in domestic dogs and cattle. Better control/vaccination protocol required. Significant zoonotic potential.
Theileriosis or corridor disease *Theileria parva* species	African buffalo is reservoir for *Theileria* parasites, which can cause disease in livestock. Eland and sable transmit *Theileria* spp, which do not cause disease in cattle. Cattle are dead-end hosts and unable to infect intermediate host's vectors.	Moderate epizootic potential. Only *Theileria parva* (corridor disease) derived from buffalo known to have serious economic impact on livestock production. Cattle can be protected by immunization.
Trypanosomiasis *Trypanosoma* species	Wildlife including elephant, rhino, buffalo, warthog, hippo, and various artiodactyls are maintenance hosts and are trypanotolerant, but can show high infection rates with various trypanosome species. Domestic livestock, horses, and dogs affected.	Moderate epizootic potential. Important disease of cattle and horses. Severely hampers livestock industry in tsetse fly endemic belts.
Brucellosis *Brucella* spp	Low prevalence of antibodies in wild bovids in Kenya. Not thought to be major problem in wildlife (although subtle impacts on fertility may be easy to miss). Difficult to eliminate disease from pastoral livestock.	Prevalence and incidence not well documented. Limited epizootic potential. Zoonotic potential. Vaccination of livestock possible.
Anthrax *Bacillus anthracis*	Outbreaks documented in domestic species in absence of wildlife. Anthrax in wildlife reported as both sporadic cases and major epidemics. Links between disease in wildlife and domestic species unclear.	Moderate epizootic potential.

of theileriosis (corridor disease) and a carrier of the SAT (South African Territories) types of foot and mouth disease virus, and wildebeest *(Connochaetes taurinus)* calves are a source of malignant catarrhal fever virus in a form that is lethal to cattle (Grootenhuis 1999).

Current role of the Kenya Wildlife Service in disease control

The Kenya Wildlife Service (KWS) Veterinary Unit supports the Ministry of Livestock by conducting serosurveillance for rinderpest in wildlife to support Kenya's declaration of provisional freedom from the disease. Surveys are conducted in selected wildlife populations, especially in areas adjacent to the Somali border. They include searches for clinical disease by examining wildlife for suspicious signs such as ocular discharges, keratoconjunctivitis, nasal discharges, or diarrhea. Disease outbreak investigations are also performed.

Although disease is an important determinant in the survival of wildlife, the KWS Veterinary Unit has been constrained in expanding its disease-monitoring activities, because the core mandate of KWS is conservation and management of wildlife. Most of KWS' funding is directed towards park management activities, while less goes to disease monitoring. To overcome this, KWS needs to strengthen its institutional linkages with other government departments, nongovernmental organizations, and institutes to expand its capacity and resources to monitor disease. These efforts should include harmonizing the disease control policies between the livestock and wildlife subsectors.

Conclusions

The Ministry of Livestock in Kenya is currently reviewing its legal and policy framework to enhance delivery of animal health services, improve disease control measures, and promote trade of livestock, wildlife, and their products. Some of the key components that Kenya must address during this review include developing an effective national disease surveillance and reporting system to identify and address animal health constraints as required by World Animal Health Codes. Currently, support for epidemiological surveillance is being provided under the Pan African Control of Epizootics (PACE) programme in 27 African countries, including Kenya. The goal is to control major diseases and allow Kenya to regain access to international markets for its live animals and animal products.

Wildlife should remain an integral component of the disease serosurveillance strategy, with a focus on pre-identified groups of key species in areas of importance. Because wild animals are not vaccinated in Kenya, they are valuable sentinels for the monitoring and control of disease, as has been shown with rinderpest. As the statistically valid sample size required is small for rinderpest (Wamwayi *et al*. 2002), wildlife surveillance can provide a feasible and valuable source of information for monitoring disease occurrence.

To improve the delivery of animal health services in the rangelands, the government needs to consider increasing public expenditure for veterinary services in these areas and to devolve some services from the central government to private, public, and community sectors. Community-based animal health workers can provide low-cost services to pastoralists in remote areas (Kock *et al*. 2002).

Livestock movement control should ensure stock inspection at markets, auction yards, stock routes, and entry points into Kenya to limit disease transmission across borders. Clinical disease and serological investigations should be ensured at key points along these routes and at slaughterhouses. Services for local markets should focus on improving productivity and reducing transmission risks for epidemic and zoonotic diseases, without the strict sanitary measures required for export markets. Disease-free zones should be established in designated areas where strict veterinary controls are applied to allow livestock for export to be maintained. Major production areas should be supported by building slaughterhouses that have cooling facilities.

Strategic vaccination, vector-control programmes, and effective management of quarantine are required to reduce infection and prevent transmission of disease in livestock.

Wildlife health management requires a wide range of skills from veterinarians, such as the restraint and capture of wildlife, diagnostic ability in the field, follow-up investigations in the laboratory, and interpretation of epidemiological data. The local undergraduate and postgraduate curricula need to be reviewed to ensure they provide sound knowledge on wildlife disease management.

To succeed in controlling transboundary diseases, Kenya needs to collaborate with East African community states to review and harmonize regional policies, laws, and regulations governing disease surveillance and control. Similar capacities for emergency preparedness and response to epizootic disease outbreaks need to be developed throughout the region.

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Chapter 4

The Influence of Veterinary Control Fences on Certain Wild Large Mammal Species in the Caprivi, Namibia[1]

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Introduction

This paper considers the effects of veterinary control fences on four wild mammal species and is based on consultancies conducted for the Ministry of Environment and Tourism, Namibia, from October 2002 to April 2003 to develop management plans for southern savanna buffalo (*Syncerus caffer caffer*), roan antelope (*Hippotragus equinus*), sable antelope (*Hippotragus niger niger*), and tsessebe (*Damaliscus lunatus lunatus*). Two background studies were done – one on buffalo (Martin 2002a) and one on roan, sable, and tsessebe (Martin 2003a). Following from these studies, management plans were prepared (Martin 2002b and 2003b).

Recent revisions to the taxonomy of the Artiodactyla (even-toed ungulates) have placed all of these species closer together (Macdonald and Morris 2001). All four species are in the family Bovidae (bovids) in a new suborder Ruminantia (ruminants). In the subfamily Bovinae (wild cattle and spiral-horned antelope), the southern savanna buffalo (*Syncerus caffer* Sparrman 1779, subspecies *S.c. caffer*) is one of four subspecies of African buffalo recognised by the IUCN Antelope Specialist Group (ASG 1998) in the tribe Bovini (wild cattle).

Roan, sable, and tsessebe are now all included in the subfamily Hippotraginae (the grazing antelope), which embraces three tribes. The tsessebe (*Damaliscus lunatus*, Burchell 1824, subspecies *D.l. lunatus*) is included in the tribe Alcelaphini (open woodland, moist grassland, and ecotonal grazers). Roan and sable antelope are in the tribe Hippotragini (savanna and arid land grazers). No subspecies of roan (*Hippotragus equinus*, Desmarest 1804) are currently recognised; four subspecies of sable (*Hippotragus niger*, Harris 1838) are thought to exist, although the validity of this classification is dubious (ASG 1998). The main subspecies *H.n. niger* occurs from Tanzania southwards in Africa. The third tribe, Reduncini, includes wetland antelope species such as the waterbuck, lechwe, and reedbuck.

In the IUCN Red List of Threatened Species (Hilton-Taylor 2000), all four species are classified as lower risk (conservation dependent), i.e., they are not threatened at the global, continental, or regional level. The species are of conservation concern at the national level in Namibia because, within their natural range, their numbers are far lower than in the recent past. They appear to be declining, and many of the subpopulations making up the national metapopulation are isolated from one another. However, because the areas in which buffalo, roan, sable, and tsessebe occur naturally in northeastern Namibia are spatially linked to larger populations in Botswana, these species would not qualify independently for any category of threat based on population numbers. Also, while numbers of roan, sable, and tsessebe have increased spectacularly on commercial farms in Namibia, most of these farms are located outside the range where the species formerly occurred in the country.

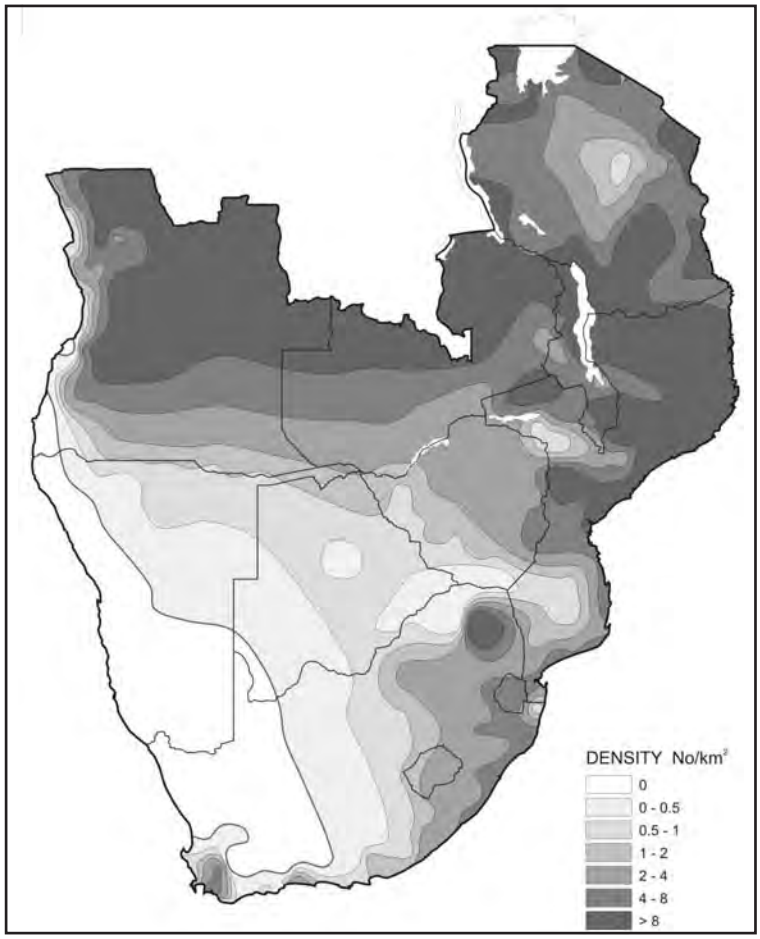
One of the main purposes of these studies and management plans is to contribute to the establishment of transfrontier conservation areas (TFCAs) in the central area of southern Africa where Angola, Botswana, Namibia, Zambia, and Zimbabwe share common boundaries. The attainment of functioning TFCAs is not envisioned as being either a rapid or a simple process; the long-term goal is being approached incrementally, with the first step being the building of linkages between Botswana and Namibia involving a number of joint species management programmes. Ultimately, these should facilitate larger transboundary conservation projects.

Historical Distribution and Status

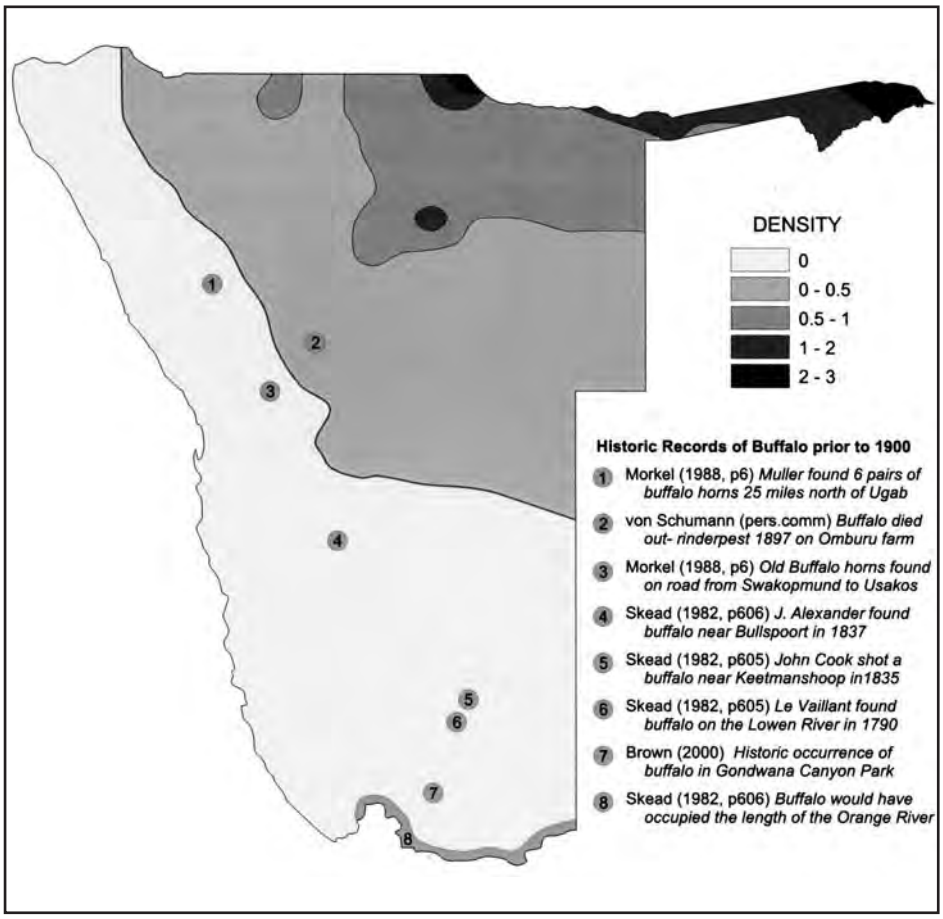
Several hundred years ago, the range of buffalo in Africa extended to most areas with an annual rainfall exceeding 250mm (Stewart and Stewart 1963). Prior to the great rinderpest epidemic at the turn of the 19th century, buffalo were widely distributed throughout southern Africa – except in South Africa, where they had been largely eradicated from the southern part of their historical range (Map 1). A relict population persisted in what is now Addo National Park in the Cape Province.

In Namibia, buffalo originally occurred throughout the northeast of the country above the 250mm rainfall isohyet and even in lower rainfall areas (Map 2). After the rinderpest pandemic, buffalo began to recolonise their former range and, by 1963, were recorded in most of the area they had originally occupied (Map 3). This trend was reversed after 1960 (see next section on veterinary control fences) and, except for two foot and mouth disease-free buffalo herds in the main body of

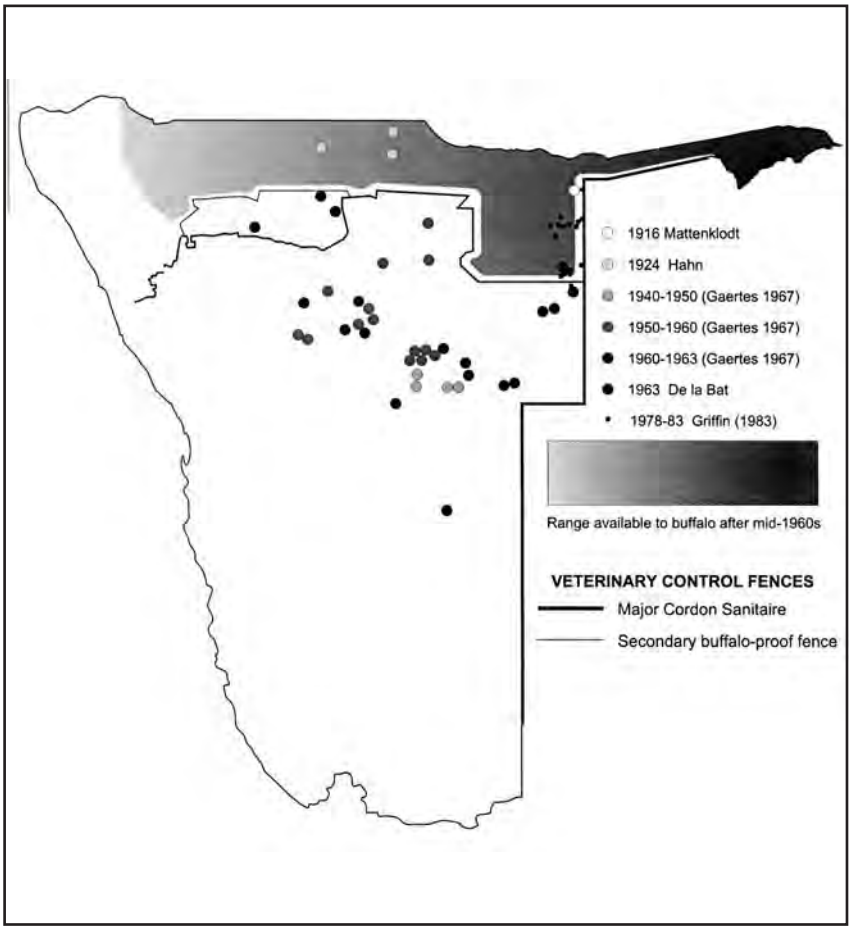
[1]See abstract on p.xxi.



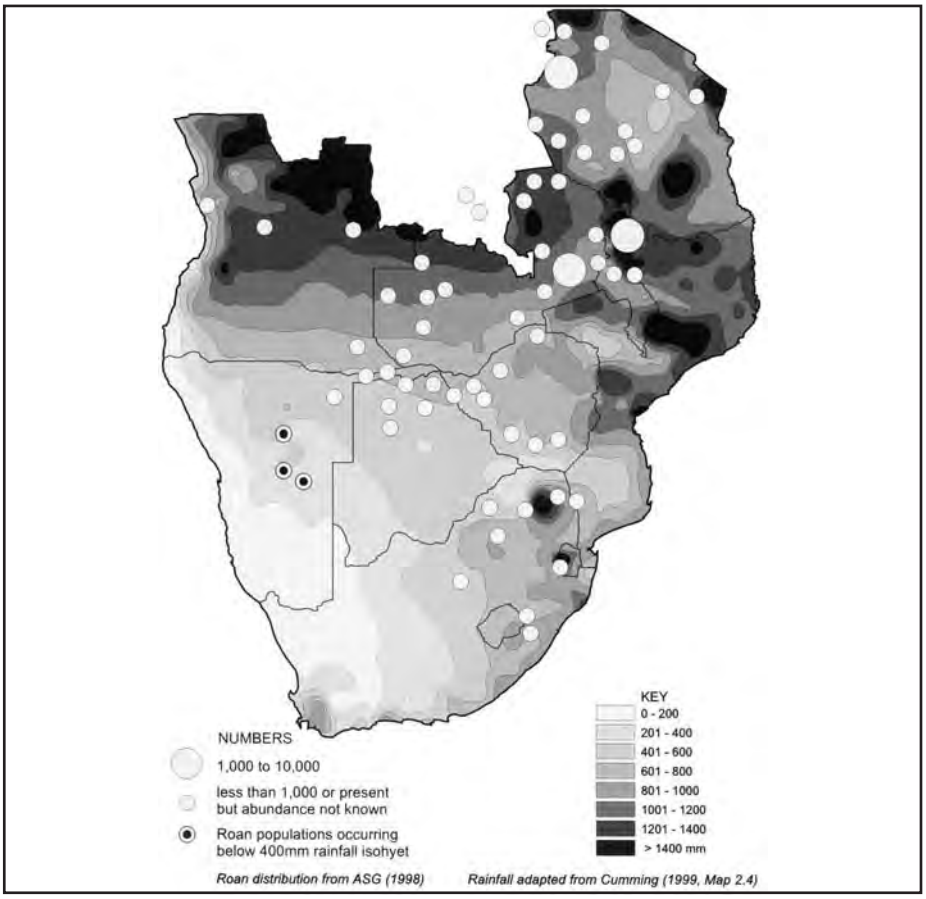
Map 1. Buffalo in southern Africa – early historic range and potential density (based on rainfall)



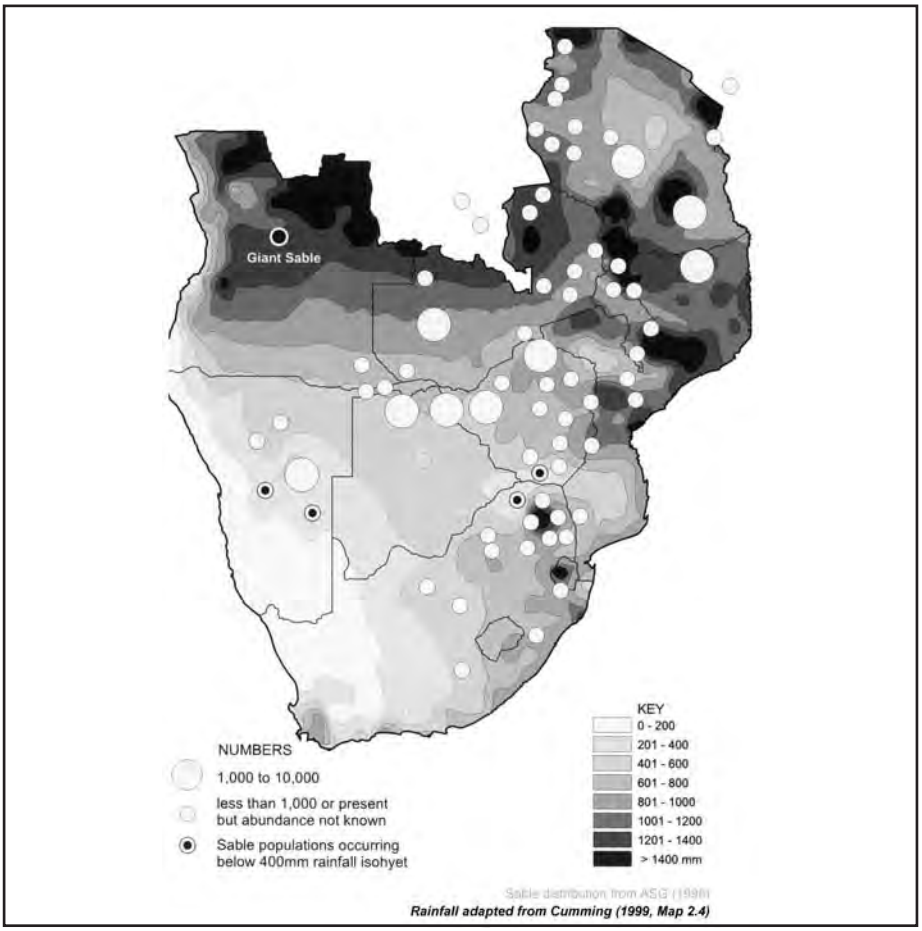
Map 2. Pre-rinderpest range of buffalo in Namibia together with potential density based on rainfall



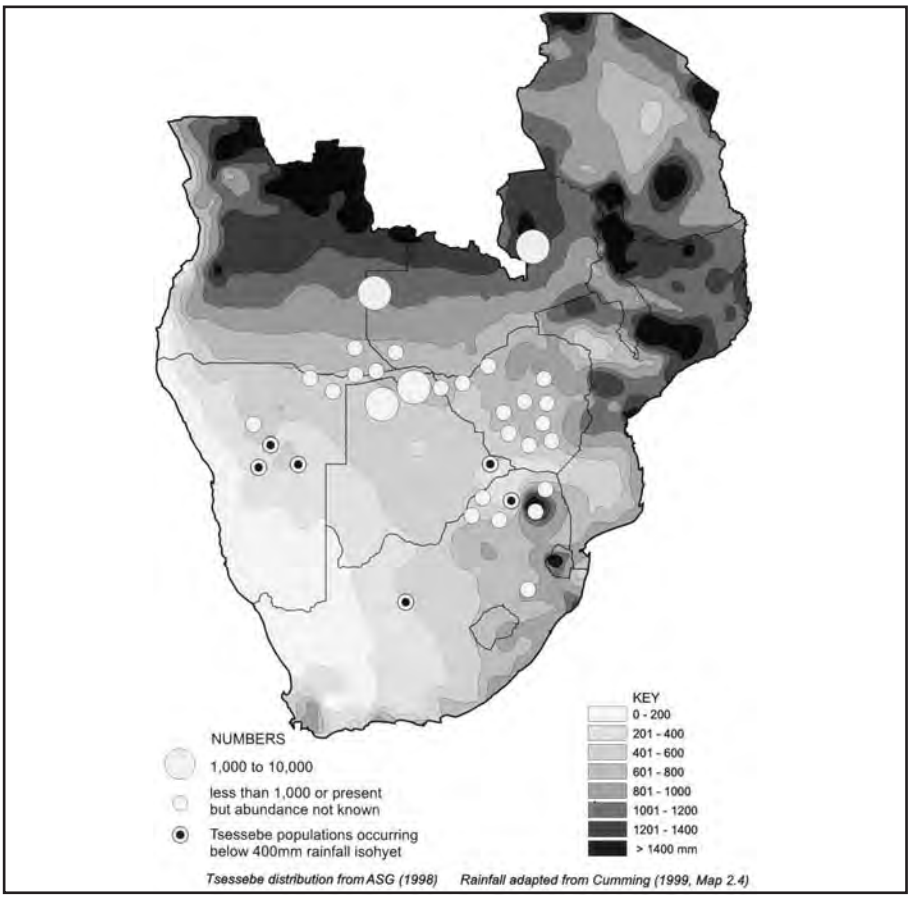
Map 3. Reported buffalo occurrences in central Namibia 1900–1963 and the reduced range available to buffalo after 1963



Map 4. Mean annual rainfall and roan antelope occurrence in southern Africa

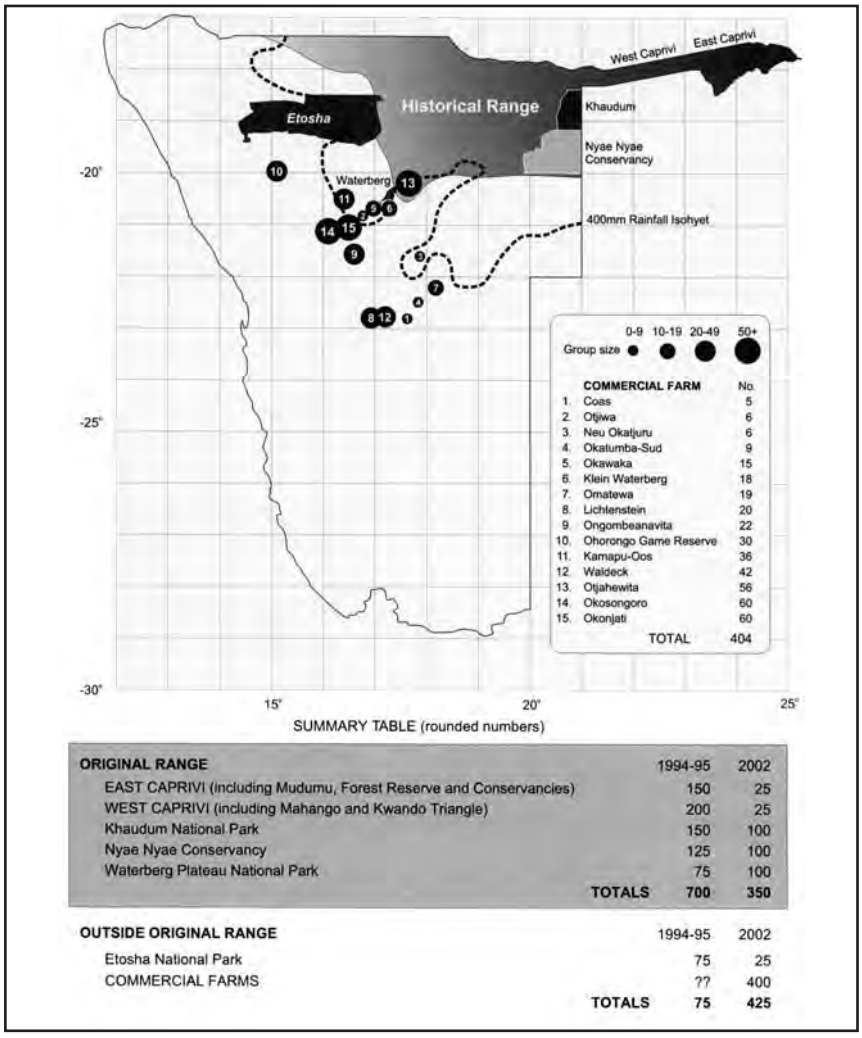


Map 5. Mean annual rainfall and sable antelope occurrence in southern Africa



Map 6. Mean annual rainfall and tsessebe occurrence in southern Africa

Map 7. Roan antelope – original range, present distribution and current status



SUMMARY TABLE (rounded numbers)

ORIGINAL RANGE	1994-95	2002
EAST CAPRIVI (including Mudumu, Forest Reserve and Conservancies)	150	25
WEST CAPRIVI (including Mahango and Kwando Triangle)	200	25
Khaudum National Park	150	100
Nyae Nyae Conservancy	125	100
Waterberg Plateau National Park	75	100
TOTALS	**700**	**350**

OUTSIDE ORIGINAL RANGE	1994-95	2002
Etosha National Park	75	25
COMMERCIAL FARMS	??	400
TOTALS	**75**	**425**

the country, the range for buffalo is now restricted entirely to the Caprivi. In 1994–1995, the estimates for the Caprivi population were some 3,000 (ULG 1994, Rodwell *et al.* 1995).

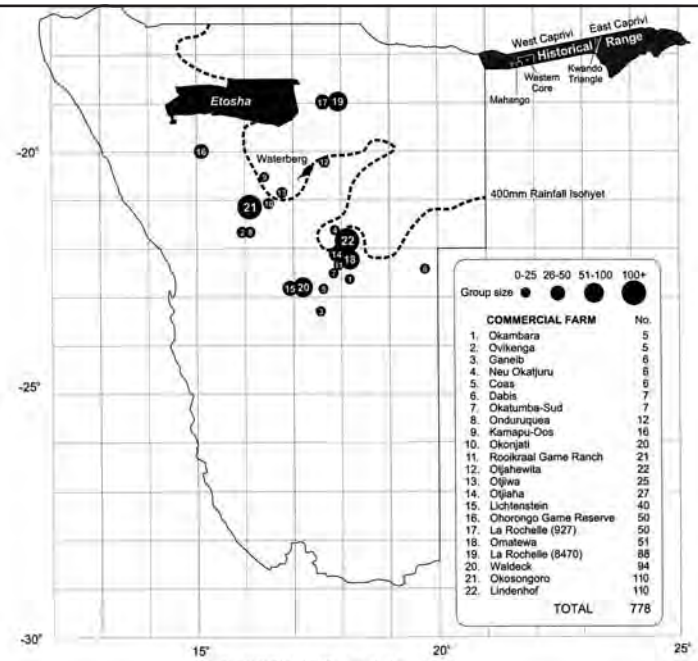
Roan, sable, and tsessebe do not occur naturally in areas where annual rainfall is much less than 400mm (Maps 4, 5 and 6). In Namibia, their historical distribution was limited to the extreme northeast of the country (Maps 7, 8 and 9), with the highest densities in the Caprivi (Shortridge 1934). New populations of all three species have been established in state-protected areas and commercial farms in the north of the country, but many of these populations are in areas where the rainfall is lower than 400mm and their long-term prospects must be regarded as parlous.

Despite erratic air survey data from 1980 to 2000, it is apparent that the roan, sable, and tsessebe populations in the Caprivi were relatively abundant until 1995. Some 500 roan were estimated in the Caprivi and Khaudum Game Reserves in 1994–1995, sable numbers were over 1,200 in fairly constant densities across the full extent of the Caprivi, and tsessebe numbered at least 200.

Veterinary control fences

From 1960 to the present, veterinary control fences have been built and continually modified in Botswana, Namibia, South Africa, and Zimbabwe. The fences relevant to this study, together with their dates of construction, are shown in Map 10 and described in detail in a consultancy report prepared by Scott Wilson Resource Consultants (2000). The early fences were mainly directed at the control of foot and mouth disease but, as veterinary research progressed in the latter half of the twentieth century, it became apparent that numerous other diseases affecting cattle had to be considered (Morkel 1988).

Obtaining much quantitative data of the effects on wildlife of the early fences is difficult. In Botswana, the first cordon fence (the “Kuke fence”) was constructed in 1958, and there are numerous qualitative accounts of losses in wildebeest, hartebeest, and zebra populations. The fence along the international boundary between Botswana and Namibia was constructed in the early 1960s and disrupted wildlife movement between the two countries. In arid land ecosystems, these movements play a critical role in species survival.

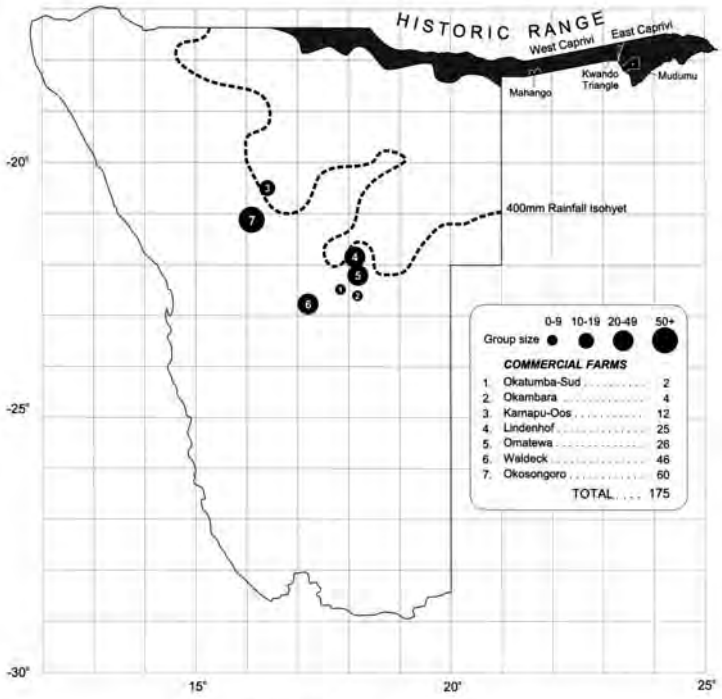


SUMMARY TABLE (rounded numbers)

ORIGINAL RANGE	1994–95	2002
EAST CAPRIVI (including Mudumu, Forest Reserve and Conservancies)	600	0
WEST CAPRIVI (including Mahango, Wester Core and Kwando Triangle)	600	225
TOTALS	**1,200**	**225**

OUTSIDE ORIGINAL RANGE	1994-95	2002
Waterberg Plateau National Park	75	125
Etosha National Park	50	75
COMMERCIAL FARMS	??	800
TOTALS	**125**	**1,000**

Map 8. Sable antelope – original range, current distribution and current status. In the early part of the 20th century, sable antelope were found only in the Caprivi (Shortridge 1934).



SUMMARY TABLE (rounded numbers)

ORIGINAL RANGE	1994–95	2002
EAST CAPRIVI (Mudumu National Park only)	125	0
WEST CAPRIVI (Mahango National Park and Kwando Triangle only)	100	50
TOTALS	**225**	**50**

OUTSIDE ORIGINAL RANGE	1994-95	2002
COMMERCIAL FARMS	??	175

Map 9. Tsessebe – original range, present distribution and current status

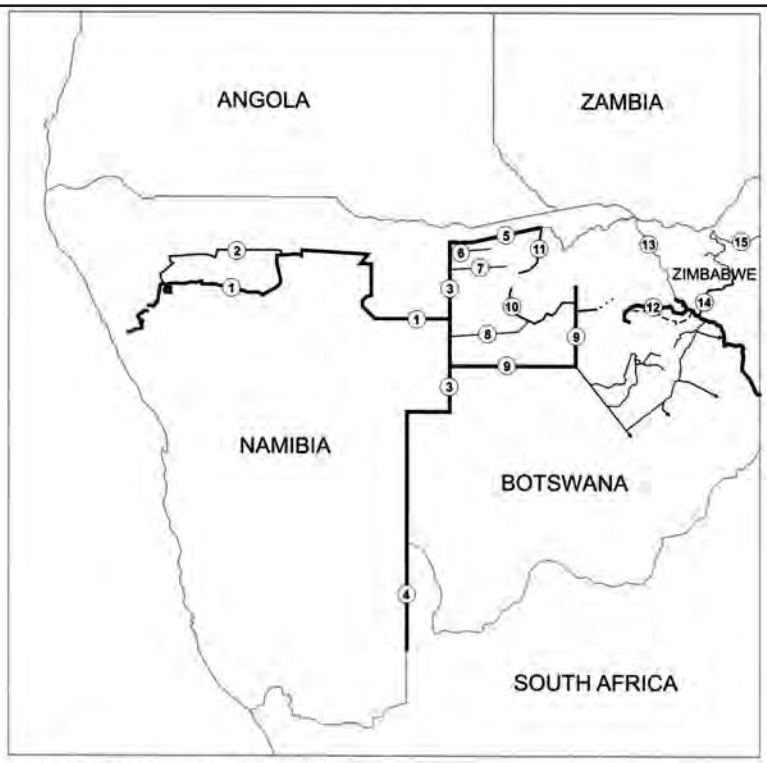
In northern Namibia, buffalo were eradicated from large areas as part of the veterinary campaign but, in any case, the construction of the fences alone would have been responsible for many deaths. Volker Grellmann (chair, Namibian Professional Hunters Association, personal communication) related the fate of some 200 buffalo in the Bushmanland area that were isolated from Botswana by the international boundary veterinary fence. Most of this group died of thirst and starvation and, by 1988, the only survivors were 18 of the original herd, which later formed the nucleus for the present foot and mouth disease-free herd in Tsumkwe. It is significant that, up until the time of their quarantine in 1996, buffalo in this herd had been in regular contact with cattle without transmitting the disease.

The outbreak of contagious bovine pleuropneumonia in 1995 in the extreme northwestern corner of Botswana (Xaudum, Ngamiland) resulted in the eradication of 320,000 cattle and a proliferation of veterinary control fences over the next few years (Amanfu *et al.* 1998).

The reduced range now available to buffalo in the trans-boundary project area is shown on Map 11. Of particular significance is the convoluted shape of this range in northern Botswana. In theory, through a disjointed set of breaks in the Botswana veterinary fences, the present buffalo range could extend as far south as the Makgadikgadi Pans; in practice, the obstacles to buffalo movement seem to preclude this. In fact, the last surviving buffalo in the Makgadikgadi Pans area were translocated to the northern part of the buffalo range in 2000. These were potentially disease-free buffalo due to years of isolation (MD Kock, personal communication 29 Oct 2003).

In Namibia, perhaps the most serious effect of veterinary fences is the effective separation of the western core wildlife areas on the Kavango River from the remainder of the Caprivi. The Caprivi Strip is a waterless tract of land, and the likelihood of any of these species traversing it is remote.

Map 10. Veterinary control fences affecting wildlife in the proposed "Four-Corners" Transfrontier Conservation Area



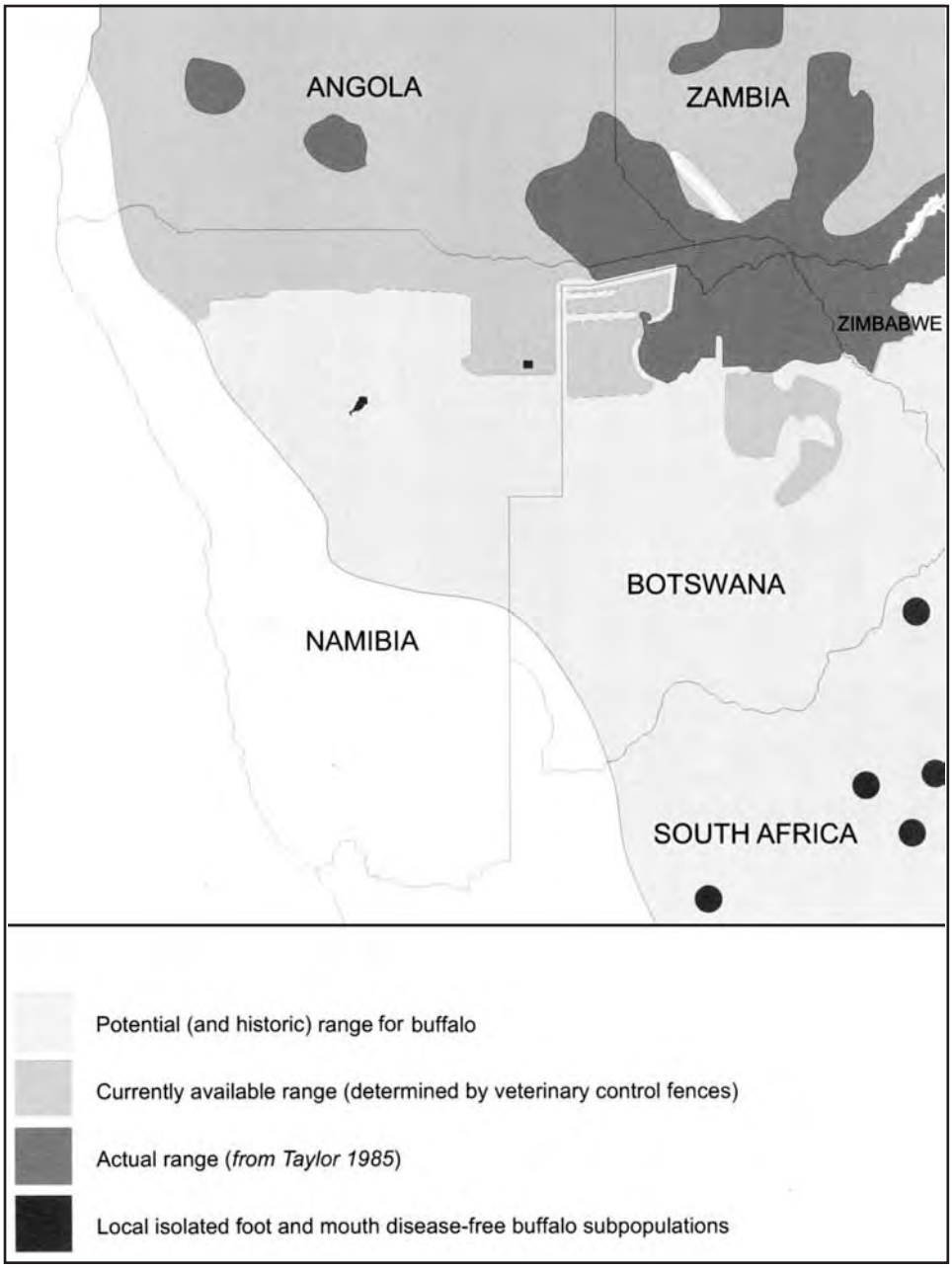
KEY TO VETERINARY CONTROL FENCES

1. Veterinary Cordon Fence: mid-1960s...
2. Etosha Northern Boundary. Fence: 1980s
3. Namibia/Botswana International Boundary: mid 1960s
4. Namibia/South Africa International Boundary: mid 1960s
5. Caprivi Border 1995 (Early fences 1970-80)
6. Samuchima 1995
7. Ikoga 1995
8. Setata 1996
9. Kuke 1958
10. Southern Buffalo Fence 1982
11. Northern Buffalo Fence 1991-96
12. Ngwatsha Fence 2000 (original Makalamabedi Fence1968 shown as dotted line below)
13. Botswana/Zimbabwe International Boundary 1984
14. Hwange National Park 1984
15. Sebungwe 1972

LEGEND

- Major Cordon Sanitaire
- Major buffalo-proof fence
- Secondary buffalo-proof fence
- Fence in disrepair
- Former fence location
- Fence continues

Map 11. Past, available and actual ranges for buffalo



Current status of populations

The most recent surveys of buffalo in the Caprivi indicate the presence of about 500 animals (Craig 1998, DSS 2002). This population is on the fringe of the larger Botswana population of about 100,000 animals (DWNP 2002); therefore, the size of the "permanently resident" population in the Caprivi is speculative. However, the Botswana distributional data does suggest that buffalo movement is restricted during the dry season, when the estimates for the Caprivi population were made.

The status of roan, sable, and tsessebe in the Caprivi is of concern; there appear to be fewer than 50 roan, about 200 sable, and less than 200 tsessebe surviving. In northern Botswana, the estimated numbers of roan, sable, and tsessebe are about 1,500, 3,000, and 10,000, respectively (ULG 1995). Although these numbers may appear high, the densities are low given the large range available (150,000km^2) and not dissimilar to those in the Caprivi. The tsessebe are concentrated in the Okavango Swamp and cannot be regarded as contiguous with the Namibian Caprivi population.

Cause and effect

The numbers of buffalo, roan, sable, and tsessebe in the Caprivi all seem to have declined sharply since 1995 when the animals were relatively abundant. The decline follows the most recent wave of construction of veterinary control fences. The question is "to what extent can the observed decline be attributed to the influence of veterinary control fences"?

Limiting factors

Rainfall

Rainfall is the ultimate factor limiting the distribution and abundance of all these species in southern African savannas. For buffalo, rainfall determines not only the final carrying capacity of the range but also the age of first conception and fecundity of females.

Using the data of Sinclair (1974b), Taylor (1985), and recent survey results from low-rainfall areas, Martin (2002a) showed that the ecological carrying capacity for buffalo is well described by the relationship in Fig. 1.

$$\text{Density} = 8.5 \times 10^{-10}(\text{Rainfall})^{3.3}$$

The Caprivi is the only part of Namibia that enjoys an annual rainfall above 500mm, and the area could be expected to carry buffalo at densities of 1–2/km^2, i.e., in an area of 20,000km^2, there should be at least 20,000 buffalo, taking into account present human settlement.

Dunham *et al*. (2004) showed that the population performance of tsessebe in Kruger National Park was strongly correlated with the long-term cumulative surpluses and deficits above and below the mean annual rainfall. Martin (2003a) observed that the effect appears to extend to roan in areas that are on the margin of acceptable rainfall (i.e., around 400mm) and may also affect sable. However, the effect seems to be less pronounced at higher rainfall such as that of the Caprivi. Based on successful populations of these species in other southern African savannas, densities of the order of 1–2/km^2 seem to be eminently feasible.

Other factors

A range of other potentially limiting factors was examined to assess the primary causes of the species' poor conservation status. In the eastern Caprivi, poor land-use planning is likely to be a major factor limiting the abundance of wild species. The ad hoc westward expansion of people and domestic livestock threatens the integrity of the range for all wild species. Wedges of human settlement are fragmenting the range and, in several places, continuity of species populations can be maintained only through spatial links with northern Botswana (Map 12).

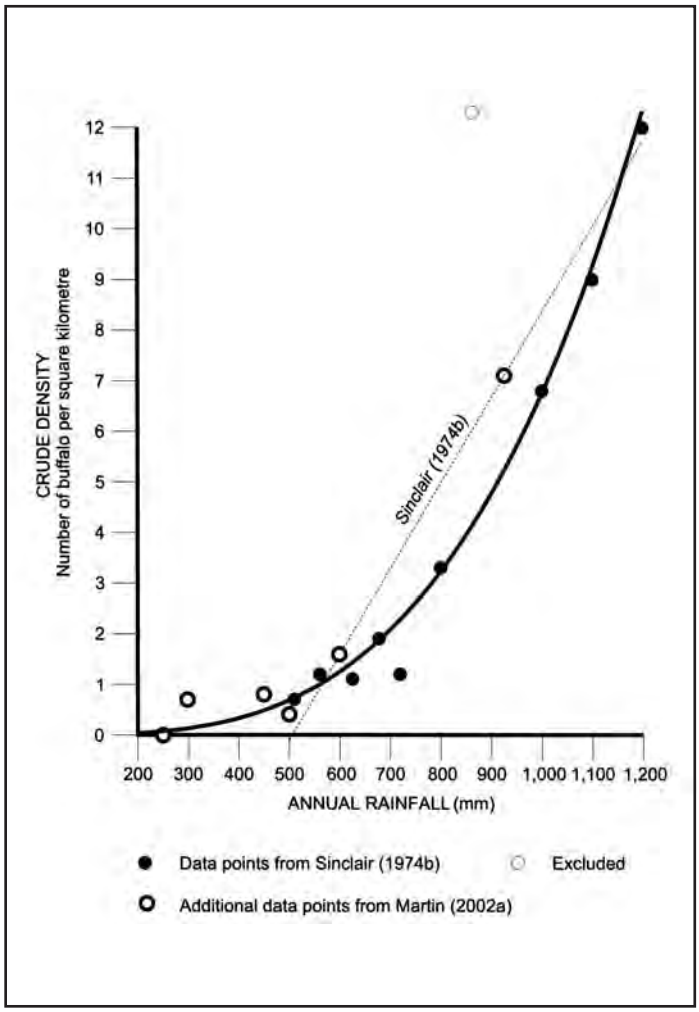
Any ill-considered placement of fences in this area would likely result in the total isolation of a number of small subpopulations and, ultimately, lead to their demise. In the western Caprivi (the Caprivi Strip), the present location of veterinary fences has caused the isolation of Mahango and Khaudum National Parks and has effectively broken all linkages not only between the east and west Caprivi but also between Botswana and Namibia.

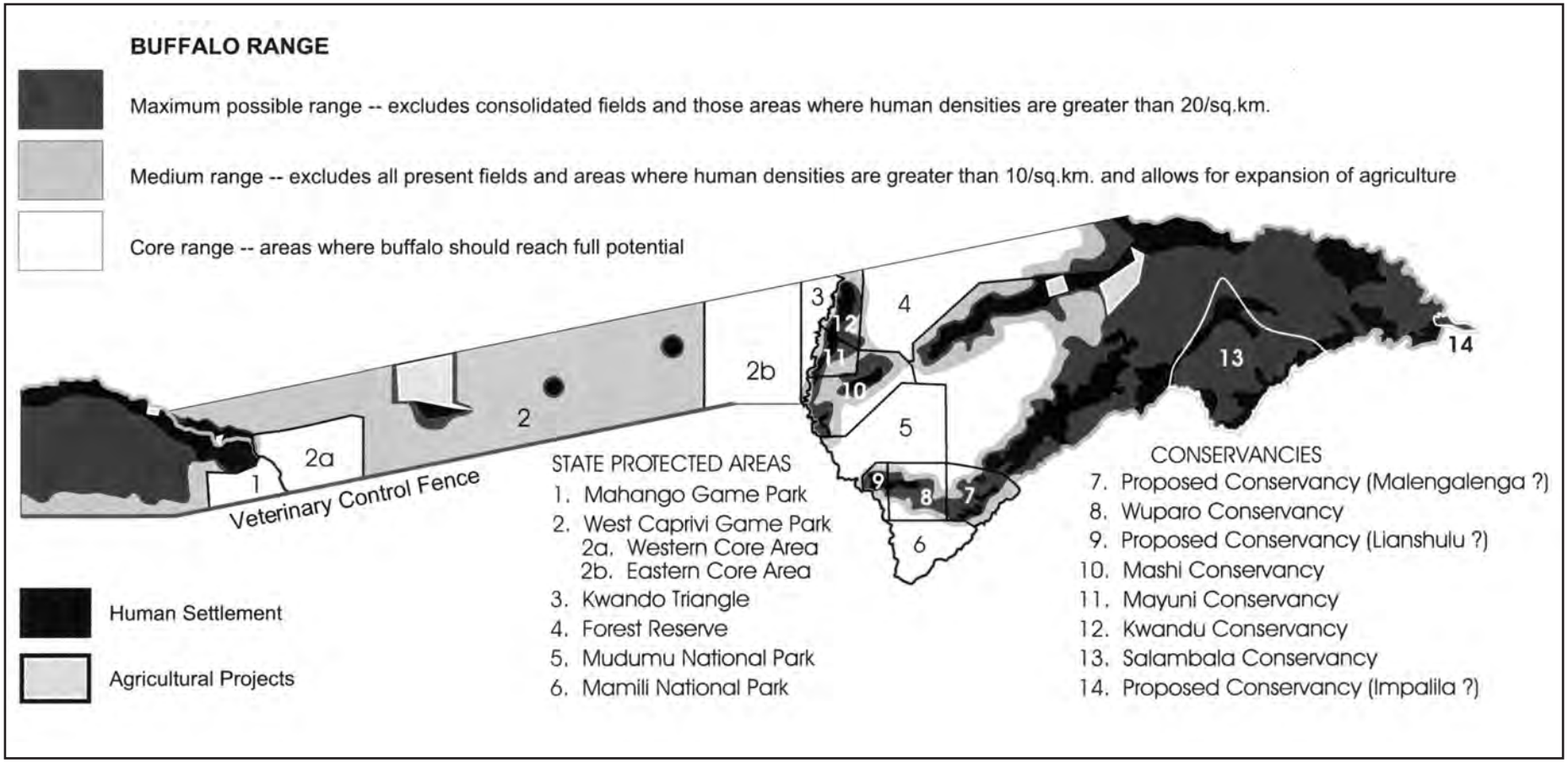
Unplanned settlement and veterinary control fences are not independent issues. Too often, the construction of a veterinary control fence is a reaction to ad hoc settlement and tends to ratify and entrench it. By so doing, options for land-use planning at a large scale are eliminated, and the likelihood of establishing successful TFCAs dims.

The burgeoning elephant population in northern Botswana and the Caprivi (currently estimated in excess of 100,000 animals) may be exerting a negative influence on all four species. Sinclair (1974b) notes that a population of any species is effectively competing with another species if it eats any of the food required by the first species. A large population of one species can have a marked impact on a smaller population of another species. In the Serengeti, large numbers of wildebeest depleted the resources of buffalo. It may well be that the very large elephant population is competing with buffalo, because both are wet-season grazers.

Roan, sable, and tsessebe are specialist feeders with habitat requirements that, despite much research, may not yet be fully understood. In those parts of southern Africa where elephant populations have increased unchecked, the major structural changes in habitats, effects of trampling, and competition for water have not been favourable for roan, sable, and tsessebe. In the Sebungwe region in Zimbabwe, all three species have been in decline for a number of years (roan and tsessebe are almost extinct), coinciding with a period during which the elephant population has continued to increase. If sable and roan prefer parkland savannas with dappled sunlight shining

Fig. 1. Carrying capacities for buffalo based on rainfall





Map 12. Caprivi – land use planning, veterinary fences and potential buffalo range

through tree canopies (thus favouring specific grass communities), then those conditions have disappeared.

Illegal hunting in the Caprivi may be responsible for reduced numbers of these species. Unfortunately, there are little data available other than verbal reports to evaluate this influence. Illegal hunting is carried out by residents of the Caprivi and by people from neighbouring countries. The arguments against this being a primary limiting factor are that there is no evidence of a sudden escalation in hunting after 1995, which would be required to explain the corresponding steep decline of the species in question; there is a reasonable level of law enforcement effort from the state wildlife agency, especially in the protected areas (Map 12); and the recent establishment of a significant number of local community conservancies (Map 12) should enhance wildlife populations.

Mendelsohn and Roberts (1997) present a compelling picture of the gravity of the fire situation in Caprivi. Burns begin as early as April each year and continue until December, when over 60% of the vegetation has been burnt and the total count of individual fires may have exceeded 3,000. Whilst a limited fire regime might have beneficial effects in preventing bush encroachment on grazing habitat, it seems more likely that burn-off of a high percentage of dry-season grazing will have a negative influence. However, the present fire regime in the Caprivi has probably persisted to a similar extent for more than half a century and is unlikely to account for a sudden decline in all four species.

More habitat in the Caprivi and Bushmanland could be made available to buffalo, roan, sable, and tsessebe by the artificial supply of water. All of these species are water dependent and seldom move further than a few kilometres from surface water (Martin 2003a). In the Caprivi, this means they must remain near the large rivers for much of the year. This limits the ability of populations in the eastern and western ends of the Caprivi Strip (the Caprivi Game Reserve) to maintain contact and, in conjunction with the veterinary control fences along the Botswana border and a hostile environment in Angola, could result in the total isolation of various subpopulations. However, the major declines in the populations of all four species have occurred in areas where surface water is adequate.

Disease has to be considered amongst the potentially limiting factors for these species. Morkel (1988) gives an excellent catalogue of the diseases affecting both cattle and buffalo, and it is clear that there are a number of strong arguments for keeping buffalo separated from cattle – as much for their own protection as for the possible threat to cattle. Except for rinderpest, the effects of various diseases to which buffalo are susceptible are relatively minor. Together, predation and disease tend to be secondary factors acting on undernourished animals (Pienaar 1969). Disease may differentially affect juveniles, but the resultant mortality is likely to cause population fluctuations rather than substantive long-term alterations to population growth rates (Sinclair 1974a). Rinderpest is an exception – the whole population is affected.

Roan, sable, and tsessebe are susceptible to various diseases of which anthrax is likely the most serious (Pienaar 1961). However, as is the case with buffalo, predation and disease acting together tend to be secondary factors acting on undernourished animals.

Discussion and conclusions

The case is by no means proved that veterinary control fences are wholly responsible for the decline in buffalo, roan, sable, and tsessebe in the Caprivi. A number of other potentially limiting factors may act in concert to reduce their numbers, although deductive reasoning suggests that none of these factors considered in isolation could be the sole cause of the decline. However, the sudden decrease in numbers of all four species immediately after the construction of double electrified fences along the western and northern sides of the international border between Botswana and Namibia is the strongest evidence that these veterinary control fences are largely responsible for the population declines.

Scott Wilson Resource Consultants (2000) state that the impact of these fences on wildlife mobility has critical long-term implications for these species' survival. They have proposed various measures to the Botswana government to mitigate the effects of the fences, including the realignment or removal of certain fences. As yet, none of the options has been implemented. At a time when expectations for TFCAs are high, this is a retrogressive situation.

Conservation issues may be secondary to the long-term development potential based on wildlife management as the primary form of land use for the Caprivi and northern Botswana. Martin (2002a) estimates that if buffalo densities could be increased to about 1/km^2 in the unsettled areas of the Caprivi (about 17,000km^2), the net annual income from safari hunting would rise to about US $12 million annually. If roan, sable, and tsessebe populations could increase to the same density over half of the available area, an additional US $5 million could be added to the sport-hunting income.

The financial and economic values offered by wildlife far exceed those possible from domestic livestock. Barnes *et al*. (2001) state that in the medium to long term, the comparative advantages of land use based on domestic livestock can be expected to decline as international subsidies are phased out. They also point out that the comparative advantages of wildlife land uses can be expected to increase over time, due to continuing rapid expansion in international tourist markets, increasing scarcity of wildlife elsewhere, and the development of markets to capture international wildlife nonuse values as income. It would be a great pity if, through myopia in land-use planning and consequent option foreclosure caused by veterinary control fences, governments and local communities were denied the development potential and long-term sustainable livelihoods that successful wildlife management could provide.

Acknowledgements

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Chapter 5

Wildlife, Livestock and Food Security in the South East Lowveld of Zimbabwe[1]

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Introduction

The South East Lowveld (SEL) of Zimbabwe provides an interesting example of the conflicts and dilemmas that arise in making policy choices between rural development options involving small-scale agropastoralists and wildlife-based tourism opportunities. The situation is further complicated by the juxtaposition of contrasting land tenure and land-use regimes and impending development of the Great Limpopo Transfrontier Conservation Area (GLTFCA), which may include large parts of the SEL within its purview. The three dominant land tenure/land-use regimes in the SEL are the Department of National Parks and Wildlife Management (DNPWM) land under state jurisdiction, Large Scale Commercial Farm Land until recently under freehold title, and Communal Lands under traditional common property regimes.

In the ongoing debate about wildlife as a potential land use in the region, the key issues depend very much on the perspectives of the various sectors involved. For subsistence farmers (small-scale agropastoralists) in the Communal Lands, livestock form a dominant component of their livelihood strategies. Animal diseases, particularly those associated with wildlife hosts such as foot and mouth disease (FMD) carried by buffalo, and trypanosomiasis, transmitted by tsetse flies but to which many wild ungulates are generally resistant while livestock are often susceptible, are a particular concern to these farmers. In addition, lions, leopards, and cheetahs prey on their livestock, and elephants raid their fields or vegetable gardens. For ranchers in the commercial farming sector, wildlife-based tourism has been an increasingly attractive economic option. However, it has been politically poorly supported, with the result that protecting wildlife resources from poaching has been increasingly problematic. Furthermore, it has been widely perceived to be a threat to food security on the grounds that land used for wildlife should be producing food through cultivation or grazing for livestock. For the state, and for private enterprise involved in tourism, transfrontier conservation areas (TFCAs) are an economically attractive and ecologically sustainable option for the use of drought-prone marginal lands. A high proportion of subsistence farmers also have high expectations for development of their remote areas in the wake of TFCA development but nevertheless feel threatened by the possibility of being sidelined or even dispossessed of their land and resources. Commercial ranchers involved in the wildlife industry see it as a major opportunity. Rural District Councils also welcome the development of TFCAs and associated wildlife tourism and infrastructure in the areas under their jurisdiction.

At the centre of the debate are two critical issues, namely, food security for subsistence farmers and the equitable distribution of benefits from wildlife-based tourism as a land use. This paper then, examines the following questions: 1) how important are livestock to food security in the SEL?, 2) can wildlife production systems meet livelihood needs as effectively as livestock?, and 3) if not, what are the alternatives?

Biophysical and land-use features of the SEL

The SEL covers an area of approximately 50,000km^2 that lies between 300m and 600m above sea level. The 600m contour provides a useful boundary between the low and middle veld and forms a line that coincides roughly with the foothills of the escarpment that rises to form the central watershed of the country. The region extends from the Tuli Circle in the west to the lower Save River in the east. Mean annual rainfall for the SEL is mostly below 400mm and is highly variable both in time and space. The coefficient of variation is greater than 35%. Mean annual temperature is between 25 and 27 degrees Celsius which, when combined with an extended dry season of several months, places great stress on plant growth. The growing season is less than 90 days, making the region unsuitable for dry land cropping.

Communal Lands cover the greatest area (approximately 22,161km^2) in the SEL, followed by commercial farm land (19,570km^2) and state protected areas (5,575km^2) in the form of national parks and safari areas. The highest population density of people, outside of towns and irrigated estates, is found in the Communal Lands (Table 1), where it varies between 10 and 50 people per km^2. Wildlife as a land use occurs in all land tenure categories and covers an area of about 17,500km^2 or 35% of the SEL.

[1]See abstract on p.xxii.

Table 1. Land tenure categories and apportionment of land in the SEL*

Land category	% of area	People/km^2
Communal Land	44.2	11–52
Large-scale commercial farm land		
Irrigation	<0.01	?
Cattle ranches	16	<3
Wildlife + cattle	9	<3
Conservancies	13	<3
Small-scale commercial farm land	0.5	10
Resettlement land (in 2000)	5.8	?
Parks and wildlife estate	11.5	<1
Total	**100**	**–**

**The total area covered is approximately 50,000km^2 with an overall population in the Communal Lands of approximately 440,000 people at a density of approximately 20/km^2 in 2000.*

Communal Lands – subsistence and vulnerability

Cereal production

The threshold for staple cereals adopted by the Famine Early Warning System (FEWS) in their assessments of food security is 250kg of maize meal/person/year (Anon 1998). In Zimbabwe, the staple cereal is maize, although sorghum and millets are important in arid areas. In most years communal farmers attempt to grow a crop, but the yields are low and uncertain. In the western part of the Beitbridge District, the most vulnerable part of the SEL, the average annual harvest of cereals falls well below the threshold of 250kg per capita (Fig. 1) and during 1980–1995, farmers produced a surplus of grain in only 1 of 15 years (Frost 1999). Small-scale irrigation schemes in the area have mostly fallen into disrepair and no longer provide a safety net for the communities they used to serve (Mead 2001).

Livestock production

Communal farmers in the SEL keep herds of cattle, goats, and some sheep and donkeys. Because the proceeds from the sale of livestock can be used to purchase food, these proceeds can also provide an index of food availability by converting the returns to "maize equivalent income" (Anon 1998). Livestock holdings per household for Machuchuta, Maramani, and Masera Communal Lands during the 1998–1999 season varied between 10 and 18 tropical livestock units (TLUs), and estimates of livestock sales and maize equivalent income for the three Communal Lands in question varied from 290kg per person in Maramani to 1,433kg per person in Machuchuta (Anon 1999). While these figures clearly illustrate the importance of livestock to food security, annual fluctuations in livestock populations and productivity also occur in response to droughts, disease, and civil disturbance. The distribution of livestock holdings is also highly skewed in most Communal Lands with Gini values of about 0.65 instead of 1.0 – the value reflecting equitable distribution amongst households (Cumming and Bond 1991). Long-term livestock trend data were not available for the Communal Lands in western Beitbridge District, but were available for an essentially similar area adjacent to the Gonarezhou National Park, the Matibi II Communal Land in the Chiredzi District. These data (Fig. 2) in conjunction with those for the human population provide a typical example of the magnitude of change that can

Fig. 1. Mean cereal production in three Communal Lands in the SEL of Zimbabwe over 15 seasons between 1980 and 1995 (data from Frost 1999).

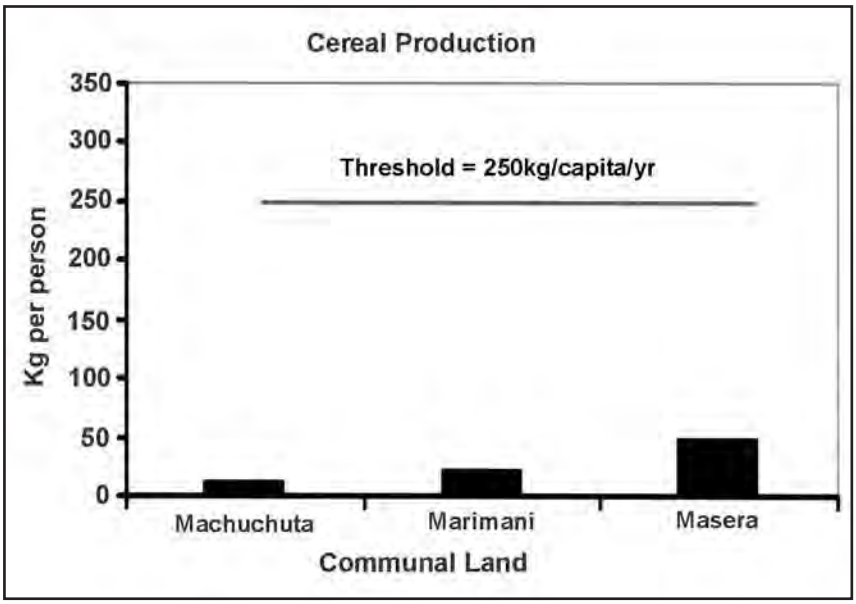
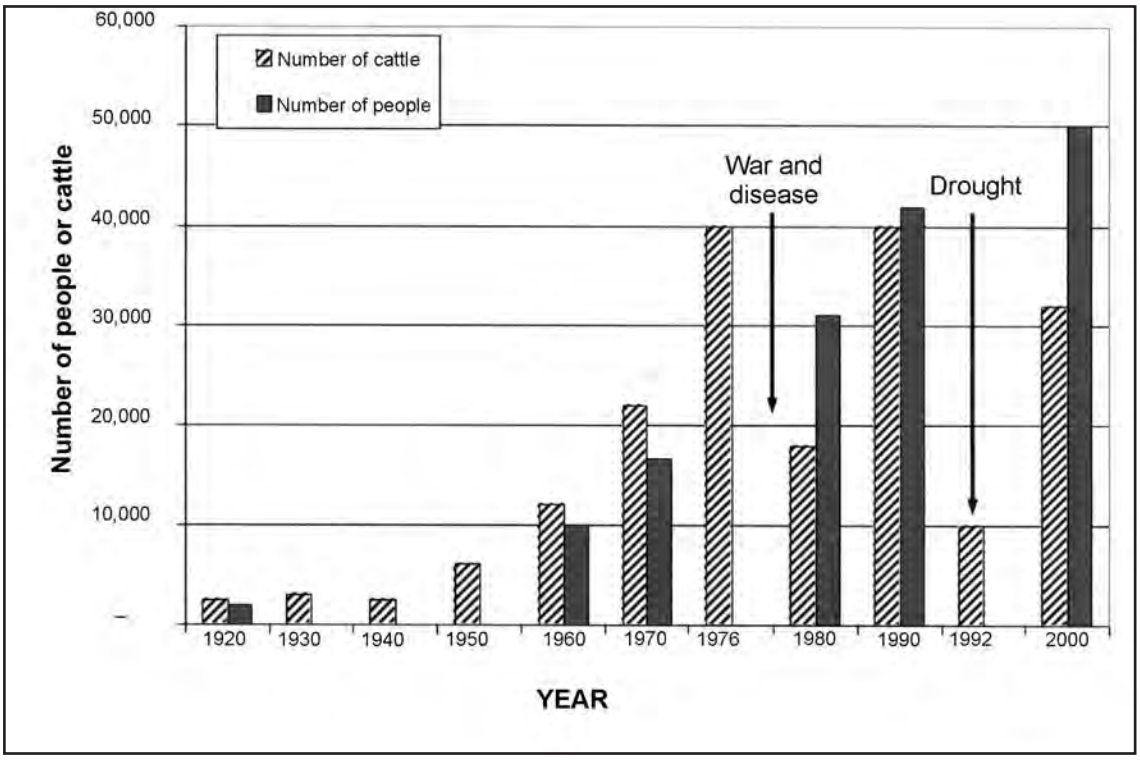


Fig. 2. Growth of human and cattle populations in Matibi II Communal Land between 1920 and 2000. Cattle numbers declined markedly in the late 1970s and during the 1991–1992 drought.



occur in livestock numbers in the Communal Lands of the SEL. A major crash in cattle numbers occurred in the late 1970s and was associated with Zimbabwe's war of independence and an associated breakdown in veterinary services and increased incidence of disease (Norval 1985). The second major crash followed the 1991–1992 drought (Fig. 2).

Population growth and farm size

The human population of Matibi II Communal Land grew more than tenfold during 1920–2000, with an accompanying decline in land available per household from greater than 600ha/household in 1920 to less than 50ha/household in 2000. The area of land required to maintain a household with minimum external inputs in a semi-arid area such as the SEL is at least 400ha. This estimate is based on the need for a household to have access to 20ha of arable land, with 5ha being planted each year on a 4-year rotation, and to 400ha of grazing land to maintain a herd of 25 cattle and 35 goats. The 400ha threshold was however unmet by 1940 when the land available had declined to 300ha per household. The capacity of the resource base to support its population has thus been exceeded in the Matibi II Communal Land for more than 60 years. This of course begs the question of how people have been able to survive under these conditions, and the answer lies in the support received from off-farm remittances from wage labour in the cities, commercial farms, and estates. Food aid programmes have also supplemented the livelihoods of resource-poor households in the SEL over the past 20 years (Government of Zimbabwe 1993).

Returns from wildlife

The establishment of the Communal Area Management Programme For Indigenous Resources (CAMPFIRE) in the late 1980s promised to boost household incomes through the commercial use of wildlife resources in communal lands still rich in wildlife resources. Substantial returns have been realised from safari hunting leases and the sale of trophy animals in Communal Land areas in the SEL. However, the key questions are how do these returns compare with those from livestock, and what level of returns from wildlife would be required to move households above the food security threshold level of 250kg/person/year?

The CAMPFIRE revenues for the Beitbridge District provide an example of the level of returns that were realised during the 1990s and until the collapse of the tourism industry in Zimbabwe after 2000 (Fig. 3). An annual return of US $30,000 to the district from wildlife was sufficient to purchase approximately 100,000kg of maize meal or enough to feed 400 people for one year. To place this figure in the context of food security for the Beitbridge District, the human population of Maramani Communal Land alone was 4,200 while that for all of the Communal Lands in the district was 72,059. Clearly, CAMPFIRE revenues make a negligible contribution to food security in the context of the SEL.

Commercial ranches – returns from wildlife

Commercial wildlife ranches provide a basis for judging the potential returns from wildlife-based land use and thus the likely contribution to the rural economy and food security in the SEL. Studies of the returns from wildlife ranching in southeastern Zimbabwe (Bond 1993, Child 1988, du Toit 1992, Jansen *et al*. 1992, Kreuter and Workman 1997, Price Waterhouse 1994) and spreadsheet analyses of the influence of farm size and rainfall on gross returns from safari hunting (Cumming, unpublished data) indicate that gross returns from wildlife-based enterprises are likely to be in the region of US $6–8 per ha. Note that these figures are for areas not involving high-valued tourism ventures. Net revenues (i.e., returns after deducting fixed costs) are approximately 50% of gross revenues resulting in a net return of US $3–4 per ha.

Converting the above levels of financial return into maize equivalents results in a return of about 10kg of maize meal per ha or enough to support three to four people/km^2/year. This in turn is equivalent to supporting one household of six people on 2km^2 or 200ha. Current densities in the Communal Lands are greater than 10 people per km^2, which translates into less than 50ha per household. Clearly, wildlife production does not provide a viable food security option, and returns would need to be four to five times higher for it to be considered as such. These financial considerations do not take into account the enormous social and cultural implications of attempting to switch from an agropastoral to a wildlife-based economy. (As one District Council official remarked in a discussion of this issue, "The problem is that cattle are *mine* but wildlife is *ours*.")

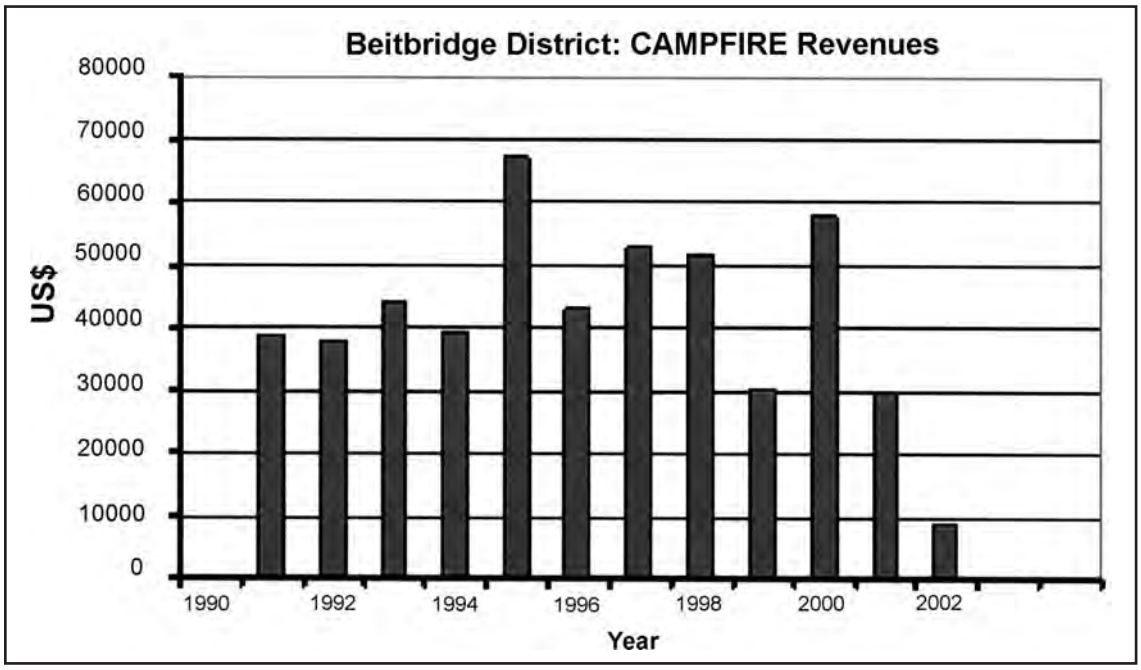
An additional constraint is that once human population densities exceed about 15 people per km^2, wildlife populations, and particularly higher valued species such as elephant and buffalo, decline or disappear (Bond 1999) with a consequent drop in revenue earned from wildlife.

Discussion

The population to resource ratio in the SEL of Zimbabwe is such that the natural resource base is not able to support the present population either through agropastoralism, wildlife production, or both. The human population in the SEL, particularly in the Communal Lands, is able to subsist through subsidies delivered to the region in the form of returns from off-farm labour supplemented by direct food aid in most years since the early 1980s. An essentially similar conclusion was reached by Campbell *et al*. (2002) following a long-term intensive study of livelihoods and production systems in the Chivi Communal Land, which is also in southeastern Zimbabwe but above the 600m contour. The population to resources ratio and the associated food security problem is also unlikely to be solved by small, incremental improvements in crop and livestock production in the Communal Lands of the region.

The bleak conclusion that existing land-use practice and policy is unlikely to resolve the problem raises the issue of what might mitigate the current problems of endemic food and environmental insecurity. In these circumstances, land tenure reform is frequently seen as a primary requirement. The current land reform programme initiated in Zimbabwe in 2000, ostensibly to decongest the Communal Lands, has had little impact on livelihoods and, if anything, has exacerbated

Fig. 3. Revenues (US$) generated by CAMPFIRE for the Beitbridge District from 1990 to 2002 (data from WWF-SARPO database).



the food security problem. Tourism has all but collapsed, production from irrigated estates has been disrupted, resettled farmers have lacked the inputs and resources to use newly settled land productively, and outbreaks of diseases such as FMD and anthrax have affected both livestock and wildlife production. Land tenure reform since 2000 has taken the form of transferring freehold land to state and leasehold land and, as Murombedzi and Gomera (2004) argue, this route is unlikely to attract investment and result in the productive use of the land in the long term.

What land-use strategies might then be adopted to mitigate the present dilemma? I suggest that the following four strategic approaches to land use and development would be appropriate.

1. *Place a premium on, and invest in, higher valued land uses and diversification*. There are many areas of irrigable soil in the SEL that merit development and others where irrigation schemes have collapsed or are underutilized. Developing potential intensive production areas in concert with appropriate livestock development would go a long way towards alleviating food shortages and unemployment. Associated investments in infrastructure to facilitate marketing of goods and services would be necessary.
2. *Decouple wealth creation from net above-ground primary production*. Because primary production in the SEL is so greatly limited by rainfall, the more wealth creation can be decoupled from a direct reliance of primary and secondary production, the less susceptible it will be to annual seasonal fluctuations in rainfall. One means of achieving this end is to develop high-valued tourism ventures in which the value is derived from services instead of from crop and meat production.
3. *Match land use and ecological process scales*. In arid areas, livestock and wildlife production systems generally require large areas over which to exploit temporal and spatial variations in the availability of key resources. Fragmentation of large landscapes by fencing and inappropriate land tenure systems and systems of resource access rights militate against adaptive strategies that may be more productive and sustainable in arid areas. The development of large-scale wildlife conservancies involving the effective amalgamation of former cattle ranches into large-scale wildlife tourism areas is a case in point (e.g., du Toit 1992).
4. *Develop legal and policy frameworks that enable local-level innovation and adaptability in resource access rights and management strategies*. Current centralized prescriptions over land use, tenure, and resource access rights effectively stifle innovation and the development of adaptive co-management regimes at larger scales and across land tenure categories. It is suggested that releasing the innovative capacities of farmers, resource managers, and communities may go a long way towards solving the food and environmental security problems of the SEL.

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Chapter 6

Tuberculosis – What Makes it a Significant Player at the Wildlife/Livestock/Human Interface?[1]

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Introduction

Tuberculosis is caused by members of the *Mycobacterium tuberculosis* complex, which consists of *M. tuberculosis, M. bovis*, *M. microti, M. africanum,* and *M. canettii* (Brosch *et al*. 2002). Human tuberculosis is most frequently associated with *M. tuberculosis,* while *M. bovis* can cause disease in a very wide spectrum of domestic and wild animals. In recent years it has become evident that the role of wildlife in the epidemiology of bovine tuberculosis (BTB) has been greatly underestimated, both in developing countries as well as in the developed world.

Once introduced into the wildlife/livestock interface, BTB cannot be eradicated by traditional control programmes and, due to lack of an effective vaccine at present, it is almost impossible for affected countries to prevent further spread of this chronic disease. Compared with the effects in developed countries, where economic losses in the livestock production sector represent the most serious effect of *M. bovis* infection, the range of implications can be much broader in the wildlife/livestock/human interface of developing countries. In the two largest protected areas in South Africa, the Kruger National Park (KNP) and the Hluhluwe-Umfolozi Park (HUP), BTB is now endemic.

The impact of BTB in wildlife is far-reaching, including effects on endangered species. In addition, BTB in wildlife poses a potential health threat to people and livestock in communities along the border of infected ecosystems. This paper examines the consequences and implications of tuberculosis infection at the wildlife/livestock/human interface in terms of human health, threats to livestock, and disease risks for wildlife.

History of tuberculosis in domestic and wild animals in South Africa

It is assumed that *M. bovis* infection was introduced to South Africa by infected cattle through European settlers but possibly also through cattle imports from Madagascar, Australia, Argentina, and other countries. During the past two centuries, the disease spread slowly within the national cattle population with intraherd prevalence rates ranging from 0.4% to 75% (Huchzermeyer *et al*. 1994). In 1929, the first cases of BTB caused by *M. bovis* were reported in wildlife, namely, in common duiker and greater kudu hunted on farmland in the Eastern Cape (Paine and Martinaglia 1929). Free-ranging wildlife in conserved habitats was first found to be infected in the HUP in 1986 and in the KNP in 1990 (Cooper 1998, Bengis *et al*. 1995). In both ecosystems, the disease had spilled over from domestic cattle during the second half of the 20th century (de Vos *et al*. 2001) and established itself in African buffalo *(Syncerus caffer)* from which it spread to other species including chacma baboon (*Papio ursinus*), warthog (*Phacochoerus aethiopicus*), honey badger (*Mellivora capensis*), and a range of other predator and antelope species (Michel 2002a). In 1997, despite their negative BTB status upon introduction the previous year, buffalo in the Spioenkop Nature Reserve, Kwazulu/Natal Province were diagnosed with *M. bovis* infection. Subsequent monitoring of game species for *M. bovis* infection led to the identification of infected greater kudu in 2000 (Cooper, unpublished data). Tuberculosis caused by *M. tuberculosis* was isolated from free-living suricates (*Suricata suricatta*) in the Northern Cape Province of South Africa and from banded mongooses (*Mungos mungo*) in the Chobe National Park in Botswana during 1999 (Alexander *et al*. 2002).

The wildlife/livestock/human interface

Throughout the world, domestic cattle are the most common maintenance host for *M. bovis* infection (BTB) from which transmission can occur to wildlife, people, or companion animals. However, wildlife act as major maintenance hosts in many parts of the world, such as New Zealand, where opossums are reservoirs (Julian 1981), and the United Kingdom, where badgers are thought to maintain infection (Cheeseman *et al*. 1989). In Africa, buffalo populations have been proved to act as reservoirs of infection and as a source of infection for other species, including domestic cattle, through either dissemination of bacilli in the environment or predation (Keet *et al*. 1996).

Several other mammals may play an important role in transmission at the wildlife/livestock interface, particularly

[1]See abstract on p.xxii.

those species that can easily cross fences. Warthogs and greater kudu are a particular concern, given that *M. bovis* infection has been repeatedly diagnosed in these species in South Africa (unpublished data). Greater kudu also have the potential to act as reservoir hosts (Keet *et al*. 2001); buffalo free of BTB became infected with *M. bovis* when introduced to a habitat in which greater kudu were subsequently found to be infected (Cooper, unpublished data). These findings suggest that greater kudu can maintain a tuberculosis epidemic in the absence of buffalo or cattle.

Mycobacterium bovis can be transmitted to people (zoonotic tuberculosis) by one of two major routes – either through aerosol transmission during close contact with infected cattle or by the alimentary route, mainly through consumption of unpasteurised milk. Although zoonotic tuberculosis has become uncommon in developed countries, it represented one of the largest public health problems during the first half of the 20th century. Before an eradication scheme was implemented in Germany, 90% of the cattle herds there were infected (Meissner and Schroeder 1974). Regional variations in incidence rates demonstrated that the frequency of zoonotic tuberculosis depended on the incidence of BTB in cattle (Goerttler and Weber 1954). In persons younger than 30, 2.5%–31.8% of tuberculosis cases were caused by *M. bovis,* and the frequency of zoonotic tuberculosis was eight times higher among children in rural areas than among town children. The percentage of pulmonary tuberculosis due to *M. bovis* was highest among persons who milked or tended cattle and reached 29.3% in the region with the highest BTB incidence in cattle (Braun and Lebek 1958, Schmiedel 1968).

The breakthrough in the eradication of BTB was achieved through mandated tuberculin testing and compulsory pasteurisation of milk. The rapid success in combating cattle tuberculosis was, however, not immediately paralleled by a decline in zoonotic tuberculosis cases, especially in adults. Possible explanations include long periods of latency in adult *M. bovis* infection and reactivation of previous foci of infection acquired before compulsory pasteurisation (Meissner and Schroeder 1974, Cotter *et al*. 1996).

In contrast, in the developing world, the BTB status of cattle populations is often undetermined, and limited control measures are applied. In South Africa, commercial dairy herds are tested regularly and producers are required to pasteurise any bulk milk before its sale. Due to a lack of resources and logistic problems, however, only limited testing of beef herds and communal cattle herds is currently performed, and meat inspection at abattoirs is used to identify and control individual outbreaks of BTB on commercial farms (van Vollenhoven, personal communication). In contrast, animals and animal products used in communal areas are largely excluded from veterinary public health monitoring and control measures. As a result, of the 1.7 million inhabitants of the magisterial districts adjacent to the KNP and HUP, an estimated 165,000 people live in close contact with livestock and on a daily basis consume livestock products ranging from unpasteurised milk to meat and offal (Michel 2002b).

The chronic nature of BTB in cattle permits spread of the disease long before its presence is even suspected. As a direct consequence, people exposed to either the infected animal or infected products are at risk of contracting zoonotic tuberculosis. This risk increases significantly with the presence of progressive immunodeficiency due to human immunodeficiency virus (HIV) infection (Raviglione *et al*. 1995). In addition to the adverse effect of HIV on TB resistance, an adverse effect of TB on HIV resistance is suggested by studies that show that the host immune response to *M. tuberculosis* enhances HIV replication and might accelerate the natural progression of HIV infection (Maher *et al*. 2002).

While generally about 10% of people who become infected with *M. tuberculosis* develop clinical tuberculosis, it was estimated in 2001 that at least 1.6 million of the 5 million HIV-positive South Africans will develop tuberculosis and that increased vulnerability leading to at least 31%–50% of new tuberculosis cases every year is attributable to HIV infection (Hausler 2001, Corbett *et al*. 2003, Maartens 2001). In Hlabisa Hospital, situated in rural Kwazulu/Natal in a district neighboring the HUP, the number of African HIV-positive patients with tuberculosis increased from 6 in 1989, to 451 in 1993 (Walker *et al*. 2003). It is possible that some of these cases were caused by *M. bovis*; examination of acid-fast bacilli in sputum smears, which forms the cornerstone of tuberculosis diagnosis in Africa, does not permit differentiation between *M. tuberculosis* and *M. bovis*.

Another potential, although less important, route by which people can contract zoonotic tuberculosis is the consumption of wildlife meat (legally and illegally hunted), some of which escapes veterinary inspection. While commercial game-meat production in South Africa is controlled by the legislation on "Slaughter, production and export of game meat," the informal small-scale sale of game meat is difficult to control. During extensive droughts, food shortages, and political instabilities, poaching activities increase sharply in game reserves and can result in infected meat entering the human food chain (Humbabush Foundation 2002).

People are not only victims of tuberculosis but also potential sources of infection at the wildlife/human interface. As recently shown, people can serve as a source of *M. tuberculosis* to free-living wildlife (Alexander *et al*. 2002). It raises the question whether human intervention, including ecotourism despite its undisputed economic and conservation benefits, may negatively affect susceptible wildlife populations through the introduction of infectious diseases.

Conclusions

Although the contribution of zoonotic tuberculosis to the human tuberculosis epidemic is currently unknown, the interaction between HIV and tuberculosis raises major concerns about the potential impact of *M. bovis* infection in people. On the one hand, tuberculosis is the commonest cause of HIV-related death in many HIV-affected settings and, on the other hand, HIV infection is driving the tuberculosis epidemic in sub-Saharan Africa. With insufficient or no control measures

in place to detect and eradicate BTB in wildlife, a large, highly susceptible human population is at risk of continual exposure to *M. bovis* by several potential transmission routes. Infection rates as high as those reported from Europe both before and soon after World War II should be considered a possible consequence of widespread *M. bovis* infection at the wildlife/livestock/human interface.

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Chapter 7

Experiences with and the Challenges of Wildlife Health Management in the National Parks of Tanzania[1]

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Introduction

Tanzania occupies approximately 945,200km^2 of the eastern African region. Its protected area network covers about 28% of the total land area. Of this, 12 national parks (NPs) represent 4%, the Ngorongoro Conservation Area represents 1%, 15% comprises 31 game reserves (GRs), and 8% comprises 38 game-controlled areas. This means at least 19% of the land (NPs and GRs) is managed primarily for wildlife protection where no human settlement is allowed, and 9% of the land is intended to enable wildlife to coexist with people. Forestry reserves also add substantially to the areas for wildlife protection.

Conflicts between people and wildlife have increased around protected areas because of increasing human populations and their activities, including settlements, agriculture, livestock husbandry, deforestation, charcoal burning, tourism, and research. These conflicts include blockage of migratory and dispersal areas, loss of habitat for wildlife, raiding of crops and attacks on livestock by wildlife, competition for resources such as watering points and grazing areas, illegal/unsustainable harvesting (poaching), and disease transmission. Tanzania has not been spared from these trends. Disease transmission from livestock to wildlife has become a more serious problem due to increasingly constrained ecosystems, which can result in stressed and immunocompromised wildlife. Emerging diseases have already affected large tracts of protected areas with little regard for international boundaries.

For the last seven years, Tanzania National Parks (TANAPA) has been developing a wildlife veterinary unit to address these numerous and emerging wildlife health challenges in the country. However, the ability of the unit to address these disease issues is low because of the expanse of the area; the diversity of species; the small number of veterinary staff; inadequate skills, funding, and equipment; and low awareness among decisionmakers of the impact of disease on wildlife systems. This paper highlights the key wildlife health challenges encountered in and around TANAPA over the last seven years.

Human/wildlife conflict

Conflicts between people and wildlife, often related to competition for land, are increasing because of the growing human populations around NPs such that major migratory routes and dispersal areas are being constrained. One major migratory route is Selela in northern Tanzania. This route connects Tarangire and Lake Manyara NPs with the Lake Natron open areas, which are essential for breeding and wet-season dispersal of wildebeest and zebra. The route's blockage has resulted in the loss of some species in Lake Manyara NP, including the gerenuk, Thomson's and Grant's gazelles, and eland. Another critical corridor, which is important for elephants in terms of their seasonal needs, connects Lake Manyara NP with the Ngorongoro Highlands. Arusha NP is now an island after being disconnected from Amboseli and Kilimanjaro NPs, and this has been detrimental to the health and existence of some wild animal species, including lions, eland, and buffalo.

Major activities conducted by people encroaching on protected areas are agriculture and charcoal burning. Chemicals applied to the crops and livestock are finding their way into park waters and are affecting wildlife. A notable example of the hazard of chemical contamination is the die-off of flamingos in the Embakaai Crater in the Ngorongoro Conservation Area due to endosulfan, an organophosphate (NCAA 2002).

Competition for grazing areas and watering points, especially during the dry season, is becoming critical in the western Serengeti, where wildlife is now denied access to Lake Victoria. However, livestock keepers have been forced to avoid some areas for fear of diseases from wild animals.

Attacks by dangerous animals on people and livestock, as well as wildlife raiding of crops, are also problems. Unfortunately, there is no compensation policy for affected individuals. Outreach programs organized by wildlife authorities are intended to smooth such conflicts and to share some of the benefits from tourism activities. Until the economic status of the local communities is improved, poverty levels will continue to fuel conflict between wildlife and people.

[1]See abstract on p.xxiii.

Loss of species

Although loss of species is a worldwide phenomenon, the situation in some Tanzanian parks is alarming. The national black rhino herd is estimated not to exceed 100 animals. Other species such as wild dogs disappeared in even some of the larger ecosystems, such as Serengeti, although recent reports of recolonising wild-dog packs are encouraging. Over the past 20 years, Lake Manyara NP has experienced the loss of several species: black rhino, gerenuk, eland, Thomson's gazelle, Grant's gazelle, and wild dogs (Marietha Kibasa, personal communication).

Transmissible diseases

Since the establishment of the TANAPA veterinary unit, disease outbreaks in wildlife populations in various parks have caused major threats to wildlife, livestock, and people. Diseases of unknown etiology and epidemiology have posed big challenges to the already constrained wildlife veterinary unit. Even other established veterinary institutions are poorly equipped in terms of diagnostic equipment, operational funds, and skills to investigate wildlife diseases.

Sexually transmitted disease in baboons in Lake Manyara and Gombe NPs

The causative agent of this disease is still unknown, but seems to be associated with humid or damp conditions, because these diseases are not seen in the troops living away from abundant water sources or wet grounds. Proper diagnosis and a management plan for disease mitigation are needed, and the long-term dynamics need to be better understood. Currently there are limited veterinary resources available to address the problem, which is manifested by grossly visible lesions of the genitalia.

Ear disease in giraffes in Mikumi NP and Selous GR

The disease was first observed in 1999 in two giraffes but now has spread to affect giraffes throughout Mikumi NP and is spreading further south into Selous GR, the largest wildlife area in Africa. In the most severely affected areas, the prevalence of the disease is estimated at 80% of the total population, with about 10% of cases observed with the severe form of this still idiopathic, suppurative, necrotizing otitis externa that seems to progress to a fatal cellulitis. This indeed is a challenge to both veterinary and other conservation professionals. A workshop organized in Mikumi NP in September 2002 to discuss the problem resulted in a research agenda. This document (TANAPA 2003) identifies a number of prioritized research topics related to the problem. Researchers and funds are invited to assist.

Giraffe skin disease in Ruaha NP

This skin disease affects only giraffe and is characterized by hair loss, followed by raising of the affected area, and later wrinkling, cracking, and encrustation. The lesions typically localize on the flexor side of the carpal joints and occasionally on the medial side of the scapula area. The disease was first seen in one area of the Park in 2000 and is now spreading to other areas of the Park. Preliminary investigation showed involvement of *Dermatophilus* species, but this could not be confirmed. The mode of spread and epidemiology need to be studied.

Unexplained deaths of sitatunga and bushbuck in Rubondo Islands NP

This problem has been recurring seasonally. Formerly, deaths were seen during the dry months, between September and October, but recently deaths have also been seen during the wettest months, between February and April. Infectious diseases such as anthrax have been ruled out. Some animals die in good body condition. Skin lesions and liver cirrhosis have been identified as pathologic changes in most cases. A long-term study is needed to establish the cause, epidemiology, and impact on the population dynamics of ungulates on this predator-free island.

Chimpanzee health problems in Gombe NP

Tanzania hosts the largest population of wild chimpanzee in the world in its Mahale Mountains, Rubondo Islands, and Gombe NPs. Jane Goodall is the lead scientist in Gombe NP, where the chimp population has been studied the longest. Survival of this population, however, is now highly threatened partly due to recurring disease outbreaks. Various diseases have been reported (Table 1) and measures instituted to control the situation, including stringent regulations for tourists. Despite those efforts, the diseases are still occurring.

Table 1. Chimpanzee deaths caused by diseases in Gombe NP (total chimp population is currently 97).

Period	Number of outbreaks	Number of deaths	Health problems documented
1960–1970	3	12	1 polio, 2 pneumonia related; remainder unknown
1971–1980	4	3	pneumonia related
1981–1990	1	10 or 11	pneumonia related
1991–2002	4	16	1 scabies, 4 pneumonia related; remainder unknown

Source: Anne Pusey

A systematic plan to monitor and manage the health of these chimpanzees is critical for their long-term survival.

Salmonellosis in elephants in Tarangire NP

This outbreak occurred in 1997 after an extensive drought that forced elephants to scavenge in staff and hotel garbage pits, which are presumed to be a possible source of infection. The disease problem has resolved since the implementation of proper waste management in the park.

Rabies and canine distemper in and around Serengeti NP

These diseases occur in most parts of the country and have had disastrous effects in Serengeti wildlife, domestic animals, and people (in the case of rabies). Surveillance of the diseases in the park and neighbouring communities and annual immunisation of more than 35,000 domestic dogs, although effective in reducing disease incidence around the park, are both labour intensive and financially demanding.

Rinderpest

Rinderpest was last reported in Tanzania in 1997 when it was diagnosed in cattle in some villages bordering Ngorongoro Crater and Lake Manyara NP. The Ministry of Agriculture, with financial and technical support from African Union/ Interafrican Bureau for Animal Resources (AU/IBAR) launched a major campaign to stop the threat. TANAPA supported this major campaign by funding vaccination of cattle in five districts surrounding the Serengeti, Tarangire, and Lake Manyara NPs, and in the Ngorongoro Conservation Area. The campaign aimed at protecting the huge, susceptible ungulate populations in these famous protected areas. The country has now stopped vaccination and no longer follows the Office International des Épizooties pathway but conducts wildlife surveillance for the disease.

Foot and mouth disease

Foot and mouth disease (FMD) is endemic in most sub-Saharan countries and is an obstacle to international trade. The last outbreak was reported in wildebeest in the Serengeti in 1997. FMD is suspected to have originated from domestic stock around the park, where cases had previously been reported. The multiplicity of strains makes control elusive, especially where movement control of livestock is also a challenge. A component of the African Union/Pan African Control of Epizootics (AU/PACE) programme addresses this issue, but the role of wildlife must be closely examined. FMD greatly affects the livestock industry and the well-being of the local community. Control of FMD will have a great impact on poverty levels in the indigenous economy. A transboundary approach may have to be considered.

Sleeping sickness in and around northern NPs

Some foci of sleeping sickness have long been known in some northern Tanzania NPs, but government efforts since colonial times have kept the disease under control. Between 2000 and 2001, probably due to ecological changes wrought by rains induced by El Niño, there was an upsurge of the disease in the northern zone. The government promptly instituted control methods, including establishment of de-flying centres at NP entry gates and deployment of insecticide-impregnated targets in intensively visited park sites. Park authorities have learned of no new cases since 2002. Wild animals are known to harbour sleeping sickness parasites, which are of major public health significance. In Tanzania, about 4 million people are considered at high risk, but control of the disease in extensive protected areas is very costly.

Low capacity

Only four Tanzanian veterinarians and three technicians currently work permanently in the Tanzanian wildlife sector. With about 250,000km^2 protected for wildlife, this is clearly grossly inadequate. A single small field laboratory is the only diagnostic facility able to perform blood smear and fecal examination in addition to processing and storing samples. Therefore, most of the specimens collected must be sent to other specialised institutions, often outside the country. This is both costly and inefficient. In general, the wildlife veterinary profession in Tanzania is limited not only by the number of professionals, but also by lack of training, low funding, and scant equipment. The lack of a local laboratory specialising in wildlife diseases further contributes to the difficulty of addressing wildlife health problems in Tanzania.

TANAPA intends to expand veterinary services to other parks by developing veterinary units on a zonal basis, each covering three to four NPs. Unfortunately, due to limited funding and inadequate staff, this goal has been difficult to achieve. It is proposed that each unit should have at least one experienced veterinarian and at least two technicians and/or additional volunteer veterinarians to meet the needs of each zone. Each unit would require proper transportation, such as a 4-wheel-drive vehicle, and laboratory facilities including microscopes, incubators, an autoclave, freezers, reagents, pipettes, and other equipment to perform basic diagnostics for wildlife diseases.

Because many of the emerging diseases around the world affect large ecosystems and cross country boundaries, including those of Tanzania, there is a need to strengthen local capacity to detect and identify disease threats, to launch efficient reporting mechanisms, and to develop concerted efforts to manage and mitigate their effects. There is also a need to work with neighbouring countries on these problems.

Conclusions

In view of the large size of Tanzania and the abundance and diversity of its wildlife species, there is invariably a wide range of issues and problems related to wildlife. One of these, wildlife health management, is enormous. Disease transmission has important implications not only for wildlife management, but also for public health, livestock development, and rural livelihoods. The apparently sexually transmitted baboon disease, seasonal deaths of sitatunga and bushbuck, and the giraffe ear and skin diseases are issues that have not been properly investigated and deserve to be priorities for resources. Unfortunately, the present resources and infrastructure are insufficient to effectively address these challenges.

The lack of ability to manage these disease problems may also increase the risk to neighbouring countries. Small teams lacking equipment, skills, and funds cannot cope with such a range of wildlife health issues. Concerted material, moral, and political support are therefore urgently needed from all partners to establish a stronger wildlife health programme in Tanzania. The wildlife we cherish today is our foremost natural heritage and threats to its survival are of grave concern to many people. It is important that decisions are made and effective policies developed to address the situation for the benefit of the region and the world at large.

Acknowledgements

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Chapter 8

Control Options for Human Sleeping Sickness in Relation to the Animal Reservoir of Disease[1]

S.C. Welburn[2], K. Picozzi[2], M. Kaare[3], E.M. Fèvre[2], P.G. Coleman[4] and T. Mlengeya[5]

Sleeping Sickness Epidemics

The Lake Shores region of East Africa has suffered from horrendous epidemics of human sleeping sickness throughout the past century. Human sleeping sickness remains endemic in several foci in eastern and northwestern Uganda, Tanzania, and elsewhere (Fig. 1). The disease exists in two forms and is caused by infection with either *Trypanosoma brucei rhodesiense* (acute sleeping sickness) or *T.b. gambiense* (chronic sleeping sickness). *T.b. rhodesiense* and *T.b. gambiense* coexist with a morphologically identical animal parasite *T.b. brucei* in geographically distinct foci across East Africa, *T.b. rhodesiense* to the east of the Rift Valley and *T.b. gambiense* to the west (Welburn, Fèvre *et al*. 2001). Although they are morphologically indistinguishable, transmitted by the same tsetse vector (genus *Glossina*), and share a wide range of vertebrate host species, the subspecies differ in one important aspect: their ability to infect people. *T.b. brucei* is sensitive to human serum and so confined to nonhuman hosts, while *T.b. rhodesiense* is resistant to human serum and infections in people cause sleeping sickness which, if untreated, leads to death. While viability of parasites in human serum forms the basis of differentiating the two subspecies, *T.b. brucei* and *T.b. rhodesiense* are essentially similar in all other respects (Ashcroft *et al*. 1959). Neither *T.b. rhodesiense* nor *T.b. brucei* causes clinical disease in cattle or other nonhuman hosts (Wilde and French 1945).

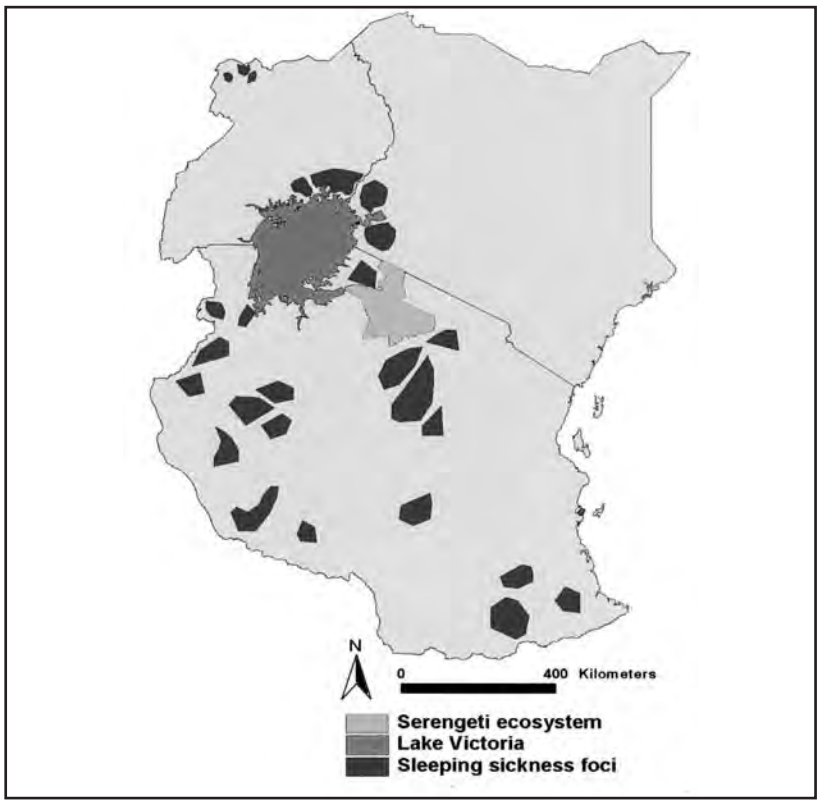

Fig. 1. Estimated locations of sleeping sickness foci in Kenya, Uganda, and Tanzania. Foci data reproduced with permission of the World Health Organization.

[1]See abstract on p.xxiii.

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A series of devastating sleeping sickness epidemics occurred in East Africa at the turn of the last century. The earliest reports of the disease in East Africa were when it was observed in Busoga, Uganda, in 1898. By 1908, a third of the population of the shore of Lake Victoria was dead, with the remainder evacuated in 1909. The vector of sleeping sickness in Busoga at this time was believed to be *Glossina palpalis,* and the disease believed to be caused by *T.b. gambiense*. However, close examination of the sleeping sickness reports (Köerner *et al*. 1995) and a retrospective study of patient records from southeast Uganda at this time (Fèvre *et al*. 2004) suggest that acute *T.b. rhodesiense* sleeping sickness was also present in the region.

In 1922, sleeping sickness was identified in Maswa District, Tanzania, and by 1946, 23,955 cases had been identified. Although cattle herds were inspected, especially animals that appeared sick, blood examination found not a single case and so efforts focused on the role of wildlife in maintaining disease (Davey 1924). In Ikoma, on the outskirts of what is now the Serengeti National Park, 2,119 cases were reported between 1925 and 1946; it was suggested that *T.b. rhodesiense* in people probably represented spillover infections from animal reservoirs (Fairbairn 1948).

In the 1940s, a second epidemic of sleeping sickness began in southeast Uganda, with 2,432 cases and 274 deaths confirmed in 1942. However, a new tsetse vector, *G. pallidipes,* was believed to be responsible for transmitting the zoonotic infection from game animals (MacKichan 1944).

Transmission from Game Animals

In 1947, Vanderplank (1947) fed tsetse flies on captive "wild" animals, including bush pigs and warthogs and showed that the level of transmission of *T.b. rhodesiense* by infected tsetse was very low and could be identified only through inoculation into rats. This was addressed by Jackson (1955), who rationalised that the life span of the fly was insufficient to maintain infections in areas of land cleared of human population. Therefore, because the disease did not disappear in the absence of man, it must be maintained by the abundance of game acting as a reservoir. Jackson suggested that "once disease has been introduced into an area, the game become infected with *T.b. rhodesiense* and they then act as reservoirs for maintaining the disease endemically."

Proof that game did harbor human-infective parasites and that those parasites were infectious to man was confirmed by the inoculation of human volunteers, which suggested that game was the primary reservoir of *T.b. rhodesiense* (Heisch *et al*. 1958). Studies on the feeding preferences of tsetse (Weitz 1963) supported this premise (Figs. 2a and 2b). The potential importance of domestic animals as a reservoir for *T.b. rhodesiense* was confirmed in the 1960s (Onyango *et al*. 1966), again using human volunteers.

A third epidemic in southeast Uganda began in the 1970s, peaked in 1980 with 9,000 cases, and fell to 7,000 cases in 1987. The vector was *Glossina fuscipes fuscipes,* and by this time cattle were found to be the major source of human-infective parasites. Very little wildlife remains in agricultural areas of Uganda, evidenced by the lack of tsetse blood meals taken on wildlife hosts (Fig. 2c). Today, the major focus of *T.b. rhodesiense* sleeping sickness in Uganda is in southeastern Uganda, where *G.f. fuscipes* is the vector and cattle are the main animal reservoir (Welburn, Fèvre *et al*. 2001). Human sleeping sickness is endemic in 12 districts, and a recent extension in the geographic range has been linked to the movement of infected cattle (Fèvre *et al*. 2001). *T.b. gambiense* sleeping sickness remains active in the West Nile region in the northwest.

In Tanzania, sleeping sickness remains among the most serious threats to human health in those areas where it is transmitted. There are eight endemic foci of sleeping sickness in Tanzania and, although many have remained stable for many years, persistently active foci are found in Kigoma,

Fig. 2. Blood meal analyses of tsetse in Uganda. Figs 2a and 2b refer to the 1950s (Weitz 1963), during which two vector species were present, namely *G. pallidipes* and *G.f. fuscipes*.

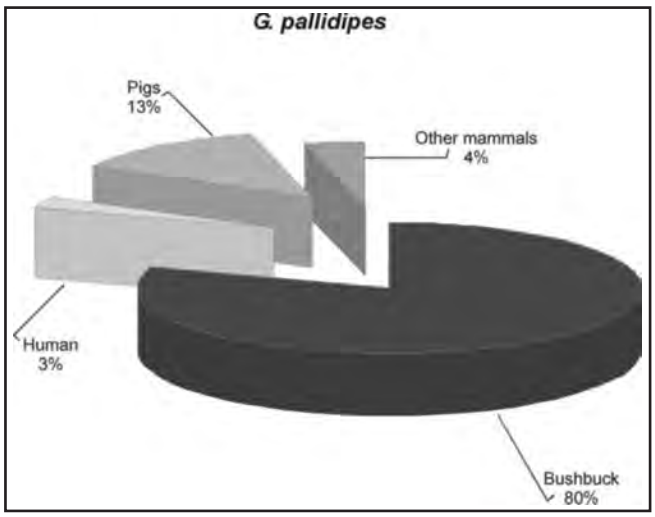


Fig. 2a.

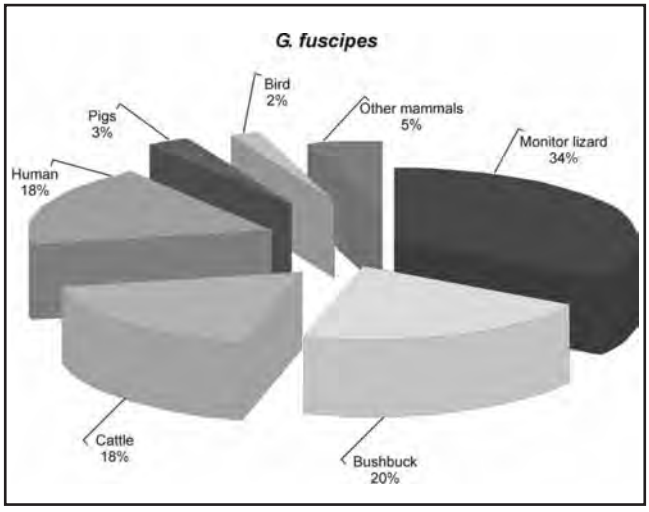
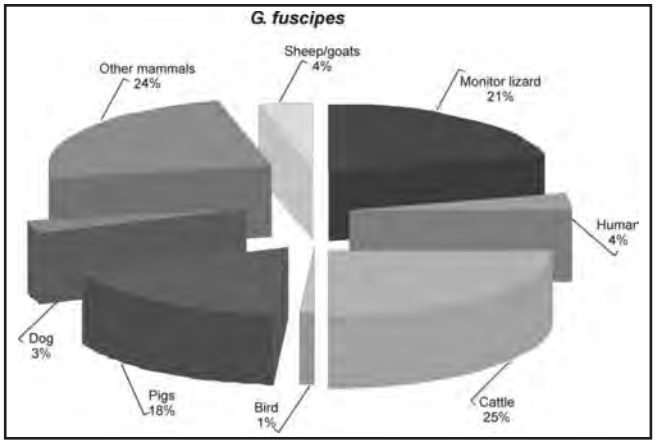


Fig. 2b.

Fig. 2c. Refers to the present (Waiswa *et al*. 2003) and shows that bushbuck have been lost as a source of bloodmeals and that domestic livestock have become a major source of feeds for tsetse. These animals are also reservoir hosts of *T.b. rhodesiense*.



Arusha, Tabora, Kasulu, and Kidindo (Mwambembe 1998). At least 500 new cases of sleeping sickness are recorded annually in Tanzania.

Characterisation of *T. brucei* resistant to human serum

T. brucei s.l. (s.l. = *sensu lato*; i.e., includes all subspecies of *T. brucei*) can be identified in the blood of wild animals and domestic livestock. However, the fact that *T.b. brucei* and *T.b. rhodesiense* are morphologically identical creates difficulties in assessing the risk posed to man from wildlife and domestic livestock when using traditional microscopy-based screening methods. *T.b. brucei* has been reported in cattle (Onyango *et al*. 1966), bushbuck, duiker (Heisch *et al*. 1958), hartebeest (Ashcroft *et al*. 1959), zebra (McCulloch 1967), wildebeest, topi, waterbuck, impala, warthogs (Baker *et al*. 1967), and lions (Sachs *et al*. 1967, Baker 1968). However, it was not known how many of these *T. brucei* s.l. were human infective. Early work in this area relied on the use of human volunteers to determine whether parasites observed in animals were infective to man. Heisch *et al*. (1958) took blood from a bushbuck and infected a rat, and subsequent inoculation to a person resulted in infection with trypanosomes in that person; similarly, Onyango *et al*. (1966) showed that some *T. brucei* s.l. isolated from infected cattle could infect people.

A novel test, the blood infectivity incubation test (BIIT), was developed in the 1970s. It tested the parasites' ability to survive challenge with human serum in a mouse model (Rickman and Robson 1970), which eliminated the need to experiment on human subjects. Geigy *et al*. (1973) validated this method on wildlife material and tested blood from Coke's hartebeest, lion, spotted hyaena, and waterbuck. They showed that blood from a *T. brucei* s.l.-infected Coke's hartebeest was infectious to human volunteers *and* was positive as human-infective using the BIIT. BIIT has since been used to show that reedbuck, waterbuck, spotted hyaena, lion (Gibson and Wellde 1985), and domestic pigs all harbour human-infective parasites (Waiswa *et al*. 2003). This technique is still in use today and can give an indication of the prevalence of human-infective parasites.

The advent of biochemical methods of parasite characterisation offered new ways to examine strains of *T. brucei* s.l. resistant to human serum. Hyaena and oribi were added to the growing list of wild animals believed, on isoenzyme analysis, to act as reservoirs of human disease along with dogs, goats (Gibson and Wellde 1985), and pigs (Enyaru *et al*. 1993) from the domestic pool. These biochemical techniques were followed by molecular methods of strain typing, and a battery of techniques is now available for examining the population structure and strain composition of *T.b. brucei* and *T.b. rhodesiense,* including analysis of restriction fragment length polymorphisms (RFLP) (Hide *et al*. 1994), analysis of variability in mobile genetic elements by PCR (MGE-PCR) (Tilley *et al*. 2003), and minisatellite marker analysis (MacLeod *et al*. 2000). These studies have all confirmed that the domestic reservoir of *T.b. rhodesiense* in southeast Uganda lies principally with cattle and that, in other foci, where there are still significant proportions of wildlife hosts, interactions between the wildlife and domestic animals in the tsetse habitat determine the degree of importance of different hosts.

Up to now, none of the methods described above has enabled us to accurately determine the prevalence of *T.b. rhodesiense* in domestic livestock, wild animals, or tsetse, because all of the methods require significant quantities of parasite material. This means that the parasite material from the host animal must first be amplified in mice prior to application of the technique. However, not all *T. brucei* s.l. observed in the field amplify in mice; up to 50% of *T. brucei* s.l. from cattle in southeast Uganda are lost during mouse passage (Welburn unpublished data). Therefore, measurements of the prevalence of *T.b. brucei* and *T.b. rhodesiense* in livestock using BIIT, RFLP, MGE-PCR, and minisatellite analysis are underestimates.

Recently, a major breakthrough led to a solution to this problem: the discovery that a single gene can be used as a marker to differentiate *T.b. brucei* from *T.b. rhodesiense*. The *SRA* (serum-resistance-associated) gene (Xong *et al*. 1998) has been used to confirm the human-infective status of parasites in cattle in southeast Uganda (Welburn, Picozzi *et al*. 2001). In that study, 46% of the local Zebu cattle were infected with *T. brucei* s.l., and up to 18% of the cattle in Soroti district were infected with *T.b. rhodesiense*. It is likely that, in the absence of tsetse control measures, the majority of the local cattle in this region are infected with *T. brucei* s.l. and that the true infection rate in these animals can be determined only by longitudinal screening; PCR-based screening indicates that infection rates are far higher than previously thought. Because the *SRA* gene is present in all *T.b. rhodesiense* isolates, and is essentially conserved across East Africa (Gibson *et al*. 2002), we are now in a position to

Fig. 3. Measuring the risk of different hosts acting as reservoirs for human sleeping sickness parasites. *p*1 = Probability of tsetse feeding on cattle, warthogs, or people; *Inf* = *T.b. rhodesiense* infection rate in cattle, warthogs, or people; *p*2 = probability of a tsetse picking up a *T.b. rhodesiense* infection from cattle, warthogs, or people. Values in the graphics are shown as proportions rather than percentages. See text for references.

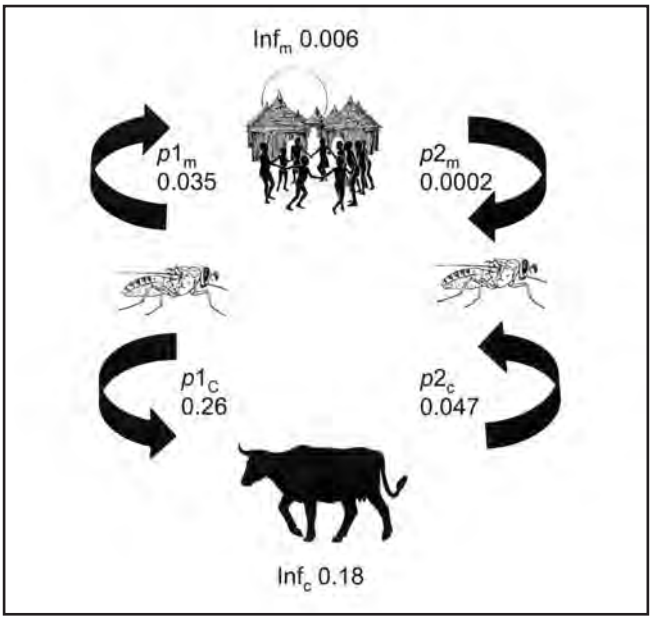


Fig. 3a. *SRA* screening of domestic cattle in southern Uganda has shown that 18% of cattle are carrying human-infective *T.b. rhodesiense* (Inf$_c$), while the infection rate in people is 0.6% (Inf$_m$). Tsetse bloodmeal analysis shows that 26% of tsetse bloodmeals are taken on cattle ($p1_c$), while only 3.5% are taken on human hosts ($p1_m$). Thus, the probability of a tsetse picking up *T.b. rhodesiense* from cattle is 4.7% ($p2_c$) and from people 0.02% ($p2_m$). Cattle are 223 times more likely to be a source of infection for tsetse than people are.

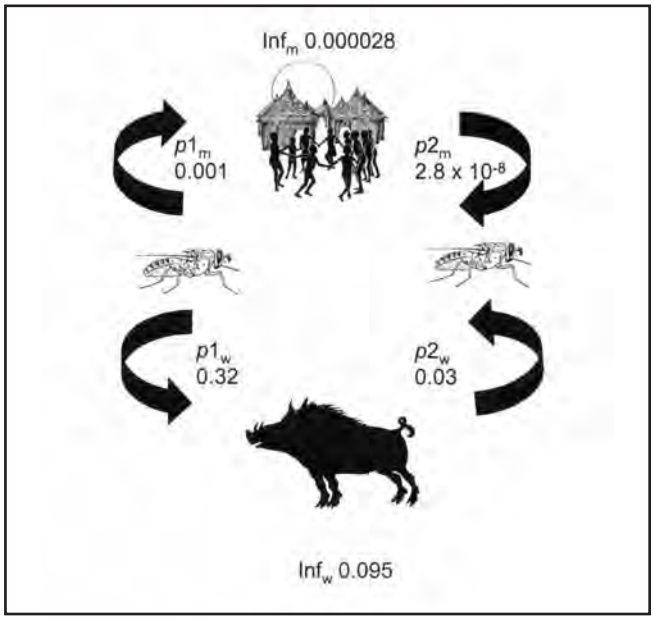


Fig. 3b. *SRA* screening of wildlife samples in the Serengeti shows that 9.5% of warthogs are carrying human-infective *T.b. rhodesiense* (Inf$_w$), while the infection rate in people is 0.0028% (Inf$_m$). Tsetse bloodmeal analyses show that 32% of tsetse bloodmeals in the Serengeti are taken from warthogs ($p1_w$), and 0.1% are taken from people ($p1_m$). Thus, tsetse have a 3% probability of becoming infected from warthogs ($p2_w$) and a 0.0000028% probability of becoming infected from people ($p2_m$). Warthogs are 1.07 million times more likely to be the source of a human-infective parasite to the fly than a person is.

accurately assess the risk posed by wildlife and domestic animals to man in this region. Blood-spot samples can be collected in the field onto filter cards that fix the DNA in situ, and these cards can be processed for *T. brucei* s.l. and *SRA* screening without needing amplification in laboratory animals (Welburn, Picozzi *et al*. 2001; Picozzi *et al*. 2002). For the first time, we are able to accurately assess the relative risks posed to man from wildlife and domestic livestock in East Africa and to design control strategies accordingly.

Case study – southeast Uganda

With the advent of molecular tools for epidemiology, modern control strategies can be designed to determine the source of infection as wildlife, domestic livestock, or both. Thus, the limited resources for disease control can be effectively apportioned.

Southeast Uganda has experienced epidemics of sleeping sickness on three occasions during the last century: the great epidemic of 1901–1920 and further epidemics in the 1950s and 1970s. For the first epidemic, when knowledge of the epidemiology of the disease was poor, the colonial solution was to remove the entire human population from the affected area. For subsequent epidemics, the first line of response has been to implement tsetse control – but is this really necessary and does it offer a sustainable solution?

Despite huge resource allocation to control tsetse flies, they still persist across southeast Uganda and sleeping sickness remains endemic. There are, however, some striking differences in the tsetse ecology of southeast Uganda today compared with that during the 1950s epidemic. In 1950, there were two main vector species: *G. pallidipes* and *G.f. fuscipes*; today, there are almost no *G. pallidipes* present and the predominant vector species is *G.f. fuscipes*. Moreover, the host-feeding preference of these flies was very different in 1950 than it is today (Figs. 2a–c). Bloodmeals from *G.f. fuscipes* now show that the flies feed on reptiles and cattle with almost no feeding on wild game in this once game-rich region. Infection rates in *G.f. fuscipes* remain low, 1:300 *T. brucei* s.l. and less than 1:1,000 *T.b. rhodesiense* (Hide *et al*. 1996), while *T. brucei* s.l. infection rates in cattle (Welburn, Picozzi *et al*. 2001) and pigs (Waiswa *et al*. 2003) are very high (*T. brucei* s.l. infection rates in 200 cattle screened for *T. brucei* was 44%). For the implications of these results on disease transmission, see Fig. 3a.

Such detailed information can be used to design control activities. In a region where such a high proportion of cattle

are infected with *T. brucei* s.l. and the vector shows low infection rates, it would be appropriate to target limited resources at removing the domestic reservoir of disease (i.e., treating cattle) and to use insecticides (livestock "pour-ons" or restricted environmental applications) to control transmission. The data show that reliance on treating human cases, while essential, will not greatly affect the transmission of the sleeping sickness, whereas interventions aimed at controlling the parasite in cattle will have profound public health implications in terms of preventing outbreaks of sleeping sickness (Welburn, Fèvre *et al*. 2001).

Case study – Musoma, Serengeti, Tanzania

Musoma district, Tanzania, had been free of human sleeping sickness since 1954, when the last three cases were reported. Disappearance of sleeping sickness was associated with the closing of the gold mines in the district, with the resultant evacuation of the mining settlements reducing man-fly contact. The surrounding areas to the east and south of Ikoma (designated the Serengeti National Park and Maswa, Ikorogono, and Grumeti Game Reserves) were sparsely populated but contained large numbers of game animals (Fig. 1). The decade that followed saw the development of the region as a tourist attraction and an increase in the human population. In the mid to late 1960s, the region experienced a resurgence of the disease: 1965 (1), 1966 (4), 1967 (6), 1968 (14), 1969 (six cases, of which two were tourists [Onyango and Woo 1971]). It was estimated that 40,000 tourists visited the region in 1971 (Onyango and Woo 1971).

In 1971, a tsetse survey was conducted in Musoma District: 6,348 *G. swynnertoni* and 623 *G. pallidipes* were caught, but no mature *T. brucei* s.l. salivary gland infections were detected in any of these flies. Of 862 bloodmeals analysed, only two were from primates, with warthog and buffalo being the most favoured hosts for *G. swynnertoni.* Furthermore, those animals with *T. brucei* infections were not, with the single exception of the warthog, hosts favoured by the tsetse fly. Warthog, with only a 7.7% (1/13) *T. brucei* s.l. infection rate, provided 25.6% of the bloodmeals of *G. swynnertoni*. It was concluded that the warthog was five times more likely to be the source of *T. brucei* s.l. infections in *G. swynnertoni* than all the other *T. brucei* s.l.-infected host animals together, simply because of the feeding preference of the fly (Rogers and Boreham 1973). Rogers and Boreham (1973) also did not find a mature *T. brucei* s.l. infection in 3,500 *G. swynnertoni*. In 1971, 3,000 people in Ikoma-Serengeti area were screened for *T.b. rhodesiense* and no evidence was found of infection, despite the fact that, four months prior to this study, four employees of the National Park had been diagnosed with sleeping sickness (Onyango and Woo 1971).

At the same time, 115 mammals from 13 species were screened, and 12 (10%) *T. brucei* s.l. infections were found: five from lions, one from warthog, three from hartebeest, two from hyaena, and one from a waterbuck. Parasites resistant to human serum were identified in five of the 12 *T. brucei* s.l. infections (a hyaena, two lions, the waterbuck, and the hartebeest). From the absence of tsetse infected with *T. brucei*, it was concluded that the "fly" and "game" areas did not generally overlap (Geigy *et al*. 1971). A follow-up survey involving 798 head of cattle in Ikoma area showed that 28 (3.5%) were infected with *T. brucei* s.l. determined by microscopy and mouse inoculation of 260 samples; ten were tested by BIIT, of which four gave positive results. This suggested that 1.4% of cattle were harbouring *T.b. rhodesiense* (Mwambu and Mayende 1971). A survey of 95 wild game animals from four species (lion, hartebeest, waterbuck, and spotted hyaena) inoculated into rats found forty *T. brucei* s.l. infections (42%), from all except the waterbuck. Spotted hyaena and hartebeest showed the highest ratio of *T.b. rhodesiense* to *T.b. brucei* (4/13 and 1/4 respectively), while only one of 24 lion-derived *T. brucei* s.l. were human infective (Geigy *et al*. 1971). The combined results of three surveys in 1966–1967, 1970, and 1971 suggest that approximately 50% of lions, 40% of hyaena, and 17% of hartebeest carry *T. brucei* s.l. infections. In 1972, a follow-up tsetse survey in Serengeti found nine strains of *T. brucei* s.l. (all BIIT negative) isolated from 11,060 *G. swynnertoni*, an infection rate of 0.08%, or less than one mature *T. brucei* infection per 1,000 tsetse flies (Moloo and Kutuza 1974). Fig. 3b shows the implications of the wildlife infection rates on transmission of *T.b. rhodesiense* in this setting where wildlife is plentiful.

Recently, the Serengeti has again been affected by sleeping sickness; nine cases in tourists associated with Tanzanian National Parks were reported through TropNetEurope (a sentinel surveillance network of clinical sites throughout Europe) (Sinha *et al*. 1999, Moore *et al*. 2002, Ripamonti *et al*. 2002, Jelinek *et al*. 2002). In 1998, the annual incidence of trypanosomiasis in tourists was 13/450,000. The response of the National Park was to implement a tsetse-suppression programme. Although information about this project is scarce, a dramatic drop in tsetse fly populations has been reported. A recent survey of 518 cattle from 11 villages bordering the Serengeti National Park using DNA probes found 23 *T. brucei* s.l. infections, giving a *T. brucei* s.l. point prevalence of 4.4%. Of these, 6/518 (1.16%) were *SRA* positive, i.e., human-infective *T.b. rhodesiense* (Picozzi, unpublished data). These came from 4 villages. Of 232 wildlife samples that were also screened, 8 (3.4%) were positive for *T. brucei* s.l. Nine lions were sampled, one was confirmed positive for *T. brucei* s.l.; 6/21 (29%) warthogs, 1/46 (2.2%) topi, and 1/68 (1.5%) wildebeest were also positive for *T. brucei* s.l. (Kaare 2003). The *SRA* gene was found in 2/21 (9.5%) warthogs (Picozzi, unpublished data).

The livestock population in Tanzania stands at 15.64 million head of cattle, 10.68 million goats, and 3.49 million sheep (Government of Tanzania 1998); 98% of the cattle population are from the traditional sector, while a small percentage are improved breeds (the main use of which is for crossing with indigenous stock to improve productivity). The pastoralist system is the major means of livelihood in semi-arid areas using extensive rangeland resources. Stock keep-

ing is based on highly mobile grazing and watering patterns, and there is potential for extensive interaction between tsetse, domestic animals, and wildlife. Extensive grazing systems and commercial farms may encroach on national parks, forest reserves, and other previously marginal land.

Summary

It is clear that sleeping sickness parasites are successful in both domestic livestock reservoirs and wildlife reservoirs, particularly warthog. We suggest that effective management of sleeping sickness in nonwildlife areas such as southeast Uganda depends on targeted treatments of the domestic animal reservoir either through use of chemotherapeutic drugs and/or "pour-on" insecticides. Such activities would also impact on trypanosomes that are pathogenic for cattle but not human infective, which cause substantial losses to the agricultural sector (Welburn, Fèvre *et al*. 2001).

In and around the Serengeti National Park and other such extensive areas with abundant wildlife, the transmission cycle appears to involve domestic livestock in villages on the park boundary interacting with wildlife and tsetse. Wildlife and domestic transmission cycles are no longer separate in such a situation, in an era of increasing contact between the two landscape systems. In this situation, control may depend on limiting the degree of interaction between livestock and wildlife, the use of chemotherapeutic drugs in cattle, and controlling tsetse through "pour-on" insecticides on cattle. In wildlife areas, there may be a case for the use of stationary tsetse targets and traps. There is also a need for a policy of non-encroachment of pastoralists into the national parks.

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Chapter 9

Rinderpest Surveillance in Uganda National Parks 1998–2003[1]

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Introduction

Rinderpest (RP), commonly known as "cattle plague," is an extremely contagious and lethal disease of cattle and buffalo. RP undermines food security and the livelihoods of farmers and pastoralists and promotes poverty in affected countries (Silva *et al*. 1998).

RP is caused by a paramyxovirus in the genus Morbillivirus along with the viruses of canine distemper, human measles, and peste des petits ruminants (PPR) (Russell and Edington 1995). The RP and PPR viruses are serologically related but not identical (Seifert 1996).

The known strains of RP virus are antigenically related and immunity, which develops after infection, is lifelong and protects against all other strains. The virus induces a strong immunological response, with antibodies detectable 5–10 days after infection.

Rinderpest is believed to have been introduced into Uganda in the 19th century, when there were no effective vaccines for the disease. Attenuated RP vaccines were available by the mid-1960s but only in sufficient quantities for eradication programmes to be conducted in already infected countries.

Between 1962–1972, a joint project (JP-15), funded by the European Union and the United States Agency for International Development (EU/USAID), was undertaken in 22 countries of eastern and western Africa. JP-15 decreased the incidence of RP and eradicated it in some countries. However, RP reemerged in 1976 in West Africa (Rossiter *et al*. 1983). Repeated outbreaks occurred throughout the 1980s.

In Uganda, RP recurred in Kotido (1980) and later spread to Luweero (1985), Jinja (1989), Arua (1988/1989), and Moroto (1994).

The Pan African Rinderpest Campaign (PARC) was launched between 1986–2000 in 34 countries of sub-Saharan Africa to tackle this re-emergence. Uganda, being a member of the Global Rinderpest Eradication Programme (GREP) of the Food and Agriculture Organization (FAO) of the United Nations, implemented its programme between 1992–2001. PARC was replaced by the Pan African Control of Epizootics (PACE) programme in 32 African countries. The main emphasis of PACE is RP surveillance in both livestock and wildlife.

The last outbreak of RP in Uganda was in Moroto district in June 1994, and RP vaccination ceased in December 2001. Uganda remains at high risk of exposure because the last suspected foci of RP infection are believed to be in southern Sudan and the Somalia ecosystem. It is therefore important to conduct wildlife surveillance on sentinel wildlife populations as an early warning for detection of circulating RP virus. This is because the presence of vaccine-induced antibodies precludes the use of livestock in such surveillance programmes. Surveillance and disease testing in young livestock born after RP vaccination was discontinued will augment the wildlife surveillance data.

This paper describes the serosurveillance in wild animals, evidence of disease, significance of wildlife in maintenance of RP, the prediction of likely routes of RP infection into populations in Uganda, and confirmation of absence of the virus in the national parks (NPs).

Materials and methods

There are ten NPs, 14 wildlife reserves, and 18 sanctuaries (two for birds and 16 for mammals) in Uganda. Wildlife in these protected areas has been on the decline for the last two decades due to forage competition, disease, and poaching. This has been exacerbated by a lack of good security in some areas of the country.

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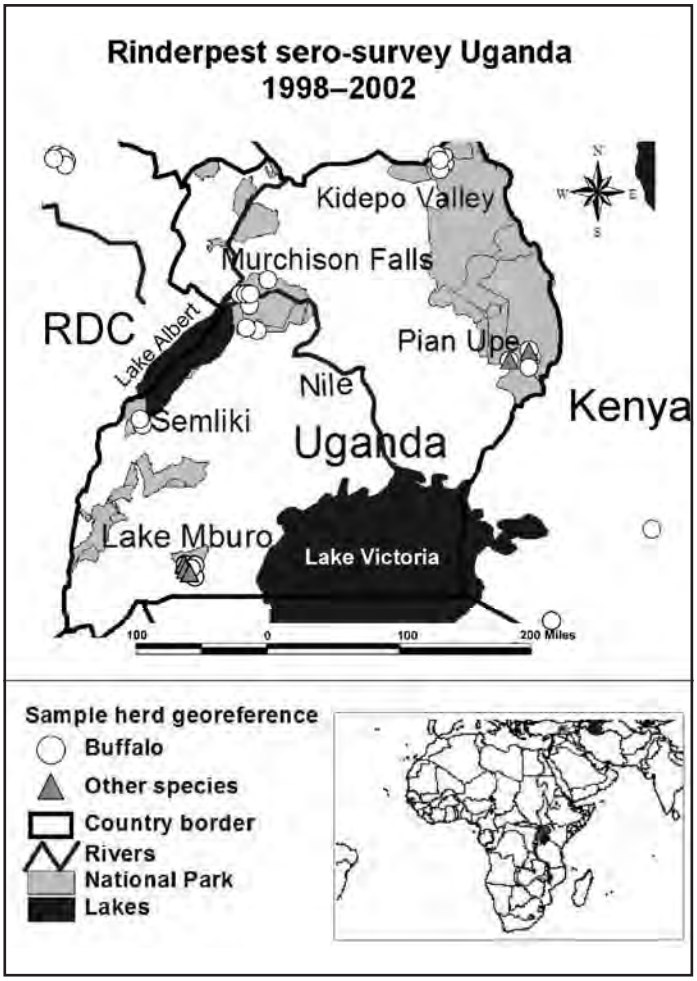
Fig. 1. Sampling sites in Uganda



Sampling sites

The locations (Fig.1) were chosen to establish the following:

- the possibility of any previous circulating RP virus in the region of Karamoja (Kidepo NP and Pian Upe Wildife Reserve)
- whether RP was a possible cause of death in bushbucks in September–October 1999 in Kibale NP
- the absence of RP virus in Murchison Falls NP where the disease had been reported in 1988
- the absence of RP virus in Semliki Wildlife Reserve because of close proximity to the Democratic Republic of Congo
- the identification of key wild animal populations for future monitoring

The choice of these locations had to be guided by the vegetation, security, and financial resources available for aerial support.

Sampling schedule

The samples were collected between 1998 and 2002 (see Table 1 for a summary of findings). In addition to the samples collected, the history of the previous disease situation, seasonal data, and other observations were made in each NP visited.

Kidepo National Park (1999 and 2002)

- Representative samples were collected from buffalo (two herds of 350 and 600 buffalo, respectively). The buffalo populations are close to the endemic foci of eastern equatoria and close to the cattle routes used by Toposa and Karimojong pastoralists.
- Different age groups (1.8–20 years) were sampled to confirm possible circulation of virus.
- Aerial darting was the method of choice.
- The last case of RP in this zone was reported in Moroto in June 1994.

Lake Mburo NP (1998 and 1999)

- Livestock (resident and migrant) and wildlife share pastures and water for most of the year (high contact risk).
- Representative samples were collected from buffalo and other ruminants (buffalo, impala, topi, and warthog).
- Different age groups were sampled.
- Ground darting was the method of choice (small area and suitable vegetation).
- Thirty impala samples, collected in 1998 by Dr. J. Okori of Makerere University, Kampala, were obtained.
- The last case of RP was reported in the 1950s.

Murchison Falls NP (2000 and 2002)

- Representative samples were collected from different species (buffalo, Uganda kob, hartebeest, oribi, and waterbuck).
- Different age groups were sampled.
- Large herds of buffalo (450+) were observed.
- Aerial and ground darting was used.
- The last case of suspected RP was reported in 1987/1988.

Kibale National Park (2000)

- Tropical forest (chimp habitat) was observed.
- Samples were taken from buffalo only but Kibale NP has bushbuck, elephant, duiker, and some cattle on its eastern side.
- Wildlife and livestock have limited contact.
- Different age groups were sampled.
- Aerial darting was used.
- The last case of RP could have been in the 1950s.

Pian Upe (2000)

- Large numbers of wildlife (buffalo, hartebeest, Grant's gazelle, waterbuck, reedbuck, kob, oribi, roan) were observed.
- A large number of livestock was observed (high contact risk).
- Representative samples were taken from buffalo, roan, and hartebeest.
- Different age groups were sampled.

Table 1. Summary of rinderpest serosurvey 1998–2002

Year	Protected Area (# animals sampled)					Test (# positive antibody results)					
	Lake Mburo	Kidepo	Murchison	Pian Upe	Semliki-Kibale	C ELISA H RPV	C ELISA N-RPV (RBOK)	C ELISA N-RPV (RGK)	C ELISA N-PPR	C ELISA H PPR	VNT
1998	Impala (30)					0	0	8	0		0
1999	Buffalo (6)					0	0	0	0		
	Topi (3)					0	0	0	0		
	Warthog (1)					0	0	0	0		
1999		Buffalo (11)				0	0		0	1	
2000			Buffalo (17)			0	0	4	0	0	4
2000				Roan (1)		0	0	0	0		0
				Kongoni (2)		0	0	0	0		0
				Buffalo (6)		0	0	0	0		0
2000					Buffalo (16)	0	0	2	0		0
2002		Buffalo (17)				0					0
2002			Buffalo (8)			0					0

- Aerial darting was the method of choice.
- The last case of RP was reported in June 1994 in the Moroto district.

Sample analysis

During the sample analysis, six tests were used: C ELISA H RPV, C ELISA N RPV (RBOK), C ELISA N RPV (RGK), C ELISA N PPR, C ELISA H PPR, and the VNT. These tests were utilized to verify the existence of RP antibodies in the samples (Table 1). The samples are believed to be representative of the various populations from which they were collected.

Results from Pace Programme 2003

The results of RP wildlife surveillance in Uganda were obtained from four laboratories (CIRAD, Pirbright, Muguga, and Entebbe). See Table 1 for a summary of the samples, their origins, animal species, number collected, and test results.

Discussion

The results and their analysis indicated the following:

- C ELISA N RPV (RGK) is a highly sensitive test, but it is not very specific, making the chances of false positives very likely. The fact is that no outbreak has occurred since the investigations were done.
- Up to the year 2000, RP antibodies were detectable in the sentinel population (wildlife) in Uganda by VNT and C ELISA RPV (RGK).
- Results of VNT and C ELISA H RPV on the samples of the year 2002 were all negative.
- Fewer animals tested positive with C ELISA N RPV (RGK) test since 1988.
- Results of VNT tallied with those of C ELISA N RPV (RGK) on the samples from Murchison Falls NP indicated four positive animals in 2000.
- Of the places sampled, Lake Mburo, Kidepo, Murchison, Semliki and Kibale showed some animals with detectable RP antibodies.

Given this evidence of antibodies in the sentinel population in Uganda, it is necessary to maintain keen interest in and continue wildlife surveillance to guard against the possibility of disease resurgence. However, the seropositive animals were adults that could have been exposed to infection earlier in life.

Conclusions

Wildlife studies remain a very important component of RP surveillance. Sampling techniques and diagnostic tests, however, need to be improved so that RP virus can be detected if present.

It is evident that there is no RP virus circulating in wildlife in Uganda NPs. This is further supported by the passive surveillance data that is collected using forms completed monthly by district staff.

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Chapter 10

Virus Topotypes and the Role of Wildlife in Foot and Mouth Disease in Africa[1]

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Introduction

The epidemiology of foot and mouth disease (FMD) on the African continent is influenced by two different patterns, viz, a cycle in which wildlife plays a role in maintaining and spreading the disease to other susceptible domestic animals and wild ungulates and a cycle that is maintained within domestic animals and that is independent of wildlife. In southern Africa, the former cycle predominates due to the presence of African buffalo (*Syncerus caffer*), the only wildlife species for which long-term maintenance of FMD has been described (Hedger 1972, Hedger *et al*. 1972, Hedger 1976, Condy *et al*. 1985, Thomson 1994, Thomson *et al*. 2001, Thomson *et al*. 2003). In East Africa, both cycles probably occur, while in West Africa, due to the absence of significant numbers of wildlife hosts, FMD is believed to be maintained primarily within the domestic animal cycle.

The disease is endemic in most countries in sub-Saharan Africa (Vosloo, Bastos *et al*. 2002). In southern Africa, where a number of countries have been able to control FMD by separating infected buffalo from livestock and by limited use of vaccination (control policies in South Africa have been described by Brückner *et al*. 2002 and Thomson *et al*. 2003), disease-free areas are recognised. FMD cannot be eradicated from southern and East Africa unless all infected buffalo are removed, which is untenable from both ecological and ethical points of view. Lack of movement control within countries and across international borders for both wildlife and domestic animals aggravates the problem, and gives credence to the fact that FMD will remain a problem on the subcontinent for the foreseeable future.

The role of different species in the epidemiology of FMD

African buffalo

The manner in which FMD is maintained within African buffalo populations is equivocal, as it is not clear how disease is transmitted from carrier buffalo to susceptible animals in the herd (Thomson 1996). FMD is probably transmitted in one of two ways: contact transmission between acutely infected and susceptible individuals, which is likely to account for the majority of infections, and occasional transmission between carrier buffalo and susceptible individuals. In Kruger National Park (KNP) in South Africa, most buffalo calves become infected by all three SAT serotypes prevalent in this region of the continent by the time they reach 1 year of age (Hedger 1972, Thomson *et al*. 1992, Thomson 1994). Calves are protected against infection by maternal antibodies, which can persist for 2–7 months (Condy and Hedger 1978), although antibodies have been detected in calves for up to 17 months (W. Vosloo and R.G. Bengis, unpublished results). Protection of calves from infection may not persist beyond 3–4 months, presumably because high antibody levels are required to maintain protection (Condy and Hedger 1978). Calves are not necessarily infected by their mothers and, in KNP at least, infection with SAT-1 usually precedes that with SAT-2 and SAT-3 (Condy and Hedger 1974, Thomson *et al*. 1992, Thomson *et al*. 2003). It seems therefore that infection of most calves in breeding herds probably occurs as a result of "childhood" epidemics, i.e., horizontal transmission between calves less than one year old (Thomson *et al*. 1992). Another possibility for transmission of disease, for which the evidence remains tenuous, is sexual transmission (Bastos *et al*. 1999, Thomson *et al*. 2003, Vosloo and Thomson, 2004).

Following the acute stage of infection, which lasts less than two weeks, detectable virus disappears from all secretions and excretions of individual animals except for those of the pharynx, where low-level viral replication persists in 60% or less of individuals (Hedger 1972, Hedger 1976, Anderson *et al*. 1979, Thomson 1996). Individual animals may retain the virus for at least five years while in an isolated herd; the infection was maintained for over 24 years (Condy *et al*. 1985). It is probable that a significant number of animals do not maintain infection for a prolonged period of time because the proportion of persistently infected animals falls after reaching a peak in the 1- to 3-year age group (Hedger 1976, E.C. Anderson and N.J. Knowles, personal communication 1994).

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More than one type of SAT virus may be maintained by individual buffalo (Hedger 1972, Anderson *et al*. 1979).

However, during the acute phase of infection, routes of virus excretion in buffalo are similar to those in cattle, although of a lower order, and viral excretion appears to persist longer in buffalo than in acutely infected cattle (Gainaru *et al*. 1986, Thomson 1994). Most transmission to cohorts and other species is believed to occur during acute infection. It has been shown unequivocally that carrier buffalo are able to transmit the infection not only to other buffalo (Condy and Hedger 1974) but also to cattle (Dawe, Flanagan *et al*. 1994, Dawe, Sorenson *et al*. 1994, Vosloo *et al*. 1996). More information is needed about the maintenance of various serotypes of FMD in buffalo populations outside southern Africa, and whether serotypes other than the SAT types have become established in those populations.

Other wildlife species

Many species of wild animals have been reported as having been infected with FMD virus (Macaulay 1963, Hedger 1981) and a wide range of species in southern Africa have been shown to have antibodies (Lees May and Condy 1965, Condy *et al*. 1969). Essentially all cloven-hoofed animals and Camelidae (i.e., members of the order Artiodactyla) are susceptible to infection with FMD viruses. FMD infection depends on the species and even breed of animals, the strain and dose of virus causing infection, and the level of immunity of the animals (Thomson 1994). The susceptibility of most wildlife species is unknown, as are the levels of virus excretion during infection. However, the bulk of evidence suggests that wildlife species other than buffalo play only a minor role in the maintenance and spread of FMD viruses in southern Africa. This is corroborated by the fact that only kudu (*Tragelaphus strepsiceros*) have been shown to maintain FMD virus in a carrier state for significant periods of time (Table 1). (Carriers are defined as animals from which virus can be isolated from the oropharyngeal area more than 28 days after infection [Salt 1993].) Impala (*Aepyceros melampus*) seem to be the most susceptible species in South Africa and are considered an indicator host for the presence of SAT viruses because infection in impala in the past often presaged the occurrence of FMD in livestock (Meeser 1962). In Zimbabwe, however, kudu have been associated with clinical FMD more frequently than impala (C. Foggin, personal communication 2003). In the Serengeti, where wildebeest (*Connochaetes taurinus*) are by far the most numerous large mammal species, FMD is infrequently reported, although a severe outbreak caused by SAT-2 was recorded in wildebeest in 1999. Evidence indicated that FMD had spread from domestic animals to the wildebeest, and at least 20% of the migratory herd of wildebeest was affected (T. Mlengeya, personal communication 2003).

Outbreaks of FMD among impala within KNP occur regularly although, strangely, other species are rarely affected. FMD in impala appears generally in areas of dense impala populations. Also, because impala depend on water, infection frequently has spread along watercourses in KNP; i.e., it is assumed that the virus is not transmitted via the water itself but by contact between animals congregated along rivers and streams. During times of low rainfall, buffalo and impala come into close contact because they congregate at watering points. The available evidence, based on genome sequencing of appropriate viruses, indicates that impala in KNP usually, if not always, become infected with SAT viruses derived from buffalo in the vicinity (Keet *et al*. 1996, Bastos *et al*. 2000, Bastos *et al*. 2003b).

Persistent infection in impala has not been demonstrated (Hedger *et al*. 1972, Anderson *et al*. 1975, C. de W. van Vuuren, personal communication 1997) and a serologic survey investigating three localities in KNP confirmed this finding (Vosloo and Thomson 2004). However, FMD epidemics caused by identical viruses have recurred in impala 6–18 months after the original outbreak (Vosloo *et al.* 1992, Keet *et al*. 1996), indicating that the virus may have been maintained within the impala population. If that were so, the mechanism whereby the viruses survived in interepidemic periods remains to be explained. An alternative explanation is that the same virus has been transmitted on more than one occasion from buffalo to impala in the same vicinity.

However, any acutely infected animal could potentially spread FMD regardless of whether it is of a known carrier species. Because antelope such as impala and kudu can jump fences up to 2.4m high, this poses a severe problem for disease control where such fences are used to separate wildlife from susceptible domestic animals; in Zimbabwe, this could explain outbreaks on cattle farms adjoining wildlife conservancies (Hargreaves *et al.* 2004).

Domestic animals

The role of domestic animals in the maintenance and spread of FMD in sub-Saharan Africa has not been studied in detail. However, it is accepted that domestic animals play a significant role in the epidemiology of FMD in East and West Africa due to uncontrolled domestic animal movement within and between countries, lack of vaccination strategies to prevent disease transmission, and the fact that cattle, sheep, and goats can become FMD carriers (Table 1). In Zimbabwe, in southern Africa, for example, FMD seems to have been perpetuated by domestic animal populations since the initial possible spread from buffalo in September 2001 (W. Vosloo, R.M. Dwarka, and C.I. Boshoff, unpublished data).

Molecular epidemiology of FMD in Africa

A better understanding of the epidemiology of FMD could greatly assist in planning control strategies. Molecular epidemiologic studies have contributed in this regard by elucidating historical and current disease transmission patterns within and between countries. Additionally, such studies have demonstrated the presence of viral topotypes in both wildlife and domestic animals, information that should be

Table 1. Duration of viral persistence in selected domestic animals and wildlife species

Species/animal	Duration of viral persistence	Reference
Domestic animals		
Cattle	2.5–3.5 years	Hedger 1976 Hargreaves 1994
Sheep	9–12 months	Burrows 1968 McVicar and Sutmoller 1968
Goats	2–3 months	Singh 1979 Anderson *et al*. 1976
Wildlife		
Wildebeest (*Connochaetes taurinus*)	28 days	Anderson *et al*. 1975
Sable *(Hippotragus niger)*	28 days	Ferris *et al*. 1989
Eland (*Taurotragus oryx*)	32 days	Anderson 1980
Fallow deer (*Dama dama*)	63 days	Forman *et al*. 1974
Kudu (*Tragelaphus strepsiceros*)	104–160 days	Hedger 1972
Water buffalo (*Bubalis bubalis*)	2–24 months	Moussa *et al*. 1979
African buffalo (*Syncerus caffer*)	5 years	Condy *et al*. 1985

heeded when planning FMD vaccination strategies (Vosloo *et al.* 1992, Vosloo *et al.* 1995, Bastos 1998, Bastos *et al.* 2001, Bastos *et al.* 2003a, Bastos *et al.* 2003b, Sangare *et al.* 2003, Sangare *et al.* 2004).

SAT-type viruses are constantly evolving in buffalo populations in southern Africa (Vosloo *et al.* 1996, Bastos *et al.* 2001, Bastos *et al.* 2003b). Therefore, different buffalo populations can be differentiated on the basis of SAT-type viruses recovered from carrier animals representative of those populations (Vosloo *et al.* 2001). Even within the buffalo population of the KNP, which numbers less than 27,000 individuals, clear intratypic differences in the genomes of SAT-1, -2, and -3 viruses from different regions of KNP have been shown (Vosloo *et al.* 1995, Bastos *et al.* 2000, Bastos 2001, Bastos *et al.* 2001, Bastos *et al.* 2003b, R.M. Dwarka, unpublished results).

Buffalo populations in southern Africa have not been completely free ranging for at least 70 years and have been concentrated mainly in conservancies and game parks where migratory routes have been disrupted by fences. This may partially explain the locality-specific distribution of viral topotypes apparent today. High mutation rates (Vosloo *et al.* 1996) and continuous, independent virus cycling within discrete buffalo populations (Condy *et al.* 1985) probably account for the current, extensive intratypic variation. However, little information is available on the buffalo populations in East Africa; possibly because of the free-ranging nature of buffalo in that region, discrete topotypes may not be found.

Based on nucleotide sequence analysis of a portion of the viral genomes obtained from buffalo and domestic animals in sub-Saharan Africa, eight independently evolving viral topotypes were identified for SAT-1 (Table 2). These topotypes originated from eight correspondingly separate geographic localities, with three different topotypes found in Uganda alone. For SAT-2 isolates, 14 topotypes have so far been identified within the sub-Saharan African region, while 6 topotypes have been identified for SAT-3. For serotypes O, A, and C- 8, 6, and 3 topotypes were identified respectively and could be related to geographic regions (Table 2).

For all FMD serotypes, the genetic differences between viruses from different topotypes is such that outbreaks should be traceable to specific countries, specific game parks, and even to specific regions within game parks, as has been described for the SAT serotypes in southern Africa (Bastos 2001, Bastos *et al*. 2001, Vosloo *et al.* 2001, Vosloo, Bastos *et al.* 2002, Vosloo, Boshoff *et al.* 2002, Bastos *et al.* 2003b). However, if uncontrolled movement of buffalo occurs in countries that have more than one topotype within their borders (such as Botswana and Zimbabwe), these viral topotypes will become commingled (as has already happened in Zimbabwe). Consequently, a single region could have high levels of viral genetic diversity that will most likely be reflected in antigenic differences. This poses challenges for vaccination schemes because for vaccines to be effective, the viruses incorporated into vaccines must be antigenically related to viruses circulating in the field (Hunter *et al.* 1996, Hunter 1998); this means that several topotypes would have to be incorporated into a single vaccine. Therefore, the uncontrolled movement of buffalo within the sub-Saharan African region could have serious implications for the control of FMD.

Based on distribution patterns of SAT virus lineages and topotypes in buffalo populations, we can clearly conclude that SAT viruses from buffalo are transmitted to other species (Bastos *et al*. 2000, Brückner *et al.* 2002, Vosloo, Boshoff *et al.* 2002, Thomson *et al*. 2003). This confirms early observa-

Table 2. Topotype distribution of FMD serotypes O, A, C, and SAT types 1–3 in Africa

Serotype	Topotype	Representative country(ies)	Reference
SAT-1	I	South Africa, southern Zimbabwe, Mozambique	Vosloo *et al.* 1995
	II	Botswana, Namibia, Zambia, western Zimbabwe	
	III	Zambia, Malawi, Tanzania, Kenya, northern Zimbabwe	Bastos *et al.* 2001
	IV	Uganda	Reid *et al.* 2001
	V	Uganda	
	VI	Uganda	Sahle 2003
	VII	Nigeria, Sudan	
	VIII	Nigeria, Niger	Sangare *et al.* 2003
SAT-2	I	South Africa, Mozambique, southern Zimbabwe	
	II	Namibia, Botswana, northern and western Zimbabwe	Bastos *et al.* 2003b
	III	Botswana, Zambia, Zimbabwe	Vosloo *et al.* 1995
	IV	Burundi, Malawi, Kenya, Tanzania, Ethiopia	
	V	Nigeria, Senegal, Liberia, Ghana, Mali, Cote d'Ivoire	
	VI	Gambia, Senegal	Sangare 2002
	VII	Eritrea	
	VIII	Rwanda	Sahle 2003
	IX	Kenya, Uganda	
	X	Democratic Republic of the Congo, Uganda	Sangare *et al.* 2004
	XI	Angola	
	XII	Uganda	
	XIII	Sudan	
	XIV	Ethiopia	
SAT-3	I	South Africa, southern Zimbabwe	
	II	Namibia, Botswana, western Zimbabwe	Vosloo *et al.* 1995
	III	Malawi and northern Zimbabwe	
	IV	Zambia	Bastos *et al.* 2003a
	V	Uganda	
	VI	Uganda	Reid *et al.* 2001
O	I	Ethiopia, Eritrea, Kenya, Somalia, Sudan, Tunisia, Egypt	
	II	Algeria, Côte d'Ivoire, Guinea, Morocco, Niger, Ghana, Burkina Faso, Tunisia, Sudan	Samuel and Knowles 2001
	III	Uganda, Kenya, Sudan	
	IV	Uganda	Sangare 2002
	V	Uganda	
	VI	Tanzania, Uganda	Sahle 2003
	VII	South Africa	
	VIII	Angola	Sangare *et al.* 2001
A	I	Mauritania, Mali, Côte d'Ivoire, Ghana, Niger, Nigeria, Cameroon, Chad, Senegal, Gambia, Sudan	
	II	Angola, Algeria, Morocco, Libya, Tunisia, Malawi	Knowles and Samuel 2003
	III	Tanzania, Burundi, Kenya, Somalia, Malawi	
	IV	Ethiopia	Knowles *et al.* 1998
	V	Sudan, Eritrea	
	VI	Uganda, Kenya, Ethiopia	
C	I	Kenya	Reid *et al.* 2001
	II	Ethiopia, Kenya	
	III	Angola	Knowles and Samuel 2003

tions made by J.B. Condy and R.S. Hedger that led them to hypothesize a link between the occurrence of FMD in cattle and the distribution and behaviour of buffalo harbouring SAT-type viruses (Condy *et al.* 1969, Hedger *et al*. 1969, Condy 1971, Hedger 1972, Hedger *et al.* 1972, Condy and Hedger 1974, Hedger 1976, Condy 1979, Hedger and Condy 1985).

Studies conducted in East and West Africa were based mostly on historical isolates obtained from previous outbreaks in domestic animals. Due to the endemicity of the disease, few outbreaks are investigated to determine the serotype and to ensure that isolates are available for further studies. The topotypes from those regions may be extinct if the disease was successfully controlled. Interestingly, it was also found that long-term maintenance of certain topotypes occurred for periods of up to 24 years and appeared in more than one country (Sangare *et al*. 2004, Sahle 2003).

Conclusions

Protecting sub-Saharan Africa's wildlife heritage is a priority, while maintaining a harmonious interaction between agriculture and wildlife conservation is also imperative. Transboundary diseases such as FMD that can be transmitted between wildlife and livestock are obstacles to livestock development and conservation. Undoubtedly, this problem will merit even greater scrutiny with the increasing drive towards the creation of export zones for livestock and animal products in order to access lucrative markets elsewhere.

The epidemiology of FMD in sub-Saharan Africa is not fully understood. The role of wildlife in East and possibly West Africa in the maintenance and spread of the disease remains to be clarified. It is not known whether isolates from serotypes A and O have become established in buffalo populations in East Africa, which is a possibility, because numerous outbreaks due to these serotypes have occurred in domestic animals in the past. The role of small stock should also be investigated to ensure that control policies are designed to exclude possible spread of FMD by sheep and goats. Current outbreaks of FMD should be researched to ensure that vaccine strains will be appropriately matched against the strains currently in the field.

Fences to separate infected wildlife from susceptible domestic animals have been used with success in southern Africa to ensure that FMD does not spread and adversely affect livestock and livestock producers. However, these fences and their impacts on the economically critical wildlife sector have been severely criticised, highlighting the need to explore alternative, ecologically sensitive ways of controlling FMD. Additionally, because FMD is only one of many transboundary diseases that can negatively affect livestock farming in the region, efforts to design novel control policies should attempt to address all important diseases.

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Chapter 11

Disease Challenges Concerning the Utilization of the Kafue Lechwe (*Kobus leche kafuensis*) in Zambia[1]

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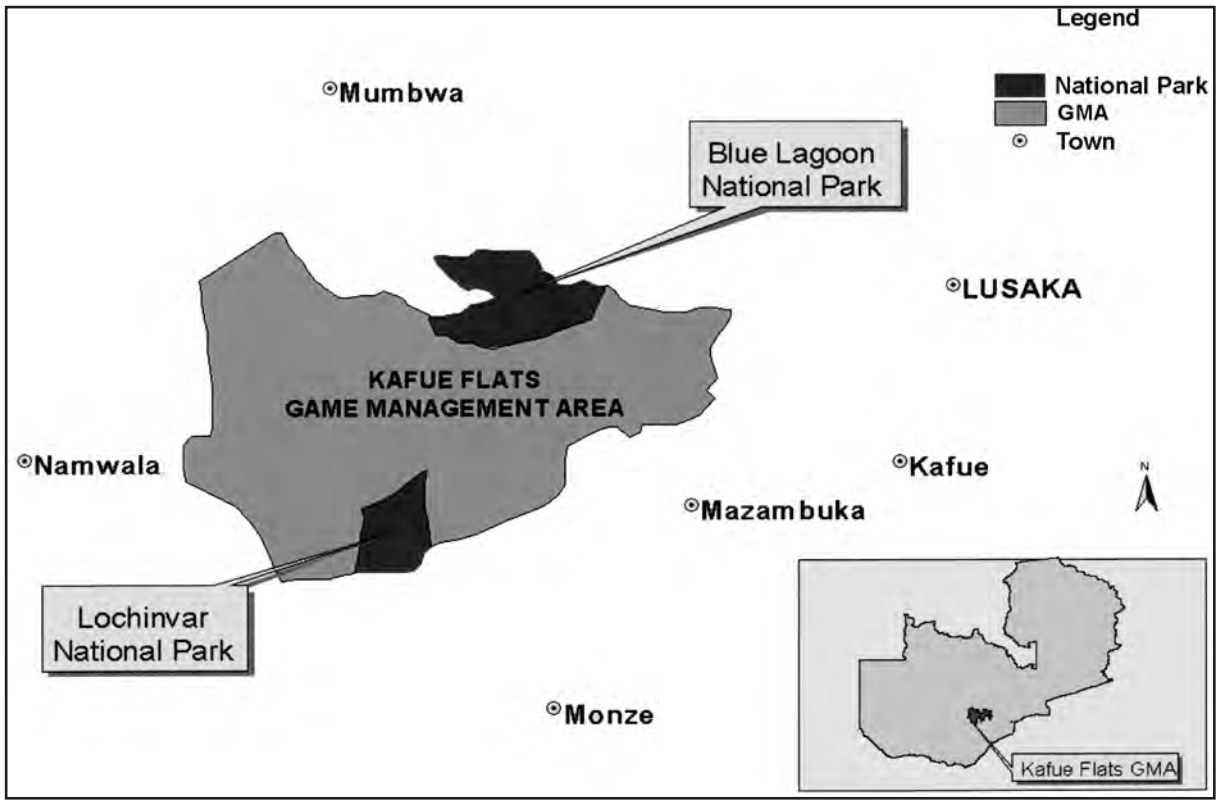
Introduction

The Kafue lechwe *(Kobus leche kafuensis)* is a medium-sized, semi-aquatic antelope that is endemic to the Kafue Flats of Zambia. The Flats are a floodplain of about 6,000km^2 (Sheppe 1985) and comprise Lochinvar National Park (NP) (410km^2), Blue Lagoon NP (420km^2), and the Kafue Flats game management area (5,175km^2) (Mwima 1995) (Fig. 1). The Kafue lechwe is the predominant wildlife species of the Kafue Flats (Sheppe 1985) and is confined to a relatively small area, particularly in and around Lochinvar and Blue Lagoon NPs.

About 700 Kafue lechwes have been translocated from the Lochinvar NP to game ranches. The Kafue lechwe population on the Flats has steadily declined over the years from an estimated 80,000 in 1975 to 41,000 in 1982. Poaching, infectious diseases, and grazing pressures are the major factors responsible for the decline (Kapungwe 1993). Other contributing factors include traditional hunting practices, human presence in the area, and small-scale agricultural practices (Sheppe 1985).

Fig. 1. Kafue Flats Game Management Area, and Lochinvar and Blue Lagoon National Parks



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A number of diseases have been isolated in the Kafue lechwe. Some of these diseases, particularly brucellosis and tuberculosis (BTB), pose serious conservation and public health challenges. The actual impact of these diseases on the animal population has not, however, been investigated. Studies on animal diseases in Zambia are generally limited to diagnosis. Little is known, therefore, of the diseases in the context of the ecosystem and the prevailing land-use practices.

Ecological and socioeconomic importance of the Kafue lechwe

Ecological importance

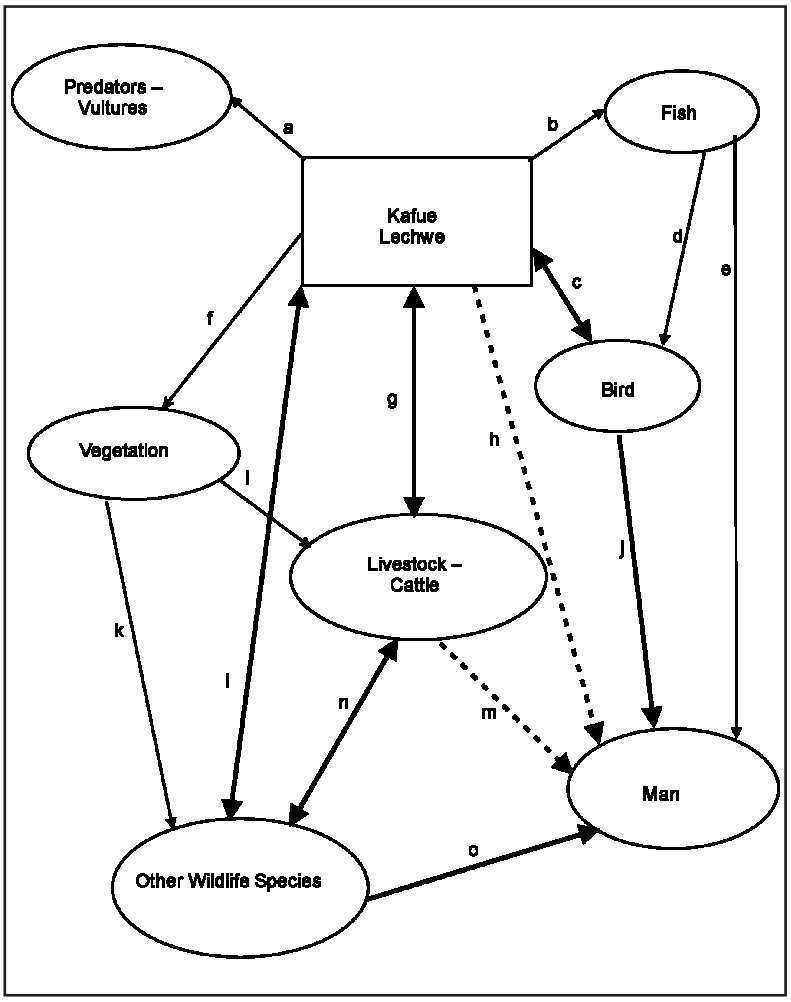
In the food chain, the lechwe is a major source of manure-food for fish; the fish in turn are the major food for aquatic birds (Fig. 2). Hence, the lechwe contributes significantly to the ecological balance of the Kafue Flats. Fish species in the area include cichlids (*Sartherodon* spp. and others), barbels (*Clarias* spp.) and *Tilapia* species, especially *T. niloticus.* The Flats support over 400 species of birds, including about 125 waterbirds. The Kafue Flats host the world's largest population of wattled cranes (*Grus carunculatus*). Other notable birds are a large variety of ducks, geese, herons, egrets, shorebirds, pelicans, storks, ibises, and cranes. Others are fish eagles (*Haliaeetus vocifer*), darters (*Anhinga rufa*), and jacanas (*Actophilornis africanus*) (Sheppe 1985).

Socioeconomic importance

Consumptive utilisation of the Kafue lechwe

The lechwe is hunted for meat, trophies, and hides and is a valued tourist attraction. Previously, the local communities adjacent to the area hunted hundreds of lechwes, mostly for meat, during traditional hunts called the *Chila*. This practice was discontinued in 1957, as it was unsustainable. Between 1995 and 1999, a total of 4,679 lechwe carcasses were legally harvested according to official figures. Of the total, 4,353 (93%) lechwe were hunted for game meat and 326 (7%) were taken on safari hunts, giving an average annual harvesting rate of 936 animals (Table 1). The average quantity of lechwe meat produced annually is estimated at 47.7 tons. The number of people who consume the meat annually is about 39,780

Fig. 2. Ecological role of the Kafue lechwe on the Kafue Flats (bold arrows indicate hypothesized routes of TB and brucellosis transmission)



(a) Kafue lechwe carcasses available in the field;
(b) manure from the lechwe;
(c) possible TB (avium type) transmission;
(d) food for aquatic birds;
(e) source of protein and income;
(f) manure fertilising the pasture;
(g) BTB transmission between the lechwe and cattle;
(h) source of protein and income, and BTB transmission from lechwe to people;
(i) pasture for livestock;
(j) source of protein and income and possible TB transmission (avium types);
(k) pasture for other wildlife species resulting in enhanced species diversity;
(l) BTB transmission between the lechwe and other wildlife species;
(m) source of protein and income, and BTB and brucellosis transmission from livestock to people;
(n) BTB transmission between cattle and other wildlife species; and
(o) source of protein and income, and BTB and brucellosis transmission from wildlife to people.

Table 1. Number of Kafue lechwe hunted on the official quota between 1995 and 1999

Year	No. animals hunted			No. animals hunted as % of total carcasses		Meat production and consumption	
	National hunting	Safari hunting	Total	National hunting	Safari hunting	Meat production in kg (tons)[a]	No. people consuming the meat[b]
1995	1,363	74	1,437	94.9	5.1	73,287 (73.3)	50,894
1996	457	66	523	87.4	12.6	26,673 (26.7)	22,228
1997	1,040	75	1,115	93.3	6.7	56,865 (56.9)	47,388
1998	668	54	722	92.5	7.5	36,822 (36.8)	30,685
1999	825	57	882	93.5	6.5	44,982 (45.0)	37,485
Total	4,353	326	4,679	93.0	7.0	238,629 (238.6)	198,858
Annual average	871	65	936	93.1	6.9	47,736 (47.7)	39,780

[a] *Mean dressing weight of 51.0 kg (Stafford* et al. *1992)*

[b] *Annual average consumption of game meat per person of 1.2 kg (Chardonnet* et al. *2002)*

(Table 1). These figures reflect the official data of the national wildlife agency (Zambia Wildlife Authority); the actual numbers of carcasses consumed and people who eat Kafue lechwe meat in Zambia are likely higher. The Kafue lechwe has come under heavy persecution for its meat for the illegal bushmeat trade. Poaching levels specific to the Kafue lechwe are speculated to be 50% of the official annual hunting quota. The main consumption centres for both legal and illegal lechwe meat are Lusaka City and Mumbwa, Monze, Kafue, Namwala, Mazabuka, and Itehi-tezhi districts (Fig. 1). The revenue generated annually from national (citizen) and safari hunting is US $47,459 and US $60,315, respectively. The average income generated per animal from national and safari hunting during said period was US $55 and US $925, respectively (Table 2), making safari hunting more lucrative per animal harvested, although the beneficiaries of various forms of utilization may, of course, differ.

Other enterprises

The ecological function of the Kafue lechwe is important for the survival of fish and birds on the Flats. The Flats support a large fishery that, in turn, supports many people as a source of both protein and income. The birds of the Kafue Flats are also a source of protein and income for many Zambians. In addition, the Flats are an important tourist destination for bird watchers.

Table 2. Official data on the economic value of the utilization of the Kafue lechwe between 1995 and 1999

Year	National hunting			Safari hunting		
	No. animals hunted	Income, ZMK (US$)	Average income/animal, ZMK (US$)	No. animals hunted	Income, US$	Average income/ animal, US$
1995	1,363	64,950,000 (72,858)	47,652 (53)	74	56,625	765
1996	457	52,900,000 (43,908)	115,755 (96)	66	62,700	950
1997	1,040	78,037,500 (58,936)	75,036 (57)	75	71,250	950
1998	668	60,120,000 (31,319)	90,000 (47)	54	54,000	1,000
1999	825	74,250,000 (30,275)	90,000 (37)	57	57,000	1,000
Total	4,353	330,257,500 (237,296)	75,869 (55)	326	301,575	925
Average	871	(47,459)	**per year** (58)	65	60,315	**per year** 932

Diseases of the Kafue lechwe of conservation and utilization importance

The diseases isolated in wild Kafue lechwe include BTB, dermatophilosis (cutaneous streptothricosis), brucellosis, blue tongue, infectious bovine rhinotracheitis, heartwater, *Coxiella burnetti*, and *Chlamydia psittaci* (Pandey 1998, Pandey *et al*. 1994, Pandey *et al*. 1992, Stafford 1991, Kraus *et al*. 1986, Clancey 1977). Stafford (1991) reported a wide variety of parasites in the Kafue lechwe, including *Schistosoma* and *Fasciola* spp. In contrast, it should be pointed out that few studies have been done on the health status of lechwe on game ranches. Diseases diagnosed so far in Kafue lechwe on game ranches include heartwater, BTB (Zieger *et al*. 1998, Pandey *et al*. 1992) and brucellosis. A summary of BTB and brucellosis, which have been widely reported in the Kafue lechwe, is given below.

Tuberculosis

The history of BTB in the lechwe dates as far back as 1954. Unpublished records at the Department of Veterinary Services indicate that BTB was introduced into the Monze District by infected cattle in the 1940s. It was diagnosed in lechwe for the first time in 1954 in Lochinvar NP (Rottcher 1976). The actual source of BTB in the lechwe is not definitively known, but it is speculated that the disease came from cattle, because the area that became Lochinvar NP in 1971 was previously a cattle ranch. Kafue lechwe coming into contact with cattle that are brought to the Flats during the dry season for grazing pasture and drinking water is not a new phenomenon.

In the early 1960s, the prevalence of BTB in lechwe in the NP was 14%. About 25% of the cattle from the Flats were found to have tubercular lesions during routine meat inspection (Anon. 1965). Rottcher (1976) estimated that about 40% of the cattle were infected with BTB. Most recent studies by Pandey (1998) show a prevalence of 19.2% in the 177 lechwe carcasses examined. Both *Mycobacterium bovis* and *M. avium* have been isolated in lechwe. BTB has also been reported in lechwes on game ranches. Interestingly, the initial stock of lechwes on the ranches originated from the Kafue Flats, Lochinvar NP in particular. The translocation was authorised in the absence of a disease-risk analysis. The lechwe is a gregarious animal that lives in large herds, which creates a favourable environment for the transmission of BTB. Pandey (1998) postulated that BTB could also be transmitted through contamination of the pastures and soils as reported via badgers in the United Kingdom and opossums in New Zealand. In short, BTB is considered to be endemic in cattle that are moved to the Kafue Flats and that share pasture and water with affected Kafue lechwe.

Brucellosis

Brucellosis has been reported in the Kafue lechwe, wildebeest (*Connochaetes taurinus*), and zebra (*Equus burchelli*) (Suzuki *et al*. 1995, Rottcher 1978). Unlike that of BTB, the history of brucellosis is not well documented. The actual prevalence of brucellosis is not well known. Rottcher (1978) found 6.5% reactors of 152 lechwes that were tested for brucellosis. Pandey (1998) reported finding evidence of brucellosis among hunted male animals. Brucellosis has also been reported in lechwe on a game ranch (Matsukawa *et al*. 1995) and, for the first time, in Blue Lagoon NP (Pandey 1998). The lechwe on the ranch were translocated from the Kafue Flats about four years before brucellosis was isolated. Brucellosis has also been isolated in cattle that have been moved to the Flats (Muyoyeta 1997, Ghirotti *et al.* 1991).

Disease challenges related to human consumption of Kafue lechwe

BTB and brucellosis are of serious conservation and public health importance. The impact of BTB and brucellosis on lechwe is through mortality, morbidity, and decreased reproductive performance. Gallagher *et al*. (1972) estimated that BTB was responsible for the deaths of at least 20% of the lechwe annually on the southern bank of the Kafue Flats, i.e., the Lochinvar area. At this rate, BTB was considered the major contributing factor to the decline of the lechwe population. The public health risk from BTB is thought to be low by some, because lesions in the cases reported to date have been localized in the lungs of the lechwe. However, the affected lungs enter the food chain due to lack of meat inspection and pose a serious public health hazard. In addition, it is not known at what stage BTB may become generalized. The lack of predators allows debilitated animals to be readily harvested, as they tend to lag behind when being pursued by hunters. The hunting policy in Zambia restricts hunters to harvesting mature male animals. Because BTB is a progressive disease, it is suspected that more BTB-affected males are hunted, as they cannot run far away when pursued by hunters. Consumption of raw milk and uncertified meat from infected cattle is likely another route of BTB transmission to people. Consumption of game meat from both legal and illegal sources is likely the most direct route of BTB transmission to people. It is estimated that about 80% of lechwe carcasses hunted for meat could be infected with BTB (Krauss *et al*. 1986, Dillman 1976, MacAdam *et al*. 1974).

Brucellosis infection is characterized by abortions and orchitis, leading to poor reproductive performance and a negative impact on an animal population's growth rate. Brucellosis can be transmitted to people through the handling of wildlife carcasses. Wildlife officials and hunters are the high-risk groups. Cattle provide an indirect route of transmitting brucellosis to people, presumptively but not necessarily due to their interaction with diseased lechwe on grazing pasture and at water sources. It should be noted that un-

published data in the Ministry of Agriculture show that brucellosis is endemic in cattle in the area. The contamination of pastures and soils with urine from infected animals places other animals at risk of contracting brucellosis.

The lechwe is considered the sylvatic host for BTB and brucellosis, thereby complicating disease control in livestock that share their grazing and watering areas on the Kafue Flats, and in cattle on the farms adjacent to game ranches stocking the Kafue lechwe.

The translocation of the Kafue lechwe to other areas such as game ranches without screening for diseases increases opportunities for transferring the diseases to uninfected areas. Consequently, other species on the game ranches (and livestock on adjacent cattle farms) are at risk of infection. Similarly, translocation of other wildlife species from other areas into the Kafue Flats for purposes of restocking the area would expose potentially naive animals to the diseases found on the Flats. The newly introduced animals could also act as a vehicle for the introduction of new diseases on the Flats. Therefore, translocation of wildlife into and outside the Kafue Flats should be subjected to disease-risk analysis, including strict quarantine measures and screening tests. Again, both BTB and brucellosis have been diagnosed in lechwes on game ranches.

It is suggested that over time BTB and brucellosis will negatively affect income generated from consumptive utilization of the lechwe. This will have a direct impact on community-based wildlife management programmes, as they largely depend on hunting revenue. On a related note, the hippo-culling quota of 1988 was reduced following the 1987 anthrax outbreak in Luangwa Valley, Zambia (Lewis *et al*. 1990). Consequently, the revenue allocated to community management programmes in the Lupande study area declined by 31% from Zambian kwacha (ZMK) 212,067 in 1987 to ZMK 146,000 in 1988.

Discussion

To minimize the risk of spreading diseases to other areas, veterinary certification of animals and animal products originating from the Kafue Flats should be introduced immediately. Meat inspection should be reintroduced as a matter of urgency to minimize the public health risk associated with consuming and handling uncertified animal products. The current practice, whereby meat is consumed without veterinary certification, places the general public at a greater risk of contracting zoonotic diseases. To further reduce the public health hazard, it is recommended that the Zambia Wildlife Authority embark on public awareness campaigns to educate people about the dangers of consuming game meat from the illegal bushmeat trade. Uncontrolled poaching, in addition to its detrimental impact on the wildlife resource, will continue to place the unsuspecting public at risk of contracting zoonotic diseases. Given Zambia's HIV/AIDS pandemic, protecting the general public from zoonotic diseases must be given serious attention. TB in people has generally been associated with HIV/AIDS.

To improve the conservation of lechwe on the Kafue Flats, innovative disease-control methods should be introduced. Testing and elimination of infected herds as suggested by MacAdam (1973) would perhaps be the most effective control method but is economically prohibitive given the large herd sizes. Eliminating or reducing contact between the lechwe and cattle has been suggested (Rottcher 1976). This would be feasible only with the cooperation and support of the local community. People would need to perceive benefits to discontinuing the transhumant grazing system. This cooperation is most unlikely, however, given that the local communities have no alternative areas in which to graze or water their animals. Fencing off the Kafue Flats would be ecologically and politically inappropriate. The translocation of clean herds of lechwe to uninfected areas that are well secure and have suitable habitat would enhance the survival of the species in the country. To improve the conservation of the species, the authors recommend that Zambian wildlife authorities create a "clean" herd of the Kafue lechwe suitable for translocation to new areas under strict quarantine and disease screening procedures. Eliminating contact between the lechwe and cattle in the new areas would further improve the survival of the species. To further enhance the conservation of the species, plans for translocations of animals into such new areas should be subjected to disease-risk analysis and include precautionary measures such as strict disease screening and quarantine protocols.

To protect the livestock that interact with the Kafue lechwe on grazing pasture and at water points, the National Veterinary Authority should improve the veterinary care delivery system for livestock in the area. Results from improved disease surveillance and monitoring in livestock could potentially serve as a proxy reflection of the situation in the wildlife in the area. Strict screening of livestock being moved into the area is also critical, as infected cattle could transmit diseases to wildlife when they come into contact.

To fully understand the ecological and socioeconomic implications of diseases in wildlife, future veterinary studies should be designed within the context of the ecosystem and the prevailing land-use practices. The need to investigate the possible spread of BTB and brucellosis to other wildlife species in the area is urgent.

Conclusions

Without animal disease investigations that address the whole ecosystem and the prevailing land-use practices, the full extent of the ecological impacts and socioeconomic implications of wildlife diseases remains largely speculative. The actual contribution of BTB and brucellosis to the reduction of the lechwe population in the area cannot be readily quantified. Further data and more comprehensive models are needed. Available disease information is difficult to interpret in the context of the overall general management plan for the protected area, or to translate into practical management decisions. A more integrative, multidisciplinary approach to problem-solving at the wildlife/livestock interface is needed.

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Chapter 12

The Health Paradigm and Protected Areas: Linkages Between People and Their Livelihoods, Ecosystems and Natural Communities, and Health and Disease[1]

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Introduction – population and poverty

Issues at the interface between wild lands and people will become more critical as the world's population is expected to increase from 6.1 billion people in 2000 to 8.9 billion by the year 2050 (United Nations Population Information Network 2003). Population growth will place ever-increasing pressure on the world's natural resources and ecosystem services, as demand continues to grow for adequate nutrition and clean water, health care for all, and overall improvements in human livelihoods and well-being (Millennium Ecosystem Assessment 2003).

Poverty is probably the single most important constraint to development and protection of the environment in Africa. Over 24% of the world's poor who live below US $1 per day reside in sub-Saharan Africa. These individuals and families will through necessity prioritize their lives with regard to the following factors in descending order of importance:

- Food on the table
- Health
- Good social relations
- Promotion of culturally appropriate rural livelihoods, including livestock-keeping
- Desire for stability and security
- Environmental concerns

Environmental concerns will remain a luxury for the world's poor whilst poverty remains an issue, and protected areas in Africa will come under increasing pressure from illegal activities, livestock production, and political as well as socioeconomic pressures (Osofsky 1997, Millennium Ecosystem Assessment 2003, Kock and Kock 2003). Poverty is an integral part of the health paradigm: poverty leads to ill health, poor productivity, and little desire to address environmental issues. The key is to link poverty reduction to improved health of people and their livestock through the promotion of healthier ecosystems that include the wildlife that lives within these systems.

In balancing the needs and expectations of Africa's rural inhabitants with those of conservationists, it is necessary to consider how disease interactions influence human, livestock, and wildlife health (WCS 2003a, WCS 2003b, Kalema-Zikusoka 2005, Kock 2005, Bengis 2005) while keeping in mind that the role of wildlife health in conservation goes beyond the presence or absence of disease (Mainka 2001, Deem *et al*. 2001). Wildlife health, in the broadest sense, is a holistic concept with a focus on populations and the environments in which they live. This focus must of course include human populations and livelihood needs, especially at the wildlife/livestock interface. While some caution is merited to prevent making too simplistic a linkage between "ecosystem health" and "human health," potentially at the expense of wildlife and conservation funding (Osofsky *et al*. 2000), it is clear in Africa that a paradigm shift is needed. Health is the key linkage that can contribute to human well-being and, therefore, promote environmental stewardship and healthy ecosystems (Margoluis *et al*. 2001).

This paper will:

- Promote an ecosystem-based approach to health and disease issues;
- Argue that the biomedical professions have powerful tools that can assist other conservation practitioners in evaluating dysfunction in ecosystems;
- Emphasize that health and disease, in their broadest sense, are important issues in protected-area management and conservation practice; and
- Stress that healthy ecosystems contribute to sustainable development and human well-being and provide a *diverse* resource base that can be utilized on a sustainable basis to address poverty.

Epidemiology and disease control – the classic approach

In many instances, both historically and currently in Africa (Kock *et al*. 2002), disease control methods that have been adopted by veterinary and health authorities have been drastic, have had a significant negative impact on ecosystem health and biodiversity, and have rarely considered the broader issues surrounding and influencing health. Classic disease control methods include vaccination, test and slaughter, blanket slaughter, vector control, and movement

[1]See abstract on p.xxv.

controls including fencing. It is the latter that requires "out-of-the-box" thinking by traditional veterinary and animal health authorities. The indiscriminate use of fencing to control disease transmission between livestock and wildlife without considering connectivity and vital linkages between ecosystems is a cause for concern (Albertson 1998, Keene-Young 1999, Scott Wilson and EDG 2000, Thomson *et al*. 2003, Kock *et al*. 2002, Martin 2005). Addressing disease issues should be an integral part of protected-area planning and management and should involve veterinary and health authorities. This is crucial as the impact of emerging and re-emerging diseases on the health of people, their livestock, and wildlife is likely to constrain the maintenance and development of protected areas and compromise conservation initiatives into the future. The potential for spread of bovine tuberculosis (BTB) from Kruger National Park (NP) to surrounding human communities (Michel 2005) is a case in point.

Infectious and noninfectious diseases are increasingly being recognized as important "emerging issues" by health specialists, disease ecologists, conservation biologists, wildlife managers, and protected area planners (Meffe 1999, Deem *et al*. 2001, Lafferty and Gerber 2002, Aguirre *et al*. 2002, Daszak and Cunningham 2002, Graczyk 2002, WCS 2003b, Kalema-Zikusoka 2005, World Parks Congress Outputs 2003). There are numerous examples of emerging diseases that are impacting on human health and biodiversity. For example, from 2001 to 2003 the Ebola virus killed dozens of people and wiped out hundreds of gorillas in central Africa (WCS 2003a); West Nile virus has afflicted a wide range of domestic and wild animals and people in North America; the deadly severe acute respiratory syndrome (SARS) virus that affected people worldwide is potentially epidemiologically linked to wild species in markets in China; BTB has been reported in buffalo, lion, and other species in Kruger NP (Clifton-Hadley *et al*. 2001, Bengis 2005, Michel 2005); brucellosis is compromising bison populations in North America (Bienen 2002, Gillin *et al*. 2002); and foot and mouth disease outbreaks in southern Africa have affected livestock and wildlife (Thomson *et al*. 2003). It is clear from these examples that the issues of health and disease need to be brought into the conservation mainstream (Deem *et al*. 2001, WCS 2003a).

Livestock and natural resources in Africa – subsistence and poverty

There are over 77 million cattle in Africa (Kock 2005), and they represent a key factor in rural livelihoods and human well-being, disease control strategies, and the future health of ecosystems and the services they provide. It is a concern that large donors' attempts to reduce poverty in Africa often focus on livestock production (Perry *et al*. 2003, DFID 2002) at the expense of wildlife and natural resources and with little consideration for alternative land-use options. Livestock production is both unsustainable (without subsidies) and a poor land-use option in many semi-arid areas of the continent (Barnes *et al*. 2003, R.B. Martin personal communication 2003, Child 1995). This focus on "livestock as livelihood" is reflected in the funding allocated by many governments, trusts, foundations, and nongovernmental organizations. The negative impacts of subsidized livestock production on ecosystem health benefit nobody. The continued dependence on livestock in semi-arid areas of Africa is likely to keep rural people poor. What is needed to reduce poverty, lift rural communities beyond subsistence living, and promote environmental stewardship is a diversification of rural livelihoods to include both sustainable livestock production and natural resources management, as well as support for existing indigenous systems such as pastoralism (Kock 2005, Grahn and Leyland 2005).

Protected area management – aquatic and terrestrial areas

Historically, protected areas in Africa have been managed without due concern for the communities that live close to these areas. This "hard edge" approach has done little to foster support for conservation and environmental issues, and this legacy can be seen in the lukewarm response that the wildlife industry receives from politicians and other decision-makers in many parts of postcolonial Africa. In southern Africa, the adoption of community-based approaches to resource management, such as CAMPFIRE (Communal Areas Management Program For Indigenous Resources), softened the hard edge and allowed communities to benefit from protected areas, be they national parks, game reserves, safari areas, or private conservation initiatives (Child 1995). Community-Based Natural Resource Management (CBNRM) programs continue to be developed and evaluated in southern Africa (Murphree 2000, DFID 2002, Weaver and Skyer 2005, D. Cumming, personal communication 2004, Murphree 2005, Lewis 2005).

In the 21st century, management of protected areas needs to go beyond just concern for improved relationships with communities through benefits such as cash returns related to CBNRM. It must consider the health of the overall ecosystem, including people, their livestock, and the flora and fauna that are part of the larger community. Additionally, management of a protected area and the communities that are terrestrially based must consider their activities in terms of their impacts on adjacent water bodies, including marine-protected areas. Runoff from land can carry undesirable contaminants and pathogens into marine and freshwater environments with potentially negative impacts on biodiversity (Miller *et al*. 2002, Lafferty and Gerber 2002, Daszak and Cunningham 2002).

The health paradigm: What is health? What is an ecosystem?

Human well-being and progress towards sustainable development are vitally dependent upon improving the management of the earth's ecosystems to ensure conservation and sustainable use (Millennium Ecosystem Assessment 2003). The World Health Organization (WHO) defines health as a state of complete physical, mental, and social well-being and not just the absence of disease and infirmity (Deem *et al*. 2001, Last 1983). Within the broader context of health, this is very much a human-focused definition and cannot be applied to wildlife or ecosystems. An ecosystem is a dynamic complex of plant, animal, and micro-organism communities and the nonliving environment interacting as a functional unit (Millennium Ecosystem Assessment 2003). People and their livelihoods are an integral part of ecosystems. Ecosystems of course vary enormously in size and composition, from a small city park to a forested basin extending over several thousand square kilometres.

An ecosystem should be viewed as a patient (Rapport 1998) and can be evaluated in terms of objective standards that relate to the system's capacity for organization, vigour, and resilience. Ecosystem *services* are the benefits people and animals obtain from ecosystems and are vital to ecosystem stability. The state of health of an ecosystem can be judged by criteria very similar to those for a person or animal, namely:

- Homeostasis (having balance between system components)
- Absence of disease
- Diversity and complexity
- Stability and resiliency
- Vigour and scope for growth

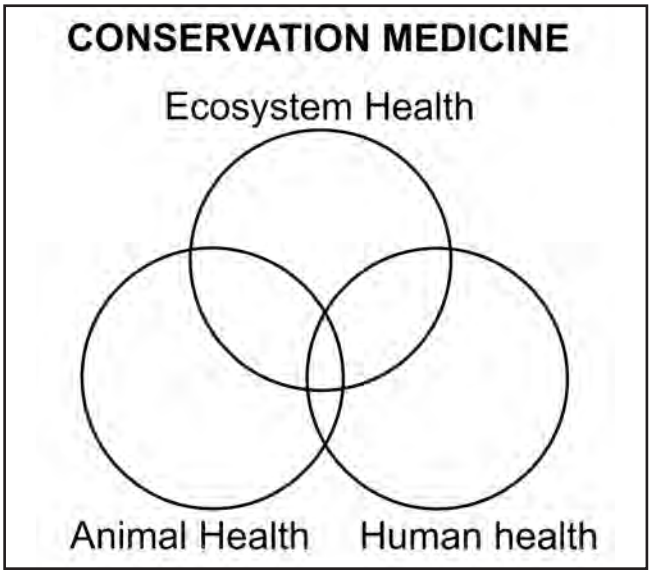
Widespread social inequities, ecological dysfunction, and climate instability are all contributing to the emergence, resurgence, and redistribution of infectious diseases on a global scale (Epstein 1998); therefore, there is an increasing need for a transdisciplinary approach to examining ecosystem health and to developing ways to assess health more broadly and objectively.

Just as conservation practitioners without a health background need to understand that health matters when considering biodiversity and protected area planning, so should veterinary and other health authorities recognize that ecosystems and their services are important and that many rural people rely on natural resources for a living.

Conservation medicine, ecosystem health, and preventive medicine

The concept of "one health" and the interface between veterinary medicine, human medicine, and public health is not a new concept. During the 1960s and 1970s visionary attempts were made to construct a bridge between medicine and agriculture by veterinarians such as Professor Calvin Schwabe. Discussions on medical ecology and zoology, animal monitors of the environment, and comparative biology and medicine were the precursors to a more holistic approach to animal and human health (Schwabe 1984). This concept has been further developed through programs such as Envirovet (Beasley 1993) and the development of ecosystem health as an integrative science (Rapport *et al*. 1998).

Fig. 1. Conservation medicine is at the nexus of the fields of human health, animal health, and ecosystem health.



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The "one health" concept takes *conservation medicine* a step further by including a broader socioecological definition of health (Kock 1996); and conservation medicine's primary goal is the pursuit of ecological health – the health of ecosystems and the species that live within these systems (Fig. 1) (Else and Pokras 2002, Tabor 2002). Conservation medicine attempts to bring together many disciplines, including human and public health, epidemiology, veterinary medicine, toxicology, ecology, and conservation biology (Meffe 1999). Adopting an ecosystem approach to health issues related to protected areas and the communities that live close to or in these areas represents an attempt to bridge the gaps that exist between the different disciplines and create an enabling environment for a win-win situation. Conservation medicine encourages practitioners to look upstream as well as downstream, e.g., for potential environmental impacts of land uses and activities (Tabor 2002). Powerful biomedical tools are available to address these complex issues and develop preventive approaches.

Biodiversity and health assessment

Just as the conservation importance of an area is typically determined by assessing its biodiversity (Sutherland 2000), so can veterinarians and conservation biologists apply similar techniques using biomedical tools to assess the health of the area and all its components (Rapport 1998). The "ecosystem as patient" metaphor can also help shape our overall approach: "Critical clinical problems mandate a rigorous

diagnostic plan, a multifaceted therapeutic plan, clear communication, and short- as well as long-term monitoring. Critical conservation problems deserve no less." (Osofsky 1997). Biodiversity assessment is essential with any conservation planning effort: if you do not know what you have, how can you determine what has been lost and identify any problems? Without baseline data on species present and their abundance it would be difficult to develop conservation priorities. Fig. 2 outlines a logical approach for organizing conservation work. The health paradigm fits neatly into this schematic because just as biodiversity needs to be assessed, so does the health status of the living components of the system, e.g., the presence or absence of disease (Fig. 3). Identification and diagnosis of problems and the application of solutions along with biodiversity assessment and monitoring is similar to the approach to ecosystem health care. In biomedical terms this would be achieved through detection, diagnosis, prognosis, treatment, and prevention. In the case of ecosystem health, the precautionary principle is supportive of an approach based on the tenets of preventive medicine – anticipatory action to protect the environment from possible or irreversible harm (Calver 2000). A preventive medicine approach allows for action to be taken without a causal relationship being proved but only suspected, thus lessening the risks of uncertainty.

Biomedical tools and ecological condition monitoring

Ecosystems provide vital services to human and animal communities, e.g., by providing natural filtering systems, sources of food and fibre, and water (Rapport 1998). Disruption of some of these natural services will have impacts on air, water, and other renewable resources and thus health. Pathogen pollution in water systems can be attributed in some instances to the disappearance of natural filtering systems such as marshes and swamps (Miller *et al*. 2002).

Ecosystems are constantly in a state of flux related to land ownership and management, water and air quality, plant and animal diversity, threatened and endangered species, exotic and invasive species, and human recreation. An adaptive approach to monitoring needs to be adopted to deal with these uncertainties and changes (Figs. 2 and 3) (Sutherland 2000, Salafsky *et al*. 2001).

The development of ecological indicators can provide powerful tools that can generate scientific information on the status or trends of important ecosystem health parameters (Sayre *et al*. 2000). In parallel, epidemiological tools such as disease surveillance and monitoring can be linked to various indicators in terms of disease and health impacts. The use of indicators will help simplify data for decisionmakers and provide a focal point for strategic planning, policy formulation, resource allocation, and specific management actions (Boyce 2003).

Fig. 2. Logical process for organizing conservation work

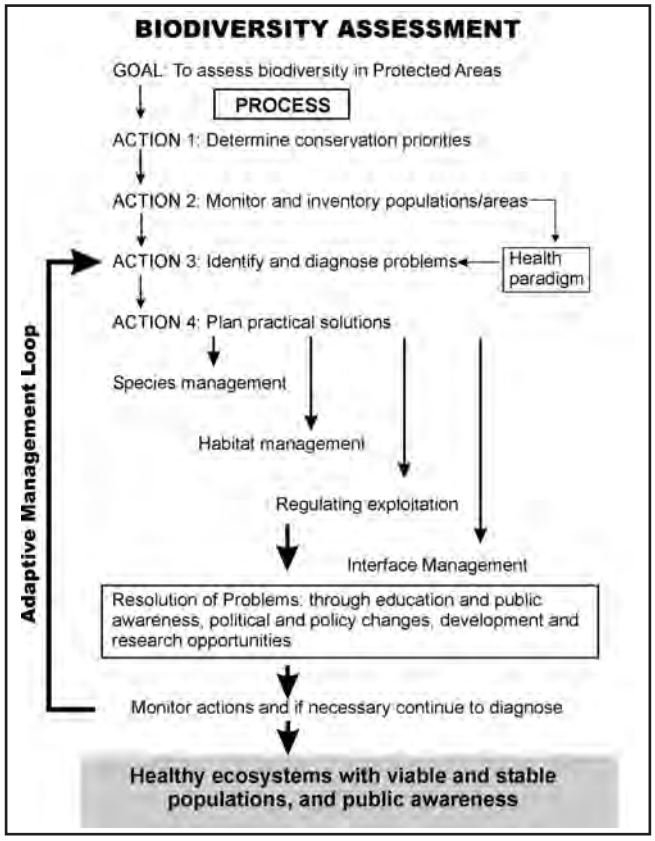

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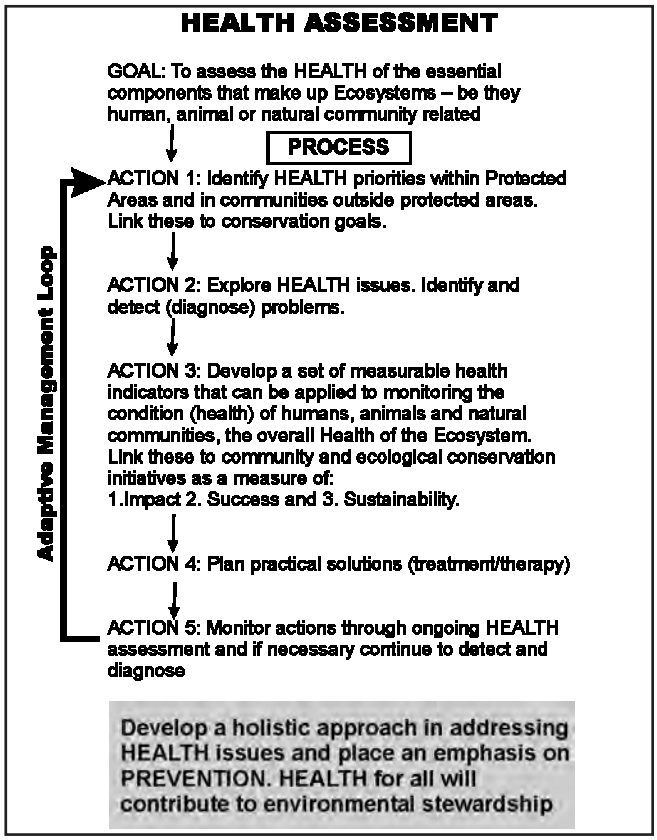
Fig. 3. Logic for health assessment of an ecosystem



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Boyce (2003) describes a conceptual model that demonstrates how and why indicators are useful. The model assumes a causal relationship between the following factors:

- Stresses placed on the environment by people or natural causes (*pressures*)
- Changes in the state or condition of the environment (*state*)
- Changes in ecological health caused by changes in environmental conditions (*effects*)
- Actions taken by authorities and stakeholders (*responses)*

For example, the introduction of an exotic and invasive plant species such as Port Jackson (*Acacia saligna*) into the Western Cape of South Africa exerts *pressures* on the environment. These pressures alter the *state* or condition of the environment, such as impacting on the water table. The change in the water table has adverse *effects* on native species by reducing water availability. Government and managers *respond* by implementing a "Working for Water Campaign" with removal of invasive species.

The following is a conceptual and hypothetical presentation of a set of ecosystem health issues (ecosystems being wild *and* human derived) and ecological and health indicators that might be used to address the issues (detect, diagnose, and treat/prevent) and monitor them.

Tuberculosis and human immunodeficiency virus/ acquired immune deficiency syndrome (HIV/AIDS) in the greater Kruger NP area: Unhealthy ecosystem because of introduction of BTB (*Mycobacterium bovis*) into buffalo, negative impact on other species, especially predators, and potential for spread to immunocompromised individuals living in human communities bordering the Park.

Desired Conditions

- Intact ecological processes and biological diversity within the park, i.e., healthy ecosystems
- Freedom from BTB or reduced prevalence of the disease (assuming chronic state)
- Reduced prevalence of HIV infection in the human communities and absence of BTB in both people and their livestock

Stressors

- Chronic BTB infection in buffalo, continued spread of the disease, and spill over into other species within the ecosystem and beyond
- Drought and other environmental stressors; focal water points
- Increasing human population around the Kruger NP
- Attitude – lack of knowledge on the means to prevent HIV-AIDS
- High HIV prevalence and full-blown AIDS cases: immunocompromised individuals
- Increasing opportunities for human-buffalo contact through illegal activities or infection of cattle through buffalo contact or drought-induced incursions by cattle into the Park

Indicators

- Abundance of buffalo
- Distribution of buffalo
- Survivorship of adult buffalo
- Cause-specific mortality in buffalo
- Presence or absence of disease in live buffalo (BTB testing using skin test and/or blood test)
- Abundance of lion
- Distribution of lion
- Survivorship of adult lion
- Cause-specific mortality in lion
- Survivorship of people bordering the Park
- Cause-specific mortality in the human community bordering the Park (AIDS-related diseases)
- Response to educational programs, e.g., use of condoms
- HIV prevalence in local communities
- Detection and/or monitoring of BTB either in human communities or their livestock, or both

The use of an ecosystem health paradigm with ecological and health indicators would provide for an integrated approach to the issues affecting both human and animal communities living within the greater Kruger NP/Great Limpopo Transfrontier Conservation Area (involving South Africa, Mozambique, and Zimbabwe). This holistic approach should also result in improved public relations and attitudes towards park management programs and broader environmental issues.

The health umbrella

In 1933, Aldo Leopold (Leopold 1933) stated, "The role of disease in wildlife conservation has probably been radically underestimated." Despite this recognition early in the 20th century, conservation efforts worldwide are still being hampered because of a critical flaw in the overall approach: the failure to recognize the critical role that health plays in animal population dynamics, species survival, and the follow-on impacts on the human condition. Improving the health of people and their domestic animals is not only a key step to raising living standards and livelihood security, it is the single most effective way to reduce the incidence of disease transmission to highly susceptible wildlife populations (WCS 2003c).

Recognition of the "ecological" context of health has been significantly boosted by the World Parks Congress "Southern and East African Experts Panel on Designing Successful Conservation and Development Interventions at the Wildlife/ Livestock Interface: Implications for Wildlife, Livestock, and Human Health," held in Durban, South Africa, in 2003. An official output from the Congress was an "Emerging Issues" declaration, and within the "Building Broader Support for Protected Areas" stream, the issue of "Disease and Protected Area Management" was recognized as one of the key emerging

issues requiring attention (World Parks Congress Outputs 2003).

The World Parks Congress has acknowledged the "one health" paradigm and how this interfaces with protected areas, as well as how healthy ecosystems can contribute to sustainable development and human well-being. People, their animals, and the flora and wild fauna on planet Earth totally depend on a flow of services that are provided by healthy ecosystems; unhealthy ecosystems are by definition more likely to harbour pathogens, pollutants, and toxins. Broader support for protected areas through application of the health sciences, with their clear link to human well-being, will provide impetus for enhancing conservation success and the sustainability of these areas in a turbulent, ever-changing world.

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Chapter 13

Conservancies: Integrating Wildlife Land-Use Options into the Livelihood, Development and Conservation Strategies of Namibian Communities[1]

Larrye Chris Weaver[2] and Patricia Skyer[3]

Introduction

This paper presents information on the Namibia Conservancy Programme and highlights the conservation and development impacts that Namibia's incentive-based conservation policies are producing in communal areas and how conservancies may enhance the viability of Namibia's park system. A case study on the Nyae Nyae Conservancy is used 1) to provide documentation on the contributions of wildlife and tourism to the livelihoods of one of Namibia's most marginalized people – the Ju/'hoansi San; and 2) to demonstrate the tremendous untapped wildlife potential that remains to be harnessed by conservancies. Lastly, this paper identifies some of the challenges facing the conservancy programme and discusses the need for government decisionmakers to recognize the long-term competitive advantages of wildlife and tourism as legitimate land uses for Namibia's arid and semi-arid environment. In this regard, it will be essential to address restrictive veterinary regulations that place wildlife production at a competitive disadvantage to a highly subsidized commercial and subsistence livestock industry.

Background

Namibia is a large country (823,988km^2) located in southwestern Africa, where it is bordered by Angola and Zambia to the north, Botswana to the east, South Africa to the south, and the Atlantic Ocean in the west. Namibia acquired its independence from South Africa in 1990, but in a short period of time has put in place a remarkably innovative and effective community conservation movement.

The population of 1,826,854 (Census Office 2002) is largely rural, with more than 65% living on communally owned lands, which is one of three predominant land-tenure regimes. Roughly 6,100 private farms (Barnard 1998) occupy 44% of Namibia, communal lands encompass an additional 42%, and a network of 21 protected areas covers the remaining 14%.

The climate ranges from hyperarid in the west, where portions of the Namib Desert receive average rainfalls of less than 25mm/year, to subhumid in the Caprivi Region, which averages precipitation of 600–700mm/year (Barnard 1998). Rainfall distribution provides a foundation for three main vegetation zones (i.e., deserts, savannas, and woodlands), which in turn, have been classified into 14 distinct vegetation types (Geiss 1971).

Traditionally, Namibian communal-area residents have depended heavily on subsistence crop and livestock agriculture to support daily livelihood needs. However, there is growing recognition of the unsuitability of much of Namibia for arable crop or sustainable livestock production, and the Namibia Ministry of Environment and Tourism (MET) has initiated a national conservancy movement that seeks to promote and integrate (where appropriate) wildlife production and tourism development efforts into the welfare and livelihoods of many communal-area residents.

Although impressive returns are being realized, the financial viability of most registered and emerging conservancies are marginalised due to their location within Namibia's designated veterinary restriction zone, where diseases such as foot and mouth disease (FMD), contagious bovine pleural pneumonia (CBPP), corridor disease, bovine tuberculosis, and malignant catarrhal fever still remain health threats and potential compromises to Namibia's livestock export markets. The resultant veterinary restrictions make it difficult for such conservancies to fully capitalize on the presence of recovering populations of high-value wildlife species such as roan antelope, sable, and disease-free buffalo, as well as burgeoning populations of common plains game species (i.e., springbok, oryx, eland, etc.) that have viable market values within Namibia or the broader southern Africa region.

Unless innovative mechanisms are found to mitigate the risks of infectious diseases and/or their associated regulatory controls, the wildlife industry in communal-area conservancies cannot reach its potential and will remain at a competitive disadvantage to a livestock industry that has been highly subsidized through years of government support and artificially inspired international export markets. Alternatively, should mechanisms to mitigate risk be found, it is predictable that the integration of wildlife and tourism activities into the livelihoods of rural Namibian residents will continue, and will in the process be promoted as legitimate,

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[1]See abstract on p.xxv.

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competitive land uses comparable with or advantageous to agriculture in Namibia's semi-arid and arid ecosystems.

Conservation policy setting

Namibia is renowned for its vast wilderness settings and rich wildlife populations. However, prior to 1970, national wildlife populations were declining. It was not until 1968, when freehold farmers were given limited rights of proprietorship over wildlife, that farmers acquired incentives to manage their wildlife for economic gain. These rights were reinforced through the passage of the Nature Conservation Ordinance of 1975, and since then wildlife numbers on commercial farmlands have increased by more than 80% (Barnes and de Jager 1996).

In contrast to the freehold situation, wildlife population trends on most of Namibia's communal lands continued to decline until the mid-1990s. In an effort to emulate a similar recovery of wildlife populations on Namibia's communal lands, MET approved a policy entitled "Wildlife Management, Utilisation and Tourism in Communal Areas" (MET 1995) that was aimed at creating equitable rights to wildlife between freehold and communal-area residents. Shortly thereafter, the Government of Namibia passed legislation that established the legal rights of communal-area residents to benefit from wildlife once they had registered as a communal-area conservancy (Government of Republic of Namibia 1996).

Impacts of communal conservancy legislation

The passage and implementation of the communal conservancy legislation has stimulated a conservation movement that is unprecedented in Namibia, and perhaps elsewhere in Africa also. Since registration of the first four conservancies in 1998, the number of registered conservancies has grown to 29 (Fig. 1).

Fig. 1. Cumulative number of communal area conservancies by year since 1997

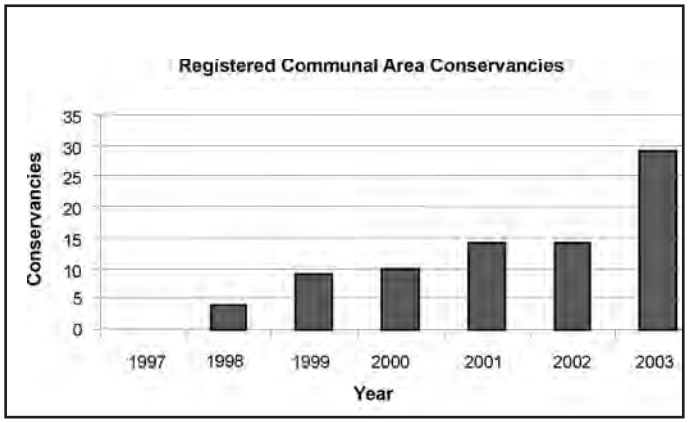
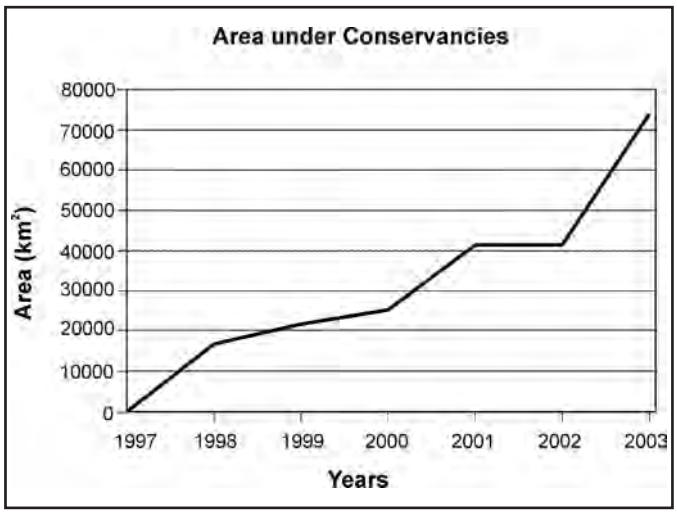


Fig. 2. Cumulative area (km²) registered under communal conservancies by year since 1997



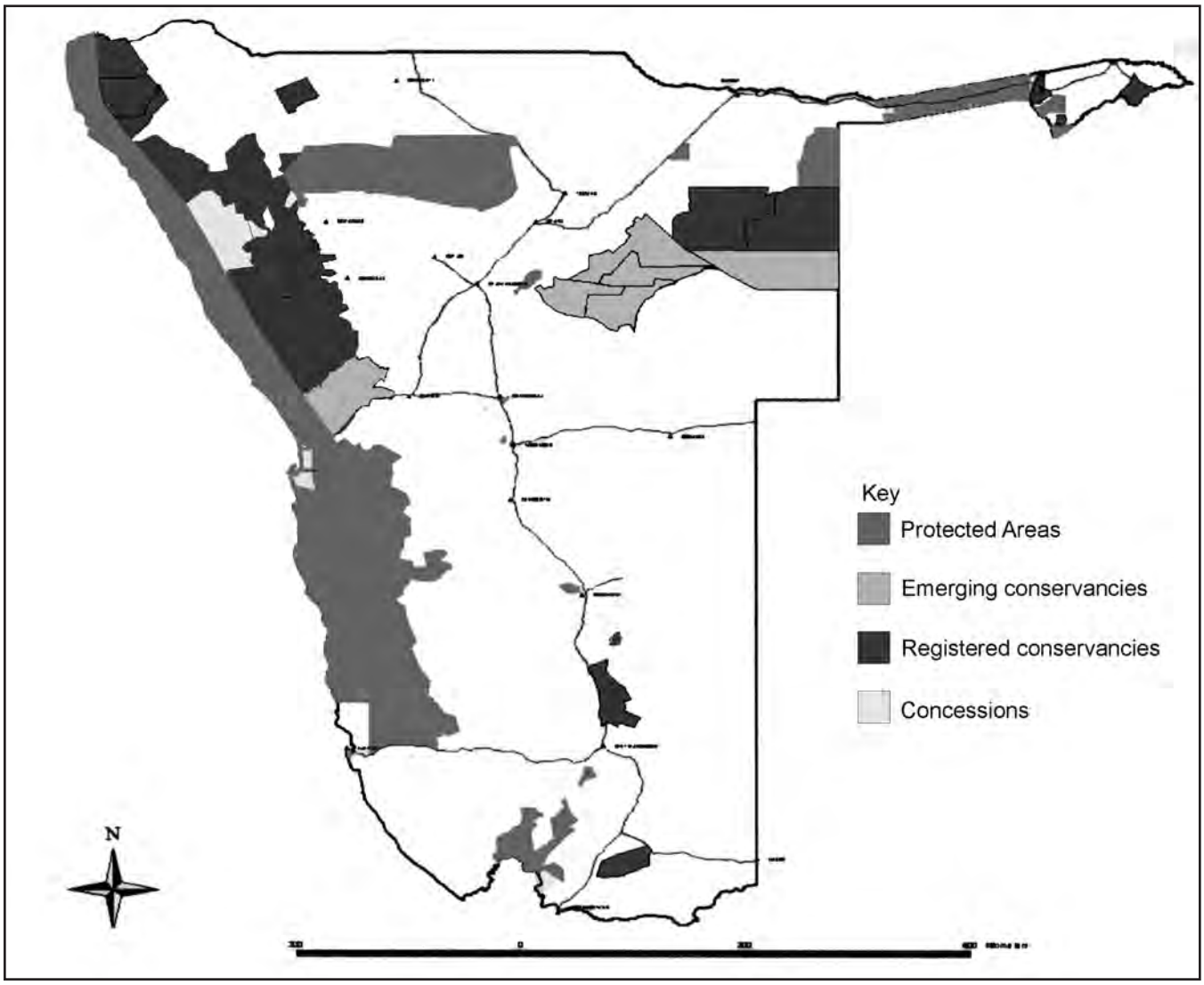
The communal conservancies are highly complementary to Namibia's 114,080km^2 protected area network. The registered conservancies encompass an additional 70,052km^2 (Fig. 2), and it is significant that 17 of these 29 conservancies are located immediately adjacent to national protected areas or in strategic wildlife movement corridors between such protected areas (Fig. 3).

These 17 conservancies place an additional 47,515km^2 of land adjacent to protected areas under compatible conservation management, thereby bolstering the protected network system by 42%. The increased conservation land base provides opportunity for wildlife to move seasonally between parks and communal areas, with the additional land base being of particular significance in times of drought or when poorly distributed rainfall force wildlife to move out of protected areas in search of forage or water.

The conservancy legislation has catalysed a fundamental shift in the attitudes of community members towards wildlife. Before this empowering legislation was passed, wildlife was deeply resented because only the State gained from the presence of wild animals that competed with livestock for grazing and water, preyed on livestock, and routinely damaged crops and infrastructure. Given the hardships wildlife imposed on communities, there was little community support for these "State assets," and wildlife was routinely and widely poached.

In contrast, following five years of conservancies receiving tangible benefits (income, employment, meat, etc.) from wildlife, there are now a documented 38,000 registered conservancy members (representing more than 150,000 communal-area residents) engaged in conservation activities in communal conservancies (DFID WILD Project 2003). Thus, the mindset and attitude of many of Namibia's communal-area residents have drastically shifted, whereby wildlife is now viewed as a community asset instead of a community liability.

Fig. 3. Registered and emerging communal conservancies in Namibia



Source: NACSO Natural Resource Working Group

The positive community attitude has had a marked impact on the recovery of wildlife populations. Northwest Namibia provides a striking example. In the early 1980s, following two decades of heavy poaching and a major drought, wildlife populations in this rugged, 50,000km^2 remote corner of Namibia were at a historical low, with populations of such species as springbok, oryx, and Hartmann's zebra being estimated at less than 1,000 animals each (Gibson 2001).

Shortly thereafter, Namibia's fledgling Community-Based Natural Resource Management (CBNRM) Programme was introduced in the form of Community Game Guards through the NGO Integrated Rural Development and Nature Conservation (IRDNC). This community initiative, which eventually led to the conservancy programme, was highly successful in reducing poaching by enhancing community stewardship over its remnant wildlife resources.

As a consequence, wildlife populations slowly began to recover, paving the way for today's burgeoning populations that are believed to include more than 100,000 springbok, 35,000 oryx, and 14,000 Hartmann's zebra.

The trends (Fig. 4) of these populations have been documented over the past four years by annual road counts that entail annual analyses of the number of animals observed per 100km over more than 6,000km of transect routes.

The recovering wildlife populations are now being translated into tangible benefits for conservancies and their members in the form of cash returns to conservancies/enterprises, employment, and in-kind benefits such as meat from game (trophy animals or own-use harvesting). Since passage of the 1996 conservancy legislation, the Namibia National CBNRM Programme has noted a rapid increase in the flow of benefits to conservancies and their members (WWF-LIFE Programme 2002). Benefits to Namibia's CBNRM participants have almost doubled during three of the last four years (Fig. 5), with documented benefits in 2002 exceeding N $11,100,000 (US $1,100,000).

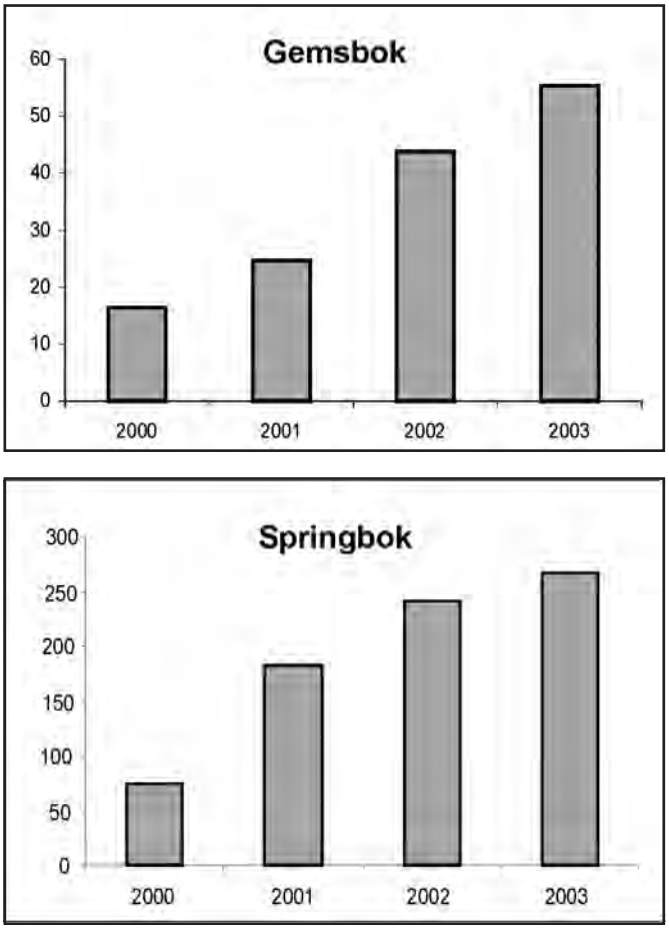
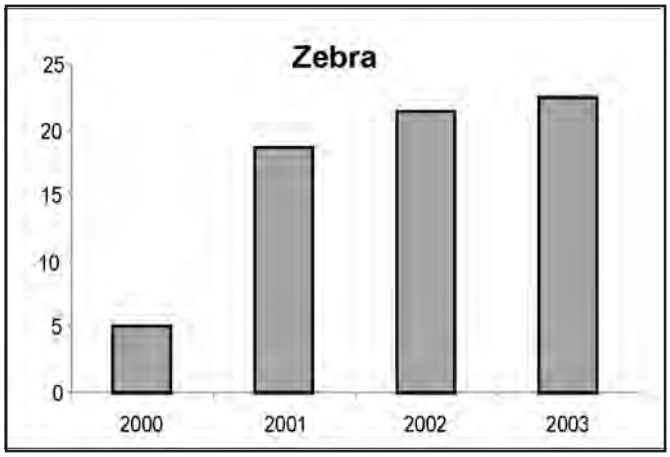
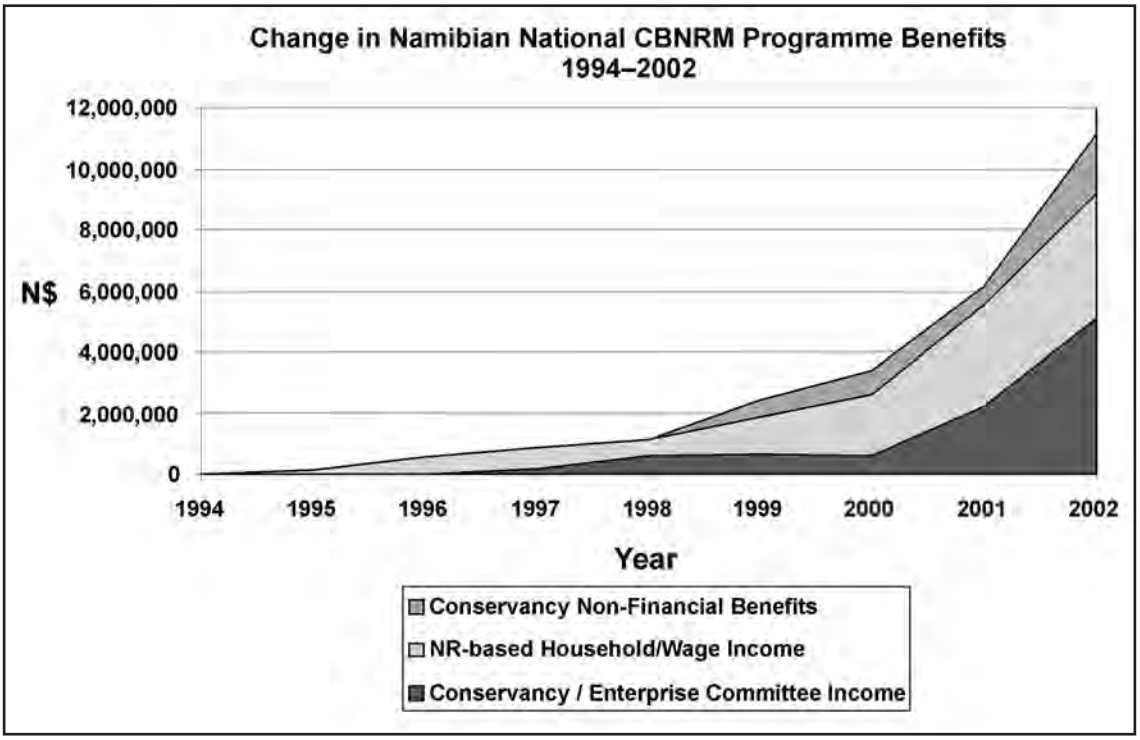


Fig. 4. Population trends for gemsbok, springbok, and Hartmann's zebra in NW Namibia from 2000 through 2003 based on animals observed per 100km driven



Source: MET/WWF/NACSO 2003

Fig. 5. Benefits generated by the Namibia National CBNRM Programme 1994–2002 (N$10 = approximately US $1 during October 2002)



Conservancies and their implications for traditional land uses

The communal conservancy programme has sparked a grass-roots movement by rural communities to integrate wildlife production activities into their livelihood strategies. In many instances, large tracts of conservancy lands have been zoned exclusively for wildlife production and tourism. A number of studies (Ashley *et al*. 1994, Ashley and LaFranchi 1997, DFID WILD Project 2003, Diggle 2003) have found that wildlife and tourism enterprises have substantial potential to complement and bolster the livelihoods of rural Namibian communities. Barnes and Humavindu (2003) recently assessed the Goddwana Canon Nature Reserve to compare tourism economic returns to those generated by livestock production activities on neighboring farms. The study documented three significant findings in favor of wildlife and tourism:

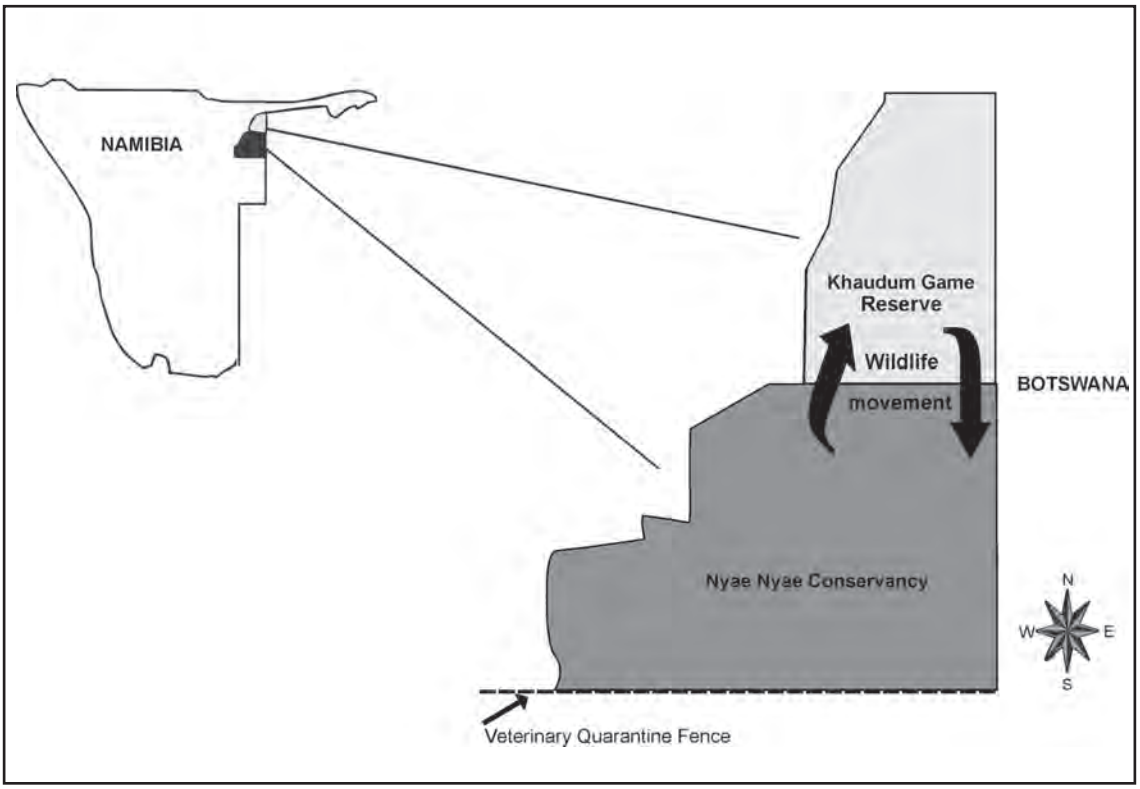
1) greater revenues generated per hectare than agriculture,
2) higher levels of employment than agriculture on neighbouring farms, and
3) the wildlife/tourism activities are significantly more ecologically friendly and sustainable for the area's arid ecosystem.

Although the viability of CBNRM in Namibia has been well documented, the communal conservancy movement is not being driven by studies. In contrast, the driving force is its benefactors – the rural community members who are reaping the direct economic, social, and environmental benefits of integrating wildlife into their livelihood planning and management practices. Thus far, the success of the conservancy movement is such that nearly one of every 12 Namibians is resident to a registered or emerging communal conservancy, and conservancy development is widely promoted in the latest Namibia National Development Plan (Government of Republic of Namibia 2002).

Nyae-Nyae Conservancy and Khaudum Game Reserve – a case study

The potential for conservancies and neighboring protected areas to effectively produce, co-manage, and market their joint natural resources has only begun to be tapped. An illustrative example is the Nyae Nyae Conservancy, Namibia's first communal conservancy, registered February 16, 1998 (Government of the Republic of Namibia 1998), and the adjoining Khaudum Game Reserve (GR). This area is located in northeastern Namibia, where it borders with Botswana to the east (fenced), communal lands to the west and north, and to the south, a veterinary quarantine "Red Line" fence established by the Ministry of Agriculture, Water, and Rural Development (MAWRD) to prevent movement of potential disease-harboring animals (wildlife and livestock) into Namibia's recognized livestock export zone (Fig. 6).

Fig. 6. Map of Khaudum Game Reserve and Nyae Nyae Conservancy



Nyae Nyae is the second largest conservancy in Namibia and encompasses approximately 9,030km^2 of Kalahari woodlands. Combined with Khaudum Game Reserve's 3,842km^2, this joint reserve/conservancy incorporates almost 13,000km^2 of wilderness wildlife habitat. The area receives approximately 400–450mm of rainfall per year, and it is estimated that more than 2,000 elephants move freely between Khaudum GR, the Nyae Nyae Conservancy, and neighboring communal lands. The area is home to Namibia's largest population of roan antelope, and also provides habitat for other common game species such as blue wildebeest, oryx, kudu, red hartebeest, eland, tsessebe, springbok, giraffe, duiker, and steenbok. Predators include a sparse population of lion and cheetah, but healthy numbers of leopard, spotted hyaena, and wild dogs. The Nyae Nyae Conservancy also contains a potentially very valuable herd of 74 disease-free buffalo that has been confined to a small 2,400ha compound due to veterinary health restrictions.

The Nyae Nyae Conservancy was founded by one of Namibia's most marginalized ethnic groups, the Ju/'hoansi San (formerly known as Bushman). The conservancy, excluding the district settlement of Tsumkwe, has 770 adult members, which represent a total population of approximately 1,800–2,000 San people (Berger *et al*. 2003).

The Ju/'hoansi San are a society in transition. Historically, the Ju/'hoansi were a skilled, hunter-gatherer society that moved seasonally over vast distances between Botswana and Namibia. However, the area now inhabited by the Ju/'hoansi is roughly one-tenth of the 90,000km^2 that an estimated 1,200 Ju/'hoansi occupied as recently as 1950 (Nyae Nyae Development Foundation 2002). This reduction in landbase, combined with the loss of traditional hunter-gatherer skills in the younger generation of Ju/'hoansi, is increasingly forcing the Ju/'hoansi to adapt to western societal norms. However, the remoteness of the area and the challenges of developing an effective, culturally adaptive educational system for the San have contributed to the Ju/'hoansi's extremely low levels of literacy and employment. Furthermore, efforts to introduce the traditional hunter-gatherer Ju/'hoansi to sedentary agricultural activities (i.e., livestock and crop production) have had limited success (Berger *et al*. 2003). These activities are further constrained by conflicts with local predators and expanding elephant populations.

Since 1993, the Living In a Finite Environment (LIFE) Project has assisted the Nyae Nyae Development Foundation to support the Ju/'hoansi San through a grant to bolster the Nyae Nyae Conservancy's ability to sustainably manage and benefit from its natural resources. A key aspect of this grant has been to assist the Ju/'hoansi to rebuild their wildlife populations from historical low levels in the early to mid-1990s back to numbers that can contribute to the Ju/'hoansi's welfare through benefits generated from trophy hunting, tourism, sustainable game-meat harvesting, and potentially, game farming of high-value species such as roan antelope or buffalo.

The LIFE Project is jointly funded by the United States Agency for International Development (USAID), MET, and the World Wildlife Fund (WWF), and administered by the WWF on behalf of the Namibia National CBNRM Programme. LIFE Project support to the Ju/'hoansi has come in a number of forms, including assistance in mobilizing the Ju/'hoansi into a conservancy; conservancy land-use zoning around different land uses (i.e., wildlife, integrated livestock, village areas, etc.); development and maintenance of game watering points; reintroduction of game to bolster the recovery rate and financial viability of the conservancy; support to the valuable disease-free buffalo herd; marketing and negotiation of trophy hunting concessions; and capacity building of the Nyae Nyae Conservancy committee to manage the above activities.

Programmatic impacts on the Nyae Nyae Conservancy and Khaudum GR wildlife populations

Previous game censuses (Table 1) of the combined Nyae Nyae Conservancy and Khaudum GR vary considerably (Stander 1995, Craig 1999). Nonetheless, it is clear that the estimated game populations are extremely low for such a vast area.

Over the past four years, the LIFE Project has worked closely with the Nyae Nyae Conservancy, MET, and private sector partners to bolster the existing game populations through a series of game translocations. From 1999 through September 2003, a total of 2,070 game animals, composed of 541 red hartebeest, 274 oryx, 86 blue wildebeest, 633 springbok, 233 eland, and 303 kudu were introduced to the Nyae Nyae Conservancy (Table 2).

The purposes of these introductions are manyfold: to increase the Nyae Nyae game populations, thereby allowing a larger and more diverse off-take of trophy animals; to increase the density of game in key areas of the conservancy, and in the general Nyae Nyae/Khaudum ecosystem, so that tourism becomes a more attractive and viable development option; and to increase the number of meat-producing species of game so that sustainable harvesting of game can begin to supplement the protein diets of the Ju/'hoansi residents of the conservancy. An additional intent is to increase the number of "buffer" species of game in the area (i.e., springbok, kudu, and oryx) so that predation pressure on more valuable species such as roan antelope and eland is reduced, thereby promoting the recovery of these species as well.

The decline of wildlife populations in the Nyae Nyae/Khaudum area during the 1980–1995 period is believed to be the result of a number of interacting factors. The earlier construction of veterinary fences along the eastern and southern boundaries of this area (i.e., Botswana/Namibia border and Namibia veterinary quarantine fence, respectively) has fragmented the historical migration routes of wildlife across the broader Kalahari ecosystem (*see* Martin – this volume). Concomitantly, the situation has been exacerbated by the settlement of the Ju/'hoansi people on waterpoints in the 1980s and the arising conflict between people and wildlife over access to water. Lastly, uncontrolled hunting has taken a toll on such species as giraffe.

Table 1. Estimated populations of the Nyae Nyae Conservancy and Khaudum GR based on MET aerial censuses in 1995 (Stander) and 1999 (Craig)

Species	1995 MET Census		1998 MET Census	
	Nyae Nyae	Khaudum GR	Nyae Nyae	Khaudum GR
Buffalo (*Syncerus caffer*)	30	–	33	0
Eland (*Taurotragus oryx*)	0	0	12	0
Elephant (*Loxodonta africana*)	302	783	552	2224
Oryx (*Orys gazella*)	110	152	429	59
Giraffe (*Giraffa camelopardalis*)	6	223	47	259
Red hartebeest (*Alcephalus busephalus*)	31	4	18	0
Kudu (*Tragelaphus strepsiceros*)	249	133	283	157
Ostrich (*Struthio camelus*)	190	26	311	29
Roan (*Hippotragus equinus*)	123	75	0	66
Springbok (*Antidorcas marsupialis*)	0	–	0	0
Warthog (*Phacochoerus aethiopicus*)	0	0	160	0
Blue wildebeest (*Connochaetes taurinus*)	164	51	204	145

Table 2. Estimated game populations for potential meat-producing animals in the Nyae Nyae Conservancy, based on the MET 1998 game census, game introductions to Nyae Nyae Conservancy 1999–2003, and extrapolated growth rates by species

Species	1998 MET Game Census	Game introductions					Total animals introduced	Est. annual growth (%)	Total estimated animals 2003
		1999	2000	2001	2002	2003			
Red hartebeest	18	42	43	230	226	0	541	15	727
Oryx	429	48	81	48	97	0	274	15	1171
Blue wildebeest	204	33	0	0	53	0	86	15	518
Springbok	0	89	92	0	209	243	633	20	823
Eland	12	0	83	0	0	150	233	15	268
Kudu	283	0	215	0	88	0	303	15	947
Elephant	558	-	-	-	-	-	-	7	733
Total	**1,504**	**212**	**514**	**278**	**673**	**393**	**2,070**		**5,187**

As a consequence of the above factors, it was necessary to coincide the game introduction effort with a complementary joint MET/Conservancy water development programme to establish and maintain wildlife water points in the Nyae Nyae Conservancy. Consequently, there are now 14 dedicated game water points in the conservancy, which is a sharp contrast to the less than five that were operational in the mid-1990s. Similarly, extensive efforts to create awareness and build capacity have been instigated to involve the Ju/'hoansi people in the management of the Conservancy's wildlife and to keep game water points free of settlement.

The combined efforts of the game translocations and water development programme have begun to generate substantial returns to the Nyae Nyae Conservancy. Although not confirmed by an additional aerial census, wildlife populations in the broader Nyae Nyae Conservancy/Khaudum GR have increased noticeably since 1998 (Alberts, personal communication 2003). Further, the frequent observation of introduced (ear-tagged) game in the Khaudum GR demonstrates the interconnectivity of Nyae Nyae and the Khaudum, and the value of the Nyae Nyae game introductions to the Reserve as well. An extrapolation of the population growth rates of the

estimated 1998 game populations, combined with the introduced game, at conservative annual recruitment estimates (ranging from 7% to 20% per year by species), reflects what is believed to be a robustly recovering game population (Table 2).

Impacts of the recovering wildlife populations on the livelihoods of the Nyae Nyae conservancy members

The Ju/'hoansi San are one of Namibia's most poverty-stricken and marginalized communities. A recent survey (Wiessner 2003) of 32 (of 33) Nyae Nyae settlements found income from non-conservancy sources to be based on 46 community members receiving monthly government pension payments and 70 people being formally employed. The total estimated annual income from non-conservancy sources was N$995,244 for 2003, or roughly N$498 per capita for the 2,000 residents of the Nyae Nyae Conservancy.

The development of the Nyae Nyae Conservancy has had considerable positive impact on the livelihoods of conservancy members. The conservancy has generated an additional 27 jobs, while conservancy members have received increased income from tourism, handicraft and devil's claw sales, and the conservancy's benefits distribution of trophy-hunting revenues back to the conservancy's 770 members (Honeb 2003). The additional 2003 conservancy-fostered income increased total estimated income to the conservancy members to more than N$2,000,000, or an estimated per capita income of N$1,039 (Table 3). Further, the above figures do not include the livelihood benefits derived from game meat consumed by conservancy members, or the support the conservancy provides towards maintenance of village and wildlife water points and small agricultural development activities.

The recovering wildlife populations are promoting an upward spiraling return to the Nyae Nyae Conservancy. Increased game populations have been translated into a much larger and diverse trophy-hunting quota from the MET. In 1998, the Nyae Nyae Conservancy received an initial, small trophy-hunting quota of 10 animals, composed of five different species. In contrast, the latest quota (2002/2003) reflects the MET's recognition of the recovering wildlife populations and includes 53 animals from 12 species.

The increased quota has had a significant impact on the trophy-hunting income. Nyae Nyae's first concession period (1998–1999) generated US $17,850/year, while the concession fee increased to US $42,900/year during the second concession period (2000–2001). In contrast, the revised 2002–2003 quota has resulted in payments of US$92,050 (N$845,697). As game numbers increase, increased quotas will continue to feed the upward income spiral.

Table 3. Cash incomes of Ju/'hoansi residents of the Nyae Nyae Conservancy 2002–2003

Source	Wiessner Data			Wiessner and NNC Records		
	No. pensioners	No. jobs	Income	No. pensioners	No. jobs	Income
Pensions	46		138,000	46		138,000
Government		47	709,764		47	709,764
Mining		12	60,480		12	60,480
Church/lodge/clinic		11	87,000		11	87,000
Handicrafts sales			240,000–300,000			240,000–300,000
Tourism			60,000			60,000
Devil's claw sales			10,000			10,000
Conservancy/hunter		12	82,200		27	235,428
Conservancy Cash Benefits Distribution						477,672*
Total	**46**	**82**	**1,387,444–1,447,444**	**46**	**97**	**2,018,344–2,078,344**

**The benefits distribution of N$477,672 was premised on accumulated trophy-hunting revenues from the 2000, 2001 and 2002 hunting seasons and does not reflect an annually viable sum of money available for distribution. Based on the hunting revenues received in 2002 of N$845,697, an amount of N$414 per member, or a total of N$318,828 was allocated to the benefits distribution. This sum was added to funds available from 2000 (N$82,940) and 2001 (N$75,904) to arrive at the total distribution of N$477,672.*

Table 4. Estimated stocking rate in Large Stock Unit (LSU) equivalents (Bothma 1996) for potential meat-producing wildlife species in the Nyae Nyae Conservancy 2003, 2007 and 2015

Species	LSU equivalent	Estimated LSUs 2003	Estimated LSUs 2007	Estimated LSUs 2015	Estimated no. animals 2015
Red hartebeest	0.37	269	438	807	2,182
Oryx	0.56	656	1,068	1,968	3,514
Blue wildebeest	0.50	259	443	815	1,629
Springbok	0.15	123	257	553	3,685
Eland	1.08	289	465	861	797
Kudu	0.54	511	833	1,534	2,841
Elephant	2.78	2,177	2,850	4,896	1,761
Total		**4,284**	**6,354**	**11,434**	**16,409**

Potential for increased generation of wildlife-related benefits in the Nyae Nyae Conservancy

An analysis of Nyae Nyae's potential for exploitable wildlife and tourism opportunities indicates that annual benefits can still increase several fold. The keys to this process are the continued growth of the Nyae Nyae wildlife populations, government recognition of the validity of wildlife and tourism as the predominant land use in the Nyae Nyae Conservancy, and development of mechanisms that allow Nyae Nyae to produce and sell high-value roan and buffalo populations to markets found within the disease-free commercial production areas of Namibia and/or South Africa.

The present wildlife stocking rate of the Nyae Nyae Conservancy is only a fraction of its potential carrying capacity. The climate and habitat of Nyae Nyae lend themselves to a conservative stocking rate of 20ha per Large Stock Unit (LSU). An extrapolation of this stocking rate against the conservancy's 903,000ha therefore indicates a conservative carrying capacity of 45,150 LSUs for the conservancy. Based on the extrapolated growth rates of the introduced and previously resident populations (1998 census), the seven most significant potential meat-producing species of wildlife found in the Nyae Nyae Conservancy would currently include 5,187 animals (Table 2). This is the equivalent of 4,284 LSUs (Table 4), or less than 10% of the Nyae Nyae Conservancy's estimated carrying capacity.

Game meat harvesting

Continued expansion of the Nyae Nyae game populations (based on 2% annual off-take rates for trophy hunting through 2007; and thereafter from 2007 to 2015 through a combination of trophy hunting at 2% and meat harvesting at 6.5% per year off-take) would still yield growing populations of approximately 11.5% per year for springbok and 6.5% for other plains game species (Fig. 7). At these growth rates, it is estimated that there would be approximately 14,648 plains game animals in Nyae Nyae by 2015. Similarly, if elephant populations maintained growth rates of 7% per year, approximately 1,761 elephants would be resident in the conservancy by 2015. Cumulatively, these six species of plains game and elephant would equate to 11,434 LSUs, or still only 25% of the conservancy's estimated carrying capacity (Table 4).

The livelihood benefits of harvesting the plains game for meat would be significant. At the above rates, 66 tons of meat could be harvested in 2007, and 117 tons by 2015 (Fig. 8). At a 3% growth rate, the Ju/'hoansi population of Nyae Nyae is projected to grow to 2251 in 2007 and to 2851 by 2015, which would translate into potential allocations of 29kg of meat per year per capita in the Nyae Nyae Conservancy by 2007 and 41kg by 2015. At today's market value of N$8/kg for venison, the present-day value of this meat benefit would be N$528,000 in 2007 and N$936,000 by 2015.

Sales of live wildlife

Plains Game: A potential alternative to harvesting the plains game for in-kind meat benefits would be to sell live game for cash payments. There is a vibrant and viable market for the sale of common plains game in both Namibia and the southern Africa region. However, the Nyae Nyae Conservancy's location in Namibia's FMD Buffer Zone presently makes it difficult to capitalize on the income these species are capable of generating. Table 5 provides an analysis of the value of these species through live capture versus harvesting for meat. While the live sale income is slightly more than the in-kind cash value of harvested game, the associated costs (i.e., feed, disease tests, death loss, etc.) of quarantining these animals for a 3-week period, plus capture and translocation costs, makes live sales a less attractive option to the Nyae Nyae Conservancy.

High-Value Game Species: Another more attractive option for income generation revolves around Nyae Nyae's high-value game species. Since 1991, the returns from sales of live animals in South Africa's game industry have risen from approximately R10,000,000 to R88,000,000 in 2001, and

Fig. 7. Extrapolated population growth rates for Nyae Nyae plains game (meat-producing) species, based on sustainable off-takes of 2% for trophy hunting through 2015 and 6.5% for meat harvesting from 2007 to 2015

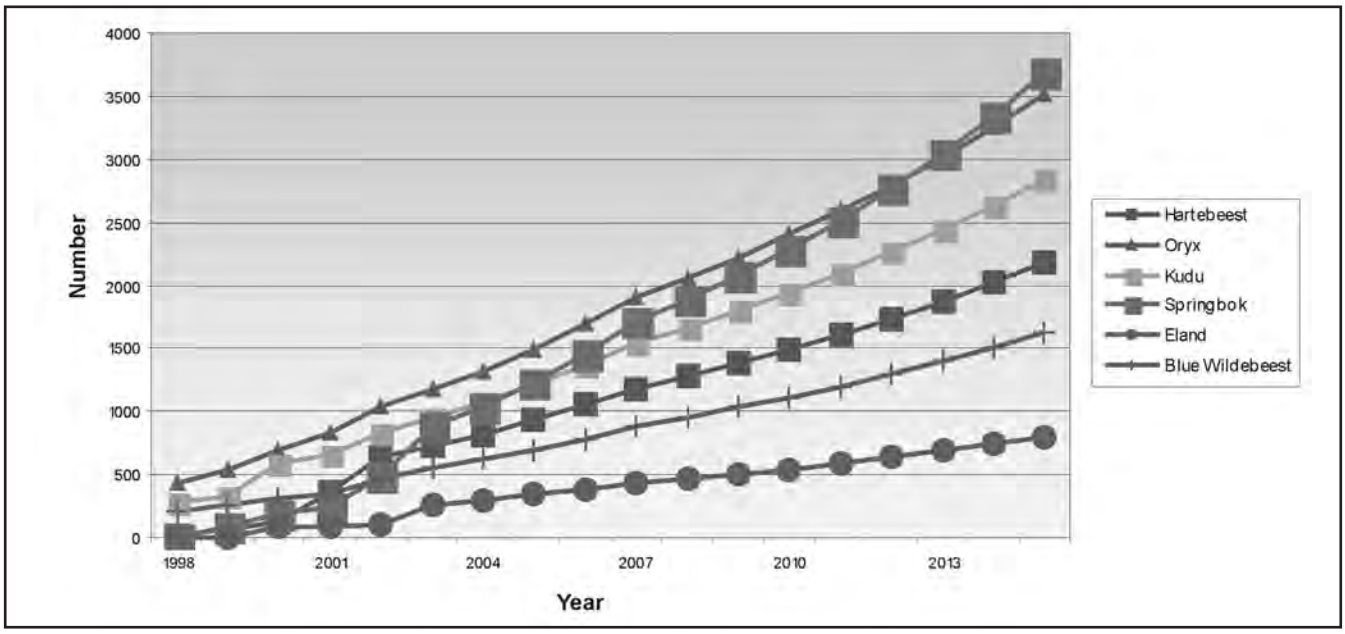


Table 5. Present-day values and potential numbers (based on 6.5% off-take) of plains game that could be sold from the Nyae Nyae Conservancy in 2007 and 2015 as an alternative to meat harvesting

Species	Present-day value (N $)	2007		2015	
		Projected no. animals for sale	Total value (N $)	Projected no. animals for sale	Total value (N $)
Red hartebeest	1,700	50	85,000	94	159,800
Oryx	1,700	80	136,000	151	256,700
Blue wildebeest	2,200	35	77,000	68	149,600
Springbok	1,000	106	106,000	241	241,000
Eland	4,000	16	64,000	33	132,000
Kudu	1,600	65	104,000	122	195,200
Total estimated income*			**572,000**		**1,134,300**

**The income projected from live sales of game reflects the total value of animals at present-day auction prices in Namibia, but does not portray the actual income the conservancy would make by selling these animals. Actual profit would be considerably less, as the costs of capture, transport, etc. of these animals would need to be subtracted from the total gross income.*

during this timeframe, values for roan antelope have increased by 178% and values for disease-free buffalo by 72% (Boonzaaier 2001). During 2002, the average regional selling prices for roan antelope ranged from N$155,000–N$170,000, while disease-free buffalo had an average value of N$126,000 (van Rooyen 2003).

The Nyae Nyae Conservancy and Khaudum GR area contains Namibia's largest concentration of roan antelope, while the Nyae Nyae Conservancy also is home to a small herd of buffalo. Both of these populations, under proper management, could yield lucrative returns to the Nyae Nyae Conservancy. But, as with the sale of the plains game, the conservancy's location in Namibia's FMD Buffer Zone presently prevents exploitation of this lucrative opportunity. Further compounding the matter is the fact that no buffalo are allowed below the Namibia Quarantine Red Line, thus preventing introduction of buffalo into Namibia's commercial farmlands where a strong demand for this species has been voiced by the hunting and game-production industry.

In 1996, under instructions from the MAWRD Veterinary Department, the MET moved Nyae Nyae's free-roaming buffalo population of 30 animals into a controlled 2,400ha camp. Shortly thereafter, the buffalo were tested for FMD, theileriosis (corridor disease), bovine tuberculosis, brucellosis, and lung sickness (CBPP). One animal tested seropositive for FMD, and it was removed from the herd and destroyed. Subsequently, the herd was again tested and found to be disease free. By September 2002, the herd had grown to 68 animals, and it was decided to reconfirm their disease-free status. Results of tests for FMD, theileriosis, and brucellosis were once again negative, reaffirming the disease-free status of the Nyae Nyae herd (Reuter 2002).

Over the past year, the Nyae Nyae buffalo herd has grown to 74 animals, but the herd is rapidly approaching the camp's carrying capacity, and costly supplemental feed now has to be provided to maintain the herd's condition. Thus, the need to enlarge the camp or construct a new one is imperative so the herd can continue to grow under optimal conditions. This could be a prohibitively expensive undertaking given the current veterinary restrictions against the introduction of buffalo onto Namibia's commercial lands and/or the transport of these buffalo across Namibia's unrestricted veterinary zones. However if these restrictions were relaxed, the commercial development of the Nyae Nyae Conservancy disease-free buffalo herd would become highly lucrative. Furthermore, the development of such a production facility could be done in such a manner that some of Nyae Nyae's roan antelope could be moved into the facility and managed for live sales as well.

According to Martin (2002), buffalo populations in 400–500mm rainfall belts can be expected to grow at rates between 2.71% and 4.13% under free-ranging conditions where predation and poaching have strong influences on herd productivity. In contrast, Stuart-Hill (1998) developed a simple population growth model for the Nyae Nyae buffalo herd that projected herd growth rates at 15.5% per year. It is interesting to note that the Nyae Nyae herd growth rate has almost identically mirrored the Stuart-Hill model that predicted a population of 76 by 2003. Thus, it would appear the Nyae Nyae herd could potentially be managed for a growth rate of 15% per year under appropriate conditions.

For purposes of projecting possible income from the live sales of Nyae Nyae buffalo and roan antelope, it is assumed that both species will reproduce at 15% per year. A management objective for buffalo could be to build the herd to 100 animals and then to begin the sale of live animals at 6% per year. This off-take level would allow maintenance of a steady growth rate of 9% per year, which could be maintained until the herd reaches a population of 150. From this point, the objective could be to sell 9% of the annual growth and maintain herd growth at 6%. Given the anticipated low starting population of the roan herd, the objective should be to not sell animals until the herd reached 50 in number. At this threshold point, the sale of live animals could start at 6% per year, while the annual herd growth rate could be maintained at 9% for the foreseeable future.

Population projections for buffalo are based on the present number of 74 buffalo and a proposed breeding herd of 40 roan antelope to be established in 2005. Based on these assumptions, the Conservancy could generate N$1,362,000 from live-game sales in 2007 (N$882,000 from the sale of seven buffalo and N$480,000 from the sale of three roan). By 2015, this figure could increase to a total of N$3,228,000 per year from the sale of 18 buffalo and 6 roan (Table 6). Perhaps even more significant is the accumulated asset value the Conservancy would acquire through this process. By 2015, the buffalo herd would have grown to 195 animals, while the roan would have increased to a herd of 99 animals. The asset value of these animals (at present-day values) would be an impressive N$40,410,000.

Table 6. Projected annual income from live sales of buffalo and roan antelope for the Nyae Nyae Conservancy for 2005, 2007, and 2015

		2005		2007		2015	
Species	**Present-day value (N $)**	**No. to be sold**	**Total value (N $)**	**No. to be sold**	**Total value (N $)**	**No. to be sold**	**Total value (N $)**
Buffalo	126,000	6	756,000	7	882,000	18	2,268,000
Roan antelope	160,000	0	0	3	480,000	6	960,000
Total per year		**6**	**756,000**	**10**	**1,362,000**	**24**	**3,228,000**

In addition to capitalizing on the production and sale of the buffalo and roan in Nyae Nyae, the Conservancy could also potentially consider reestablishing a white rhino population and introducing sable from nearby West Caprivi. These species would also contribute substantial financial returns to the Conservancy from live sales. Further, the presence of all four of these species in a 10,000ha high-value game production center would prove highly attractive to an up-market lodge operation in the Nyae Nyae Conservancy.

Expansion of trophy-hunting operations

As the game populations increase, the annual trophy quota can be expanded. Table 7 reflects a projection of the potential increased quotas and associated trophy-hunting revenues that Nyae Nyae could achieve in 2007 and 2015. These projections are based on a number of factors, including 2% and 1.5% harvest rates for plains game species and elephant, respectively; annual growth rates of 20% for springbok, 15% for the remaining plains game species, and 7% for elephant; and meat harvesting of plains game at a rate of 6.5% of the respective populations from 2007 on. The projections also assume game water points are expanded and the area remains predominantly managed for wildlife. In addition, as game numbers increase, the volume of trophies available for harvesting will far exceed the capacity of one concessionaire.

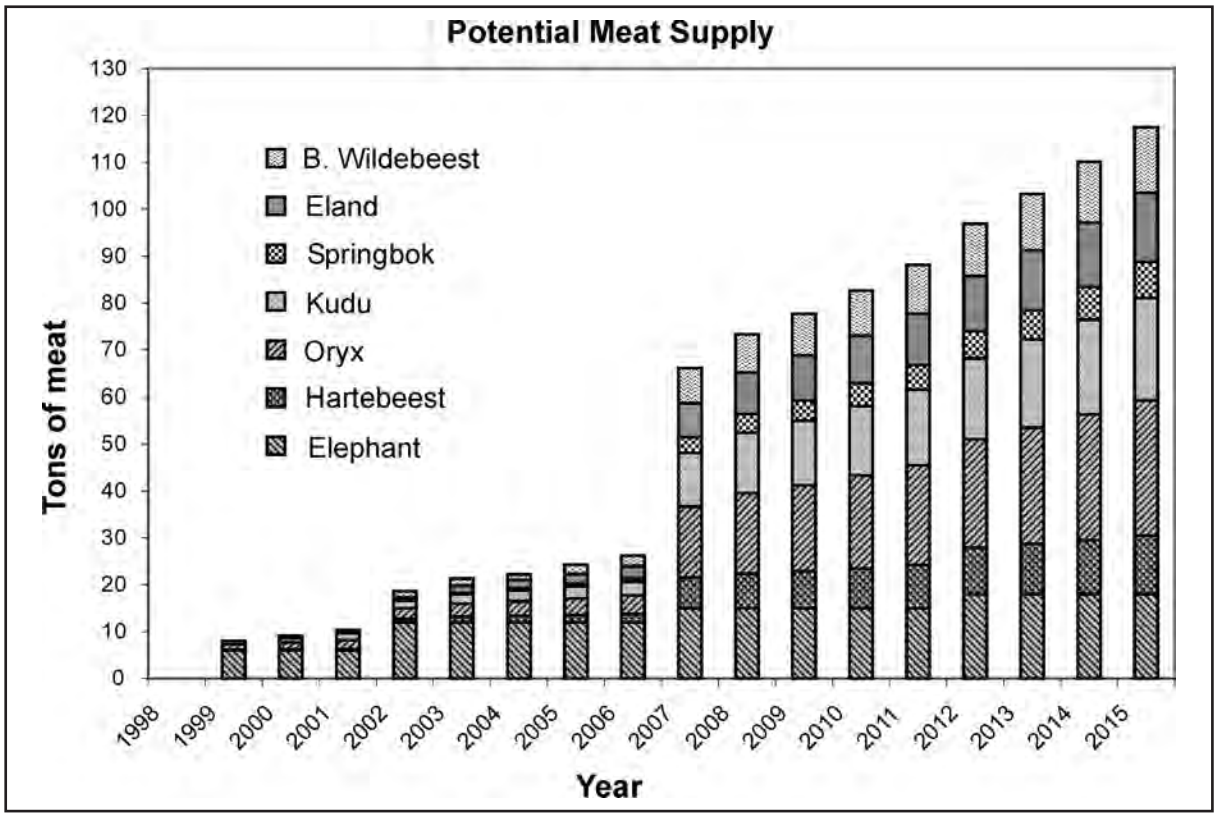
Hence, it is projected that the Nyae Nyae Conservancy will be partitioned into two hunting concessions in 2007 and five by 2015, and the Conservancy would then receive additional conservation support fees from each concessionaire similar to those paid by the current concessionaire. Lastly, no increased quotas or fees have been factored in for leopard, hyaena, duiker, steenbok, or roan antelope, as these species have not been built into the model. But income from these species would most certainly increase as well.

Based on the above calculations, the 2007 trophy-hunting operation has the potential to generate US$206,950/year (N$1,655,600), and by 2015, a total of US$588,950 (N$4,711,600) could be reaped. In addition, the creation of four additional hunting concessions would produce approximately six more jobs per concession, with the employment value being roughly N$35,000/year per concession or an additional N$175,000/year. These increased cash revenues would prove instrumental in promoting further recovery and management of the conservancy's natural resources and would significantly contribute to the livelihoods of conservancy members through dividends or development activities. Finally, the meat from the trophy animals would complement the potential game-meat harvests of 66 tons in 2007 and 117 tons in 2015 (Fig. 8).

Table 7. Current number and value of Nyae Nyae Conservancy trophy animals versus projected numbers and values in 2007 and 2015 based on current concession values of each species

	2003		2007		2015	
Species on quota	**Quota no.**	**Value (US $)**	**Quota no.**	**Value (US $)**	**Quota no.**	**Value (US $)**
Elephant	4	60,000	7	105,000	26	390,000
Kudu	8	6,400	27	21,600	53	42,400
Oryx	8	5,600	34	23,800	65	45,500
Leopard	3	3,000		3,000		3,000
Hyaena	2	600		600		600
Blue wildebeest	5	2,500	18	9,000	33	16,500
Red hartebeest	8	4,000	21	10,500	40	20,000
Springbok	3	750	29	7,250	67	16,750
Eland	3	3,000	9	9,000	16	16,000
Duiker	4	600		600		600
Steenbok	4	600		600		600
Roan antelope	1	2,000		2,000		2,000
Concession Conservation Support Payments	1	7,000	2	14,000	5	35,000
Totals	**53**	**$92,050**	**145**	**$206,950**	**300**	**$588,950**
N $ Equivalent (at N $8 to US $1)		N$736,400		N$1,655,600		N$4,711,600
Employment income (No. concessions)	(1)	N$35,000	(2)	N$70,000	(5)	N$175,000

Fig. 8. Projected tons of meat that could be harvested from Nyae Nyae Conservancy plains game and trophy elephants



Joint-venture tourism lodges

The growing wildlife populations, combined with the recent opening of a border gate between Botswana and Namibia on the eastern boundaries of the conservancy, have also sparked interest from the private sector with regards to establishment of an up-market tourism lodge in the conservancy. To date, the remoteness of the Nyae Nyae Conservancy and Khaudum GR has prevented meaningful tourism development. However, a new border gate will conceivably allow development of a popular southern Africa tourism route between the Okavango Delta and the Etosha NP, with stopovers in the Nyae Nyae/Khaudum complex, making tourism a viable activity. The development of a private sector/conservancy joint-venture up-market 16-bed lodge, similar to the Damaraland Camp in Torra Conservancy, would generate approximately N$300,000/year in revenues for the conservancy, and an additional N$250,000/year in employment benefits through the creation of 13–15 more full-time jobs. Furthermore, as the area becomes better known and marketed, it can be hypothesized that a second lodge would also become viable by 2010, and a third by 2015. Should this scenario unfold, the tourism benefits returns to the conservancy and members would add an estimated N$900,000/year in cash and N$750,000/year in employment benefits back to the conservancy by 2015.

Synergetic benefits of cooperative management of the Nyae Nyae Conservancy with Khaudum GR

The optimal development of the Nyae Nyae Conservancy and adjoining Khaudum GR will require coordinated and synergetic management between the two areas. Such management will increase the elasticity of both areas, thereby allowing game to move freely between the park and the conservancy as climatic conditions dictate. Under this scenario, the risks of typical "boom and bust" production cycles so prevalent in arid and semi-arid habitats will be substantially reduced by minimizing the chances of extensive, long-term overgrazing of either area. Further, the larger management unit provides scope for Khaudum's elephant population to expand, thereby alleviating anticipated threats that dense populations of elephants pose to such high-value species as roan antelope.

Summary of potential Nyae Nyae Conservancy development opportunities

Table 8 highlights the benefits currently being generated by the Nyae Nyae Conservancy versus those that are potentially achievable in 2007 and 2015. As portrayed, wildlife and tourism-related benefits generated in the Nyae Nyae Conservancy could feasibly increase from the N$1,270,574 in 2002 by 360% in 2007 and by 930% in 2015.

The above figures translate to the equivalent of pro-rated per capita benefits for the Ju/'hoansi people of N$635 in

Table 8. Actual income and benefits generated by the Nyae Nyae Conservancy in 2002 versus projected income and benefits if increased game populations facilitate expansion of the trophy-hunting operation and introduction of game harvesting, tourism lodges, and high-value game production operations

Source of income/benefit	Actual (2002) versus projected value of income and/or benefit ($ N)					
	2002		2007		2015	
	Cash	Employment/ in-kind	Cash	Employment/ in-kind	Cash	Employment/ in-kind
Hunting concession payment	845,697		1,655,600		4,711,600	
Wages from professional hunter(s)		36,101		70,000		175,000
Handicrafts sales*		264,334		406,711		810,396
Value of game meat consumed		124,442		528,000		936,000
Joint venture tourism lodge revenues			300,000		900,000	
Joint venture tourism employment benefits				250,000		750,000
Live game sales			1,362,000		3,528,000	
Annual subtotal	**845,697**	**424,877**	**3,317,600**	**1,254,711**	**9,139,600**	**2,671,396**
Annual total	**1,270,574**		**4,572,311**		**11,810,996**	
Per capita benefit	**635**		**2,031**		**4,144**	

**Handicraft sales have been increasing at a rate of 9% per year, which is in line with the current annual tourism visitation increases in Namibia.*

2002, N$2,031 in 2007, and N$4,144 in 2015 (assuming the present-day conservancy population of 2000 people grows at an annual rate of 3%). It should be further clarified that these figures represent present-day values and do not take into consideration inflationary increases, potential increases in market values of the products being offered, nor the long-term trend of the devaluation of the Namibian dollar against the US dollar or euro, which will be the currency used for most of the tourism-related products.

Summary of Nyae Nyae Conservancy/ Khaudum GR Case Study

Thus far, the Nyae Nyae Conservancy has made a promising start towards improving the livelihoods of its highly marginalized Ju/'hoansi people. The 1996 conservancy legislation granted communities the rights to benefit from wildlife, and this Act provided the Ju/'hoansi community members incentive to become more involved in the management of their wildlife resources. As a result, wildlife populations in the Nyae Nyae Conservancy are increasing, which results in increased cash and in-kind benefits to conservancy members. Although Conservancy cash and in-kind benefits amounted to a substantial N$1,270,574 in 2002, it is believed the Nyae Nyae Conservancy's wildlife resources have the potential to generate almost 10 times this level of return by 2015. In addition, there is scope for even greater returns, as these projections are premised on a wildlife stocking rate of only 25% of the Nyae Nyae Conservancy's estimated carrying capacity.

Should the Ju/'hoansi continue to develop their wildlife resources, it is likely that wildlife and tourism activities will become the primary source of their welfare. However, there are a number of conditions that must be met to optimise the development of the Nyae Nyae Conservancy's resources:

- First and foremost, there is a need for the Government of Namibia to give greater recognition of the validity of wildlife and tourism as legitimate land uses, and in the process, demonstrate a willingness to zone and manage extensive portions of Namibia's arid landscapes for this purpose. In the case of Nyae Nyae, there is strong pressure from neighbouring Herero herdsmen to move large herds of cattle into the Conservancy. Should this happen, uncontrolled grazing and escalating cattle numbers will ultimately lead to degradation of Nyae Nyae's pristine wildlife habitat, thereby spreading a debilitating desertification process northwards from heavily overgrazed rangelands to the south of Nyae Nyae.
- There is a crucial need to change the mindset and paradigm of government decisionmakers. There is often a perception that land not being used for livestock or crop production is land unproductively used. In the case of Namibia's fragile arid and semi-arid landscapes, this is a particular fallacy, as overgrazing by livestock is especially damaging to low-rainfall grazing

regimes and efforts to produce crops, more often than not, lead to failure. Although conservancies are beginning to demonstrate the viability of wildlife and tourism as competitive land uses, the agricultural sector continues to be strongly subsidised at the expense of wildlife and tourism development opportunities. Namibia's agricultural sector is receiving 320% more financial support than the MET (Kangueehi 2003), even though tourism generates equal or greater economic returns to the Namibian economy than does agriculture.

- Integration of wildlife and agricultural production activities into the daily livelihood strategies of rural community members needs to be improved. The rigid veterinary restriction on the movement of wildlife (especially the disallowance of buffalo) from north of Namibia's Red Line into its commercial areas is a prime example of a highly subsidised agricultural initiative that undermines the ability of communities to optimise their financial and economic returns from ecologically more appropriate wildlife production approaches. Both South Africa and Zimbabwe have found means of legitimately promoting wildlife production systems, and it is hoped that Namibia will soon follow suit.
- The integration and harmonization of wildlife and agricultural activities at village community levels needs to be enhanced. In the case of Nyae Nyae, introducing small horticultural production activities is possible, but will require introducing measures to mitigate the conflict being created by expanding Nyae Nyae and Khaudum elephant populations. Although arable agricultural production has limited potential in Nyae Nyae, there is a need for the Ju/'hoansi to introduce appropriate technology (i.e., drip irrigation systems) to allow small-scale gardens to be developed at the village level to supplement their nutritional needs.
- There is a strong need for the Government and the Ju/'hoansi to coordinate and jointly plan and manage the Nyae Nyae Conservancy and Khaudum GR as a contiguous landscape. The development of wildlife watering points in the conservancy and Khaudum GR and introduction of game into Nyae Nyae are examples of solid initiatives that have benefited both the Conservancy and the Reserve. However, both initiatives have been underfunded and weakly coordinated, and the synergy that is possible by co-planning and co-management between the Conservancy and Reserve needs to be strengthened.
- The transitional nature of Ju/'hoansi society and culture places the Ju/'hoansi people at a competitive disadvantage to other ethnic groups in Namibia. Given current low literacy levels and the disadvantaged position of the Ju/'hoansi people, long-term donor commitment and effective coordination of donor inputs are needed if the capacity of the Ju/'hoansi people is to be appropriately developed in the coming years.

Conclusion

The Namibia conservancy movement, although still young, has made extensive progress since registration of the first conservancies in 1998. The presence of 17 of the registered conservancies adjacent to protected areas is increasing the viability of Namibia's protected area network, while the 29 registered conservancies cumulatively increase land under conservation management in Namibia by more than 70,000km^2. Some conservancies, such as the Nyae Nyae Conservancy, are now contributing significant benefits to their members, and conservancies are becoming embedded into the livelihoods of rural community members.

Although the benefits from conservancies have doubled in three of the past four years, most communal conservancies remain financially marginalized due to their presence in Namibia's FMD Buffer Zone and their resultant inability to realise the full value of their burgeoning wildlife populations. This situation is further compounded by a paradigm that guides many government policymakers to believe that wildlife and tourism enterprises are not productive land uses. As a consequence, Namibia's subsistence and commercial agricultural sector receives a budget that is more than 320% higher than the national conservation budget, even though tourism contributes equal or greater amounts to Namibia's Gross Domestic Product.

Optimal development of Namibia's promising wildlife resources will require policy adjustments that recognise the validity of wildlife and tourism as competitive land uses with agriculture and promote the effective integration of wildlife/tourism enterprises. In particular, there is a need to constructively address rigid veterinary restrictions that prevent conservancies from capitalizing on the presence of their high-value game species such as roan and sable antelope and disease-free buffalo.

Implementing the above adjustments will help promote economically competitive and more environmentally appropriate forms of *wildlife-based* land use in Namibia's arid and semi-arid landscapes.

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Chapter 14

"Counting Sheep": The Comparative Advantages of Wildlife and Livestock – A Community Perspective[1]

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This paper is dedicated to the memory of Mr Nick Ankudey, Executive Director of the Ghana Wildlife Division. Tragically killed in a vehicle accident in November 2003, Nick had the vision to see wildlife from a community perspective and understand the comparative advantages of livestock and wildlife.

Dead or alive? Where is the value?

It was a hot humid morning as always in the small village of Amokwasuaso in Ghana's western region. We sat in the small, dilapidated community meeting hall awaiting the arrival of a World Bank fact-finding mission. The Amokwasuaso community has achieved some celebrity in Ghana as the first community to have the rights to manage wildlife devolved to its residents by the State. The fact-finding mission wanted to know how this had been achieved and whether this approach could be tried elsewhere. As we waited for the World Bank team to arrive, we talked informally about issues and problems facing the community. Then I asked the gathering a question, "If I brought you a goat and a bushbuck and you could choose one of them, which would you prefer?" A woman in the assembly immediately shot back with the question, "Are they alive or dead?" I had not expected this question, but replied that we should assume that they are alive. Her response was swift, "I would take the goat!" "Why?" I asked. "Well, if you have a goat you can control it, get another, breed it, and own it. If you have a bushbuck you cannot control it and it will run free and be taken by others." This was a logical and sensible response. Then I asked, "And what if they were dead?" Again there was no hesitation in the response, "Certainly, I would choose the bushbuck!" Again I asked why. With a smile on her face and to the amusement of all gathered, she said, "Everyone knows that the bushbuck is much better meat!"

In this short exchange, this lady from Amokwasuaso had highlighted the challenges faced by governments all over Africa that seek rural development, including improved domestic animal husbandry, while looking after the environment and wildlife resources. The challenge is to understand comparative advantages and values of wildlife and domestic livestock, to seek a scenario that gives people the freedom to choose but that also changes the tenurial status of wildlife resources so that the value is more than just "better meat." For conservation of wildlife in Africa to work, a significant shift is needed in the current real and perceived comparative advantage of livestock over wildlife.

Incentives and disincentives for wildlife

The challenge for wildlife conservation is not simply to replace domesticated livestock production with domesticated wildlife. The challenge is more about keeping ecosystems intact and wildlife wild, with people having an incentive to use and conserve wildlife resources. Many of those incentives are clear and immediately achievable, while some are more complex and require significant changes in public perceptions, policy, and legislation. Some of the immediate incentives for wildlife use and conservation include:

- the preference for meat of wildlife over that of domestic animals;
- strong cultural sentiment or religious significance of wildlife;
- strong link to wildlife hunting in sport and culture;
- wildlife's superior disease resistance and tolerance of local environmental change;
- generally (although not always) better use of and impact on habitat by wildlife than by domestic stock (an exception being large elephant populations in southern Africa, which confer negative impact);
- income or other benefits to the community if there is a community-based natural resource management (CBNRM) programme present.

In Zimbabwe, the policy for wildlife maintains that wildlife holds a "comparative advantage in economic terms" (Child 1995). Unfortunately this is not enough. The disincentives for wildlife centre on the problem of ownership; often the key to wildlife conservation in Africa is getting ownership right, whether this be private, communal, or even State. Some of the disincentives for wildlife in this regard include the following:

- Wildlife is a mobile resource and difficult to control.
- There is rarely individual ownership (unless the animal is dead).
- Tenure over wildlife rests with the State or, in some cases, the community but not with the individual unless the land title is freehold.
- Wildlife resources usually require a collective management system, often even where land title is held individually.

[1]See abstract on p.xxvi.

- Wildlife often poses a threat to other livelihoods through direct competition or disease transmission.
- In communally managed situations, direct consumptive use is often discouraged and sometimes illegal.

So what is so great about livestock?

The incentives for domestic livestock tend to be readily understood, and, while there are strong incentives, there are also strong disincentives that are often overlooked even by producers. Some incentives for raising livestock include the following:

- Livestock are easily controlled and bred.
- Ownership and tenure are well defined.
- State support and subsidies are often offered.
- Livestock are easily traded for cash, goods, and services.
- The benefits are immediate when livestock are sold or consumed, and transaction costs tend to be minimal.
- Livestock can be used for work.

One of the problems in rural development in Africa, a problem often overlooked by agricultural departments and rural development agencies, has been the manner in which domestic livestock production, especially that involving cattle and small ruminants, has been promoted. The development of livestock production in much of Africa has been heavily subsidised by policy, legislation, and direct financial investment. Some areas have suffered severe ecological damage due to very high stocking levels and poor range management. In many cases, there are also livestock-owning elites who control access to grazing and water at the exclusion of other community members (Isaacs *et al*. 2000). In summary, disincentives for livestock production include the following:

- Livestock can be an expensive investment for poor farmers; if the animal dies, the loss can be devastating.
- Livestock are prone to disease, especially in remote, "wild" areas.
- Livestock are not as resilient as wildlife to local environmental changes such as droughts (certain animals excluded).
- Access to grazing is often controlled by local elites.
- Environmental costs result if ranges are poorly managed.

Where is community-based natural resource management?

During the late 1980s and early 1990s, a CBNRM revolution swept through southern Africa. This revolution brought fundamental change in the relationship between rural communities and wildlife resources. CBNRM is largely based on the following principles (Murphree 1991):

- Effective management of wildlife is best achieved by giving it focused value for those who live with it.
- Differential inputs must result in differential benefits.
- There must be a correlation between the quality of management and magnitude of benefit.
- The unit of proprietorship should be the unit of production, management, and benefit.
- The unit of proprietorship should be as small as practicable within ecological and sociopolitical constraints.

The importance of these principles is that they are not part of an "either/or" approach that seeks to coerce communities into saving wild animals. These principles challenge policymakers and governments to create an enabling political and economic environment that allows wildlife to improve its comparative advantage over domestic livestock.

While considerable progress has been made and, in some cases, wildlife has significantly changed peoples livelihoods, the following can also be said of many CBNRM initiatives in southern Africa:

- For the most part, CBNRM in southern Africa has spoken to these principles but rarely applied them, resulting in livestock retaining the competitive advantage from an individual and community perspective.
- Another difficulty with CBNRM is that, in most cases, financial returns from wildlife tend to be small at individual levels, cumbersome to manage, subject to bureaucratic pilfering, and provide only annual payouts.
- In southern Africa, CBNRM has relied on third-party–use regimes, relegating communities to passive participation in wildlife management. There are few cases in which communities use wildlife directly; in most instances, wildlife is sold to a safari operator who in turn sells it to the hunter or tourist.
- Community members who directly use wildlife are classified as poachers and CBNRM in southern Africa has emphasised maximum economic return, even when this is not a community priority (Sithole and Frost 2002).
- Southern African governments are comfortable with the status quo and are reluctant to devolve full management rights and responsibilities to communities. In some cases, the devolutionary process has been captured by a new set of bureaucratic elites at the provincial or district level.
- The retention of management rights by the national and subnational bureaucracies has disadvantaged wildlife, especially from individual perspectives.

The result of this has been that the initial strides made in CBNRM in southern Africa have slowed as state and community struggle for control over access rights, management rights, and benefits. This is a no-win situation that does not benefit people, wildlife, or livestock. In this case, CBNRM acts only as a hand brake on the drift of competitive advantage to livestock until wildlife ceases to be a viable option. In some cases in which CBNRM programmes have been problematic, Sithole and Frost (2002) argue that the CBNRM programme actually contributes to giving livestock a comparative advantage.

Conclusions

Clearly, CBNRM approaches in southern Africa have not sufficiently applied their own principles, especially in respect to devolution of authority and benefit. In addition, agricultural and veterinary policies have distorted economic and ecological advantage in favour of livestock production. If wildlife is to secure a comparative advantage over livestock, then policy and practice need to be reconciled with governments recognising that the future of wildlife is determined at local levels. It is important that wildlife is recognised as a legitimate component of rural livelihoods and land use, and not simply an object of conservation.

The challenge today is to create the political, social, and economic environment that enables rural farmers to count both sheep and wildlife.

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Chapter 15

Foot and Mouth Disease Management and Land-Use Implications in the Zimbabwean Lowveld: the Rationale for Creating a Biosphere Reserve[1]

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Introduction

The Lowveld region of Zimbabwe is the semi-arid south-eastern sector of the country, in which mean annual rainfall is 300–600mm per year. This region comprises approximately 20% of Zimbabwe. It includes state land (notably the Gonarezhou National Park [NP]), communal lands (subsistence production), and commercial ranching areas which, until recent political unrest in Zimbabwe, were rapidly converting their primary land use from ranching to wildlife production. These commercial ranching areas hold approximately 260 black rhinos, which constitute about half of Zimbabwe's total black rhino population. In addition, the Lowveld has significant populations of wild dogs, elephants, cheetahs, white rhinos, etc. The initiation of the Great Limpopo Transfrontier Conservation Area (TFCA) can and should lead to the inclusion of wildlife-producing areas of the Lowveld within a massive regional wildlife complex.

Land-use patterns in the Lowveld have recently been disrupted by land invasions and by associated problems during a period of economic and political instability. Nonetheless, the future of the area clearly lies in the comparative ecological and economic advantage that has been demonstrated in wildlife-based land uses, regardless of who owns the land. There is an urgent, immediate need to initiate planning and dialogue between stakeholders to maximise the wildlife potential of the Lowveld as Zimbabwe emerges from its current instability. This can be achieved by initiating a Lowveld Biosphere Programme, for which international funding and technical support must be secured. This programme would have to be strongly linked to the reestablishment of control measures for foot and mouth disease (FMD), which must become a priority for future development assistance to Zimbabwe owing to the impact of this disease not only on Zimbabwe's beef industry but also on the economies of adjacent countries (South Africa and Botswana).

Rationale for creating a biosphere reserve

Better coordination among the stakeholders in the Lowveld wildlife industry is needed. Various initiatives have arisen, notably the Great Limpopo TFCA initiative, the World Bank/Global Environment Facility rehabilitation project for Gonarezhou NP and its "support zone," a strategic tourism development initiative, ad hoc liaison between conservancies on land reform, FMD zonation, etc. However, these have tended to be transient coordination arrangements, and a more comprehensive and longer-term framework for stakeholder dialogue and planning is desirable.

The need for such coordination is intensified because of the land reform process. The wildlife industry will include new indigenous participants, either on a community basis or as individual entrepreneurs. It is clearly in the interests of the overall industry to streamline integration of these new participants, minimizing disruption of the region's economic potential for wildlife-based land uses. One problem is unplanned resettlement, which is foreclosing options for wildlife movement corridors between key wildlife areas. Thus better spatial planning of land uses is required at a regional level. Another problem is that arrangements for resource-sharing, "indigenisation", etc., between some stakeholders can set awkward precedents for others. With different management structures in place on different land units, a totally uniform approach towards land reform is impossible; nonetheless, it is in the overall interests of stakeholders to maintain some degree of coordination. The key term in all of the varied land reform arrangements is "partnership"; coordinating a biosphere reserve at a regional level is based on this concept.

Assuming that Zimbabwe's international relations will normalise in due course, major international support (grant and loan funding) can be envisaged for the mainstays of the Lowveld economy, i.e., irrigation development and wildlife operations. The latter will be stimulated by the Great Limpopo TFCA initiative. Coordination of the various stakeholders in the wildlife industry will ensure that they have a driving role in this process, rather than having development agendas imposed upon them by national and international agencies.

[1]See abstract on p.xxvi.

Given that the Lowveld has mixed land use, with islands of irrigation, and state, private, and communal sectors, the most appropriate framework for integrated land-use planning and resource conservation appears to be the "biosphere reserve" concept. This involves a process of registration through the United Nations Educational, Scientific, and Cultural Organization (UNESCO). The biosphere reserve concept would provide positive publicity for Zimbabwe after recent international concern over the loss of wildlife due to land invasions, and would provide a politically neutral concept for integrating stakeholders within the various sectors.

Apart from being directed towards the development of new wildlife-based models for land reform in this region, international funding would have to focus on the issue of FMD control. Although FMD does not directly affect flagship species such as the black rhino, it has a massive indirect effect because of the control fencing that is required to keep wildlife (especially buffalo, which are natural carriers of FMD) separated from cattle, and because of the strict land-use pattern that is imposed. Therefore, planning for the development of a Lowveld biosphere reserve would have to devote considerable attention to FMD issues.

Foot and mouth disease

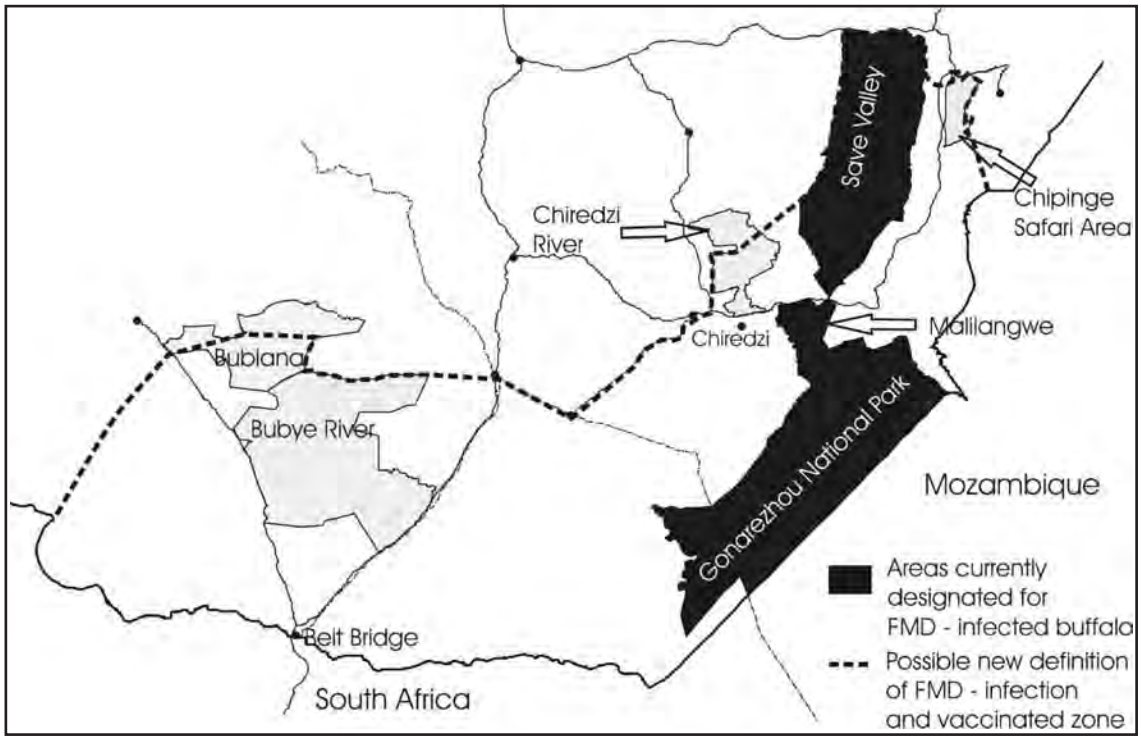
Some salient points regarding FMD in the Lowveld are as follows:

The existing veterinary fencing for FMD control in southeastern Zimbabwe has been extensively damaged, and totally removed along some sections, during the current peasant occupations of commercial farming areas. These occupations have extended into the northern section of Gonarezhou NP.

The fencing was originally intended to confine FMD-infected buffalo within Gonarezhou NP together with a relatively small area between Chiredzi and the Mozambique border (Fig. 1). Infected buffalo were subsequently permitted within double-fenced enclaves in certain commercial ranching areas of the southeastern Lowveld, notably Save Valley Conservancy, where a land-use review (Price Waterhouse 1994) of this semi-arid zone showed that full-scale wildlife production had become more profitable than cattle ranching. Within the "buffer zone" and the "clear zone," FMD-free buffalo have been permitted on a few properties under stringent controls.

The attempt to use the fence to confine FMD-infected buffalo within Gonarezhou NP was continually undermined by the presence of small herds of these buffalo remaining within the Beitbridge-Mwenezi-Chiredzi ranches and communal lands. Additionally, large numbers of wild ungulates (notably kudu and impala) outside the Park have spread FMD during major outbreaks despite the fence, which is only 1.2m high and therefore unable to stop the movement of antelope. Also, unique to the southeastern Lowveld, the spread of FMD virus appears to be enhanced by the cool, damp spells that arise during winter when southeasterly winds bring moist air ("guti") to the region. Thus, there are environmental conditions that militate against the concept of using the park boundary as a defence line for FMD control.

Fig. 1. Current and proposed FMD fencing alignments. The proposed expansion of the defined FMD-infection and vaccination zone offers opportunities for an economically attractive Lowveld Biosphere Programme.



Since the major drought in 1992, there has been an increasing emphasis on wildlife production as opposed to cattle ranching in the semi-arid southeastern Lowveld, due to various economic trends combined with the long-term adverse ecological effects of monospecies livestock production. Thus, from an economic land-use perspective, it is no longer in the national interest to preclude buffalo from the significant commercial wildlife operations that have evolved in the southeastern Lowveld. This species is key to safari hunting operations, allowing safari operators to virtually double their daily rates because buffalo-hunting quotas enable more attractive "big game hunts" as opposed to "plains game hunts." Wildlife tourism operations are also economically boosted by the presence of buffalo as one of the "big five" species. Buffalo in the southeastern Lowveld, outside Gonarezhou NP, are also economically important for safari hunting and live-sale deals within the Communal Areas Management Program For Indigenous Resources (CAMPFIRE) Community-Based Natural Resource Management (CBNRM) programme, especially in Beitbridge District.

The veterinary control fencing will have to be replaced as soon as possible to regain beef export markets (notably in the EU), and cattle movements once again strictly controlled. One consideration in planning for the fencing to be rebuilt is whether it should follow the previous alignment or whether new circumstances suggest the need for a different alignment, expanding the "FMD zone."

Expanding the defined "FMD zone" need not significantly disrupt the present patterns of cattle production within the southeastern Lowveld. Beef and cattle from the existing "vaccination zone" and "buffer zone" cannot be freely marketed outside these zones; therefore, the legal cattle economy is internalised within these zones and could continue as such provided the cattle within the expanded "FMD zone" are vaccinated against FMD. There may well be economic justification for establishing a new abattoir within the expanded "FMD zone," possibly at Chiredzi, to support not only the ongoing beef production but also the marketing of venison from wildlife operations.

The current FMD control fence terminates on the Mozambique border east of Chiredzi. In terms of disease control, this is an arbitrary point to end the fence, as it relates merely to a national boundary and is not connected to any physical barrier that can stop cattle or wildlife movement to the north of this point, between Ndowoyo Communal Land and Mozambique. The risk of FMD transmission from Mozambique to the southeastern Lowveld of Zimbabwe via this unfenced section would not matter if the fence were to be aligned further to the north, terminating in the highlands of Chipinge District. Through this realignment, a more effective barrier would exist between Zimbabwe's beef export zone and the lower-lying region of the southeastern Lowveld and Mozambique.

Because of the very high costs of properly maintaining FMD control fences, it is essential that the alignment of the fence is made as cost effective as possible by following appropriate terrain and by taking advantage of existing major roads and bridges, both for ease of access and to maintain a cleared line along the fence. The current alignment of the fence is not optimised in this regard. For instance, a section of FMD control fencing runs along the eastern boundary of Save Valley Conservancy, along the Save River, where it is prone to flood damage and to the pressure of elephants and other large ungulates that tend to push through the fence to get to the water and riverine food resources.

Any realignment of the fence should consider land reform arrangements, and must ensure that options for inclusion of areas within the Great Limpopo TFCA are not foreclosed. Within conservancies, there is likely to be some peripheral habitation that will have to be separated from the core conservancy areas by game fencing, not only for disease control but also to prevent wild animals from causing crop damage and other problems in the settled areas.

Conclusion

The development of a Lowveld Biosphere Programme, with international technical and funding support, would help to rehabilitate the economy of this region and to provide a conducive environment for the long-term conservation of black rhinos and other flagship species.

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Chapter 16

Protected Areas, Human Livelihoods and Healthy Animals: Ideas for Improvements in Conservation and Development Interventions[1]

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Introduction

Disease is becoming increasingly recognized as a threat to wildlife conservation, especially for endangered species (Werikhe *et al*. 1998). Often the threat is increased by diseases that can be transmitted between closely related species such as people and primates or cattle and buffalo. Transmission of such diseases at the interface of protected areas with human settlements can be exacerbated by mixing of people, wildlife, and domestic animals when wild animals leave the park boundaries, when domestic animals graze illegally within the park (Bengis *et al*. 2002), and when, for example, tourists, researchers, and field staff enter protected areas to view primates (Macfie 1992, Woodford *et al*. 2002).

Zoonotic disease transmission is particularly important in local communities around protected areas, which, in developing countries, tend to be surrounded by some of the poorest of the population (Balmford and Whitten 2003). Problem animals threaten these people's lives and property (Karanth and Madhusudan 2002), possibly reducing the value of land around protected areas. In the case of Uganda, with a gross domestic product (GDP) per capita–purchasing power parity of US $1200 (CIA 2003), those community and rural settings have very limited basic health care because most people have no transportation and live at least 20 miles away from the nearest health centre (Ministry of Planning and Economic Development 1997, Homsey 1999). This marginalized target group also has very little access to information on zoonotic disease prevention because very little content has been developed for local education (Grant 2002). Even when people manage to get to the health centres, many centres are not adequately equipped to diagnose and treat diseases. This has resulted in a persistence of preventable diseases such as tuberculosis (TB) and scabies that can be transmitted between people, wildlife, and domestic animals.

Although there are relatively few documented cases of disease transmission between people and wild primates, there is a growing number of cases of suspected disease transmission (Table 1). A disease for which transmission from primates to people has been proved is Ebola, from a chimpanzee (*Pan troglodytes*) in Cote d'Ivoire (Formenty *et al*. 1999) and, more recently, in outbreaks (Leroy *et al*. 2004) involving western lowland gorillas (*Gorilla gorilla gorilla*) and chimpanzees.

Diseases that have reportedly been transmitted from domestic cattle to cape buffalo (*Syncerus caffer*) in Africa include BTB (Woodford 1982, de Vos *et al*. 2001) and rinderpest (Kock 1999). Foot and mouth disease can be transmitted between cape buffalo and cattle (Dawe *et al*. 1994, Chilonda *et al*. 1999, Sutmoller *et al*. 2000). There are also examples of disease transmission between species that are unrelated; for example, mongooses (*Mungos mungo*) in

Table 1. Cases of suspected disease transmission from people to primates

Disease	Species	Location	Reference
Polio	Chimpanzees, *Pan troglodytes*	Gombe National Park, Tanzania Beni, Democratic Republic of Congo	Goodall 1971 Kortlandt 1996
Scabies	Mountain gorillas, *Gorilla gorilla beringei* Chimpanzees	Bwindi Impenetrable National Park, Uganda Gombe National Park	Graczyk *et al*. 2001, Kalema-Zikusoka *et al*. 2002 Pusey 1998
Measles	Mountain gorillas	Parc de Volcans, Rwanda	Hastings *et al*. 1991
Intestinal parasites	Baboons, *Papio cynocephalus anubis* Mountain gorillas	Gombe National Park Parc de Volcans	Murray *et al*. 2000 Sleeman *et al*. 2000
Yaws	Baboons	Gombe National Park	Wallis and Rick 1999

[1]See abstract on p.xxvii.

Botswana and suricates (*Suricata suricatta*) in South Africa have contracted human TB (*Mycobacterium tuberculosis*) from a rubbish heap outside a tourist lodge frequently visited by someone with a chronic cough (Table 1) (Alexander *et al*. 2002).

The following case study describes a few health interventions that were carried out in the aftermath of a scabies disease outbreak in mountain gorillas in Bwindi Impenetrable National Park (BINP) in southwestern Uganda in 1996. This outbreak is thought to have been associated with scabies in the local community. This paper provides a situation analysis of the BINP environment, with an emphasis on the status of human and primate interaction leading up to the disease outbreak. Included are descriptions of the first reported scabies outbreak in mountain gorillas that resulted in the death of an infant gorilla, and a subsequent conservation and development intervention that was carried out in specific community and rural settings to improve the situation through health education campaigns. Potential opportunities for improvement in conservation and development interventions are described, as well as how to address cross-sectoral linkages between health, wildlife conservation, education, ecotourism, and information technology.

Human and primate interaction in Bwindi Impenetrable National Park, Uganda

Mountain gorillas and people are very closely related and are therefore potentially at risk of transmitting pathogens to each other (Ott-Joslin 1993, Wallis and Rick 1999). Approximately 300 of the estimated 655 mountain gorillas (*Gorilla gorilla beringei*) live in BINP, southwestern Uganda (Fig. 1). The remaining individuals of this highly endangered species are found in Rwanda, Democratic Republic of Congo (DRC), and Mgahinga National Park in Uganda (McNeilage *et al*. 2001). A small forest remnant in Sarambwe, DRC, is contiguous with BINP. The area surrounding Bwindi and the Virungas has one of the densest human populations in Africa, with an estimated 200–300 people per square kilometre (UWA 2001). BINP is approximately 331km^2 and was gazetted in 1991 (Butynski and Kalina 1993). The establishment of this park restricted people's access to the forest to controlled activities such as tourism and research, while allowing multiple-use access for products such as medicinal plants, basket-weaving materials, and honey (UWA 2001).

Bwindi gorillas have close contact with tourists and researchers (Macfie 1992) and when crop raiding (Madden 1998) or foraging on community land. Some of the foraging areas outside the park are crossed by village pathways or are in areas where villagers obtain firewood. Additionally, fragmented patches of secondary forest owned by local people surround parts of Bwindi, and gorillas utilize these land patches. In addition to poor health services and information, the local communities lack hygienic amenities including clean water and pit latrines (Ministry of Planning and Economic Development 1997, Homsey 1999). These factors have resulted in a large percentage of people suffering from preventable diseases that can spread to gorillas. These include scabies, diarrhoeal diseases, measles, and TB (WHO 2002). TB is exacerbated by a greater than 35% coinfection with human immunodeficiency virus/acquired immune deficiency syndrome (HIV/AIDS) (Kibuga 2001) of which Uganda, Rwanda, and DRC are among the highest-prevalence nations in the world (Castro 1995) and are among the 22 countries contributing to 80% of the global TB burden (WHO 2002). Fortunately, Uganda's HIV rate has dropped from an estimated 35% to 6% (CIA 2003), and this has been attributed to education (Kiwanuka-Tondo, personal communication 2003).

Uganda Wildlife Authority (UWA), a national conservation authority, has developed an ecotourism program in BINP. Sustainable ecotourism depends on maintaining gorilla health, improving the welfare of local communities through tourism, and promoting the national economy. Often the welfare of local communities in BINP has been improved through tourism revenue (via sharing of funds), development

Fig. 1. Mountain gorilla range

Courtesy of Dr. Michelle Goldsmith.

of income-generating activities (selling crafts, food, and lodging), and employment in restaurants and lodging facilities (Kamugisha *et al*. 1997, Ratter 1997). The national economy is enhanced by the funds generated by mountain gorilla tourism, funds which amount to up to 50% of the overall income of the Uganda National Park System in some years (McNeilage *et al*. 2001).

Continuous monitoring of gorilla health is carried out by UWA and supporting agencies. However, successful management of gorilla health is undermined by an unhealthy buffer zone surrounding the gorilla habitat. For example, of the 19 parishes surrounding BINP, three are in Kisoro district, which has an estimated population of 1,867,000 and a population density of 301 people per km^2. To support this population, Kisoro district has 11 health centres, of which only two have laboratory services (Rooney and Sleeman 1998). If human health in the areas surrounding BINP is not improved, then gorilla health is put at an ever-increasing risk.

According to the district medical personnel surrounding BINP, the most commonly treated diseases in people are malaria, respiratory tract infections, diarrhoeal diseases, scabies, ringworm, intestinal parasites, tropical ulcers, and eye infections, including river blindness (R. Sajjabi and B. Nkomejo, personal communication 2001). Through self-reported medical histories, it was determined that respiratory disease was the most common clinical manifestation seen in the local community of Kibale National Park. Respiratory disease was also reported more frequently than diarrhoea in tourists visiting the park (Adams *et al*. 2001).

Mountain gorilla scabies outbreak

The first reported scabies outbreak in mountain gorillas occurred in 1996 in a tourist-habituated group of four gorillas adjacent to the Buhoma tourist site in BINP. The gorillas were scratching excessively and developed white scaly skin. The group was treated with ivermectin, and all recovered after one treatment except for an infant that died (Kalema-Zikusoka *et al*. 2002). The source of the scabies was never determined, although people were suspected for two reasons: scabies is common in the local communities, and the gorillas' severe reaction to the disease indicated a lack of prior exposure to this mite from a closely related host. The gorillas could have been exposed to scabies through contaminated clothing or other fomites of infected people during tourist visits or when the gorillas were outside the park boundary raiding banana crops.

Four years later, a scabies outbreak occurred in another group of gorillas being habituated for tourism in Nteko parish, also in BINP, resulting in morbidity of some of the group. They, too, recovered with ivermectin treatment (Graczyk *et al*. 2001). While the ivermectin treatment was successful, it was felt that interventions addressing the public health situation around BINP were needed to prevent further outbreaks.

Health education intervention

In early to mid 2000, UWA conducted health education workshops with local communities to improve the situation. Over 1000 people in 5 of 19 parishes surrounding BINP participated in the community outreach, which included eight villages. During these participatory rural appraisal workshops, the team presented lectures in the local language to introduce diseases common in the BINP area that can be transmitted between gorillas and people. Prevention strategies were also discussed.

There was initial concern among wildlife managers that the local community would believe the park authorities valued gorillas more than people. However, those communities that had directly benefited from the creation of BINP were actually very receptive to these ideas, and gave more recommendations than those communities that had benefited less. Most people received at least one educational brochure to take home at the end of the workshop. Two or more posters were given to the local parish council leaders to display in public areas.

Having a multidisciplinary team of community conservation, wildlife health, human health, and education personnel appears to have been helpful. Additionally, the target communities seem to realize that healthy gorillas can generate income to build villages, which have already become trading centres as a result of ecotourism. Additionally, communities that received conservation education appear to have a greater understanding of the need to protect mountain gorillas both for conservation and a sustainable income (Kalema-Zikusoka *et al*. 2001). By contrast, one community in DRC that had received very little conservation education and virtually no tourism and research benefits did not trust the team enough to admit that they had seen gorillas.

One village in Nteko parish was adjacent to the range of a gorilla group undergoing habituation and that subsequently contracted scabies. The community recognised the benefits of the health education workshop because they desperately wanted tourism so that their village could eventually look like Buhoma, an established tourist site. They were aware that one of the reasons that UWA was not establishing tourism in spite of the adjacent gorilla group being fully habituated was that this gorilla group spent over 50% of the time outside the park in public land and people's gardens. They had been told that the park authorities were concerned about these gorillas getting infected by exposure to contaminated clothing, uncovered rubbish heaps, and shallow pit latrines. Communities realised these problems had to be addressed.

Recommendations from the communities were divided into three categories: medical, nonmedical, and hygiene. Medical recommendations, with the Ministry of Health having primary responsibility, included bringing health services, such as mobile clinics, closer to the protected area and employing a nurse for Bwindi. Issues such as having access to safe water were also discussed. Nonmedical recommendations included strengthening the human/gorilla conflict (HUGO) team, made up of local community members trained by UWA, to chase gorillas back to the park; and holding more health

education programmes. UWA was deemed to be primarily responsible for these measures. Hygiene recommendations included covering rubbish heaps and digging proper pit latrines of at least 10 feet (three metres) deep. The local community would have primary responsibility for these activities.

Despite receiving economic benefits from tourism, some villages complained about problem animals. A farmer was interviewed when a tourist gorilla group had just damaged his banana crop. He acknowledged that the mountain gorillas have brought wealth and economic development to his village and his children have benefited from park employment, but pointed out that farmers like himself whose crops are destroyed are not being compensated for individual loss of income, which could be used to pay for children's school fees and to build family assets. In this case, problem animals undermined the success of the health education workshops.

As long as problem animals exist, the potential for disease transmission at the human, wildlife, and domestic animal interface will always be present. Problem animals also undermine conservation efforts such as revenue sharing and conservation education. Compensation for problem animal damage is often controversial because, for example, it is often difficult for the victims and the organization responsible for providing compensation to agree on how much payment is sufficient and fair (Nyhus *et al*. 2003). However, individual compensation appears to have reduced the resentment of farmers to wildlife (wolves) taking their livestock around Yellowstone National Park in the USA (Nyhus *et al*. 2003), and may have been able to appease this farmer (at least in the short term) whose crops were destroyed by mountain gorillas.

Health education appears to be a conservation tool that can bring together the public health, wildlife conservation, and ecotourism sectors. Local communities that received mountain gorilla ecotourism benefits recognized that they could prevent mountain gorillas from getting human diseases by doing things like digging better pit latrines and covering rubbish heaps. However, some recommendations were beyond their control, such as access to better health services or safe water. The lack of access to clean water not only contributes to a range of gastrointestinal illnesses but also undermines efforts to control scabies, as the mites survive on dirty clothes that can be handled by curious wild animals, such as mountain gorillas (Fossey 1983).

Ideas for improvements in conservation and development interventions

An integrated approach to controlling disease transmission between wildlife, people, and domestic animals needs to be developed by stakeholders. This could start with dialogue among the affected communities and professionals from the wildlife, human health, veterinary, education, and information and communication technology sectors, and sharing of information using print, radio broadcasts, video, CD-ROM, handheld computers, databases, or the internet to play a supportive role in improving education and enhancing access to health services and information (Grant 2002).

Multidisciplinary teams from the wildlife management, medical, and veterinary sectors could be established to carry out joint education, health training, and research programmes while helping to maximize the use of limited resources. Close collaboration among governments, nongovernmental organizations, the private sector, universities, and schools is needed to develop effective and efficient programmes, focusing specifically on interrelated human and animal diseases such as TB, BTB, scabies, brucellosis, rabies, and Ebola. Local involvement in designing these programmes is crucial for long-term success.

Examples of such interventions include joint education programmes, such as the health education workshops carried out in BINP in 2000. These grassroots education programmes would benefit from input from all key stakeholders to ensure that the materials used would be relevant to the local situation and printed in local languages. Participatory rural appraisal techniques can help to promote local community ownership of the recommendations put forward by the affected communities at a grassroots level. UWA has started to hold planning workshops with health policymakers and local leaders to further strengthen links between wildlife conservation and public health (Rainer 2002).

Developing "multiple use" health care and diagnostic services and facilities can potentially be more effective in preventing diseases that spread between people, domestic animals, and wildlife because information can be shared more easily. Sharing facilities and services could also save costs. Many places with wildlife have poorly developed infrastructure and few resources for transporting needed goods to the population. Tour operators and wildlife managers with access to good vehicles could help by transporting free medication, such as TB medication (WHO 2002), from the capital city, Kampala, to the people who need it. A similar programme has been successfully carried out via the Healthy Community Initiatives of the Kayapo Health Project in Brazil, where researchers bring malaria medication to people residing next to the forest (Margoluis *et al*. 2001). Joint domestic and wild animal laboratories at the interface of protected areas and human settlements could help to facilitate information sharing and better control of disease outbreaks.

Joint training programmes could involve medical and veterinary technicians carrying out laboratory work together and could help wildlife personnel, veterinarians, medical doctors, and other health workers to carry out integrated education campaigns on interrelated wildlife conservation and public health issues. In addition to promoting collaboration, local community involvement could be encouraged through "training of trainers" to educate others.

Research on interrelated wildlife conservation and public health issues should be encouraged to increase our understanding of these links, and results should be shared with policymakers. Such research could help to identify the most common diseases that pose a threat to public health, wildlife conservation, and ecotourism.

Other research studies could help to evaluate local community attitudes and behaviour that facilitate disease transmission at the interface. Because public health depends on people's behaviour, evaluation of programmes integrating wildlife conservation and public health should focus on how people's behaviour is changing (or not) over time. Behaviour such as failing to boil milk and eating uninspected meat occurs commonly in rural areas of Uganda (Opuda-Asibo 1995), predisposing people to infectious diseases, such as zoonotic BTB from cattle (Cosivi *et al*. 1998). Recent field surveys have shown that almost 50% of the people living around Queen Elizabeth National Park in Uganda drink unboiled milk, potentially exposing them to BTB from cattle that mix with buffalo. Studies to determine how poor wildlife conservation and public health practices are affecting socioeconomic development would be useful. Furthermore, research could explore models for sustainability for integrated conservation and public health programmes.

Finally, there is growing evidence of the need for an integrated approach to wildlife conservation and public health to maximize the limited resources available to control disease transmission between wildlife, people, and domestic animals at the interface. Funds from wildlife conservation could be allocated to public health, where it directly affects conservation, such as the case of scabies in the Bwindi mountain gorillas. Similarly, donor funds earmarked for health improvement could be allocated to wildlife conservation where it directly affects public health, such as the case of people being exposed to bovine TB from drinking unboiled milk, and people contracting Ebola from eating gorillas or chimpanzees (Leroy *et al*. 2004).

Beyond reducing the risks of disease transmission across the wildlife/domestic animal/human interface, a favourable outcome of improving the health status of local communities living around protected areas is the potential to cultivate a more positive attitude towards wildlife conservation and public health.

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Chapter 17

Impact and Value of Wildlife in Pastoral Livestock Production Systems in Kenya: Possibilities for Healthy Ecosystem Conservation and Livestock Development for the Poor[1]

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Introduction

Despite decades of habitat loss, some parts of East Africa are still unrivalled in diversity and abundance of wildlife. The traditional pastoral approach to livestock husbandry has always been considered compatible with and complementary to wildlife. In Kenya, more than half of the wildlife habitat is outside protected areas in communal grazing lands and group ranches, where wildlife, people, and livestock all interact and compete for the same natural resources. As human population has increased, agriculture has expanded into more marginal areas and formerly open communal grazing lands have been transformed into high-density rural settlements of small-scale farmers engaged in cultivation and livestock grazing (Aligula *et al*. 1997, Reid *et al*. 1999). Pastoralists whose range has become too restricted for traditional livestock grazing practices have increasingly turned to agriculture (Thompson *et al*. 2002). As the pressure on land becomes more intense, there is considerable potential for conflict between wildlife and people over grazing land, predation of domestic livestock, and disease transmission. Wildlife populations have been adversely affected by these changes. In the Mara ecosystem, for example, populations of some herbivores have declined by nearly 60% over the last two decades (Ottichilo *et al*. 2000, Said 2003).

The situation is serious across East Africa and if solutions are not found, wildlife will disappear in the very near future. One way that wildlife can be conserved in shrinking pastoral areas is if socioeconomic benefits from wildlife can be realised by the pastoral communities, and negative wildlife-related impacts such as disease and predation minimised. Recent research (Nuding 1996, Homewood *et al*. 2001, Ashley and Elliott 2003, Barnes *et al*. 2003) has indicated that returns from integrated wildlife and livestock production can be higher than returns to either enterprise on its own. In order to maintain or, in most cases, restore a healthy ecosystem, economically attractive solutions must be developed and implemented.

We conducted in-depth socioeconomic surveys at the household level in two semi-arid areas in an attempt to quantify both positive and negative impacts of wildlife for pastoral households raising livestock. In Laikipia and Kajiado districts, wildlife numbers have been fairly stable over two decades, with some species increasing in number (Peden 1987, Rainy and Worden 1997, de Leeuw *et al*. 1998). Both communal and commercial ranches support wildlife in these districts and, although they cover relatively small areas, they are increasingly important for Kenyan wildlife conservation. The goal was to quantify wildlife-related costs and benefits to a range of communities where livestock are being raised in close proximity to wildlife.

Ideally, such a study would follow particular households over several years and average the costs and benefits over the period to "smoothen" within and across seasonal (e.g., rainfall) variability. However, we are particularly interested in the relationship between the different causes of losses (e.g., losses due to disease compared with losses due to predation), and thus a one-shot survey across different communities facing similar environments is appropriate for gathering this type of information. Communities we selected are from agro-ecologically similar zones, but there are more sociological and ecological differences between Laikipia and Amboseli than between individual Laikipia communities. Noting these limitations, it would nonetheless be interesting to quantify the relative costs and benefits attributable to similar factors. For example, there are four major limiting factors that pastoralists perceive: grazing competition, water competition, disease, and predation (Muthiani 2001). This paper will focus on quantifying the latter two factors in the livestock production systems studied.

Disease imposes a significant cost to both livestock ranching and pastoralism (Homewood and Rodgers 1991, Mizutani 1995, Karani *et al*. 1995, Maddox 2003). In a study spanning 23 years, losses to disease were found to be twice as high as the total annual losses due to carnivores (Mizutani 1995). If disease transmission can be minimised in a livestock/wildlife system, it is critical to explore whether the impact of the losses of livestock to carnivores, and of the competition

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between livestock and wild herbivores for feed and water, is manageable. The economic benefits of livestock production are self evident, but wildlife, too, is valued in the culture and economics of pastoral communities. The longer-term question that this research explores, but does not yet answer, is what the optimal ratio of livestock to wildlife density is where livestock and wildlife continue to coexist with people. Maintaining this optimal ratio would minimise costs due to disease and death, prevent degradation of land/range resources, and allow for sustainable utilisation of wildlife as an asset.

Wildlife is often regarded as a danger to livestock production by Western livestock producers, who are concerned with perceived increases in the risk of infectious diseases. Management usually involves controlling and eliminating disease "carriers" or "reservoirs" in wildlife populations. Evidence exists, however, that livestock may actually better tolerate pathogens in the presence of wildlife (Ford 1971, Waller and Homewood 1997, Barre *et al*. 2001), and that by adopting certain improved husbandry practices, it may be possible to limit disease outbreaks while managing the coexistence of livestock and wildlife. Western science sees "health" as normal and "disease" as abnormal (Waller 2004) and tries to fence the diseased areas out (van Sittert 2002), whereas African herders regard disease as natural and inevitable, and potentially as a stable part of the environment. Pastoralists are aware of the vulnerability of animals that lack acquired immunity, and use movement and controlled exposure to endemic diseases (Ford 1971) as protection against epidemic outbreaks. They may accept limited losses to safeguard their herds. Current research on disease control emphasises the importance of naturally acquired immunity and of accepting lower productivity as a price to pay for less expenditure on disease control and reducing risk of infection (Baker *et al*. 2003). Arguably, the best methods of disease prevention have thus arisen through indigenous knowledge of the causes of disease. Kenyan traditional herders appear to have evolved husbandry practices that can accommodate wildlife and disease (Waller and Homewood 1997). A primary strategy has been to move the animals across landscapes and to alternate grazing areas so as to avoid disease outbreaks and predation. Such use of pastures implies that there is sufficient available land to provide isolation of infected herds and to protect the remaining animals from the outbreak.

Regarding household income sources, the poorer the household, the higher is the importance of available natural resources (including wildlife) to rural incomes and livelihoods (Scoones *et al*. 1992, Cavendish 2000). This is especially true for the semi-arid areas, where farming is not a viable land-use option and more natural resources are available and used for multiple purposes. However, when a few individuals take the bulk of the income derived from natural resources (Swanson and Barbier 1992, Ribot 1998, Emerton 1999a, Emerton 1999c), and in cases in which transparency in managing communal benefits from those resources is missing, differences in wealth will only be accelerated by community-based enterprises (Emerton 1999b, Rutten 2002, Thompson and Homewood 2002).

Background

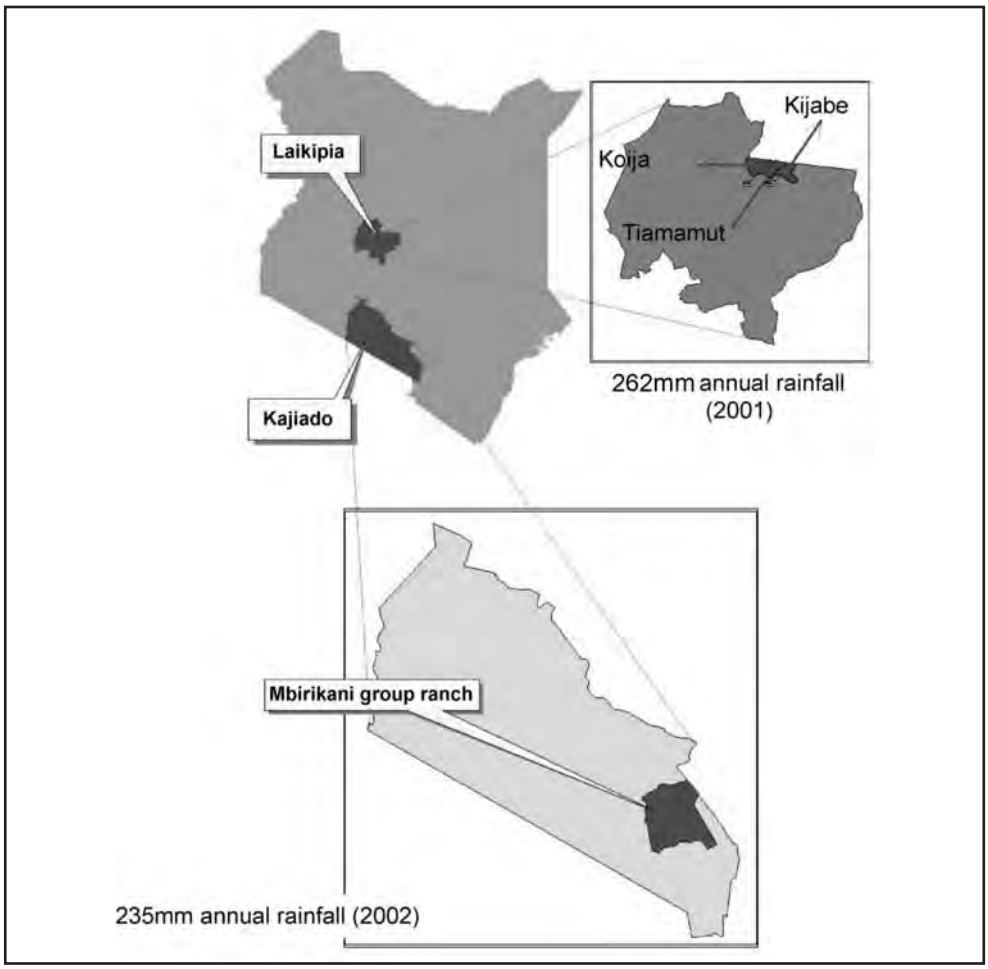
Agricultural development of East Africa in the 1970s was influenced by a paper published by Hardin in *Science* in 1968 called "The Tragedy of the Commons." Hardin proposed that land degradation was occurring due to the overstocking of livestock arising from a traditional system in which land was owned communally, leading to a lack of incentives to manage it properly in the long run. The Kenyan Government began encouraging private land ownership in pastoral systems, with the aim of intensifying and commercialising livestock production. The first major step towards privatisation came in 1968 with the introduction of the Group Land Representatives Act, which provided for the adjudication of group ranches (Bekure *et al*. 1991, Rutten 1992). Group ranches are organisational structures in which a group of people have a freehold title to land, although their livestock are owned and managed individually. Under the Kenya Livestock Development Project, the Mukogodo Reserve in northern Laikipia was divided and adjudicated into 13 group ranches in the late 1970s, while in Amboseli, this process had occurred during the 1960s.

Materials and methods

Tiamamut, Kijabe, and Koija group ranches in Laikipia, and Mbirikani group ranch in Amboseli, Kajiado district, hereafter referred to as Laikipia 1, Laikipia 2, Laikipia 3, and Amboseli, were chosen as study sites (Fig. 1). The four study sites are in agro-ecological zone VI (semi-arid to arid land with rainfall less than 700mm, suitable for ranching). The Laikipia group ranches are on the border between Laikipia and Isiolo districts in northern Kenya. The Amboseli group ranch is northeast of Mt. Kilimanjaro, within the Amboseli National Park/Tsavo National Park wildlife corridor. The detailed ecologies of the study areas are described in reports by Mizutani (2002a, 2002b). According to the Farm Management Handbook of Kenya (Jaetzold and Schmidt 1983), the sites are characterised as upper midland ranching zone with moderate-to-low soil fertility (Laikipia 1 and Laikipia 3) or variable soil fertility (Laikipia 2), and lower midland ranching zone with moderate-to-low soil fertility (Amboseli). Ecotourism is a more recent development in Laikipia than in Amboseli.

Data were collected from March 2001 to March 2002 in Laikipia, and from April 2002 to March 2003 in Amboseli. In terms of animal health and livestock production, the year monitored was considered by the community as an average/good year for Laikipia and a bad year for Amboseli. Annual rainfall during the monitoring was 262mm in Mukogodo (LRP 2002), Laikipia, and 235mm in Mbirikani, Amboseli. The long-term mean annual rainfall, which is biomodal with temporal and spatial variation, is 446mm for Mukogodo (Mizutani 2002b), Laikipia, and 350mm (Altman *et al*. 2002) for Amboseli. The estimated wildlife biomass, excluding elephants, is estimated to be 11kg/ha in both Laikipia and Amboseli, using the air census data from Georgiadis and

Fig. 1. Koija, Tiamamut, and Kijabe group ranches of Laikipia district and Mbirikani group ranch in Amboseli district



Ojwang' (2001) and unpublished air census data from Bonham in 1999.

Community members were trained to conduct a questionnaire regarding household income and to undertake participatory monitoring of livestock production with 100 households at each group ranch. The households were selected randomly from each village within a ranch. The survey was structured in four sections. In the first section, general information was collected about the household, including information on schooling of children and on distribution of bomas and livestock. Socioeconomic variables such as sex, age, marital status of respondents, and family composition, all of which affect resource use, were also recorded. The second section dealt with the structure of herds, transfers, and parameters of livestock production; it covered all transfers seasonally, including births, losses due to stillbirths, abortion, slaughter, donation, and sale, and all deaths due to diseases, predation, accidents, lost animals, theft, and drought. Additionally, information on milk production and domestic consumption, and on other factors such as timing of weaning, price realised at sale, and weights of different types of animals, was collected. The third section dealt with other economic activities such as honey revenue, crops, and off-farm income. Crop production was recorded in terms of inputs and outputs, including domestic consumption of crops.

The final section of the questionnaire dealt with interventions aimed at reducing poverty in Laikipia and at reducing livestock losses due to wildlife in Amboseli. In addition, for the Amboseli community, ages of herders of different types of livestock were recorded, as were interventions that the households knew of or took to reduce predation losses. Questionnaires were open-ended and allowed for multiple entries.

Livestock productivity is difficult to measure. While the data are collected over a relatively short period, the longer-term breeding life cycles of the animals in the herd and the composition of the herd must be taken into account. The livestock off-take and related parameters of the livestock production systems were analysed using the Livestock Production Efficiency Calculator (LPEC) model (PAN Livestock Service 1991, Peeler and Omore 1997), and estimated production costs established in a recent survey of Maasai households in Kitengela, Kajiado District of Kenya (Kristjanson *et al*. 2002). The LPEC model calculates a value

for the production of the herd over a certain period based on the nutrition of the animals (obtained from forage, including grazing and crop-based feed resources). Productivity is expressed in terms of the ratio of the *value of output per unit of time* to the *value of input per unit of time*. Because it is difficult to estimate the economic value of feed, it has been proposed that the economic margin per unit of forage is an appropriate index for many livestock production systems (James and Carles 1996). Thus, the productivity measure used for this analysis was refined, becoming the ratio of the *value of output less the value of inputs other than forage* to *quantity of forage input*. The LPEC model is a valuable tool to assess the sensitivity of productivity to various production parameters and to identify the most promising areas for improvement strategies.

Data were collected according to a number of classes or types of animals. In the case of cattle, breeding females are defined as cows that have successfully calved. Replacement females are heifers used to replace cows. Surplus females are heifers that are surplus to requirements for maintaining a given herd size. This category is not commonly recognised within the target communities and almost all female stock is considered replacement. Because no distinction is made between replacement females and surplus females, in our case the same production parameters were used. Breeding males are defined as bulls of commonly recognized breeding age. Replacement males are young bulls not yet used for breeding. Surplus males are bulls reared for purposes other than breeding. The LPEC parametres such as mortality and culling rates, parturition rate, stillborn rate, and 24-hour survival rate are calculated on an annual basis. Livestock holdings were converted into tropical livestock units (TLU) to allow for comparisons between communities, in which 1TLU equals 250kg live body mass as defined by the Food and Agriculture Organization of the United Nations. The average body masses of the different management groups from previous studies were used to estimate the TLUs. For instance, in cattle, a breeding female is equal to 1TLU; a breeding male, 1.29; a replacement suckling, 0.40; a replacement weaned female, 0.70; a weaned male, 0.68; and a surplus weaned male, 1.05TLUs. For sheep, a breeding female is equal to 0.11TLU and a breeding male, 0.15TLUs. For goats, a breeding female is the equivalent of 0.11TLU and a breeding male, 0.17TLUs.

Because natural resources such as grazing, water, wild plants, and fruits are communally owned, the outputs of the pastoral economic activities come from a shared ecosystem. Therefore, we aggregated the results from 100 households to calculate the total output from livestock production in one locality. The community members also found it easier to interpret the results with such an aggregation. The number of adult equivalent (AE) and TLUs were estimated at the level of 100 households to avoid taking means of different clusters of non-normally distributed samples.

Results

Livestock holdings and socioeconomic characteristics of households in Laikipia and Amboseli

Table 1 summarises the land and livestock resources for each of the communities. The communities in Laikipia own less than a quarter of the livestock kept by the Amboseli community, indicating that the Laikipia communities are relatively poorer, at least in terms of livestock assets, than the Amboseli community studied. The Laikipia communities had far fewer cattle, with less than one-eighth of the cattle holdings of the surveyed Amboseli community.

The results from the questionnaire on herd dynamics are summarised as the proportion of annual off-take due to mortalities and net culling in relation to herd size (Table 2). While cattle production in Laikipia 3 does not appear to be viable (with a mortality rate of 72% in 2001), the Laikipia 2 and Amboseli communities are keeping relatively stable herds. Cattle herd growth rates are 0% for Laikipia 1 and 3 while greater than 10% for Laikipia 2 and Amboseli (Table 3). Of the 37 households in Laikipia 3 that kept cattle, 38% purchased them recently or received them as gifts. However, no output from those animals had so far been recorded.

The pastoralists interviewed noted that crossbreeding local with exotic livestock improved the productivity of the livestock. Typically, crossbreeds make up close to half of the sheep herds, while goat herds are made up of almost totally indigenous breeds. Crossbred sheep suffer higher mortalities (Table 2) than indigenous goats, and the growth rates of goats are higher (Table 3). On the other hand, half of the cattle in Amboseli are crossbreeds, but cattle in the Laikipia communities are mainly indigenous (Table 4). The breakdown of the various causes of mortality (Table 5) indicates that cattle herds in Laikipia 1 and 3 and Amboseli suffered significant losses due to drought during the year of the survey. As the surveyed year was considered a bad year for Amboseli, these cattle spent half the time away from the homesteads (6 months) seeking water and grazing. In Laikipia 1 and 2, cattle stayed away for 7 and 9 months, respectively. In Laikipia 3, cattle hardly left the homestead within the ranch, and it was here that the highest milk off-take was recorded. For the four communities surveyed, the reduction of income due to drought was highest in Amboseli.

The estimated annual net income from livestock per adult equivalent (Table 6) was approximately US $147 for Laikipia 1, US $155 for Laikipia 2, and US $141 for the Amboseli community, while for Laikipia 3, it was negative (–US $9). Net annual livestock income per TLU ranged from –US $8 to US $61 in Laikipia communities and was US $21 in Amboseli. The breakdown of livestock production revenues and profits suggests that the current cattle production systems of these communities are relatively unprofitable, while more income is earned from sheep and goats, particularly amongst the poorer Laikipia communities.

Table 1. Land and livestock resources of the surveyed households (hh) (100 per site)

Site	Compensation or revenue from wildlife	Density of wildlife without elephants (kg/ha)[1]	Surveyed period and rainfall in % of long-term average rainfall	Agro-ecological zone	Total hhs in the surveyed sites	Total AE of 100 hh	Total TLU of 100 hh[2]	TLU per AE[3]	Size (ha)[4]	Grazing areas used (ha)[5]
Laikipia 1 Conservation trust established in 2002	**No**	**10.7 (+ 3.1)**	March 2001–March 2002 59%	Upper midland ranching zone	121	**391.9**	**Total 936** cattle 369 sheep 240 goats 327	2.4	5,215	115,000
Laikipia 2 Construction of a community-owned lodge in progress					136	**458.7**	**Total 1,166** cattle 539 sheep 243 goats 383	2.5	6,323	122,200
Laikipia 3 Community-owned lodge constructed and in operation since 2001	**Yes**				193	**456.2**	**Total 535** cattle 204 sheep 199 goats 408	1.1	7,641	113,800
Amboseli Lodge in operation since 1986; new community-owned lodge proposed		**11.0 (+0.2)**	April 2002–March 2003 67%	Lower midland ranching zone	490	**711.2**	**Total 4,754** cattle 4,152 sheep 302 goats 301	6.6	33,741	>381,250

[1]*Sources (Georgiadis and Ojwang' 2001; Bonham, unpublished data); figures in parentheses are density of elephants.*
[2]*The Laikipia communities hold some camels but they are excluded in this calculation.*
[3]*The concept of AE (adult equivalent) is based on the differences in nutrition requirements according to age and sometimes sex. It assumes that the life-cycle stages have an important influence on the needs of members or individuals of the same household. The study adopted the consumption weights used by the Ministry of Finance and Planning in Kenya, GOK (Government of Kenya 2000). Age 0–4 (years) = 0.24 AE, age 5–14 (years) = 0.65 AE, age 15+ (years) = 1.00 AE. TLU = tropical livestock unit.*
[4]*Total area covered by this survey was an entire group ranch in Laikipia, and three out of four villages, where the majority of the people reside in Amboseli.*
[5]*Laikipia communities utilise the areas that belong to absentee landlords as grazing lands, while 92% of the Amboseli community graze within the group ranch. The grazing area available outside the group ranch is currently being analysed using GIS.*

Table 2. Annual livestock off-take rates of four sites (aggregation of 100 hh)

	Annual off-take rates (%)			
	Laikipia 1	Laikipia 2	Laikipia 3	Amboseli
Cattle				
Net culling	9	16	6	9
Mortality	22	7	72	6
Sheep				
Net culling	18	24	28	9
Mortality	21	25	24	16
Goats				
Net culling	14	2	18	11
Mortality	12	12	19	13

Table 3. Annual livestock growth rates at four sites

Site	Growth rates (per year)		
	Cattle	Sheep	Goats
Laikipia 1	0%	7%	17%
Laikipia 2	15%	3%	11%
Laikipia 3	0%	2%	1%
Amboseli	12%	7%	7%

Table 4. Percentage of indigenous livestock kept by communities

Site	Indigenous livestock (%)		
	Cattle	Sheep	Goats
Laikipia 1	93%	53%	100%
Laikipia 2	86%	63%	100%
Laikipia 3	92%	43%	100%
Amboseli	47%	47%	72%

Table 5. Annual mortality of livestock by different causes

Causes of death	Total deaths per year (%)			
	Laikipia 1	Laikipia 2	Laikipia 3	Amboseli
Cattle				
Disease	81%	78%	7%	67%
Predation	9%	9%	3%	11%
Drought	5%	0%	84%	10%
Theft and gone missing	2%	0%	2%	10%
Snake bite	0%	0%	0%	0%
Other	3%	12%	4%	3%
Sheep				
Disease	59%	64%	48%	60%
Predation	22%	25%	15%	18%
Drought	7%	0%	0%	0%
Theft and gone missing	11%	7%	21%	12%
Snake bite	0%	3%	7%	0%
Other	1%	1%	8%	2%
Goats				
Disease	49%	66%	34%	59%
Predation	34%	20%	35%	18%
Drought	3%	0%	5%	10%
Theft and gone missing	9%	12%	12%	12%
Snake bite	0%	1%	7%	0%
Other	5%	1%	6%	1%

Table 6. Estimated net annual income from livestock

Source	Estimated net annual income (US$)			
	Laikipia 1	Laikipia 2	Laikipia 3	Amboseli
Cattle	3,837	19,663	-20,558	76,054
Sheep	19,288	13,754	2,064	11,690
Goats	34,430	37,875	14,260	12,344
Total net income per 100 hh	57,555	71,293	-4,234	100,088
Income/AE	147	155	-9	141
Income/TLU	61	61	-8	21

Table 7. Estimated net annual income from various sources

Source	Estimated net annual income (US$)			
	Laikipia 1	Laikipia 2	Laikipia 3	Amboseli
Livestock	57,555	71,293	-4,234	100,088
Off-farm	10,377	11,530	12,062	8,419
Honey related	6,829	0	11,175	187
Crops	0	0	0	5,986
Food relief	18,359	25,188	24,744	9,915
Wildlife related	0	0	16,053	1,964
Total net income per 100 hh	93,119	108,010	59,800	126,559
Net income per year per AE	238	235	131	178
Net income per day per AE	0.7	0.6	0.4	0.5

Total annual net income was calculated on the basis of 100 households for each group ranch. Estimated annual net income aggregated for the 100 households varied from US $59,800 to US $126,600 (Table 7). When these figures are calculated in terms of income per person per day, all four communities fall below the international poverty threshold of US $1 per person per day. Included in this figure is estimated off-farm income, which includes wage earnings from both informal and formal employment, remittances from relatives and families, and income from business revenues such as brewing beer or selling firewood. It also includes wildlife-related income, coming from warrior dancing, craft sales, sales from a cultural manyatta, and direct employment related to tourism, such as game guiding or employment at tourist lodges. In Laikipia 3, 99% of the households had some off-farm income, while in other communities about 50% of the households had off-farm income. Bee keeping was practised by the majority of the households in Laikipia 3, by 33% of households in Laikipia 1, and by 8% of households in Amboseli. Of the Amboseli households, 27% had planted crops.

Livestock products, such as meat and milk, contribute more to total income than do other sources for Laikipia 1 and 2 and Amboseli. However, off-farm income, food relief, and wildlife-related earnings are higher than livestock earnings (which are actually negative [Table 6]) in Laikipia 3 due to the recent restocking and poor livestock husbandry.

During the household survey, the respondents were asked to treat 10 beans as their total income and to allocate them towards five types of income (livestock, off-farm income, honey revenue, food relief, and wildlife), so as to represent the relative importance of their household's livelihood sources (Fig. 2). This was cross checked against the total annual income (Table 7) and found to be very similar. Laikipia 1 and 2 and Amboseli communities rely mainly on livestock for their livelihoods. The Laikipia 1 and 2 communities do not perceive any direct or indirect benefits from wildlife. Laikipia 3 shows greater diversification of income sources, with households on average receiving 13% of their total income from honey and 18% from wildlife (ecotourism). The survey also revealed that government food relief represents a substantial part of overall household income in all four communities. Off-farm sources of income are relatively small across the communities.

Fig. 2. Mean contribution of different income sources to total income as perceived by household members (n=100)

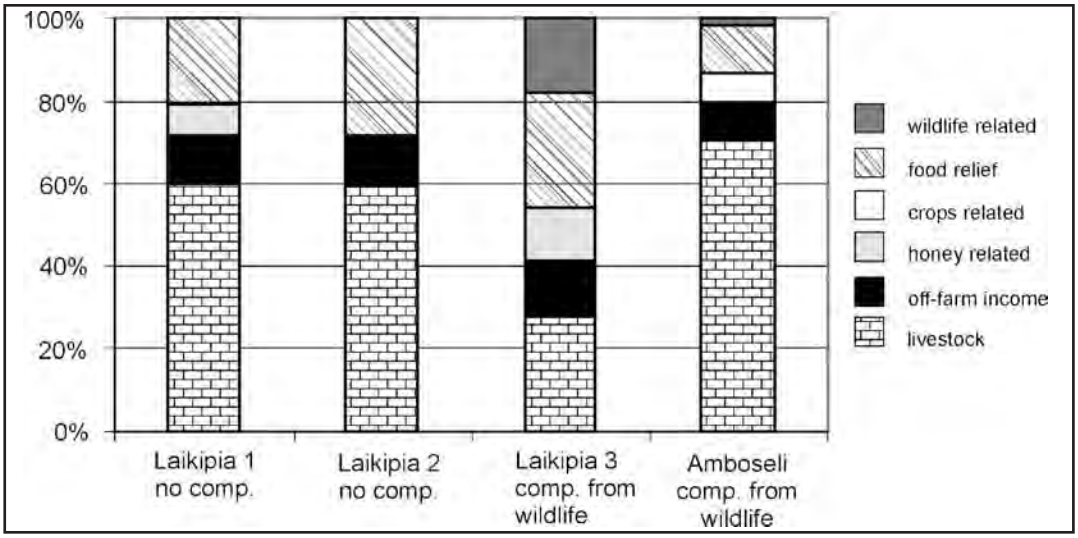
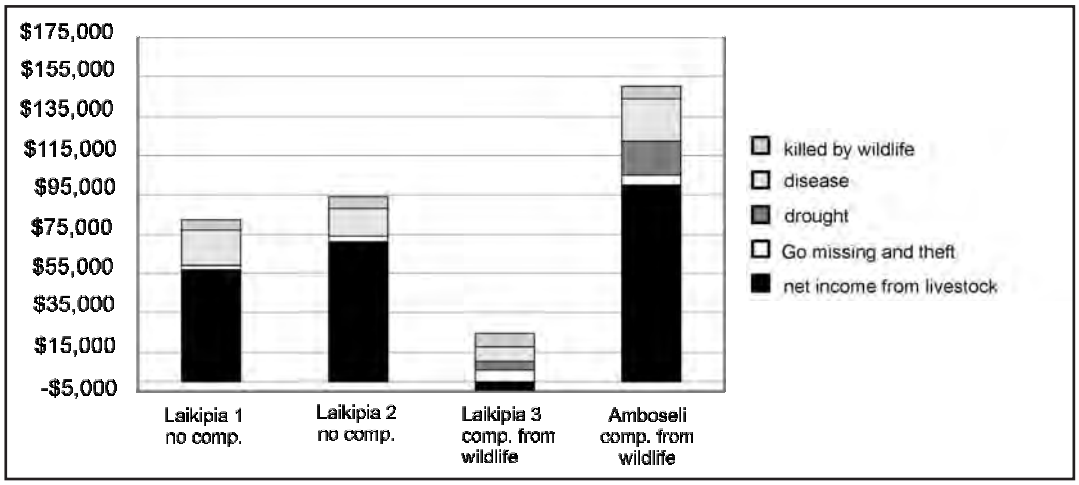


Fig. 3. Estimated net income from livestock compared with costs of losing livestock (lost revenue in US$) by cause of loss



Impact of disease and predation on livestock production

Losses to disease result in the most significant costs associated with livestock production across all four communities (Table 8 and Fig. 3), although losses from predation (including livestock killed by buffalo and elephant) are regularly absorbed as well. Diseases had the highest impact on net revenue from livestock across all communities, and lost revenue due to predation was similar across the communities. The Amboseli survey respondents listed the following interventions to reduce or minimise predation losses: improved herding during the day (13 %), better and secure bomas (night kraal, 100%), keeping dogs (48%), fire at night (18%), and having a night guard at the boma (7%). One quarter of respondents reported taking some action to reduce the predator population, but less than half (44%) of them experienced satisfactory results. This seems to indicate that there is a threshold point beyond which losses due to predation become unacceptable to these households, and they then take action to reduce predators.

Regarding losses to predation, sheep and goats are more likely than cattle to be killed by predators (Table 5). One reason is that sheep and goats are more often herded by children younger than 16 years old who may be less capable of deterring predators (90% of herders for sheep, 86% for goats, 66% of herders for cattle).

We estimated losses due to disease and predation in terms of lost income (Table 8) and found that the diseases that the communities perceived to be caused by wildlife, such as tick-borne diseases and malignant catarrhal fever (MCF) do not present as high a cost as other diseases that are not associated with wildlife. The Amboseli community claimed during the feedback meetings that MCF was a wildlife hazard. However, the cost of the losses due to MCF turned out to be less than the costs due to anthrax or diarrhoea. Estimated lost revenues from livestock to tick-borne diseases

Table 8. Annual cost of major diseases and predation

Disease or predator	Lost income (US$)			
	Laikipia 1	Laikipia 2	Laikipia 3	Amboseli
Contagious bovine/caprine pleuropneumonia	3,425	5,780	3,551	22,351
Tick-borne diseases	6,172	6,323	2,749	-703
Anthrax and blackquarter	0	0	0	5,053
Diarrhoea and scouring	1,236	2,300	13	3,813
Lumpy skin disease and sheep pox	682	3,805	0	1,470
Lions	756	748	1,602	3,009
Hyaena	2,259	2,764	4,736	2,436
Leopards	906	2,979	1,563	501
Cheetahs	508	0	35	0
Wild dogs	829	0	16	0
Total	16,773	24,699	14,265	37,930

are not a problem in Amboseli but are significant in Laikipia. The highest losses experienced by all four communities are caused by two major diseases, contagious bovine and contagious caprine pleuropneumonia (CBPP and CCPP), found particularly in the Amboseli community.

Discussion

The total TLUs we found in Laikipia were similar to those reported by Herren (1990), and our findings for Amboseli are within the ranges of published literature showing TLUs for this area (Bekure *et al*. 1991, S. BurnSilver, personal communication). According to nutrition requirement estimates, 5TLUs are required to obtain the necessary food intake annually to sustain one adult in similar current pastoral systems (Lamprey 1983, Schwartz 1993, Aligula *et al*. 1997). Thus, livestock production in Laikipia communities (1.2–2.5TLUs per AE) alone cannot provide food security for the Laikipia communities, and diversified sources of food and income are necessary to maintain livelihoods. The total net income per person per day was also well below the commonly used international standard measure of poverty (US $1 per person per day). They are closer to the Kenyan poverty line of Ksh 1,239 per person per month, which is roughly US $198 per person per year (CBS 2003).

Findings from a large-scale livestock/wildlife ranch with an extensive livestock production system using mobile bomas and herders in Laikipia (Mizutani 1995, 1999a, 1999b) are consistent with the results of this study. First, the percentage of deaths due to predation across all four communities studied is similar. Second, the different causes of mortality in Laikipia and Amboseli communities concur with observations made on the ranch (Mizutani 1995, 2002c). However, the traditional strategy of using space to isolate infected herds and to outrun the outbreak of disease seems to have been lost within the pastoral communities. Smaller stock are also more vulnerable to predators due to their body size. Across all four communities, animals were lost to theft and had gone missing.

Considering the loss of livestock to theft, missing animals, and predation, herders are more likely to blame predators than other causes particularly if losses might be due to their own negligence. Opportunistically, predators often kill livestock that has gone missing. If not, livestock may succumb to diseases out of the sight of the herder, and then be scavenged by predators.

Our findings suggest that husbandry interventions (diagnosis and treatment of diseases, and improved hygiene, herding, and security) and management efforts aimed at sustainability of the habitat of natural prey species are essential in the effort to contain livestock losses in mixed systems.

Crossbreeding of livestock with exotic types is likely to result in an increase in types and prevalence of diseases and thus an increased requirement for animal health care (Ayalew *et al*. 2003, Baker *et al*. 2003). The Amboseli community members had more crossbred cattle than the Laikipia communities, and this may explain the lower net output of the cattle production system in Amboseli during a year of relatively low rainfall (crossbreeds require more forage than do indigenous cattle). Mastitis was also reported to be a major problem in the crossbred Amboseli cattle, reducing milk production significantly during this poor year.

The idea that natural prey might act as a buffer against livestock losses to predators (Mizutani 1999a) was not a concept recognized by community members interviewed. Instead, the increasing number of wild herbivores is perceived as increasing the competition with livestock for scarce forage. This contrasts with the experience in the Marsabit area (northern Kenya), which is currently being studied, where

depletion of natural prey is coinciding with increasing livestock losses to hyaena. The Kitengela area, located adjacent to Nairobi National Park is also experiencing high losses of livestock to lions during a period of declining wild herbivore populations. Investigations of losses of livestock to predators at different wildlife biomass densities are ongoing to try to identify a threshold wild herbivore density that correlates with contained livestock losses (Serneels *et al*. 2002).

Conclusions

We confirmed that there are certainly wildlife-associated losses in pastoral livestock production areas (outside protected areas) where wildlife numbers have been maintained or have increased in recent years. We found, however, that the estimated losses due to wildlife, both by disease and predation, are in fact negligible.

Losses to disease are much higher than losses to predation, and diseases that are not transmitted by wildlife impose much higher costs than do those most likely transmitted by wildlife. These findings are from a 1-year survey only, and ideally one needs to capture the stochastic nature of the sub-Saharan ecosystems. However, similar findings are reported from a long-term study of a mixed livestock/wildlife system in Laikipia (Mizutani 2002c).

Our findings show that these communities face a poverty challenge, with most households earning far less than US $1 per person per day. But we have also found evidence that healthy ecosystems and conservation of wildlife can contribute to improved incomes for poorer livestock keepers. Within such mixed systems, there is ample room for improvement of livestock husbandry on the basis of the identified major problems in the livestock production systems (Bekure *et al*. 1991, Grandin *et al*. 1991, IDL Group 2003). Such improvements include prevention of diseases, limiting losses due to drought, better security, improvements in basic hygiene for young stock, and prevention as well as treatment of mastitis to increase milk yield. Implementing basic vaccination schemes against such diseases as anthrax or limiting zoonotic diseases such as coenurosis are potential strategies for improved productivity within these poor communities. (Maasai people in these areas were reportedly once resistant to anthrax and therefore consumed carcasses after the animals died. However, the Amboseli community claims that today an increasing number of people suffer from this disease.)

Other possibilities include improved herding practices during the day and guarding the animals at night, as well as more tolerance for natural prey species populations that will act as "buffer zones" for predators and thus avoid or minimise livestock predation losses. Such developments will increase the likelihood of stemming the loss in biodiversity in East Africa while providing sustainable livelihoods for its people. Longitudinal and cross-sectional monitoring and evaluations (Bayer and Waters-Bayer 2002, Catley and Mariner 2001) will assist communities to better evaluate their productivity levels and to develop collective community-based action plans. Above all, benefits from wildlife likely offer the most important opportunity for these poor pastoralists in terms of income diversification possibilities. National natural resource and wildlife management policies urgently require attention if impoverished pastoralists are to benefit directly from natural resources such as wildlife. Better use of existing livestock and interventions to improve livestock productivity (e.g., increased use and sale of milk, appropriate crossbreeding practices for cattle and sheep) also offer opportunities for enhanced livelihoods. Promoting ecosystem health and livestock development for the poor can substantially contribute to the maintenance of biodiversity in an area where so many of the world's large mammals can still be found.

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Chapter 18

Complementarity between Community-Based Animal Health Delivery Systems and Community-Based Wildlife Management? An Analysis of Experiences Linking Animal Health to Conflict Management in Pastoralist Areas of the Horn of Africa[1]

Richard Grahn[2,3] and Tim Leyland[2,4]

Introduction

Community-based Animal Health Systems (CAHS) have been developing since the early 1980s across all continents. Their success in delivering animal health services to remote, marginalized, and under-served livestock-keeping communities and the consequent improvements in livelihoods has led to a concerted drive to ensure the sustainability of such delivery systems through privatization and the development of enabling policies and legislation. The process of underpinning the sustainability of CAHS has led practitioners and advocates of such systems to consider and respond to core non-animal health challenges to CAHS. Such constraints include poor access to markets, lack of voice of marginalized communities in policy processes, conflict, and the negative consequences of disaster relief strategies. After some success in building upon gains from CAHS to address core non-animal health challenges, practitioners are now examining the possible beneficial linkages between CAHS and sustainable wildlife management in pastoralist areas.

Situation of pastoralists in the Horn of Africa

This paper primarily addresses pastoralist communities in the Horn of Africa, but many of the principles discussed are applicable elsewhere. Throughout the Horn of Africa, pastoral communities are politically marginalized and suffer from increasing food insecurity, levels of violence, and worsening service provision. Pastoralists in the region mostly depend on livestock for their basic needs but are unable to develop these assets because of factors such as inadequate animal health services and limited access to adequate water sources. Pastoralists particularly prioritize livestock disease as a problem for very straightforward reasons: sick animals provide fewer offspring, less milk, and less meat; they are less economically and practically valuable. Disease, therefore, reduces household food consumption both directly and indirectly, as fewer animals are available to sell or exchange for cereals. Although pastoralists possess extensive knowledge of their environment, livestock dominate economic and social functions in pastoral areas, and livestock keeping comprises the key livelihood strategy in areas with limited scope for other means of making a living.

While wildlife is a concern of pastoralists, it is viewed primarily from the perspective of how it can serve to improve their food security through bush meat consumption. The scale of bush meat consumption in Africa has been reported by Barnett (2000). This paper argues that approaches to Community-Based Natural Resource Management (CBNRM) that were rooted in community-held priorities would address pastoralists' key concerns such as food security and service provision. Conservation goals will be achieved in pastoral areas only if conservation initiatives are linked to tackling the pressing issues faced by pastoral communities. A recent study by the Department For International Development (DFID) estimates that as many as 150 million poor people (one eighth of the world's poorest people) perceive livestock to be an important livelihood asset (DFID 2002). Although aware of the loss of wild fauna and flora in their areas, pastoralists generally prioritize improved livestock health more than they desire wildlife conservation and management. If such initiatives do not contribute to maintaining and/or enhancing their livelihoods, pastoralists are likely to be less committed to collaborating in community conservation schemes.

It is our contention that Community-based Animal Health Systems could provide an opening for CBNRM initiatives in these areas in a way similar to how they have acted as an entry point for successful conflict management initiatives. CAHS have been successful because they benefit pastoralists directly, and experiences with conflict resolution show that pastoralists are keen to achieve peace because of the accompanying improvements to animal health and therefore livelihoods.

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Box 1. Some examples of the impact of Community-based Animal Health Workers (CAHW) on human livelihoods

- In Malawi, the savings from increased livestock production in those areas where CAHW were active was US $57,000 in the year 1998–1999. Farmers with CAHW services were more likely to afford a tin roof, window glass, ox cart, plough, and radio than farmers without access to CAHW services (Hüttner 2000).
- In Afghanistan, CAHW programmes reduced mortality by 5% in calves, 10% in lambs, and 38% in kids, compared with control areas without CAHWs. The benefits to farmers were estimated to be US $120,000 per district per year, while the costs of the programme were US $25,000 per district (Schreuder *et al*. 1996).
- In a specified district, Kenya farmers without access to CAHW reported 70% more cattle deaths than those farmers who had access to CAHW. The decrease in mortality provided benefits worth US $48 a year to each farmer using CAHW (Holden 1997).
- A review of Oxfam UK/Ireland's CAHW project in northeast Kenya in 1998 compared livestock mortality in project and nonproject areas (Odhiambo *et al*. 1998). In nonproject sites, annual mortality in camels, cattle, and sheep and goats was estimated at 31%, 32%, and 25%, respectively, whereas in project sites, annual mortality was 20%, 17%, and 18%. The reduced loss of livestock was valued at Kenya Shillings 22,853 (approximately US $350) for each household in the project area, and this sum was sufficient to buy grain to feed two adults and four children for 250 days.
- Established in 1998, a CAHW project in Simanjiro District, Tanzania, was assessed in May 2001. The use of interviews and participatory methods showed how Maasai pastoralists associated the CAHW service with reductions in calf mortality of between 59% and 93%. This led to increased sizes of milking herds and more cows milked per household. For example, the average number of cows milked per household increased from 5.3 to 24.2 cows. Communities concluded that the increased milk availability had a huge impact on local food security (Nalitolela *et al*. 2001).

Community-based Animal Health Systems

The concept of Community-based Animal Health Workers (CAHW) probably arose from experiences in the human health sector. The term "barefoot vets" (Halpin 1981) seems to derive from China's successful and ongoing use of "barefoot doctors" to bring basic services to the general public, as described by Chetley (1995). In the early 1970s, the World Bank advocated that livestock producers' associations should include "grassroots level para-veterinarians" (de Haan and Nissen 1985). This advice was influential and raised awareness. Since that time, various actors have developed and refined CAHW systems. For example, in eastern Africa, nongovernmental organizations (NGOs) and bilateral agencies have been particularly influential, whereas in southeast Asia, government veterinary services have been at the fore in their development (Leidl 1996).

In a comprehensive review of available data, McCorkle (2003) estimates that CAHW initiatives have been implemented in 46 nations since the 1970s. A recent survey by the African Union/Interafrican Bureau for Animal Resources (AU/IBAR) identified over 390 CAHW projects in Horn of Africa countries alone. Growing interest in CAHW systems is largely related to the high impact on animal health and human livelihoods resulting from improved basic veterinary care in rural communities. Some examples of the impact of CAHW on livelihoods are shown in Box 1. Equally impressive documentation on the impacts of CAHS on livestock disease control and surveillance can be found elsewhere (Mariner *et al*. 1994, Hanks *et al*. 1999, Mariner 2002, Baumann 1993, Leyland and Catley 2002).

Box 2. Key requirements for sustainable and effective Community-based Animal Health Worker (CAHW) delivery systems

- Livestock owners perceive they have an animal health problem.
- Local communities participate in an interactive way in all aspects of service development, including defining the problem, planning, contributing time and resources, defining criteria for selection of CAHW, agreeing on a prescribed relationship with private vets (including payment of full cost for services rendered by CAHW and the government vets who regulate and monitor), selecting CAHW, conducting post-training reviews, monitoring, de-selecting CAHW who perform poorly, recognising refresher training, etc.
- The CAHW System is based on sound business principles in terms of capitalization, loans, turnover, reinvestment, and profit generation.
- Training is based on participatory and adult-learning methods, standardized but flexible to respond to needs within different communities.
- The roles and reporting relationships of the cadres of "CAHW," "Animal Health Technicians," and "veterinarians" are described and recognised by the veterinary authorities. This includes geographical definition of where CAHW are allowed to operate.
- The opportunity exists for private veterinary practitioners to be awarded contracts for provision of public good services (vaccination, disease surveillance) so that the so-called "sanitary mandate" is availed.
- The policies and strategies of the veterinary authorities towards Community-based Animal Health Systems (CAHS) are in line with practice and enforcement of veterinary professional legislation, including pharmaceutical supply laws.

Although CAHW have provided very useful primary animal health care services to livestock keepers, many projects have failed to address important technical, social, and sustainability shortcomings. Indeed, a very wide range of modes of project design and implementation are currently used, with varying levels of success. Common key weaknesses with CAHS include failure to fully involve communities in analysis of problems and solutions, and limited attention to financial sustainability (McCorkle 2003). Within Africa, many years of experience have demonstrated the importance of establishing CAHW systems as partnerships between communities, government, and the private sector. The key requirements for establishing sustainable CAHW projects are summarised in Box 2.

Incorporating CAHW systems and improving the quality of veterinary service delivery at a national level is a complex task. It requires long-term strategic and operational plans that are regularly reviewed, and that have the commitment and support of the national authorities. The process of establishing such services and the policy implications have recently been comprehensively described by Catley *et al*. (2002) and the IDL group (2003). It is our view that there is much that can be learned from CAHS in CBNRM, particularly as they can be seen to have many of the same requirements for success including a perceived problem, meaningful community participation, and policy-level support. It is equally the case that lessons for CAHS may be derived from the rich CBNRM literature, although this is beyond the scope of this paper.

Community-based Animal Health delivery Systems and conflict management

AU/IBAR has built on the success of CAHS to tackle the insecurity in the greater Horn of Africa that is an impediment to animal health service delivery. After real animal health benefits were seen, the pastoralists of the Karamojong cluster approached veterinary doctors and said in very simple terms, "Now that we have seen some benefits from your work with us, we want you to help us to solve our problem of livestock raiding and conflict." Whilst not being experts in conflict resolution, these veterinarians offered to bring together the traditional leaders from neighbouring communities that were in conflict with one another and where CAHS had been successful. Initial meetings were uneasy and risk prone but at the same time succeeded in initiating the dialogue that has subsequently made a significant contribution to conflict management (Grace 2001, Waithaka 2001, Minear 2001).

The key aspect of the success of these conflict management initiatives has been the high level of participation by pastoral communities, or "co-learning." AU/IBAR developed its conflict work in direct response to the request from elders to tackle conflict in order to really tackle animal health problems. Since then it has continued to base its methods and approaches on the suggestions and involvement of pastoral communities. The methods have been continually revised as community members themselves create new ways of transforming their conflicts. For example, AU/IBAR followed the advice of youths and sought to involve pastoral women in peace dialogues, moving the conflict transformation activities to remote contested areas in order to understand their perspective on conflict and the role of women in preventing and provoking conflict.

Over time the confidence of communities in their development partners has grown, and the work has evolved into a two-pronged conflict management strategy of both rebuilding the authority of community elders over youths and of formalising natural resource management agreements. Methods designed to implement this strategy include community dialogues involving elders, youths, and women with politicians, local administrators, and cross-border counterparts (Border Harmonisation Meetings). These methods collectively fulfill the vital function of strengthening the role of elders within their own community and opening up the space for discussions about peace between communities that are traditionally in conflict. Through the deliberate involvement of local administrators, members of parliament, and other stakeholders, trust is increased between communities and those who represent them and those who are employed as administrators on their behalf (CAPE 2003a, ITDG-EA and CAPE 2003).

Similar to the approaches of AU/IBAR's conflict management initiatives, CBNRM aims to be genuinely participatory and should seek to tackle the concerns of pastoral peoples directly, based on their input. This will demonstrate tangible benefits to them and ensure that participation is meaningful and equitable. It is our view that the systematic strengthening of the role of elders could well prove useful in managing some types of wildlife-based conflict because elders are able to persuade community members to support or undermine CBNRM strategies. For example, the problem of poaching within buffer zones exhibits a strong similarity to issues of conflict management in support of animal health goals. The parallel in conflict work is that a handful of youths equipped with readily available modern semi-automatic weapons are able to undermine the traditional or formal peace agreements put in place by elders, regardless of the role played by outside actors. This phenomenon has been documented by the Community-based Animal Health and Participatory Epidemiology (CAPE) Unit with respect to its work with pastoral women in peace building (CAPE 2003a). However, as with all problems of collective action, it is critical that almost all members of the community adhere to the management approaches if they are to be effective. This is most elegantly theorised in the Prisoners' Dilemma, a situation in which all parties need to cooperate on the basis of imperfect information if they are to achieve the best possible outcome for all participants, but they usually opt for a second-best solution because they are not aware whether the other parties will cooperate. Taking, for example, the issue of poaching, a handful of community members who opt to disobey the agreed-upon CBNRM rules or customs can seriously undermine the conservation goals, for example, by poaching (or facilitating the poaching) of rare species.

Community-based animal health and conflict management at the policy level

Community-based success requires the interactive participation and buy-in of whole communities, particularly opinion leaders. But for community-based efforts and achievements to be sustained, national and local authorities need to provide a supportive policy and legislative framework. For example, there is a compelling case that CAHS need to be made sustainable through privatization, but in many countries of the Horn of Africa legislation prevents this. Using conflict management, communities can resolve to live peacefully and share natural resources and establish local early warning and response mechanisms. However, governments still need to provide security and to recognise and cooperate with such grassroots structures. Above all, governments need to integrate their security concerns with the development priorities of pastoral areas to ensure that the root causes of conflict in pastoral areas are tackled over time.

For community initiatives to succeed under conditions of poverty and marginalization, enabling policy and legislation are vital, but it is not always clear what the correct policies and legislation should be. This is particularly true in pastoral areas, where policymakers often have a poor understanding of pastoral livelihoods. It is for this reason that AU/IBAR, along with many others, has concluded that community empowerment is required. Providing a platform for pastoral communities to advocate their own concerns is crucial (Sones and Catley 2003, CAPE 2003b). Over time, pastoralists and other marginalized communities will be able to influence policies and laws to make them more supportive of their development priorities and consequently improve their livelihoods.

Linking Community-based Animal Health Systems and community-based wildlife management

Many wildlife-rich areas in the Horn of Africa are located in arid and semi-arid areas. These are the same areas where CAHS have proved highly effective. In these agro-ecological areas, pastoralist or agropastoralist lifestyles predominate (Barrow *et al*. 2001). Transhumant nomadic pastoralist communities often move close to wildlife-rich areas either on a seasonal basis or during times of hardship. These pastoralists are often neglected by policymakers and administrators. In many instances pastoralists have had access to their dry-season grazing lands restricted when these areas are designated as protected areas. Outside the conservation areas, large dispersal zones are required for mobile wildlife species to cross. The people on whose land mobile species graze and travel across are key stakeholders in conservation and must be recognised as such, even if they are remote from protected areas (Adams and Hulme 2001).

It is also worth noting that the communities one most strongly associates with pastoralism are very often those one associates with conservation, for instance the East African Maasai communities of the Maasai Mara, Serengeti, Amboseli, and Ngorongoro. During discussions with pastoralists in the Horn of Africa about their problems, veterinarians have been surprised to discover that opinion leaders have consistently expressed concern about the loss of wildlife and damage to the environment through uncontrolled burning of rangeland. These communities, although depleting their wildlife stocks over the last 30 years because of easy availability of guns, social unrest, and the breakdown of traditions, are aware that they are losing something rich and meaningful to their lives.

A key opportunity for linking CAHS, conflict management, and CBNRM can arise from the fact that pastoralist communities are often aware of the wildlife loss problem and the causes of wildlife destruction through, for example, uncontrolled habitat burning. The pastoralists themselves have made numerous recommendations to their veterinary partners facilitating CAHS about the need to do more to "to preserve the wildlife for the benefit of posterity." Box 3 shows some of the typical views of pastoralists on the causes of and solutions to wildlife destruction in pastoralist areas. As the voice of pastoralist groups in the Horn of Africa is slowly growing through efforts to strengthen pastoralist civil society groups, the opportunity to engage them on wildlife issues should be taken.

One consistent request that pastoralists pass on to their veterinary partners is for assistance with control of problem animals, for instance, elephants invading crops or predators killing or maiming livestock or people. This theme emerges time and again in conservation and CBNRM literature (Barnett 2000). In our own fieldwork, the issue of hyaena has been of particular concern to pastoralists.

It is evident that some CBNRM initiatives have improved pastoralist livelihoods (IIED 1994, Child 1995, Child 1996, Murphree 2000). Documented examples of CBNRM where tangible benefits have accrued to community members include the DFID-funded Mpomiba project with 19 villages close to the Ruaha National Park in Tanzania and the Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ)-funded project with 40 villages adjacent to the Selous Conservation Area. In Namibia, the National Community Wildlife Conservancy Programme has led to the registration of significant numbers of community-owned conservancies, many of which have entered into private-sector joint ventures. In Zimbabwe, the Communal Areas Management Program For Indigenous Resources (CAMPFIRE) programme has enabled communities to sell hunting quotas and secure incomes from wildlife tourism. Even though the current political situation means that the scheme is now on hold, CAMPFIRE has proved exceptionally influential in conservation and wildlife management thinking.

In general, pastoralist communities are likely to perceive the main CBNRM benefits to be the managed and more sustainable cropping of bush meat, increased revenues gained from consumptive tourism (hunting) and nonconsumptive

Box 3. Root causes of wildlife destruction and indiscriminate burning of pastures and forage, and elders' suggestions for addressing wildlife destruction, as given during cross–conflict-line elders' meetings in the Karamojong Cluster (1999–2002)

Root causes of wildlife destruction and indiscriminate burning of pastures and forage

- Wrong impression that game is the immediate food solution to severe drought.
- Livestock raiders on either side rely on wildlife for food while staging a raid through bush, which houses the game animals.
- Wars that erupted in Africa increased the number of guns in pastoral areas; these guns were used for extensive hunting.
- The notion that there is no owner of the wildlife.
- The notion that the game will always be around.
- Accidental fires by honey harvesters or children roasting hares, squirrels, etc.
- Burning some portion of pasture to clear ticks – then fires become wild.
- Raiders intentionally but secretly burn the neighbours' pasture to force them to move nearer for ease of attack.

Elders' suggestions for addressing wildlife destruction

- Stop cattle raids by making peace.
- Create alternative means of livelihood to avoid poaching, e.g., trade, crop agriculture.
- Game life is no longer an answer to famine or protein needs (this is because the pastoralists have killed game animals en masse and game numbers have been drastically reduced); the elders pledged to change their attitude and pass the message to their youth in order to save their heritage.
- Stop bush fires so as to preserve the bush habitat of wildlife.
- Governments and development agencies should promote environmental protection services at parish and location levels.
- Communities should stop using the "burning technique" to promote new grass; this can be achieved through community education and self-policing.
- Game departments should intensify efforts to rid pastoral areas of poachers.
- Promote tree planting and the establishment of small tree nurseries.
- Wildlife department and veterinary personnel should cooperate to treat sick game.
- Game department should have a strong presence in the pastoral regions.
- Create awareness of importance of wildlife to development.
- If situation becomes desperate because of severe drought, introduce relief food to people to save the game life.

tourism (wildlife viewing), or enterprise and employment opportunities in the tourism sector. There are also indirect gains in which investments in wildlife-related tourism lead to improved infrastructure such as roads, water mains, electricity, and communications.

It is our view that pastoralists are more likely to address issues of wildlife and habitat destruction once their more crucial livelihood problems (particularly animal health and conflict) are being solved. Thus, CBNRM schemes are more likely to succeed if linked to CAHS and if they are seen to help address key wildlife community concerns such as losses arising from predators like hyaena. After addressing a real and worrying problem, pastoralist leaders will be more open to discussing other issues. The authors do not currently have an acceptable solution to hyaena attacking livestock and people.

At the ethical level, it should be noted that pastoral communities bear many of the costs of global conservation initiatives. They are the exceptionally poor communities who find themselves unable to enter land they have historically called their own, who are unable to follow traditional transhumance and grazing patterns, and who lose animals and crops to wildlife. Levels of investment in conservation are significant. The World Bank for example has built up a portfolio of conservation projects worth around US $2 billion over the last decade, and the Global Environment Facility (GEF) has more than 400 biodiversity projects in 140 countries worth US $5.4 billion (DFID 2002). There is a powerful case that the particular concerns of pastoralists with regard to wildlife should be addressed, at the very least because they bear many of the costs of providing these global public goods. When the pastoralists open the door and admit they have a problem of wildlife loss, the opportunity to assist should be taken.

Conclusion

In conclusion, there are good grounds to think that CAHS can be linked to CBNRM and, indeed, that there are lessons to learn from both literatures. CBNRM cannot work when pastoralists remain risk prone and food insecure. CAHS help to strengthen pastoralist livelihoods through increased

productivity and access to markets. Furthermore, they build trust and confidence. Both of these factors will allow CBNRM a higher chance of success. In pastoralist areas, conservationists need to consider how they can link CAHS and CBNRM and learn lessons from the experiences of enhancing CAHS and community-based conflict resolution and management. This consideration should not be limited to wildlife-rich areas but should also include the much wider dispersal zones and areas. It is our view that the complementarities and similarities we have outlined warrant further exploration and consideration, preferably in discussion between practitioners of the two approaches, community-based wildlife management and community-based animal health care, as well as with the pastoralists themselves, who are also wildlife custodians.

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Chapter 19

Approaches to Disease Control in Domestic Canids for the Conservation of Endangered Wild Carnivores[1]

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Introduction

Disease is an increasing threat to many of the world's endangered and rare carnivores. Wildlife managers are increasingly being required to deal with both the threat and reality of disease outbreaks in canids, but they are relatively poorly equipped to do so. In addition, the required evidence is often lacking to assess which strategy might be best employed in any given situation.

To date, rabies and canine distemper have been of the greatest concern, causing severe population declines and local extirpations in a range of species such as black-footed ferrets, Channel Island foxes, Ethiopian wolves, African wild dogs, and lions (Funk *et al*. 2001, Cleaveland *et al*. 2002, Woodroffe *et al*. 2004). These and other pathogens that have caused outbreaks are generalists – they have the ability to infect a wide range of species (Cleaveland *et al.* 2002). Indeed, epidemiologic theory predicts that pathogens that cause major host mortality or that reduce fertility are unlikely to be able to persist in small populations (Lyles and Dobson 1993). These generalist pathogens must therefore persist in another reservoir population (Haydon *et al*. 2002), from which they can spill over and cause a single or repeated epidemics in an endangered population of conservation interest. Control of canid diseases in wildlife can therefore be aimed at reducing disease incidence in either the reservoir or the target population of concern (Table 1), or at reducing transmission between these two groups. In this paper, we review and illustrate these general approaches and outline important factors that might influence their success.

Reduce transmission between reservoir and target populations

Manage interactions between host species

Reducing interaction between reservoir hosts and target hosts that are threatened should be effective in reducing the threat of disease. This could be achieved by eliminating range overlap between the reservoir and target species, i.e., physically separating the species. For example, bighorn sheep (*Ovis canadensis*) have been protected from pneumonia and scabies transmitted from domestic sheep (*Ovis aries*) by barring domestic sheep from buffer zones surrounding bighorn populations (Jessup *et al*. 1991). Physical separation could also be achieved or enhanced by fencing; indeed fences around Kruger National Park may partially explain the absence of evidence of exposure to canine distemper virus and canine parvovirus among wild dogs (van Heerden *et al*. 1995). In theory, separation of hosts could be achieved in national parks, where the reservoir is a domestic species and there are no boundary transgressions. In reality, however, controlling free-ranging domestic dogs as well as wild canids is a substantial challenge and may be nearly impossible in many situations. Even where fences have been used to physically separate host species, such as in Madikwe in South Africa, this did not prevent an outbreak of rabies inside the Park, probably due to the ease with which small carnivores such as jackals can cross some fences (Hofmeyr *et al.* 2000). Furthermore, when wild carnivores occur or range outside national parks, such as when following migrating herds, disease transmission between domestic animals and wild carnivores could lead to the spreading of a disease to endangered carnivores back inside a protected area.

Where ranges of target and reservoir hosts overlap, measures can still be taken to reduce disease transmission. Controlling the ranging of domestic dogs, for example, by keeping them confined at the household by fencing or tying, could be useful and would reduce the chance of wildlife/dog contact. However, cultural obstacles may prevent this, for example, because of the role of dogs as guards or cleaners of the human environment. In other situations, cultural taboos prohibit close contact with dogs, and owners may be reluctant to handle dogs to tie them up. In addition, where dogs are not adequately fed by their owners, they have to range to find food. For several years, the Ethiopian Wolf Conservation

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Table 1. Management options for disease control for wild canids (adapted from Laurenson *et al*. 2004)

General approach	Options	Advantages	Disadvantages	Assumptions	Likely benefits/chance of success
Do nothing		Cheap, easy, may evade controversy	Population viability not guaranteed		Depends on degree of threat
Reduce disease incidence in **reservoir** species		No intervention with target. Public health and economic advantages to communities (zoonoses)	No guarantee of protection in target	Know reservoir	
	1. Vaccination	1. Effective vaccines available	1. Expensive, logistics, large area		1. May be high if wide *cordon sanitaire*, and properly managed
	2. Culling		2. Cost, welfare, cultural attitudes, limited effectiveness		2. Not sustainable
	3. Limit reproduction	3. Can be very effective	3. Effective methods not yet available over large areas		3. High in theory, but may not be practicable
	4. Treatment	4. Therapy availability depends on pathogen	4. Limited effectiveness		4. Poor
Reduce disease in **target** species	1. Vaccination	1. Direct protection	1. Effective vaccines not always available		Variable: may be high as short-term emergency plan or in specific situations if feasible and cost-effective
	2. Treatment		2. Often not feasible, no therapeutic agent available		1 and 2. Last chance in emergency situation
Reduce transmission between reservoir and target species	1. Fencing/physical barrier	No intervention with target	1. Often not feasible	Know reservoir	Medium on continental situation High on islands
	2. Restraining domestic animal reservoir		2. Cultural constraints/conflict with dog function in long term		
	3. Buffer zone		3. Feasibility		

Programme carried out an education programme that encouraged dog owners living in Ethiopian wolf habitat to own fewer dogs and to tie them up. The programme also provided owners with collars and chains (Sillero-Zubiri and Laurenson 2001). Although dog owners listened to and discussed these issues with the education officer, few if any dogs were subsequently tied up. In some cases when dog owners did attempt to tie up their dogs, adult dogs that had never previously been tied up simply escaped. In other cases, the collars and chains had been used for tying up livestock, such as calves. Overall, the success of this approach may be limited and it must be recognised that cultural change occurs slowly in terms of the generational time of both people and dogs.

Reduce disease incidence in reservoir population

The second general approach to controlling canid disease in wild carnivores involves reducing or preferably eliminating disease in the reservoir population and thus reducing the chance of the disease being transmitted to the target host. Clearly, this approach depends on determining the reservoir of infection. In many circumstances, this is the domestic dog, but wild reservoirs have also been implicated in a number of situations. For example red foxes (Europe), yellow mongooses (South Africa), and raccoons and skunks (North America) are examples of wild reservoirs for rabies, whereas a suite of wild carnivores may be involved in sustaining endemic canine distemper infection in Europe and North America.

Disease incidence in a reservoir is reduced by reducing the number of susceptible hosts in the reservoir population, and thus reducing R_0, the measure of how rapidly a disease can spread in a population. R_0 is the basic reproductive rate of the disease (Anderson and May 1991) and is defined as the number of secondary cases arising from a primary case. If R_0 can be reduced to below 1, then the disease will not persist in the reservoir because each case will result in less than one new infection on average, and the infection will disappear. Even if the disease is not eliminated, any reduction in R_0 will decrease the chance of transmission to the target species.

In general, there are three methods of reducing R_0: reduce the population density (assuming density-dependent transmission), reduce the number of susceptible hosts through vaccination, and reduce transmission between hosts.

This approach to disease control directly parallels the control of diseases of public health concern such as rabies and visceral leishmaniasis in domestic dogs and abundant wild canids. Therefore, the successes and failures of this approach, for example through the culling and vaccination of reservoir hosts, provide important lessons for the conservation of rare canids threatened by infectious disease.

Limit host density

Dog density might be reduced by controlling fertility, by culling, or by changing human attitudes so that fewer dogs are owned. Fertility control, which reduces the number of susceptible hosts being introduced into the population and thus eventually total population size, shows some theoretical promise (Barlow 1996). In practice, given that surgical sterilisation of female dogs is expensive, as well as being culturally and logistically difficult, and that dog populations are rarely closed, this approach may also be limited in its success. Fertility control would be even more difficult to achieve among wild canids, although initial investigations of immunocontraceptive vaccines that target the release of reproductive hormones have shown encouraging results for red foxes in France and Australia. Oral contraceptives are available for use in wildlife (Tuyttens and Macdonald 1998), but their use in areas occupied by threatened populations would be inappropriate (as would the use of poisons for reservoir control). Despite these concerns, immunocontraception, especially if it could be combined with vaccination, may hold some promise for the future management of disease reservoirs.

Culling reservoir domestic dog populations is a superficially attractive means of controlling dog population sizes. Where wildlife is a reservoir, culling wild canids such as foxes to control rabies, while sometimes successful in the short term in a limited area, has otherwise met with failure due to the rapid recovery of fox populations and thus the continued (expensive) culling effort required (Macdonald 1980). In addition, changing moral attitudes towards wildlife culling potentially render this approach obsolete. Humane culling of domestic dogs, although occasionally a potentially useful short-term adjunct in urban areas where stray dogs may subsist on human rubbish, also does not address the root issue: dog populations are actually usually limited by humans (Perry 1993). Where dogs have a role in human society as guards or cleaners, people will keep dogs to fulfil this role until a better option is available. Thus, cultural attitudes towards dog ownership and the optimal number of dogs must change before dog populations can be reduced. This is clearly a considerable challenge, particularly where human populations are expanding. Moreover, dog populations in rural areas of developing countries are generally growing faster than the human population. The reasons for this are not well understood, but reduced household sizes or an increased perception of security problems may be involved. Finally, where human densities are high, even comparatively low dog:human ratios may generate dog populations large enough to represent a disease risk to local wildlife. Overall, these factors mean that this approach entails considerable challenges, and indeed we know of no successful programme.

Reduce the number of susceptible reservoir hosts through vaccination

Vaccination of reservoir hosts, which essentially reduces the susceptible population size for the pathogen, is a common approach to disease control in both human and domestic animal populations. For example, experience from the rabies control programmes suggests that vaccination of both reservoir domestic dogs and wild canids may be powerful tools for wildlife managers. In North America and Europe, rabies control programmes for public health have successfully controlled or eradicated rabies in extremely large areas. (Aubert *et al*. 1994, Mackowiak *et al*. 1999). This approach is increasingly being incorporated into disease control for wild canids in a number of countries, particularly where safe and effective vaccines are available, as is the case for many viral diseases of dogs.

In rural Tanzania, results demonstrate that a simple central-point vaccination strategy, resulting in vaccination of 60%–65% of dogs adjacent to Serengeti National Park, significantly reduced the incidence of rabies in dogs and risk of exposure to people, with opportunities for transmission to wildlife also decreasing (Cleaveland *et al*. 2003). Dog vaccination campaigns have also been conducted around other national parks such as Ruaha, Arusha, and Tarangire. In Ethiopia, no cases of rabies or canine distemper were reported within wolf range within the Bale Mountains National Park between 1998 and August 2003, when a dog vaccination campaign was being conducted both inside the Park and, where resources allowed, in neighbouring communities outside the Park. Cases of rabies in dogs and other species still occurred at the edge of vaccination zones, although the overall incidence in dogs and people was very much reduced (Ethiopian Wolf Conservation Programme, unpublished data). However, in September 2003, rabies broke out in Ethiopian wolves in one area of the park, thought to have been brought in by an immigrant domestic dog (Randall *et al*. 2004). A wide "cordon sanitaire" is clearly required, particularly where transhumance of people and their domestic animals occurs. This has illustrated the disadvantage of this approach: there is no direct protection of the target species, and success cannot be guaranteed if intervention is carried out on too small a scale. Clearly, the area to be covered would be vastly bigger for the same size population of African wild dogs (home range 400–1,200km^2 per pack) (Woodroffe and Ginsberg 1998) than of Ethiopian wolves (home range 6–11km^2 per pack) (Sillero-Zubiri and Macdonald 1997), although this will also vary with the shape of the habitat patches (Laurenson *et al*. 2001). As both these species remain surrounded by landscapes that have been altered by people and

that are inhabited by domestic dogs, regional eradication is nearly impossible without a widescale coordinated rabies control programme. In addition, such vaccination programmes would have to be maintained in perpetuity to control the disease threat. As was the case in Ethiopia, inadequate resources to cover such areas may result in failure of this approach. Furthermore, where payment for vaccination is expected, or where dogs are used for illegal hunting and are not presented for vaccination, the success of this approach may also be curtailed.

Concern has been expressed that vaccination of disease reservoirs – especially domestic dogs – could remove an agent of population limitation and thus lead to increased host density (Moutou 1997). This could be potentially damaging, especially if vaccine cover were to be halted. However, preliminary studies indicate that while dog vaccination in northern Tanzania has led to a significant decline in disease-related mortality rates, population growth rates have not increased. This has been attributed to a reduced demand for puppies, and thus a lowering of recruitment rates, and a dog population that is generally more stable (Cleaveland, unpublished data). However, this effect may only be temporary and research is still required to assess longer-term demographic impacts, as well as to assess the demographic impact of mass vaccination in other types of settings.

Coordinated rabies control programmes involving both public health and livestock authorities could reduce the cost borne by the conservation community, and both financial (primarily from a reduction in livestock losses) and public health benefits would accrue to local populations. Vaccination of domestic dogs by wildlife managers also provides additional nonfinancial benefits that may improve relationships between protected areas and local communities. This is an example of an outreach activity in which both parties may cooperate in a mutually beneficial activity (Sillero-Zubiri and Laurenson 2001). As such, it can be a powerful tool that is underutilised by protected area managers who are looking for opportunities to improve communication with local communities.

Decrease susceptibility or spread in target population

The third general approach to improving the control of canid diseases in wild carnivores is to reduce the susceptibility or rate of spread of disease in the target population. This approach may work even when the reservoir species is unknown or when a relatively intractable wild reservoir population is involved. This approach, whilst reducing the mortality of individuals, may also limit transmission within the host population.

Target hosts can sometimes be directly treated, for example, against mange in arctic foxes (Goltsman *et al*. 1996). However, vaccination of threatened hosts is a more common conservation tool (Hall and Harwood 1990, Woodroffe 2001). To date, demonstration of the effectiveness of this approach has been limited (but see Hofmeyr *et al*. 2000, in which vaccinated wild dogs survived a rabies outbreak that killed other members of the pack), not least because most cases have been crisis interventions dealing with acute disease risks where unvaccinated controls have not been left. However, if vaccines are safe, effective, and require relatively little disturbance to the subject animals to administer, they can potentially improve the viability of canid populations severely threatened by infectious disease.

The approach has been used in African wild dogs, Channel Island foxes, and Ethiopian wolves. For African wild dogs in which rabies and, to a lesser extent, canine distemper represent acute threats to the persistence of small populations, direct vaccination has met with mixed success. The issues and controversy surrounding these attempts in wild dogs have been extensively reviewed (Woodroffe *et al*. 1997, Woodroffe 2001). In summary, the efficacy of killed rabies vaccines in wild dogs, particularly after a single dose, is questionable and is the subject of further research. However, the feasibility and efficacy of using oral vaccines warrants further investigation. Preliminary trials suggest that an effective baiting system can be designed (Knobel *et al*. 2002).

In southern Africa, vaccination of jackals and captive-bred African wild dogs using live oral rabies vaccines (SAG strains) demonstrated the safety and potential efficacy of oral vaccination, with high rates of seroconversion in both species (Knobel *et al*. 2003, Bingham *et al*. 1999). However, no field trials have yet been conducted. Nevertheless, recombinant rabies vaccines, which incorporate only part of the rabies virus genome and cannot induce rabies in target or nontarget species, are a safer alternative from a vaccination perspective (Kieny *et al*. 1984, Blancou *et al*. 1986), but have yet to be tested in these African species. Potential environmental impacts in terms of local nontarget species must of course be evaluated as approaches involving various types of recombinant vaccines continue to be developed and explored.

Direct vaccination has also been used to protect Channel Island foxes from canine distemper. A new recombinant distemper vaccine, using a canarypox virus vector, was first tested on six captive foxes and shown to elicit seroconversion with no observed ill effects (Timm *et al*. 2000). Vaccination protocols were then conducted on the western part of Santa Catalina island. The epidemic had, however, by then faded (S. Timm, personal communication). Unfortunately, in the absence of challenge experiments, it is impossible to be certain that vaccination confers protection from canine distemper. However, the existence of a distemper vaccination protocol known to be safe and likely effective in free-ranging island foxes is a valuable tool for conservation of this critically endangered species (Woodroffe *et al*. 2004).

Most recently, in late 2003, an emergency trial parenteral vaccination campaign was carried out to control an outbreak of rabies in Ethiopian wolves in the Bale Mountains (Randall *et al*. 2004). As permission had not been granted to test the efficacy of oral vaccines, wolves were trapped and vaccinated by injection with an inactivated rabies vaccine. Preliminary results suggest good seroconversion rates, but the trial is still ongoing. Only extensive monitoring work will enable the success or failure of this approach to be assessed, although

again it is impossible to be certain that wolves are protected in the absence of challenge experiments.

Overall, although this approach has some clear advantages (Table 1), vaccine availability is a severe constraint, because few vaccines have been tested for safety and efficacy in wildlife. In addition, in the absence of challenge experiments in captivity, only situations in which target hosts are challenged will ultimately enable the efficacy of vaccines to be assessed. Nevertheless, in a crisis situation, as for the Channel Island foxes and Ethiopian wolves, this may be the conservation manager's only intervention option in the face of an outbreak. Developing such potential tools in advance of a crisis situation is clearly desirable.

Which approach is best?

This paper has attempted to outline the general approaches available to wildlife managers for carnivore disease control, illustrating these approaches with some specific examples and pointing out the general advantages and disadvantages of each approach. It is clear that conservationists are ill equipped to manage the threat of infectious disease to wild canids. Lack of information hinders management of this newly recognised threat. There are no established models to follow, and some early and unsurprising failures have attracted damaging controversy (Woodroffe 2001). This makes it difficult to assess which approach is most likely to meet with success. However, it is also important to recognise that the decision not to intervene must in itself be a conscious choice that reflects a consideration of all options. Where intervention is warranted, vaccination either directly of endangered wildlife hosts or of the domestic animal reservoir hosts are our most feasible disease management options. This approach may be effective if safe, effective, and practical vaccination protocols are available, depending on the local epidemiological circumstances. Vaccination of wildlife reservoirs is, however, more problematic. In all situations, the specific conditions in the area will determine what actions can be taken by local wildlife managers.

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Chapter 20

Impacts of Wildlife Infections on Human and Livestock Health with Special Reference to Tanzania: Implications for Protected Area Management[1]

Sarah Cleaveland[2,3], Karen Laurenson[2,3] and Titus Mlengeya[4]

Introduction

Human, domestic animal, and wildlife medicine are usually viewed as separate disciplines; however, this distinction is largely irrelevant in the field of epidemiology, because many pathogens are generalists, infecting multiple host species. The majority of human pathogens (62%) also infect animal hosts (Taylor *et al*. 2001) and nearly half (44%) are also known to infect wildlife (Cleaveland, Laurenson *et al*. 2001). Similarly, most of the pathogens that have caused recent epidemics in wildlife infect a wide range of hosts (Cleaveland, Hess *et al*. 2001). A particular concern for conservationists is the ability of these generalist pathogens to spill over from more abundant reservoir hosts (e.g., domestic animals) to infect small, vulnerable wildlife populations (Daszak *et al*. 2000, Laurenson *et al*. 2005).

In terms of wildlife management and infectious diseases, the focus of concern in recent years has been the direct threat of disease epidemics to the survival and health of endangered wildlife populations. However wildlife infections have far-ranging impacts that extend beyond these direct disease threats to encompass issues relating to public health, livestock production, and rural livelihoods, each of which has important consequences for wildlife management.

Wildlife infections and emerging human diseases

Although we understand very little about the dynamics of infectious agents in most wildlife populations, there is growing evidence that wildlife plays a key role in the emergence of human diseases. Reviews commonly note that many emerging human diseases are zoonotic (i.e., can be transmitted between animals and humans) and also involve wildlife (Morse 1995, Murphy 1998, Palmer *et al*. 1998, Chomel 1998, Daszak *et al*. 2000, Feldmann *et al*. 2002, Ludwig *et al*. 2003). Well-documented examples include viruses (such as West Nile virus, avian influenza virus, and the Hendra, Nipah, and Hantaviruses), bacterial pathogens (such as *Borrelia burgdorferi* of Lyme disease), and protozoa (such as *Trypanosoma* spp found in Africa). Recently, consumption of wildlife has been identified in the zoonotic transmission of hepatitis E (Tei *et al*. 2003), and emergence from wildlife hosts has been suggested as the possible origin of HIV-1 (Gao *et al*. 1999) and HIV-2 (Hirsch *et al*. 1989), as well as the more recent emergence of severe acute respiratory syndrome (SARS) (Pearson *et al*. 2003).

In line with observations of wildlife involvement in many emerging diseases, recent systematic quantification of human pathogens has shown that the ability of a pathogen to infect wildlife is an important risk factor for disease emergence. Thus, human pathogens that can also infect wildlife are more than twice as likely to cause an emerging human disease than those that do not (relative risk=2.44; Cleaveland, Laurenson *et al*. 2001).

Ecological factors that affect patterns of contact and transmission between people and wildlife are commonly cited to explain the growing importance of wildlife infections in human diseases. For example, deforestation, population movements, and intrusion of people and domestic animals into new habitats have resulted in the emergence of several pathogens, such as yellow fever virus, California encephalitis virus (Mahy and Murphy 1998), Ross River virus (Daszak *et al*. 2000), and Marburg and Ebola viruses (Peters *et al*. 1994, Ludwig *et al*. 2003). Weather events and climate change also have the potential for wide-ranging impacts on host/vector/pathogen dynamics, particularly those with complex life cycles (Patz *et al*. 2000, Harvell *et al*. 2002). For example, climate-induced increases in wild rodent density have been linked with the emergence of Hantavirus outbreaks (Glass *et al*. 2002).

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Control and investigation strategies for wildlife reservoirs: problems and implications

The link between wildlife and human health has several important implications for wildlife management. First, the lack of knowledge of infection dynamics in wild animal populations limits the development of effective strategies to minimise human health risks. A common problem relates to the identification of wildlife reservoir hosts of new or reemerging human diseases. Definitive identification of reservoirs is complex and challenging, and wildlife hosts have often been proposed as reservoirs on only weak evidence (Haydon *et al*. 2002). This may result not only in ineffective disease control, but also can sometimes have dire consequences for wildlife. In East Africa, for example, isolation of *Trypanosoma brucei rhodesiense* (the cause of the Rhodesian form of sleeping sickness) from a single bushbuck in the 1950s (Heisch *et al.* 1958) resulted in widespread culling of wildlife.

Second, even when wildlife reservoirs have been identified and disease control considered desirable in the face of human health risks, the options for control are limited and often have implications for wildlife welfare. Many strategies, such as culling and creation of barriers, invariably result in harm to wild animals. But conventional approaches to animal disease control, such as vaccination or treatment to reduce transmission (e.g., of sleeping sickness in cattle) have limitations in wildlife populations. Specific vaccines and treatments are often unavailable or untested for use in wildlife, and delivery in field settings is beset by logistic, financial, and ethical considerations. Nonetheless, the success of oral rabies vaccination campaigns in wildlife in Europe and North America demonstrates the huge potential of oral vaccines to control wildlife infections and reduce human health risks.

Although culling animals to control infectious diseases has a strong basis in epidemiological theory (Matthews *et al.* 2003), the culling of wildlife has rarely been successful in practice for a variety of practical, logistic, and ethical reasons. Before oral vaccines for rabies were introduced, culling remained the mainstay of rabies control in red foxes in Europe but was never demonstrated as an efficient method of disease control (Artois *et al.* 2001). Culling of badgers and opossums to control bovine tuberculosis (BTB) in wildlife reservoirs in the United Kingdom and New Zealand remains the subject of intense debate. Similarly, suggestions to contain BTB in buffalo in Kruger National Park, South Africa, through selective culling of high-prevalence herds have been criticised on epidemiological, ecological, and practical grounds (de Lisle *et al.* 2002). Nonlethal approaches, such as wildlife vaccination, wildlife sterilisation, and farm management practices (Krebs *et al.* 1997, Hutchings and Harris 1997, Buddle *et al.* 2000) have been suggested as alternative approaches for control of BTB in the United Kingdom, for example, and current research includes studies that evaluate the likely effectiveness of these strategies (Krebs *et al.* 1997, Delahay *et al.* 2003).

A third issue is that epidemiological investigations to identify wildlife sources of human diseases may have adverse impacts. For example, widespread killing and sampling of large numbers of small mammals has been justified in the search for wildlife reservoirs of Ebola virus in the Democratic Republic of Congo (Leirs *et al.* 1999) and Central African Republic (Morvan *et al.* 2000). In these types of studies, balancing the need to identify wildlife reservoirs of human diseases against potential adverse impacts on wild populations is an issue that should clearly involve both public health agencies and wildlife managers. Further consideration should perhaps be given to conservation and animal welfare ethics, as is done in grant applications involving laboratory experimentation and in clinical trials on human subjects.

Indirect effects: the example of wildlife tourism

A further consequence of wildlife involvement in human diseases is the potential threat to the wildlife tourism industry. The economic damage caused by a decline in visitors to countries suffering from SARS and Ebola virus clearly highlights this potential threat. Equally clear is the important lesson learnt from the SARS epidemic about the need for open exchange and dissemination of epidemiological data of public health importance. Balancing these requirements presents a dilemma for managers of wildlife areas and needs to be openly discussed.

A creditable approach has been taken by the veterinary unit of Tanzania National Parks, which reacted promptly to recent outbreaks of sleeping sickness and anthrax to contain threats to wildlife, to reduce risks of transmission to people, and to identify wildlife sources of infection (Mlengeya *et al.* 1998, Jelinek *et al.* 2002, Mlengeya and Lyaruu 2005). Furthermore, timely dissemination of information in the public domain facilitated the prompt diagnosis and treatment of people who developed clinical signs of sleeping sickness after leaving East Africa. Neither of these disease outbreaks appears to have affected tourist numbers in Tanzania. However, what advice should be given to park managers in their approach to diseases such as Ebola or Marburg that may generate greater alarm and impact on the tourist industry? Additional dilemmas will invariably arise as sensitive molecular tests increasingly allow detection of human pathogens (or pathogen material) in an expanding range of wildlife hosts. The epidemiological interpretation of these results and appropriate management of potential disease risks pose major challenges to wildlife veterinarians.

In summary, the recognition of wildlife as hosts and reservoirs of emerging human diseases poses considerable challenges to wildlife managers and the public health sector, not only because very little is currently known about the dynamics of wildlife diseases but also because the limited options for investigation and control of these infections are often harmful to wildlife. To date, there has been very little interaction between the two sectors, but the interface between wildlife and public health provides exciting opportunities for professionals to develop innovative, collaborative, and integrated approaches to wildlife management that will mitigate disease risks for people and minimise adverse impacts on wildlife populations.

Wildlife infections and livestock health

As is the case with emerging human diseases, the ability of pathogens to infect wildlife hosts is a significant risk factor for the emergence of livestock diseases (Cleaveland, Laurenson *et al*. 2001). Similarly, pathogens that infect wildlife are significantly more likely to be among those listed by the Office International des Épizooties, i.e., those pathogens that have serious socioeconomic and/or public health consequences at national and international levels. More than 70% of these disease agents infect wildlife hosts, including those of rinderpest, foot and mouth disease, African swine fever, theileriosis, brucellosis, and BTB (Cleaveland, Laurenson *et al*. 2001).

Interactions between domestic livestock and wildlife populations are a key issue in livestock economies worldwide, and in East and southern Africa in particular, where many communities live in close contact with wildlife. Several excellent reviews discuss the pathogens that coinfect livestock and wildlife and their role in livestock diseases (Bigalke 1994, Fröhlich *et al*. 2002, Bengis *et al*. 2002, Kock *et al*. 2002). Transmission of infection from wildlife reservoirs has the potential to decimate livestock economies and to exacerbate problems of rural poverty caused by declining livestock production – situations that invariably generate conflict between people and wildlife. A clear example is the enduring debate over the impact on wildlife of game fences constructed to prevent transmission of foot and mouth disease from buffalo to cattle.

In southern Africa, the value of the beef export market is a huge financial incentive to separate wildlife reservoirs from cattle by constructing game fences. In contrast, in Tanzania, the tourism sector has greater economic weight and relatively few efforts have been made to protect the livestock sector from diseases transmitted from wildlife. For example, in the Ngorongoro Conservation Area, Maasai cattle must be moved away from prime grazing lands in the short-grass plains to avoid malignant catarrhal fever, a fatal disease of cattle that is spread primarily by wildebeest calves, which are asymptomatic carriers of the virus (Plowright 1990, Machange 1997). Confinement of Maasai cattle in non-productive highland pastures has far-ranging impacts, increasing the pressure on fragile highland ecosystems and exacerbating the problem of tick-borne and directly transmitted diseases (Field *et al*. 1997; Misana 1997; Cleaveland, Kusiluka *et al*. 2001).

The resulting decline in livestock production has been a major factor behind the expansion in cultivation, a form of land use that is generally considered incompatible with both traditional pastoralism and wildlife conservation. Although conservationists often perceive livestock as a threat to wildlife, a greater threat is likely to arise if traditional livestock-keeping practices are replaced by large-scale cultivation. Innovative programmes that support the needs of both pastoral development and wildlife conservation could provide considerable benefits for both sectors.

Livestock disease as a contributory factor to rural poverty and a threat to biodiversity

Rural poverty is a key factor underlying long-term threats to biodiversity. Recent studies from communities adjacent to the Serengeti National Park, for example, demonstrate a strong inverse relationship between livestock ownership (or access to these resources) and involvement in game-meat hunting (Campbell 2001). This suggests that the requirement for dietary protein and cash income among resource-poor farmers is a driving force behind local game hunting. Livestock development programmes could provide alternative sources of protein to replace demand for wildlife meat in these areas, but livestock production in these areas is severely constrained by infectious diseases, including diseases transmitted from wildlife, such as trypanosomiasis (IFAD 1995). The establishment of effective veterinary services in these areas has the potential to improve rural livelihoods and reduce demand for wild animal products and thus illegal hunting activities. However, further work is still required to assess the impact of improved livestock production on levels of wildlife hunting in the Serengeti.

Conclusions

Infectious diseases of wildlife have far-ranging impacts, with important implications for public health, wildlife conservation, and rural economies. The complexity of issues surrounding wildlife diseases poses great challenges for the management of wildlife and protected areas. The need for disease surveillance is well recognised but, even in the public health sector, surveillance has never been a high priority. Wildlife veterinary units are generally poorly funded, and disease surveillance is rudimentary or nonexistent in almost all wildlife populations, even in the developed world. Lack of knowledge about wildlife diseases and their infection dynamics invariably hampers attempts to control, prevent, or eliminate those diseases that threaten human health and biodiversity.

To understand and control emerging infectious diseases of both people and animals, it is necessary to bridge artificial divisions between human and veterinary medicine, and to develop consistent, integrated approaches that incorporate expertise from wildlife managers, ecologists, conservation biologists, and environmental scientists.

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Chapter 21

Synergies between Animal Husbandry and Wildlife Conservation: Perspectives from Zambia[1]

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Introduction

Over two-thirds of Zambia's large wildlife estate, which exceeds 290,000km^2, is on community land. As a state-owned resource, wildlife in Zambia has a history of protection that has relied largely on law enforcement by government-employed wildlife scouts. In the late 1980s, the Zambian Government recognised it could not police such a vast area and enrolled communities to help. In return, these communities received a share of safari-hunting revenues. It was the beginning of a community-based wildlife management approach that became known as the Administrative Management Design for Game Management Areas (ADMADE) programme.

Over the next two decades, ADMADE evolved its approach by improving local capacity to manage wildlife and adopt land-use practices conducive to wildlife production. Today, ADMADE is guided by Community Resource Boards (CRBs), which are made up of democratically elected leaders within single chiefdoms who have legislated powers and responsibilities to manage wildlife populations. They do this by employing their own "village scouts" to protect wildlife and by implementing their own land-use plans to control human activities that threaten wildlife. In exchange, CRBs receive 45% of all safari-hunting licenses and fees generated from their respective wildlife resources. In addition to supporting wildlife management costs from these revenues, CRBs also invest these revenues in community improvements.

Despite these advancements, a significant percentage of households residing in these wildlife areas have remained poor and frequently experience seasonal shortages of food. Many adopted coping strategies not compatible with wildlife production, such as snaring or poisoning of waterholes. Not only did these practices prove difficult to control by law enforcement, but they also accounted for significant loss of wildlife.

Many wildlife-based Community-Based Natural Resource Management (CBNRM) programmes in southern Africa have confronted such problems and have faced enormous difficulty in extending the benefits of conservation to all households in ways that could sustain community-wide commitment to conservation. These problems proved to be major challenges to conservation efforts in the region, and emphasised the need to more closely study community relationships with wildlife.

Our work in Zambia has pursued such studies and has increasingly shown that these relationships are closely tied to three variables: household livelihood needs, household-level skills, and available markets that sustain rural livelihoods. To apply this knowledge to wildlife conservation, our work taught us that it was necessary to build adaptive synergies with other disciplines that could make wildlife management more a livelihood practice and less an external management intervention imposed on rural communities. In a number of important wildlife areas of Zambia, we found that animal husbandry provided such a synergy for communities that depended on domestic animals but also shared the land with wildlife. By losing livestock to disease, affected households also lose income and food security, and to cope with these losses, households often turn to illegal use of wildlife. The significance of this simple relationship was not fully appreciated until recently.

This paper highlights two examples in Zambia in which the balance between wildlife and people was influenced by disease of domestic animals, and in which improved synergies with animal husbandry practices and rural markets can significantly influence wildlife production in and around protected areas.

Chickens and wildlife: the Luangwa Valley story

In a random sample of 1,065 households outside Luangwa Valley's four national parks (Lewis *et al*. 2001), poultry were the most common source of income but ranked only 34 of 50 income sources for relative contribution to total household income. Annual income for the head of the household was US $67 per year, with the actual contribution to household income from the sale of chickens only US $8 per year. On average, households owned at any given time 10–20 chickens, which also provided an important source of animal protein to the family's diet. Newcastle disease is endemic in the Valley and annually infects up to 60% of the chicken population with death rates as high as 80%–90%. In addition, mortality from predators and disease of young chickens often exceeded 50%.

[1]See abstract on p.xxxi.

From these results, it was clear that poultry production was well below its potential, limiting the level of income and food security that chickens could provide to communities in Luangwa Valley. We learned from household interviews that the loss of income or food from chickens that succumbed to Newcastle disease placed greater pressure on wildlife to make up for the shortfall.

Our research then turned to chicken husbandry, and we suggested that poultry production could increase 3- to 4-fold by vaccinating against Newcastle disease and by reducing mortality of young chickens using simple enclosures to reduce predation. We estimated that households that improved chicken husbandry practices could increase their income by an additional US $30 while also significantly increasing their supply of chicken protein for household consumption. With improved access to higher market prices, households could bring their total income from poultry to US $50 per year, or six times current levels.

These same communities resided in safari-hunting concessions outside national parks and on average received a revenue share from hunting of about US $55,000 for an average of 1,800 households, or approximately US $30 per household. Theoretically, income derived from poultry could exceed revenues derived from safari hunting. Our research also suggested that safari-hunting revenues were more than adequate to help households finance low-cost veterinary and husbandry support costs. This raised wildlife's value by significantly improving the security of household livelihoods while also reducing the threat of illegal wildlife hunting.

In 2002, we introduced a low-cost vaccine against Newcastle to test these predicted results. We provided the necessary training for community-based technicians or "barefoot vets" to administer the vaccine throughout their community. In 2003, of an estimated total of 22,000 chickens, 8,300 were vaccinated; total purchase cost of the vaccine was only US $24. In addition, families were organized to form poultry producer groups and shared the use of a 25m wire fence enclosure to safeguard young chickens from predation and to maintain high-quality feed for promoting growth. Finally, we assisted producer groups in bulking live chickens at local depots for collection by a regional trading centre that offered a 20% increase in purchase price of chickens if purchased in bulk. The Conservation Farmer Wildlife Producer Trading Centre provides animal health support to, as well as improved market access for, poultry producers. The trading centre is a pilot initiative to develop economic incentives for producer groups to invest greater levels of effort in livelihood practices other than illegal use of wildlife.

The following preliminary results are based on informal household interviews:

- Incidence of Newcastle disease has become negligible in most areas.
- Value of chickens has increased relative to illegal game meat. This is because illegal game meat cannot be sold on the open market for its "real" market value.
- The increased value and supply of chickens is reducing local demand for game meat.
- Households recognised the value of vaccinating against Newcastle disease and, to help support the purchase and delivery costs of the vaccine, households provided one free chicken to their regional trading partner for every 50 chickens vaccinated.
- Improved husbandry skills and increased market value have elevated household interest in poultry as a livelihood activity.

Low-cost husbandry and veterinary support for poultry owners clearly can increase food security and income among relatively poor households in wildlife areas. This work also illustrates how such linkages, when understood as a basis for promoting livelihoods, can enhance rural development models for supporting wildlife conservation.

Cattle disease and poaching in Kafue National Park

Wildlife poaching in the southern border region of Kafue National Park reached unprecedented levels in 2000 and remains a serious problem today. Its consequences on tourism could well be in the tens of millions of dollars, a loss that will likely require years to recover. A preliminary analysis of the problem suggested that increased rural poverty and chronic food shortages, precipitated by large-scale, disease-related mortality of cattle and drought-related crop loss, played significant roles in contributing to this poaching crisis. In hindsight, government authorities and conservation groups could have recognised the developing problem and planned for corrective measures to avoid the high costs now being paid by the wildlife and tourism sectors.

Background – with a focus on Southern Province

Over the past two decades in the western half of Kalomo District, Southern Province, livestock numbers have declined sharply. In 1986, approximately 80% of all households owned cattle; by 2000, only 35%–40% owned cattle (O. Makondo, personal communication). Epidemic outbreaks of bovine diseases, primarily East Coast fever (a theileriasis with high mortality) and trypanosomiasis, accounted for most of the drop in livestock numbers (P.C. Mubanga, personal communication). This decline in household ownership of cattle correlated with an estimated 65% loss of total cattle numbers for this same area.

During years of drought, cattle provide a critical source of cash needed for food and other domestic requirements and thus are an important "safety net" against crop failure for rural communities in this region. When cattle losses from disease reached extreme levels during the 1990s, rural livelihoods were primed for a more total collapse if severe drought were to occur. This was the case in 1994 and 2000, and many households had few livelihood options other than wildlife poaching in the adjacent protected areas. The current estimate

of average household annual income in areas surrounding the southern end of Kafue National Park, for instance, is below US $100 (P. Ngulube, personal communication 2002).

A comparison of local hunters, regarded as poachers, from Southern and Eastern Provinces in Zambia suggest that poaching in Southern Province is more than a coping strategy – it is increasingly becoming an alternative livelihood to more traditional livelihood practices. Hunters in Southern Province consistently use more modern and destructive firearms, kill more animals annually, and market their illegal game meat more profitably than their counterparts in Eastern Province.

While the absolute magnitude of this problem is not well described, the severity of faunal collapse in areas once noted for both wildlife numbers and diversity of wildlife species in the Southern Province is generally accepted as fact. Sichifulo Game Management Area (GMA) averaged US $70,244 per year from safari hunting in animal license and hunting fee sales during 1997–1999 from an average harvest of 70 animals, representing 20 species. In 2003, Sichifulo was regarded as a depleted wildlife area with little capacity to sustain a hunting quota or the levels of revenues needed to encourage community compliance with laws protecting wildlife.

Scale of veterinary problems and history of services provided

Until 1990, the Zambian government provided free veterinary services for livestock owners and, in Kalomo District, this included dipping to reduce tick-borne diseases such as East Coast fever and red water fever (babesiosis) and efforts to prevent trypanosomiasis. Cost for this service in the communities surrounding Sichifulo GMA was estimated to vary from US $10,000 to US $20,000 per year (P.C. Mubanga, personal communication).

Following 1990, policies regulating government-supported veterinary services changed, and households assumed responsibility for their own cattle. This hardship was compounded by a drought in 1994, and infection levels increased. Limited donor assistance was provided from 1989 to 1994 with the introduction of 4,500 tsetse fly traps provided by the European Economic Commission but the government of Zambia did not sustain such tsetse control efforts after 1994. Similarly, Swedish International Development Aid provided assistance for 26 dipping tanks from 1987 to 1990, but the government of Zambia again did not sustain these after 1990. During the ensuing years, disease-related mortality increased progressively in livestock populations in rural communities throughout much of Kalomo District. In 2002, for example, in 603 cattle sampled from four selected areas outside Sichifulo GMA, 63.4% were infected with trypanosomes, whereas in the late 1980s, less than 1% were infected (P.C. Mubanga, personal communication).

Realizing the severity of the problem, the Zambian Government created a special loan fund in 1998 to assist livestock cooperatives' purchase of their own drugs. Unfortunately, a number of the participating cooperatives defaulted on repayment, and the local bank administering the funds closed the programme. In 2002, the government provided limited assistance to purchase drugs used to treat sick cattle. In the same year, World Vision introduced a cost-recovery programme that allowed livestock owners to purchase drugs to treat 1,600 head for trypanosomiasis.

In addition to the lack of drugs and preventive treatments, frequent droughts led to wild animals drinking from pools used by cattle, thus increasing the likelihood of disease transmission at this more intensive interface. Growing numbers of households relied on poaching to cope with lowered food production and loss of livestock. When returning from the bush with meat and animal skins, hunters also brought tsetse flies back to their areas of residence and livestock areas.

Lessons learned and a "win–win" strategy

The Kafue story underscores the critical linkages between cattle, disease, household livelihoods, and wildlife. It also demonstrates the need for improved dialogue among potential partners that have complementary stakes in both cattle and wildlife populations. If such partners had collaborated and coordinated their needs and potential sources of help, the collapse of both livestock and wildlife populations might have been prevented. Such synergies typically work best at the local level, where economic consequences are most easily recognised and where stakeholders can complement support most effectively. To improve outcomes of future similar scenarios, the following arrangements are recommended:

- Safari operators, community leaders, local veterinary officers, and Zambia Wildlife Authority officials coordinate information and ideas for developing a workable, low-cost programme for treating livestock against key diseases.
- Private sector, government, and community stakeholders share veterinary costs and promote household appreciation of the idea that revenue from safari hunting can help cover these costs only if wildlife is conserved.
- Local residents, trained as "barefoot vets," administer treatments and vaccinations while promoting public awareness that disease control and prevention is supported by wildlife-generated revenues.
- Revenue shares from safari hunting are set aside to support veterinary costs and are administered jointly by collaborating parties, possibly seeking matching funds from government.
- Community leaders convene community meetings to build consensus for proposed veterinary solutions while seeking commitment from households to not poach or degrade wildlife habitat.
- Community leaders organize livestock owners as producer groups to oversee the work of "barefoot vets" and as leaders in wildlife production by reducing potential conflicts between wildlife and livestock.

- Veterinary officers monitor and supervise interventions and report back to collaborating stakeholders.

Conclusions

This paper illustrates the potential for synergies between animal husbandry and wildlife conservation in rural areas around Africa's national parks. Rural development models have largely ignored such linkages, especially where institutional barriers have historically reduced dialogue and collaboration between different disciplines. In turn, this has limited opportunities to pursue more adaptive approaches to resource management and rural development.

The examples in this paper underscore the importance of analysing rural livelihood needs and their relationships to environmental threats as a basis for developing practical management interventions for conservation. The two examples provided in this paper emerged after research helped clarify how such relationships influenced rates of illegal wildlife use and what disciplines and synergies were necessary to apply an effective wildlife management response. Veterinary interventions, such as supporting rural capacity to vaccinate chickens against Newcastle disease, with the cooperation of an external trading partner who helps subsidize veterinary costs, can clearly have a role in conservation that has not been fully appreciated previously.

Acknowledgements

Wildlife Conservation Society recognises its partnerships with the Zambia Wildlife Authority, World Food Programme, Community Resource Boards, and the CONASA consortium as major contributors of support to the work reflected in this paper. Additional appreciation is extended to Nemiah Tembo for his field activities contributing to improved poultry practices in Luangwa Valley.

Reference

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Appendices

The IUCN World Congress on Protected Areas, or **IUCN World Parks Congress** as it has become known, is a 10 yearly event which provides the major global forum for setting the agenda for protected areas. Previous Congresses have had a tremendous impact in assisting national governments to create new protected areas, and direct more resources towards biodiversity conservation.

The Vth IUCN World Parks Congress will be held in Durban, South Africa, from 8 to 17 September, 2003. Both Patrons of the Congress, former South African President and Nobel Peace Prize winner Mr Nelson Mandela and Her Majesty Queen Noor of Jordan strongly endorse the theme of the Congress, "Benefits Beyond Boundaries".

The Vth IUCN World Parks Congress is organised by IUCN – The World Conservation Union, its World Commission on Protected Areas (WCPA), South African National Parks and the Government of South Africa.

www.iucn.org/wpc2003

WPC OUTPUTS

Vth World Parks Congress Emerging Issues

Stream 1: Linkages in the Landscape/Seascape

1. Ecological restoration

Many protected areas exist as habitat remnants within a matrix of agricultural lands and degraded areas. Some protected areas contain degraded areas within their boundaries. These circumstances mean that the integrity of the ecosystems within these protected areas and the ecological processes that sustain them are threatened. These changes also mean that communities living in the area around these protected areas are no longer able to get many of the goods and resources upon which they previously depended.

Ecological restoration offers a means by which these problems may be addressed. It can involve a variety of approaches differing in the extent to which biodiversity is recovered, the rate at which recovery takes place and the extent to which various goods and services are supplied. These various approaches differ in cost and can include relatively low cost approaches (which may involve long recovery times) as well as more costly approaches (which may have faster recovery periods).

Many landscapes will require a combination of these various approaches depending on the ecological and socio-economic circumstance prevailing at different localities within the landscape. Optimising biodiversity and functional outcomes will require trade-offs, the nature of which will be determined by the stakeholders present.

Stream 2: Building Broader Support for Protected Areas

2. Building Support for Protected Areas through Site-Based Planning

Participants in the workshop on Building Support for Protected Areas through Site-Based Planning restate their fundamental objection to destructive industrial practices including logging, mining, and oil and gas exploration and production in protected areas, and seek:

- The strengthening of legislation and enforcement of environmental impact assessment procedures
- That greater capacity be provided to communities to participate in equitable benefit sharing
- That international NGOs, donors etc be mindful of community aspirations and allow for longer-term funding to ensure sustainable community participation in project development and implementation.

3. Disease and Protected Area Management

The health of wildlife, domestic animals and people are inextricably linked.

Small improvements in the health of domestic and wild animals and thus their productivity can lead to dramatic improvements in human livelihoods and thus the reduction of poverty.

Alien invasive pathogens should be addressed with vigor equal to that devoted to addressing more 'visible' alien invasive species.

The role of disease in protected areas and the land-use matrix within which they are embedded must be recognized and addressed within the context of protected area and landscape-level planning and management.

Animal and human health-based indicators may reveal perturbations to natural systems not detectable by more commonly employed methodologies, thus improving the quantitative evaluation of trends in a protected area's health and resilience.

Stream 3: Governance: New ways of working together

4. Private Protected Areas

Privately owned protected areas continue their quiet proliferation throughout much of the world. Despite this expansion, little is known about them. Preliminary evidence suggests that private parks number in the thousands and protect several million hectares of biologically important habitat. They serve as increasingly important components of national conservation strategies. In a time when many governments are slowing the rate at which they establish new protected areas, the private conservation sector continues its rapid growth. Conservationists need to examine this trend closely, assessing its overall scope and direction, and determining ways to maximise its strengths while minimising its weaknesses.

In Eastern and Southern Africa, privately owned lands play a particularly important role in conserving critical biodiversity. Private protected areas in Southern Africa alone protect millions of ecologically important areas, especially in critical buffer zones and corridor areas.

Annex I (English only) at the end of this section contains what may be the world's first Private Protected Area Action Plan. The Action Plan summarizes key aspects of the private protected area sector and suggested important next steps in the evolution of this promising conservation tool.

Stream 5: Maintaining Protected Areas Now and in the Future

5. Sustainable Hunting, Fishing and other wildlife issues

Participants of Session 6 "Hunting and Fishing" (Workshop Stream *Building Support from New Constituencies*) are concerned that the Congress does not recognize the importance of appropriate forms of wildlife utilisation to generate revenues for conservation. Instead overemphasis is placed on non-sustainable external funding.

Therefore, we [request] that IUCN-WCPA take account of this emerging issue[1] when developing their future work programme and/or ensure that it is addressed by other appropriate units in the IUCN.

Sustainable hunting and fishing (including trophy and subsistence hunting) and other wildlife uses contribute to biodiversity conservation by:

- Providing finance for the management of protected and non-protected natural areas
- Generating income and benefits for local communities and landowners
- Creating strong incentives to manage and conserve wildlife and its habitats
- Offering indigenous people economic opportunities, whilst retaining rights, knowledge systems and traditions

In this context, the IUCN [should] identify best practices of sustainable hunting and fishing and assist in their dissemination and implementation.

6. Management of Invasive Species

Management of Invasive Alien Species (IAS) is a priority issue and must be mainstreamed into all aspects of PA management. The wider audience of protected area managers, stakeholders and governments needs urgently to be made aware of the serious implications for biodiversity, PA conservation and livelihoods that result from lack of recognition of the IAS problem and failure to address it.

Promoting awareness of solutions to the IAS problem and ensuring capacity to implement effective, ecosystem based methods must be integrated into PA management programs.

In addition to the consideration of benefits beyond boundaries, the impacts flowing into both marine and terrestrial PAs from external sources must be addressed.

Cross-Cutting Theme: Communities and Equity

7. Gender Equity in the Management and Conservation of Protected Areas

The Discussion Group on Gender Equity in the Management and Conservation of Protected Areas taking into account that:

- All major international agreements, meetings and conventions in the last 15 years in relation to conservation and use of natural resources have stated the importance and necessity of gender equity issues for the conservation of biodiversity;
- Men and women often have different needs, access and control to resources, opinions, and priorities, face different constraints, have different aspirations and contribute to biodiversity conservation and sustainable development in different ways;
- Achieving gender equity in the management of protected areas requires a gender analysis of resource tenure and use and conservation knowledge and skills;
- Only with a gender perspective can an adequate and applicable understanding of human relationships, environmental processes and ecosystems be constructed;

[1] Supported by the FAO

- There is significant experience and lessons learned that demonstrate women are effective change agents, leaders and natural resource and protected area managers;
- In consonance with good governance and democratic principles, consolidating, expanding and improving the global system of protected areas must respect the rights, interests and concerns of women and men, including their right to participate as equals in decision making regarding protected area management;

Calls upon governments, multilateral institutions, international conventions, PA agencies, donor agencies, NGOs, indigenous and local communities, research institutes and the private sector, and in particular The World Conservation Union (IUCN) known for its inspirational leadership for well coordinated and synergistic efforts, to:

1. Ensure that further work towards building comprehensive protected area systems fully incorporates the rights, responsibilities, interests, aspirations and potential contribution of both women and men;
2. Adopt policies and incentives that require equitable, effective involvement of women and men in decision-making and management of existing and future protected areas;
3. Undertake programmes to develop and strengthen institutional and human capacities for mainstreaming a gender equity perspective for the planning, establishment, and management of protected areas;
4. Develop tools and best practices for the incorporation of gender issues into specific management activities and tasks;
5. Strengthen local women's and men's capacity with new skills for sustainable livelihoods and environmental leadership to contribute to conservation; and
6. Monitor and evaluate benefits of gender equity and disseminate lessons learned to managers, policy makers, and community members.

Cross-Cutting Theme: Marine

8. Amendment to the IUCN Definition of Marine Protected Areas

In order to better refine reporting on marine protected areas, it would be desirable to reconsider the existing IUCN definition of a marine protected area. In particular to consider the exclusion of coastal/intertidal sites if these do *not* include subtidal water. This to be discussed in preparation for presentation at the forthcoming World Conservation Congress.

IUCN defines a marine protected area as:

> "Any area of intertidal or subtidal terrain, together with its overlying water and associated flora, fauna, historical and cultural features, which has been reserved by law or other effective means to protect part or all of the enclosed environment[2] "

This definition differs from many others through its inclusion of "intertidal terrain". Under this definition, any terrestrial site that extends as far as the mid-tide mark is a *marine* protected area. This means that a very large number of sites whose boundaries are set at the coastline are being included in MPA lists and statistics.

[2]GA Recommendation 17.38, Costa Rica

This has contributed to the lack of good figures on the numbers and sizes of MPAs. With the WSSD target now being implemented, it is important that we are able to get better facts and achieve a broader consensus.

We suggest that a new definition be adopted by IUCN:

> "**Any area which incorporates subtidal terrain,** together with its overlying water and associated flora, fauna, historical and cultural features, which has been reserved by law or other effective means to protect part or all of the enclosed environment"

Such a definition will only exclude sites that do not have subtidal areas. Sites with both subtidal and intertidal water will remain, and it is likely that many areas which are predominantly terrestrial will still be included.

9. Moratorium on Deep Sea Trawling

The Marine Theme participants, in endorsing WPC Recommendation 5.23 regarding protection of the high seas, considered the following recommendation as being of significant importance meriting recognition as an emerging issue.

CALL on the United Nations General Assembly to consider a resolution on an immediate moratorium on deep sea trawling in high seas areas with seamounts, cold water coral reef communities until legally binding international conservation measures to protect the areas are in place.

Africa Day

10. HIV/AIDS Pandemic and Conservation

The HIV/AIDS pandemic is starting to seriously affect conservation success in Africa, and is likely to have big impacts in next-wave countries such as Russia, China, India and Eastern European countries. It is reducing the biodiversity management capacities of protected area staff, local communities and mobile peoples. It is also resulting in increased and often unsustainable offtake of natural resources and greater poverty, as AIDS-affected households lose salary earners and capacity for heavy agricultural labor.

The conservation community needs to acknowledge the problem, work to understand conservation impacts better, and take action to mitigate impacts in affected countries. This includes promoting of HIV/AIDS prevention in protected area staff and communities; finding solutions to relieve unsustainable harvesting (e.g. through non-labor-intensive micro-enterprise to support community livelihoods); developing HIV/AIDS strategies in protected area authorities; and collaborating with other sectors including health and agriculture.

ANNEX 1

Private Protected Area Action Plan

(13 September 2003)

WPC Governance Stream, Parallel Session 2.5
"Protected Areas Managed by Private Landowners"
Session leaders: Dr. Jeff Langholz & Dr. Wolf Krug

Background

This document represents the consensus opinion of participants at the Vth World Parks Congress Session on "Protected Areas Managed by Private Landowners" with respect to the future of privately owned protected areas worldwide. Its purpose is to chart a course for the coming decade that improves and expands biodiversity conservation occurring on privately owned lands. It was adopted by unanimous vote on 13 September 2003.

Definitions: A private protected area (PPA) refers to a land parcel of any size that is 1) predominantly managed for biodiversity conservation; 2) protected with or without formal government recognition; 3) and is owned or otherwise secured by individuals, communities, corporations or non government organisations.

Recognising that:

Ecological and biological issues

- A great share of global biodiversity occurs on privately owned lands;
- Private lands represent an opportunity for significant expansion of the world's network of protected natural areas;
- Private land holders have demonstrated a willingness and capacity to protect natural habitat and endangered species successfully;
- Conservation on private lands represents an essential and expanding complement to public conservation efforts by protecting corridors, buffer zones, inholdings, areas under-represented in public park systems, and other key components of larger ecosystems that governments are not protecting for lack of financial resources, political will, or other reasons;
- Private conservation models, like publicly protected areas, vary greatly in terms of management objectives, allowable activities, and level of protection. These may include formally declared private areas, lands subject to conservation easements, game ranches, mixed commercial operations based on sustainable use, land trusts and other options; and
- Privately owned protected areas best serve as supplements to, not replacements for, strong public protected area systems.

Economic and social issues

- Private protected areas provide public goods in conserving biodiversity and natural resources at comparatively low cost to society.

- The private sector has shown it can be efficient, accountable and innovative in conserving natural resources and biodiversity while integrating economic uses in a sustainable way. Examples include activities such as nature tourism, game ranching, or harvesting non-timber forest products, which provide revenues that make private conservation appealing and financially feasible.
- Private lands conservation may be vulnerable to economic fluctuations caused by changes in policy at the local, national and international level that increase the profitability of competing land uses such as agriculture, logging, and ranching.
- Some private land conservation mechanisms are extremely flexible, and can be used to implement conservation practices on productive lands in a manner that can attain a broad range of social and economic benefits.
- That there is an increasing tendency for landholders to form collaborative networks.

Legal and political issues

- That secure property rights to land and natural resources form an essential foundation for any long-term conservation strategy, particularly one involving private sector participation and investment;
- That private landholders represent an important stakeholder group that can contribute meaningfully to local, national and international conservation planning efforts;
- That many privately protected areas are subject to legally binding conditions and restrictions regarding land use practises, that can ensure their durability and long-term conservation, including in perpetuity; and
- The increasing tendency for multiple private landholders to form collaborative reserves and conservancies that jointly manage large conservation units;

The international workshop on privately owned parks (Session 2.5 of the Governance Workshop Stream) at the Vth World Parks Congress, in South Africa (8–17 September, 2003), makes the following recommendations to governments and civil society:

1. Strengthen the legal framework for private lands conservation, including through:

Conducting a global assessment of the current legal frameworks for private lands conservation, identifying key gaps in the design, implementation, and evaluation of relevant legislation;.

Working to fill existing legal gaps by developing laws, regulations, policies, and programs that support creation of appropriate land use planning regimes, formally declared private protected areas, conservancies, conservation easements and similar instruments, conservation concessions, and other protection mechanisms;

Strengthening the legal security for conservation lands, including the recognition of rightful owners, reform of land tenure laws and improved law enforcement. Secure use rights over land and wildlife are an essential ingredient in any strategy to conserve and encourage long-term investment in wildlife habitat; and

Ensuring that the IUCN protected area category system explicitly addresses privately owned protected areas.

2. Strengthen economic incentives for private land conservation, including:

Develop economic incentives for private landowners to adopt private lands conservation practices. These should include property tax exemptions for lands placed in conservation status; payments for the environmental services provided by conservation lands; development of markets for environmental goods and services; purchase or transfer of development rights; and other forms of government financial and technical assistance. In providing incentives, priority should be given to lands that are within publicly protected areas, or have been granted official recognition as private conservation lands;

If not already established, governments should establish environmental trust funds, with donor support, and authorize the use of such funds to support key private lands conservation actors.

3. Strengthen institutional capacity for private lands conservation:

Increase capacity of *federal and state governments* to authorize and monitor formal private conservation protection efforts, and better integrate private lands conservation actions into their overall conservation strategies. This includes ensuring that even those government agencies whose primary responsibility is not conservation work to support private lands conservation actions (e.g., land reform, tax, and planning agencies);

Identify and remove gaps and overlaps in institutional responsibilities regarding conservation initiatives on private lands;

Improve capacity of *local governments* to ensure that local registrars properly record private land conservation instruments;

Increase capacity of *government judicial systems* to enforce private and conservation mechanisms effectively and consistently; and

Expand efforts by *conservation NGOs* and government agencies to: 1) develop private lands conservation tools; 2) identify private lands conservation priorities; 3) establish and maintain private conservation areas; and 4) provide technical assistance to conservation-minded landowners;

4. Improve and expand education and training opportunities for private lands conservation, including:

Design, develop, deliver, and evaluate a comprehensive portfolio of education and training opportunities for key sectors involved in private lands conservation. Target audience includes government parks agencies, conservation NGOs, commercial entities, registrars, judges, prosecutors, and private and community landowners. Topics range from general capacity-building to the application of detailed technical issues and procedures. Delivery formats will include short courses, field work, various forms of workshops, internships and fellowships, and formal academic education programs.

5. Increase public-private collaboration in the management and conservation of protected lands:

Integrate private lands conservation efforts into public conservation strategies. This includes:

a. increasing overall collaboration between public and private conservation sectors, including communicating available programs and conservation options;
b. maximising protection of ecosystems inadequately represented among public protected areas;
c. enhancing public protected areas by protecting buffer zones and conservation corridors; and
d. improving the management of privately owned lands within “mixed” public/private protected areas.

6. Promote community involvement and sustainable development through privately owned protected areas:

Increase and deepen the transfer of technology, knowledge and experience between private landowners and other stakeholders.

Improve and promote cooperation between private landowners and other stakeholders, particularly regarding complementary land uses.

7. Create information networks, including:

Establish networks of conservation owners and other stakeholders for the purpose of sharing information, knowledge, and expertise on a regional, national, and international basis;

Conduct a global inventory of privately conserved lands that characterises their overall contribution to protecting natural habitat, endangered species and cultural resources;

Conduct a global analysis on the economics of private lands conservation, including financial sustainability, contribution to national economies, job creation, and other economic and social costs and benefits;

Identify, then work to remove, perverse economic incentives at the regional, national and international level that distort the market and promote unsustainable land use practices (e.g., subsidies for unsustainable agricultural practices);

Investigate the myriad social issues surrounding privately owned protected areas worldwide, including levels of social acceptance and costs and benefits to local communities.

March 6, 2003

Dear Colleague:

It is our pleasure to invite you to participate in a unique forum being organized for ***September 14th and 15th, 2003*** within the context of the World Parks Congress:

Southern and East African Experts Panel on Designing Successful Conservation and Development Interventions at the Wildlife/Livestock Interface:

Implications for Wildlife, Livestock, and Human Health

Who and What – You have been selected for invitation to this important forum because of your expertise and experience at the interface between wildlife, livestock, and human health. The theme of this World Parks Congress is, quite appropriately, 'Benefits Beyond Boundaries.' The World Parks Congress itself is only held once every 10 years, and fewer than 50 international animal health and other experts have been invited to participate in this opportune working meeting focused on the wildlife/livestock interface (see invitees list attachment **4-AHEADInvitees.xls**). We hope you will join us, and help raise the profile of your issues in this important conservation venue. In fact, we welcome co-sponsorship by your home institution. It is our hope that by the time the Congress arrives, many of you will be co-conveners of this important meeting along with the Wildlife Conservation Society (WCS), the IUCN SSC Veterinary Specialist Group (VSG), the IUCN SSC Southern Africa Sustainable Use Specialist Group (SASUSG), the Pan-African Programme for the Control of Epizootics/Inter-Africa Bureau for Animal Resources (PACE/IBAR), and others.

Where and When –

****Southern and East African Experts Panel on Designing Successful Conservation and Development Interventions at the Wildlife/Livestock Interface: Implications for Wildlife, Livestock, and Human Health:*** **SEPTEMBER 14 and 15, 2003**

*Within the ***IUCN World Parks Congress*** **SEPTEMBER 8–17, 2003**

*Associated with Congress Stream ***"Building Broader Support for Protected Areas":*** **SEPTEMBER 11–15, 2003**

The IUCN World Parks Congress is being held in Durban, South Africa September 8–17, 2003 (attachment **"3-WorldParksProgram"** provides an overview of the agenda, with more details on the Congress itself available at www.iucn.org). The relevance of animal health to protected areas and conservation more broadly will be introduced in the open sessions of the "Building Broader Support for Protected Areas Stream" on the 12th. ***To participate in the wildlife/livestock/human health forum it is essential that you arrive before the two full-day working sessions on Sunday September 14th and Monday September 15th.*** Please see attachment **5-DraftAHEADagenda**. We of course encourage you to participate in as much of the Congress as you are able. [Please complete attachment **2-WPCNominForm.doc** and e-mail or fax it back as indicated to IUCN. They need the form to manage logistics of the meeting.] *We hope to be able to cover the costs of all invitees for airfares and lodging for the nights of the 13th, 14th and 15th.* More details on funding will follow, as we are still exploring options with several potential donors.

Why– For those of you familiar with the convening institutions, you know that bringing the health sciences more intimately into conservation's mainstream has been among our strongest collective goals. The Wildlife Conservation Society (WCS), lead sponsor of this forum, is the only large international nongovernmental conservation organization with a Field Veterinary Program dedicated to strengthening the links between the conservation and health sciences. WCS is now launching a collaborative initiative called **A**nimal **H**ealth for the **E**nvironment **A**nd **D**evelopment – ***AHEAD***. With the World Parks Congress being held in South Africa, this seems like a perfect venue to kick it off. ***AHEAD***'s initial focus is on Southern and East Africa and its key protected areas, buffer zones, and corridors (real and proposed within the transboundary vision continuing to gain momentum regionally). We look to you to help define the most pressing animal-health related conservation and development challenges, and to also share the solutions you feel are most promising. The IUCN SSC Veterinary Specialist Group (VSG), now co-chaired by Dr. Richard Kock and Dr. William Karesh, is very interested in the nexus of conservation and animal health policy. To that end, co-sponsoring this forum is very appropriate for the VSG as we begin our first triennium together. The Pan-African Programme for the Control of Epizootics / Inter-African Bureau for Animal Resources (PACE/IBAR), representing the first continental epidemiology programme, focuses on unraveling the epidemiology of diseases of economic and ecological importance to livestock as well as wildlife, including but not limited to rinderpest. The IUCN SSC Southern Africa Sustainable Use Specialist Group (SASUSG) works to bring sound science to bear on natural resource management decisions that directly affect the livelihoods and cultures of Africa's people, as well as the future of Africa's wildlife. Acting as a catalyst for research, policy debate, information management, and action on sustainable use issues, the SASUSG has long recognized the importance of the health sciences to sound natural resources management. As socioeconomic progress demands sustained improvements in health for humans, their domestic animals, and the environment, our institutions recognize the need to move towards a "one health" perspective- an approach that we hope will be the foundation of our discussions in Durban.

Our goal for this forum is to be catalytic. **The ideas you bring to the table remain your own.** Simply put, by raising the profile of these issues, it is our hope that the donor community will also be sensitized to the importance of the types of work we all believe are critical. As described below, this forum is meant to foster the development of concrete plans for conservation and development work at the wildlife/livestock/human health interface, and we hope to work with you to help find funding to help you get the work done. While we can of course make no guarantees at this stage, we do feel that the forum we hope you'll participate in in Durban is an excellent first step toward building a network of colleagues willing to share lessons learned and work together- to enhance prospects for conservation and development in their areas of focus for years to come. In short, we hope you'll become an active member of the ***AHEAD*** network and help shape its core conceptual underpinnings.

An agenda for the two-day working forum is outlined below. The symposium focuses on concrete deliverables – a plan for follow-on action, as described in the agenda. Catalyzing real world change for the better is of course very important to all of us. We think animal and related human health issues represent an unfortunately all-too-often neglected sector of critical importance to the long-term ecological and sociopolitical security of protected areas around the world. Whether we are talking about the

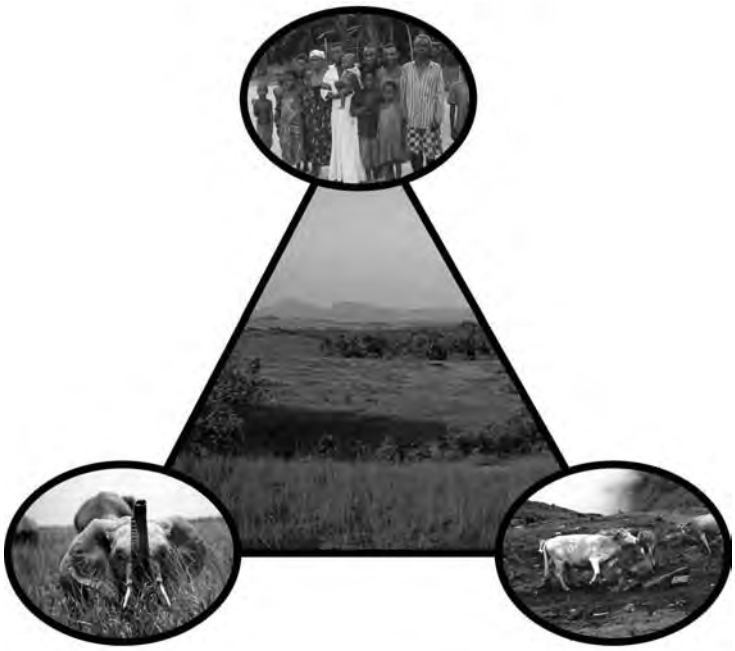
ongoing tuberculosis crisis in and around Kruger National Park, the impacts of foot and mouth disease on land-use planning in southern Africa, or the brucellosis saga costing US authorities in and around Yellowstone National Park millions of dollars to manage, these issues merit more *proactive* attention in and around many of the world's protected areas, conservancies, buffer zones, and corridors than they have gotten to date. We hope you agree.

Please note that the draft agenda below is illustrative. Any of the topics listed are "up for grabs" if you want to address them in the paper / 15 minute talk we are asking you to consider presenting. Feel free to suggest any other topic you feel is relevant. Once we know who is planning to attend and what topics they will address, a final agenda will of course be circulated (a draft mock agenda showing time allotments is in attachment **5-DraftAHEADagenda**). *Please note that there are only 26 fifteen-minute speaking slots available* (one day of such presentations). We will try to accommodate as many proposed presentations as possible- likely on a 'first come, first served' basis. Even if you choose not to present a talk on day one of the working meeting, we still want you to join us! The Working Group Sessions on the second day of the forum (again, see agenda) are *essential* for the outcome of this meeting to be successful, and your participation in these creative, interactive sessions is needed! Please see attachment **1b-ReplyForm.doc** sent with this letter for the information we need you to send back to us ***as soon as possible*** in order to ensure a results-oriented, productive meeting. If for some reason you would like to recommend a specific colleague in your place, we are open to such suggestions as well as to suggestions of other participants we should consider (see **4-AHEADInvitees.xls** for current list of invitees). Please recognize that space is very limited, so it is unlikely many additional invitations can be extended.

We look forward to hearing from you! Again, please send back the reply sheet (**1b-ReplyForm.doc**) sent to you with this letter as soon as possible. The additional informational attachments referred to above will be sent to those invitees indicating they will attend, or to any invitees requesting additional information.

Sincerely,

Steve Osofsky, Senior Policy Advisor, Wildlife Health, WCS Field Veterinary Program
William Karesh, Head, WCS Field Veterinary Program; Co-Chair IUCN SSC VSG
Richard Kock, Technical Officer, Wildlife Epidemiology Unit PACE/IBAR; Co-Chair IUCN SSC VSG
Michael Kock, Animal Health Advisor, IUCN SSC SASUSG



PLEASE SEE NEXT PAGE.

Southern and East African Experts Panel on Designing Successful Conservation and Development Interventions at the Wildlife/Livestock Interface:

Implications for Wildlife, Livestock, and Human Health

Organized/sponsored by (list still under development): Wildlife Conservation Society (WCS) (lead); IUCN SSC Veterinary Specialist Group; Pan-African Programme for the Control of Epizootics/Inter-African Bureau for Animal Resources (PACE/IBAR); IUCN SSC Southern Africa Sustainable Use Specialist Group (SASUSG); YOUR INSTITUTION HERE??

Activity: A two-day interactive forum at which invited Southern and East African and other experts share their vision for conservation and development success at the wildlife/livestock interface with World Parks Congress attendees and invited representatives from bilateral and multilateral development agencies and other interested parties.

Purpose: To foster a sharing of ideas among African practitioners and development professionals that will lead to concrete and creative initiatives that address conservation and development challenges related to health at the livestock/wildlife/human interface. The focus of presentations will be ongoing efforts and future needs in and around the region's flagship protected areas and conservancies and their buffer zones- the places where tensions and challenges at the livestock/wildlife interface are greatest.

Day 1- Overview of Challenges to Conservation and Development at the Livestock / Wildlife Interface:

Opening Address: Dr. Richard Kock, PACE/IBAR and IUCN SSC Veterinary Specialist Group

(Sample Possible Themes of Day 1 Invited Presentations. ***Please tell us what you would like to present on – these are just suggestions!):***

* Diseases that affect the natural resources management and livestock sectors
* Human livelihoods and healthy animals- ideas for improvements in conservation and development interventions
* Disease surveillance in wildlife, livestock and people- importance and practicalities
* Community-Based Animal Health Care- successes and failures around protected areas
* Grass-roots human health and animal health intervention strategies- are there economies of scale (and of science) in combined approaches?
* Veterinary services and the role of governments- priorities for the future
* Conservation NGOs and Development NGOs and the 'human health-livestock health-wildlife health triangle'- models for better collaboration
* Transboundary conservation landscapes and implications for domestic and wild animal movements and international management
* Animal and human trypanosomiasis: potential for expansion of tsetse fly range via transboundary protected areas
* Persistence and re-emergence of human sleeping sickness in the Serengeti-Mara ecosystem
* Persistence and re-emergence of human sleeping sickness in and around Uganda's protected areas
* Containing wild animal maintenance hosts of foot and mouth disease (FMD): implications for countries with disease-free status / those seeking disease-free status
* Virus topotypes and the role of wildlife in foot and mouth disease (FMD)
* Food-security and land-use policy: finding the right balance between wildlife and livestock in marginal semi-arid lands
* Role of disease prevention and control in poverty reduction and food security strategies- public and private sector animal health policy and implementation needs within and beyond park boundaries
* Protected areas, animal disease, and impacts on trade- balancing priorities in East and Southern Africa
* Wildlife as a land-use choice: practical and regulatory veterinary concerns for community-based as well as large-scale commercial enterprises

* Rinderpest: historical impacts and current issues for protected areas and pastoralists- strategies for control at the livestock/ wildlife interface
* Options and trade-offs related to improved livestock production tempering a growing bushmeat trade
* Communications and health: the value of improved information technologies to the 'human health-livestock health-wildlife health triangle'
* What if we do nothing? 'Business as usual' and prospects for ecosystem health in protected areas and their buffer zones

Day 2- Moderated Working Groups bringing African and other experts and senior foreign assistance professionals together to outline key priorities for future work on the themes discussed on Day 1:

AM- Moderated Working Groups outline project concepts they think can practically address the challenges discussed on Day 1. Working Groups to be landscape-focused so the proposal outlines that are developed are geo-referenced to places (which include core protected areas) of conservation interest (landscapes of focus will likely depend on final representation at the meeting). The emphasis should be on projects that can and should be developed and implemented soon. Concepts emphasizing further research must justify that the proposed research is critical to improved management practices on the ground.

AM session 1: Working Groups, arranged by country, meet to outline pilot project ideas for Botswana, Kenya, Malawi, Mozambique, Namibia, South Africa, Tanzania, Uganda, Zambia, Zimbabwe. Concepts for transboundary work to be included in these outlines. Each Working Group should focus on no more than 3-4 pilot project concepts (including transboundary endeavors) to outline.

AM session 2: plenary- Each Working Group selects a representative to explain pilot project concept(s) outlined for their region.

Working lunch- Representatives from each working group convene to delineate "measures of success"- what criteria should these conservation and development interventions be measured by? A suggested list of indicators of success relevant to goals at the livestock/wildlife interface should be outlined. This outline is to be distributed to all participants as the afternoon Working Groups get underway.

PM session 1: Working Groups Meet, this time together with any other Group relevant to identified transboundary work (thus forming larger Transboundary Groups). Transboundary project concepts are to be outlined and refined, with 'cross-border' sharing of ideas essential. Working Groups without identified transboundary needs continue to work on project concepts for their chosen landscapes.

PM session 2: plenary- Each Transboundary Working Group selects a representative to briefly explain pilot transboundary project concept(s) outlined for their region. Working Groups without identified transboundary needs select a representative to summarize key new thoughts since the AM sessions. Presenters should reference how identified or modified "measures of success" may help them monitor conservation / development results in their landscapes.

Closing Address: Dr. Steve Sanderson, Chief Executive Officer of the Wildlife Conservation Society (if available)

Follow-up: The immediate product of the meeting will be proceedings of the talks given on Day 1, and a written summary of the outlines for envisioned future work produced by Day 2's Working Groups.

Longer term, WCS will work with interested participants from the various Working Groups to help them more fully develop the outlines into full proposals for donor consideration. Obviously this will involve broader consultation within the regions of focus with a wider range of stakeholders than could be accommodated at this initial forum.

PLEASE SEE SEPARATE REPLY FORM – THANK YOU.

Southern and East African Experts Panel on Designing Successful Conservation and Development Interventions at the Wildlife/Livestock Interface: Implications for Wildlife, Livestock, and Human Health

AHEAD Forum, September 14–15, 2003 Durban, South Africa

Working Group Notes

Editors' note: **These Working Group Notes reflect brainstorming sessions held within the *AHEAD* forum. They do not necessarily reflect the official opinions of any of the institutions or sponsors involved in the forum. The listing of a particular organization anywhere below does not mean that that organization consented to participate in any particular activity; it simply means that a meeting participant felt that the listed organization was one that should be involved in the process to further develop project ideas being discussed (should those ideas move forward).**

Each Working Group focused discussion on the following (please see World Parks Congress ***AHEAD*** Agenda on p.xv for the detailed instructions that were provided to working groups):

- Prioritized Protected Areas/Complexes
- Challenges and Threats
- Proposed Projects

WORKING GROUP	REGION(S)	PRIORITY AREAS SELECTED
Group A	**South Africa and contiguous areas**	**Great Limpopo TFCA; Hluhluwe-Umfolozi; Shashe-Limpopo**
Facilitator/Recorder:	Roy Bengis/Philip Nyhus	
Members Day 1:	Paul Bartels, Koos Coetzer, Jacques Flamand, Wayne Getz, Markus Hofmeyer, Nick Kriek, Anita Michel, Banie Penzhorn, Wilna Vosloo	
Members Day 2:	Paul Bartels, Koos Coetzer, David Cumming, Raoul du Toit, Jacques Flamand, Chris Foggin, Wayne Getz, Markus Hofmeyr, Nick Kriek, Neo Mapitse, Anita Michel, Banie Penzhorn, Wilna Vosloo	
Group B	**Botswana Namibia Zimbabwe**	**Four Corners; Etosha**
Facilitator/Recorder:	Mike Kock/Bob Cook	
Members Day 1:	Jan Broekhuis, David Cumming, Holly Dublin, Raoul du Toit, Chris Foggin, Guy Freeland, Neo Mapitse, Laurie Marker, Rowan Martin, Norman Mukarati, Gary Mullins, Chris Weaver	
Members Day 2:	Jan Broekhuis, Guy Freeland, Rowan Martin, Norman Mukarati, Gary Mullins, Chris Weaver	
Group C	**Kenya**	**Ewaso-Laikipia; Tana**
Facilitator/Recorder:	Richard Kock/Elizabeth Wambwa	
Members Day 1:	George Gitau, Fumi Mizutani, Elizabeth Muthiani, Jacob Mwanzia, Jesse Njoka, Helga Recke, Kenneth Waithiru	
Members Day 2:	George Gitau, Simon Kinyaga, Tim Leyland, Fumi Mizutani, Elizabeth Muthiani, Jacob Mwanzia, Jesse Njoka, Helga Recke	

WORKING GROUP	REGION(S)	PRIORITY AREAS SELECTED
Group D	**Tanzania** **Uganda** **Albertine Rift**	**Gombe-Bwindi; Akagera Basin**
Facilitator/Recorder:	Billy Karesh/Karen Laurenson	
Members Day 1:	Philippe Chardonnet, Sarah Cleaveland, Gladys Kalema-Zikusoka, Titus Mlengeya, Pete Morkel, Nicole Muloko, Craig Packer, Robin Reid, Chris Rutebarika, Innocent Rwego, Claudia Schoene, Sue Welburn, Michael Woodford	
Members Day 2:	Philippe Chardonnet, Gladys Kalema-Zikusoka, Nicole Muloko, Craig Packer, Chris Rutebarika, Innocent Rwego, Claudia Schoene, Sue Welburn, Michael Woodford	
Group E	**Tanzania +**	**Greater Maasailand/Tsavo;** **Selous-Niassa-W. Tanzania**
Facilitator/Recorder:	Sarah Cleaveland/Elizabeth Muthiani	
Members Day 1:	Philippe Chardonnet, Holly Dublin, Robert Fyumagwa, Tim Leyland, Titus Mlengeya, Pete Morkel, Jesse Njoka, Robin Reid	
Members Day 2:	Philippe Chardonnet, Holly Dublin, Mark Eisler, Robert Fyumagwa, Tim Leyland, Titus Mlengeya, Pete Morkel, Jesse Njoka, Robin Reid	
Note: Working Group E grew out of an originally larger Working Group C.		
Group F	**Zambia** **Mozambique** **Malawi**	**Zambia-Malawi-Mozambique Triangle;** **Kafue**
Facilitator/Recorder	Laurel Neme/Rod de Vletter (Day 1)/Victor Siamudaala (Day 2)	
Members Day 1:	Mark Eisler, Dale Lewis, Tim Leyland, Misheck Mulumba, Victor Siamudaala, Bartolomeu Soto	
Members Day 2:	Dale Lewis, Tim Leyland, Misheck Mulumba, Bartolomeu Soto	

WORKING GROUP A

Region: South Africa and contiguous areas

Prioritized Protected Areas/Complexes

1) **Greater Kruger NP Complex + TFCA partners (GLTFP)**
2) **Hluhluwe/Umfolozi NP**
3) **Limpopo/Shashe TFCA**

Marikele NP
Lebombo TFCA
Madikwe, etc.

Challenges and Threats

Rank 1: GLTFP: Greater Kruger NP Complex + TFCA partners

- Unfenced border, many people along edge, moving into reserve
- There will be zones of less and less protection
- Issue of management may be different on both sides of the border, although once underway management is supposed to be more similar on both sides
- Diseases: tsetse/Nagana/sleeping sickness, BTB, *Brucella*, FMD, ASF, MCF, corridor/ECF, rabies, RVF, canine distemper, AHS, anthrax, *Echinococcus*, neosporosis/toxoplasmosis, EMC

Should tsetse be managed?

Suggestion to organize by wildlife, livestock, human health problems:

Prioritized health-related challenges/threats roughly ranked by importance

Wildlife	Livestock	Human
BTB	FMD	BTB
Anthrax	Theileriosis	Anthrax
Rabies	MCF	Rabies
Distemper	BTB	*Echinococcus*
Trypanosomiasis??	Anthrax	Neosporosis/toxoplasmosis
RVF	ASF	RVF
	Tsetse	
	Brucella	
	RVF	

Brucella: not common but a lot of money invested in eradication
Rift Valley fever: seasonally every 15 years or so, Kruger on edge of range, comes when major flood events, wild animals can get infected (would be in all three columns). (Big outbreak in East Africa in El Niño 2000–2001, many human deaths)

Chosen as a priority area because:

- Important conservation area
- Human interaction – human conflict potential when opened up
- High political profile
- Classic example of multiple interactions at various levels
- Important economically – regionally and for the country
- Social, economic, security issues as well
- Q: wondering if option is to remove people or livestock as well
- Majority of parks will face fence-related decisions/issues
- Issue: regionalization of country
- Export zones – Southern Africa has some of the few countries with export zones
- What happens in Mozambique is going to be important – hard to control what is happening on other side of border, but can control on South African side as well
- Because of expanding areas, need to anticipate

Rank 2: Hluhluwe/Umfolozi NP

Chosen as a priority area because:

- Important tourist area
- Neighbours – high concentration
- Completely surrounded by communities
- One of the biggest rhino sanctuaries in world
- Different genetic pool of buffalo than Kruger GLTFP (FMD-free)

Prioritized health-related challenges/threats roughly ranked by importance

Wildlife	Livestock	Human
BTB	BTB	BTB
Rabies	Theileriosis	*Echinococcus*
Distemper	Trypanosomiasis	Rabies
	African swine fever	

Rank 3: Limpopo/Shashe

Chosen as a priority area because:

- Transfrontier park with three countries
- Important linkage park
- Surrounded on two sides by local communities
- Has all aspects of wildlife – commercial, community
- Semi-arid, bushveld complex
- No buffalo
- Diffuse area

Prioritized health-related challenges/threats roughly ranked by importance

Wildlife	Livestock	Human
Rabies	FMD (Zimbabwe)	Rabies
Distemper	Anthrax	Anthrax
Anthrax	ASF	
ASF	MCF	

Proposed Projects

Priority Area: GLTFCA

Project Title: "Monitoring and Management of Diseases in the GLTFCA"

Phase 1

Integrated survey of the major diseases and related elements common to wildlife, domestic stock, and people in the component regions of GLTFCA.

Key Questions to Address for Each Disease:

- What species are carrying BTB? What species are (maintenance) hosts?
- What is the current spatial distribution in GLTP of these species?
  - Where are they?
  - How are they moving around the landscape? (i.e., what is their basic biology and epidemiology?)
  - What is the spatial distribution of potential hosts? (e.g., are there potential gaps among species?)
  - What are the reservoirs and dynamics?
- What is status of BTB in human hosts? What is distribution of human habitation/activities?
- What is the susceptibility of people?
- What is the BTB status and distribution of livestock?
- What is the potential for spread – what are risks for areas that are not infected? (first need to determine above)
- What are potential management options?
- What information is necessary to make a decision?
  - Spatial: We need a better picture of the landscape at interface of three country borders
  - Need to look at land use patterns
  - Q: What to do when we have this information?

Important Considerations

This needs to be a regional project. It will not work if it is piecemeal. We need to identify what data we have and what data we need to gather.

Possible Outcomes

Supply information essential for future decision-making for:

- National Regulatory Authorities
- TFCA Joint Management Board (JMB) and conservation agencies

Additional Notes

- Need to understand the role of kudu in the epidemiology of FMD (brought up from Zimbabwe side)
- Considerable discussions around role of fencing on the Zimbabwe side of border and its impact on livestock, etc.; discussion of different scenarios
- Concern was expressed that as the parks become more and more connected, it will become more difficult from a regulatory standpoint to control disease (i.e., if the parks are connected, disease will spread). This will open up many challenges.
- Concern was expressed that there is a need to discuss social issues, that landscape is broken down into different land tenure types, etc.

Additional FMD Projects

- Topotype status of buffalo in the three contributing countries
- The role of kudu as reservoirs and vectors

Options for Control/Containment of BTB

The following were identified as currently existing strategies for control of BTB:

- Fences at interface (barriers)
- Total or zonal depopulation
- Vaccines
- Development of diagnostic tests for a range of species

The issue of fences (and their effectiveness) came up several times in discussions.

Project Leaders/Coordinators

Champion/Leader: David Cumming

Others:

Paul Bartels (Biomaterial Banking [WBRC])
Roy Bengis (SA Dept. Vet Services)
Chris Foggin (Zimbabwe)
Wayne Getz (UC Berkeley)
Markus Hofmeyr (KNP)
Nick Kriek (Onderstepoort)
Anita Michel (OVI)
Bartholomeu Soto (Mozambique TFCA Coordinator; to be confirmed)

Priority Area: GLTFCA

Project Title: "Disease Status in Wildlife, Livestock, and People in the Three Contributing Areas (South Africa, Zimbabwe, and Mozambique)"

Conservation and Development Importance

Zimbabwe claims to be BTB free. What is the status on the Limpopo?
What is the BTB status in wildlife populations and livestock in these three areas?
Does *M. bovis* occur in human populations? Should we check late-stage HIV/AIDS positive people? (sputum culture)
Need to look at Sengwe Corridor (foot and mouth also problem)
(Why don't they want these diseases? – Tsetse fly and rabies are of risk to South Africa; BTB for Zimbabwe; BTB and foot and mouth to Mozambique)
Assumption that if corridors/fences taken down, then by and large expect same diseases in entire area that may now be distinct (with caveat that some biological boundaries may limit some spread)

Objectives

BTB surveillance

- Sengwe – cattle sentinels (Zimbabwe side)
- Limpopo – cattle sentinels (Mozambique side)
- Includes western boundary interface

For all, should culture the organism and be able to type it – which strain is it?

Leaders

Each country should do this – JMB Veterinary Subcommittee should be the leader of the work (subcommittee of the Conservation Committee). This relates just to this park.
Driven by Veterinary Subcommittee of JMB (this is just advisory committee).
Ideally, should have consortium of people, including government and academic (scientific consortium).
The people who would have to do this would be authorities or, if funds unavailable, funds raised by researchers, etc.

Basic methodology

There needs to be a common protocol so not done in its own way in each country
Intradermal Comparative Tuberculin Test (cattle) / ? Gamma Interferon (buffalo)
(Cattle and buffalo; buffalo will be much more expensive)
People: culture (possible sputum culture), radiographs

Proposed timeframe

One year if just animals, possibly longer if with people (for initial test)
Longer-term/follow-up monitoring necessary as well

Definition of success (monitoring/evaluation) during the project and at its conclusion

Results – by doing this, possible to improve health of local communities, because better able to manage the health of the people and animals
Recommended outputs to JMB
Capacity of neighbouring countries (Zimbabwe and Mozambique) to monitor the disease will be enhanced

Key partners (governmental, communities, and otherwise)

- Directorates of Animal Health
- Communities
- Consortium of academic institutions or NGOs
- Department of health
- Conservation committee

Political obstacles/vested interests that could impede project success

Three different countries – political
(BTB and foot and mouth have had some impact on development of Peace Parks)
Politicians are concerned that disease may introduce disease/trade barriers
Issue of land-use planning – disease becomes less important if zoned. If fragmented, then everyone is exposed.
Must consider SADC (Southern Africa Development Community) objectives
Agreement by animal health regulators

Critical training needs for success and sustainability

Community-based animal health technicians (two-week courses available, but need people)

Will new or improved legislation be needed for project success?

There is already a joint treaty – a treaty has been ratified (improved legislation is in place)

Anticipated project communications needs/support (outreach, print media, radio, television, web)

Argument is we want healthy cattle and to reduce the risk
Need to "win the hearts and minds" of local people
Need to convince local people (should be obvious that they die from this)
May be suspicion that if there is high incidence of disease, animals will be slaughtered.
Initially would have to purchase a sample of positive cattle for slaughter (research basis) to determine genetic differences. Will need samples from different areas if find disease in separate areas to see if same or different types.
Would need people who speak Portuguese because these areas are very remote

Budget (what funds are already available, from whom?)

Transport, training and extension, subsistence, equipment, laboratory space, consumables, labor, salaries, compensation for slaughtered animals (purchase of animals), and coordinating committees
Limited funds available from Peace Parks Foundation budget
Limited funds available for strain identification from academic institutions
Directorate of Animal Health would cover western boundary

Prospects for long-term (post-project) success (sustainability)

Not applicable, because depends on results of tests
May require repeat monitoring in the future

Additional Discussion Points

- Why do we want the Peace Parks? Increase pool of biodiversity, enhance livelihoods of local people.
- With our current technology, almost impossible to manage BTB.
- Discussion about who should do this – advisory group or informal group of scientific/NGO community.
- Roy mentioned value of survey – prevalence and primary detection survey (part of policy-making process). But Wayne and others brought up question of management – what can be done if BTB, etc. found? Are there options? Roy responded that currently we don't really have an answer, but valuable to have the information.
- Idea that "we have to accept" (Roy) that once the conservation areas are brought together (fences etc. brought down), the disease will become issue in all areas. Unless vaccine becomes available, really no way to keep from spreading to entire area.
- Need to come back to issue of containment – can/should it be done?

Priority Area: GLTFCA

Project Title: "Monitoring of Tsetse Fly – Expansion of its Range"

Conservation and development importance

If we allow the tsetse to come down through Kruger, we will have all the negative spin-offs and will lose cattle; possible to suppress if we know tsetse are there.
Tsetse in Gonarezhou and North of Save River
KNP and LNP are currently free
Need to try to limit to Zimbabwe side – can suppress if know it is there

Objective

Surveillance of tsetse fly

Leaders

Wildlife Unit, Zimbabwe Veterinary Services and Trypanosomiasis Control Branch
Mozambique Veterinary Services
RSA Vet Services – Kruger

Basic methodology

Strategic traps and targets (it may be possible to manage the spread; possible to suppress but not possible to eradicate)

Proposed timeframe

Extended monitoring (longer-term than for BTB)

Definition of success (monitoring/evaluation) during the project and at its conclusion
Success = Results (Suppression of spread)

Key partners (governmental, communities, and otherwise)
National Departments
Communities
Conservation Authorities
Academic institutions

Political obstacles/vested interests that could impede project success
No, treaty has been ratified.

Critical training needs for success and sustainability
Community-based-servicing and monitoring of traps/targets
Dipping of cattle in mobile traps

Will new or improved legislation be needed for project success?
No

Anticipated project communications needs/support (outreach, print media, radio, television, web)
Communication between regulatory agencies, animal health technicians, and communities

Budget (what funds are already available, from whom?)
Transport, training and extension, subsistence, equipment, laboratory space (minimal), consumables, labor (higher than for BTB), and coordinating committees

Prospects for long-term (post-project) success (sustainability)
Good

WORKING GROUP B

Region: Botswana, Namibia, Zimbabwe

Prioritized Protected Areas/Complexes

1) **Four Corners: Namibia/Botswana/South Western Zambia/Angola** (should consider) – includes Okavango Basin and north of the fence. **Note the addition of a new 1000km fence between Angola and Zambia. This fence, funded by the Netherlands, will be constructed soon to protect Zambian cattle from CBPP in Angola.*
   - Major TFCA
   - Heavy wildlife/human/livestock issue
   - High biodiversity
   - Changing environment
   - Elephant issues
   - Divergent government planning agendas
   - Fragmented migration routes due to fences
2) **Limpopo: (Great) Limpopo Basin – across Zimbabwe, Tuli, Gonarezhou**
   - Major potential as a TFA because livestock disease problems are transboundary, high biodiversity, unique environment, tourism, archeological importance
   - Veterinary issues- fence, FMD control, BTB, tsetse fly
   - In Zimbabwe, changing land-use pattern

- Heavily used by livestock, wildlife, and people
- Political momentum
- Zimbabwe issues: land resettlement, disease issues (FMD)

3) Etosha: Etosha watershed, Namibia

- Boom/bust environment (far west arid, Etosha semi-arid environment)
- Veterinary structures (fence) prevent flexibility to respond to game changes during different periods
- Major constraint on movement of animals due to veterinary restrictions (preventive measures)
- Area to be assessed for land redistribution

4) Zambesi: Middle-Lower Zambesi

- Veterinary issues: tsetse fly, illegal movement of cattle into area
- Overexploitation of water resources
- Illegal activity: poachers, bush meat movement and elephant poaching
- Settlement: people have moved into areas where they weren't before (unauthorized)

Challenges and Threats

Need to emphasize not only health of wildlife, but also links with people and domestic livestock.

Four Corners:

- One of the prime potential areas for development of TFCA. But very problematic because at the point of Zambesi, Chobe Rivers also where Namibia, Zimbabwe, Angola, and Botswana meet.
- Caprivi area where Rowan has worked is also an area with encroaching human settlements. Wildlife needs to travel into Botswana and back into Zimbabwe, but veterinary fences in 1995 and international fences block unimpeded movement of wildlife. In times of stress, animals don't have the ability to migrate but must now be permanent.
- Caprivi strip
- Zimbabwe/Botswana interface: moves to establish a corridor between Four Corners and Kafue National Park in Zambia. No FMD from Zimbabwe side. *Note new fence mentioned above.
- Northern Botswana: four major protected areas. Elephant populations 123,000 in Botswana with 122,000 in this area.
- Elephants concentrated along Namibian border.
- Interface largely on the outside of this system.
- Major veterinary fences from the east and west with parts currently being completed. The remaining fences are outside the area, but have an effect on animal movement. One of the major fences (in the west) is to be removed due to protests about the inability of animal movement, but removal has been deferred. The west fence was first constructed to contain CBPP, but failed to do so.

The fence:
All obstructions to wildlife in this western area should be removed. This corner of Botswana is being controlled for the sake of a few cattle, and this is not effective.

> International boundary fence is the issue – should drop the idea of having an export zone in this area. Can keep cattle and wildlife together by vaccinating the cattle.

What are the issues that have a health component (at interface), i.e., root causes of policy?

- Policy issues
  - Perverse policy problem in this area, which challenge both animal (domestic and wildlife) and human health.
- Understanding the resource base/interactions
  - Too many people, too few resources in the area
  - Inefficient use of resources
- Sustainable livelihood options
  - Sustainable livelihood issue – 68% of people in this area live below poverty level. Equate poverty with ill health and then an unhealthy ecosystem.
  - For whatever reasons, they are unable to explore the breadth of the sustainable livelihood options.
- Administrative and political complexity, capacities vary greatly between the countries
  - Include governance, financial resources, capacity of governments to deal with livestock diseases
  - Botswana has much more capacity (stable and financially sound) than Zimbabwe for example.

- Elephant issues will impact on endangered species (rhino), nutritional components.
- Animal movement, especially on Namibia side, bottleneck in west Caprivi
- Illegal activity, i.e., poaching on eastern side.
- Specific health issues, disease and control (direct and indirect)
  - CBPP
  - FMD
  - Tsetse/trypanosomiasis
  - Malaria
  - HIV/AIDS (42% of human population in this area; higher rate of human TB).
  - Human TB
  - Tapeworm (*Cysticercus bovis*)
  - *Theileria*: uncertain if it is a problem, maybe in Zambia side.
  - Anthrax: Significant issues will increase due to extensive elephant environmental destruction. Not yet recognized as a significant problem. Zoonotic potential makes this relevant to departments and governments.

Disease Control Priorities:

- FMD
- CBPP
- Tsetse and Trypanosomiasis

Zimbabwe: need for institutional capacity to address

Limpopo Basin TFCA: extends through eastern Botswana, southern Zimbabwe, western Mozambique, Kruger in northern South Africa

Issues

- TFCA agenda (top-down approach and being "steam-rollered" by politicians)
- Private sector and security fencing as well as veterinary issues; security fence along northern South Africa
- FMD topotypes, differing status of buffalo in the region
- Botswana on west is FMD negative for buffalo. Cattle may be positive – Zimbabwe buffalo from Hwange are probably FMD carriers and kudu are also suspect. Cattle have been infected, but may be a carrier cattle situation from Zimbabwe communal land cattle.
- Tsetse/trypanosomiasis reincursion
- *Theileria*
- BTB: *M. bovis* moving into southern Zimbabwe from South Africa; action or inaction (is there anything to do to stop it?)
- Land resettlement/tenure issues
- Land restitution claims/court action
  - Property rights issues/settlements are big issue
  - Indigenous peoples want to resettle lands or restitution.
- Illegal activities (poaching)

Overarching prioritized issues:

- Animal disease/human diseases
- Human resource issues (poverty)
- Policy issues
  - Lack of internal incentives to participate (a top-down directive)
  - Mozambique and Zimbabwe
  - Namibia (4 corners) and Zimbabwe policy change will be a long, slow process
- Lack of common vision
- Discrepancy in government agency ability to deliver capacity
- Resource access rights

Etosha

Challenges and threats to health at the interface:

- Anthrax has existed for hundreds of years; may not be a threat, just endemic; tourists don't really come into contact.
- Porous fencing allows wildlife to mix with livestock on the northern and western border.
- FMD control: cannot use Etosha game for restocking due to this.

- Transmission of disease from domestic animals to wildlife (rabies, distemper)
- FIV? in lions not fully understood, don't know if it will impact the population.
- Lack of vision on part of Veterinary Services-not enough adaptive management on disease issues (buffalo).
- Predation of livestock by wildlife (problem animals) provokes public reaction. Commercial farmers kill wildlife.
- Birds and fish: no outstanding threats
- Perverse incentives

Most pressing ETOSHA issues

- FMD control protocols:
  - LOME Convention influences export markets
  - Heavy subsidies from EU of meat prices.
- Failure to adapt veterinary policies to changing needs
- Rabies

Proposed Projects

Priority Area: Four Corners TFCA

Project Title: "Examination of Policy Issues Related to Disease Control and Potential Formation of a TFCA"

Project 1a: Examine current veterinary policies vs. land use in Namibia and Botswana. Establish dialogue by working with IUCN Regional Office (IUCN - ROSA) and the IUCN Veterinary Specialist Group, IUCN Antelope Specialist Group.

Issues include:

- Veterinary Departments respond to government policy to maintain export market, may need higher-level government engagement.
- Creating TCFA may take 3–5 years to be successful. Cannot be perceived as NGO driven.
- Should involve:
  - Ministry of Finance (are interested in export market income)
  - Ministry of Agriculture - Veterinary Department
  - Ministry of Environment - Wildlife Department
  - Stakeholders (landowners)
- Need to incorporate into larger Four-Corners partnerships, including Angola, Zambia (even more so with the construction of the new fence), and Zimbabwe.

Project 1b: Research/information gathering on the viability of the resource-return from wildlife to run concurrently with Project 1a to provide the data to feed into Project 1a to substantiate direction.

- Being done in Namibia
- RAMSAR site in Botswana - IUCN-Okavango management plan
- Need to do a disease assessment in all partner countries

Project 1c: Study of scenario with/without export zone in Ngamiland fences

- To include alternatives to export zone
  - Corridors
  - Wildlife movement
- If exclude export zone, must demonstrate benefits to people

Project 1d: Study of FMD ring vaccination efficacy. Word is that there is no good vaccine. Cross-cutting project.

Project Outline

Preamble: The present veterinary control policies and strategies are inimical to the optimal development and sustainability of a major TFCA of the Four Corners and buffer areas.

A. Why does this challenge/threat need to be addressed?
   1. Sustainable livelihoods/poverty reduction-wildlife development to full market value (by reducing veterinary restrictions)
   2. Development of major TFCA-must address disease control relationship.

B. What needs to be done? ***Change policies to create an effective TFCA***
   1. Gather existing information

2. Gap analysis: create focused studies to argue the case and develop options
    a. Export zone issue in Botswana and the overall value of the cattle industry – indications that there is a major review of the Botswana cattle industry.
    b. Economic multiplier studies
3. Create forum using IUCN ROSA- facilitator (other groups?)
4. Bring key parties to the table- to discuss the disease and health issues related to the development of TFCA using IUCN
5. Examine general veterinary policy as these affect wildlife
6. Forum would meet with the two Ministries and two Departments of the five countries. Might consider first meeting between Namibia and Botswana (where veterinary concerns are greatest) and then expand to the five countries. Invite secondary stakeholders as appropriate.

C. Who will lead the work? To be decided

D. Major players:
1. Finance Ministry
2. Agriculture Ministry
3. Wildlife Department
4. Veterinary Department
5. Secondary stakeholders
    a. NGOs – IUCN-ROSA AND SSC-VSG, WCS, AWF and others
    b. Landowners and farmers
    c. Community constituents
    d. Local government officials
    e. Peace Parks
    f. IUCN
    g. World Bank?
    h. USAID

E. How will the work be done (i.e., basic methodology)?
1. Gap analysis
2. Gather data
3. Collect data
4. Analyse data
5. Policy process: forum may commission some of the data gathering and collection, which may run concurrently.

F. Timeframe: 24 months (?) – important to be gathering data immediately, urgency is to have information as soon as possible (within one year) to influence policy.

G. Michael Kock coordinating with other key members (may want Jon Barnes to do initial study to look at feasibility, strategic plan, etc.)

H. Measurements
1. Changing veterinary policies
2. Fence removal or realignment (corridors)
3. Establishment of the TFCA
4. Wildlife census: measuring increases in wildlife populations may be an indicator of success of fence removal and TFCA formation (need to examine indicators more thoroughly).

5. Human health benefits: communities and livelihoods

Goal: **To realize the full potential of the Okavango/Upper Zambezi ecosystems for the enhancement of biological diversity and sustainable human livelihoods.**

Objective: To promote an enabling policy environment
Activities:

- Provide information, advice, and technical support on the health of people, livestock, and wildlife.
- Inform policymakers of different land-use options and their relative advantages; by which multiple countries will agree on the establishment of the TFCA.
- Perform veterinary assessment: disease issues analysis/cost-benefit analysis of various land-use options
- Create an enabling environment to realize the potential of the natural resources for the area's stakeholders (balance in land use).

WORKING GROUP C

Region: Kenya

Prioritized Protected Areas/Complexes

1) Ewaso Nyiro Basin (Laikipia to Habaswein)

- Holds endangered species
- Pastoral systems
- Ecosystem is unhealthy
- Important disease corridor, high poverty and conflict levels

2) Tsavo ecosystem

- An important component of a transboundary system
- Pastoral conflicts
- Livestock movements
- Disease corridor
- Good biodiversity value, can hold mega herbivores
- Large protected area

3) Tana Basin

- High biodiversity
- Disease corridor
- Conflicts/poverty
- Pastoral systems
- Added value of marine/forest (mangrove, riverine, and coastal ecosystems)
- Lack of protected areas, so vulnerable

Notes

- Ecological zone I and II
- Ecological zone III (humid): Ruma
- Ecological zone IV (subhumid): Nairobi NP, Thika, Kongoni, Maasai Mara, Laikipia, Marsabit, Nakuru, Shimba Hills Mwea (high livestock production, high wildlife numbers)
- Ecological zone V (semi-arid): Samburu, Isiolo, Ewaso Basin, Mathews range, Tsavo, Amboseli, Kora, Meru, Taita, Baringo
- Ecological zone VI (arid): Sibiloi, Losai

Significance

Nairobi National Park: The survival of wildlife is threatened. The surrounding ecosystem is being destroyed and the corridor is eliminated by settlement.

Maasai Mara: It holds a large number of wildlife and there is potential for the spread of transboundary diseases.

Laikipia: Increasing wildlife activities, important species such as hunting dogs, hartebeest present in this ecosystem, and they could be eliminated by a disease threat.

East Tana/Lamu: Have endangered species and rich biodiversity such as rare Tana red colobus, mangabey, sea turtles, and hirola antelope.

Nakuru: A closed system, big populations of species that need to be managed, an important Ramsar site.

Tsavo/Amboseli: Animal populations depressed through disease and poaching. It is linked to other cross border systems, like Somalia and Tanzania.

Samburu: Has endangered and special species such as Grevy's zebra, oryx, etc. The system is pastoral.

Meru/Kora: Second largest protected area system in the country. Populations are very depressed due to poaching, disease, and resource competition with livestock.

Baringo and Bogoria: Very small populations of wildlife.

Challenges and Threats

The criteria for ranking the areas of importance were: Health and impact of investment on biodiversity, livestock and human livelihoods/health.

Rank 1: Ewaso Basin (Laikipia to Habaswein)

- Has relatively better infrastructure, closer to markets
- High wildlife/livestock potential
- Disease control and livestock/wildlife/human health important to improve food security and livelihoods, reduce poverty.

Challenges

- Policy/legislation on the use and marketing of livestock/wildlife to improve benefits from both sectors
- Lack of data, capacity, and infrastructure to guide policy
- Poverty – need for livelihood diversification.
- Increase in wildlife on plateau due to changes in land use and security
- Animal health delivery services need improvement, but wildlife services and private/community wildlife services improving
- Decline in certain species, e.g., Laikipia hartebeest and Grevy's zebra; endangered species (possibly related to disease, parasites, RVF zone)
- Public health issues with bushmeat
- Lack of organized livestock marketing systems

Threats

- Declining water resource due to land-use change and poor water capturing.
- Limited access to forage due to conflicts/insecurity. Decrease of wildlife in the lowlands caused by increased competition for resource.
- Increased contact at interface between people, livestock, and wildlife especially in Laikipia due to increasing human population and settlement, increased agricultural activity and livestock (goats, camels, sheep) numbers; therefore, overall land degradation around settlements leading to unhealthy animals and new emerging diseases
- Specific disease threats associated with dynamic transboundary movements especially of livestock. Corridor for livestock from Ethiopia and Somalia to Nairobi, threat of spread of diseases such as rinderpest, CBPP/CCPP, PPR.
- Possibility of introduction of disease into protected areas (e.g., Meru ecosystem) through translocation.

Rank 2: Tana River Basin

- Rich in biodiversity but security and infrastructure is poor.
- Community richer (relatively) and habitat degradation slightly less advanced.
- Less time imperative

Challenges

- Policy/legislation on the use and marketing of livestock/wildlife to improve benefits and equity of distribution from both sectors.
- Lack of data, capacity, infrastructure, and awareness of the community.
- Addressing biodiversity threats to species such as antelope (Hirola and Topi), carnivores (e.g., wild dogs), and primates.

- Restoration of Meru NP involving translocation of animals into the area with potential for introduction of disease.
- Interference with water catchments area around protected areas such as Meru ecosystem and pollution of water sources.
- Improved livestock marketing to address poverty.

Threats

- Limited access to water resources and pollution at the headwaters. Excessive extraction of water. Marine ecosystems exploited (fishing and oil) and presence of settlements and agriculture along rivers a threat to biodiversity.
- Disease threats: rinderpest, PPR, tsetse, tick-borne diseases, CBPP/CCPP, FMD, ECF, *Brucella*, BTB. Still a lack of data on many of these diseases.
- Increased human populations, and decreased livestock (except camels) and wildlife populations. Subsequent land degradation where there is concentration of people associated with bush encroachment due to declining elephant numbers and climate change; therefore, loss of grazing land.
- Refugees and government settlements disrupting local people, threatening land tenure and creating insecurity.
- Livestock movements and translocation of wildlife causing possible threat of disease introduction.

Karamajong Cluster

- Advanced species extinction
- Disease issues: CBPP, CCPP, FMD, rabies, tick-borne diseases, etc.
- Insecurity
- Lack of markets, infrastructure, data and capacity to provide policy direction

Rank 3: Tsavo/Amboseli ecosystem (moved to Group E*)

- Livestock trade, illegal grazing in protected areas, and use of area as a livestock corridor
- Disease threats to wildlife: rinderpest, PPR, anthrax, canine distemper, rabies, others
- Livestock disease threats: FMD, CCPP, intestinal parasites, etc.
- Habitat change
- Bushmeat: public health threat
- Pollution of Galana-Athi River from Nairobi

Cross-Cutting Issues

- Veterinary and livestock production services are poor. Need to improve herd health and nutritional management services to pastoral communities. Need to develop participatory methods.
- There is lack of data on ecosystem health such as epidemiology of diseases, dynamics of the ecosystem in relation to change, vegetation, etc.
- Need to develop livestock marketing/export systems.
- Benefits from livestock through better marketing systems and wildlife through policy change (ownership), equity in benefits sharing
- Livelihood diversification
- Competition for water and forage resources

Proposed Projects

Priority Area: Ewaso Basin (Laikipia – Habaswein)

Project Title: "Ewaso Basin Development Project Through Improved Ecosystem Health"

Note: *An important assumption is that water projects stalled within the government will be reactivated.*

See next page.

Challenge/threat to be addressed and why	Goal/objective	Basic methodology	Lead organizations	Time frame	Estimated budget (US $)	Project champion
Policy and legislation	Reduce burden of current animal health legislation on pastoral systems and refocus Equitable distribution of benefits accrued from wildlife resource with responsibility over the resource	Establish a lobby group Establish a database to achieve policy change	AU-IBAR	3–4 years	$1 million	George Gitau
Livelihood diversification	Improved livelihoods and incomes in pastoralist communities	Encourage community-based wildlife enterprise/use (consumptive and nonconsumptive) Promote sustainable use of natural resources (e.g., honey, gums and resins, medicinal plants)	Private sector/NGOs	Phase I: 3 years	$500,000	Fumi Mizutani
Improve current livelihood strategy	Improved livelihoods and incomes in pastoralist communities	Exploration of new markets/systems (export zones) Adding value to products (processing milk, meat, etc.) Improve wildlife/ livestock/human health (veterinary services, drug availability, community education, etc.) Identify strategic partners to improve banking and micro-finance for communities	AU-IBAR KARI MOLD/KWS NGOs	5 years 3 years 3 years 1 year	$250,000 $250,000 $600,000 $50,000	Richard Kock

Indicators:

1. Support data for required changes presented by lobby group to policymakers in annual updates/briefs
2. a) Awareness about possible wildlife-based enterprise raised in 10 communities over the first year. Monitoring systems introduced at minimally five representative communities on wildlife impact on livestock systems simultaneously and data assessed over a minimum 2-year period.
   b) Viability studies on income diversification from other natural resources carried out within the first two years and best choices/practices introduced to about five selected communities by the end of year three.
3. a) Economic and ecological viability of various marketing outlets such as export zone/slaughter houses/cooling facilities, etc., in the Ewaso Basin assessed within first year (partly on-going).
   b) Strategy to expand existing expertise on processing of livestock products to Ewaso Basin developed within first 6 months. Resources solicited and strategic partners contracted to implement at least three pilot projects at community level before end of year 2. Progress and impacts at household and community level monitored over a minimum of two years.

c) Improve wildlife/livestock/human health (veterinary services, drug availability, and community education, etc.). Awareness campaigns about prevention, diagnosis, and control of common livestock diseases and related public health issues carried out in a minimum of 25 communities within the first year. Veterinary Department staff (Ministry of Livestock Development) and KWS Veterinary Unit augmented through establishment of specialist units to ensure sustainable delivery of veterinary services, drug availability, and community education within 2 years. Collaboration between the veterinary specialist unit and agricultural extension staff fostered to enhance livestock productivity and impact at household level, monitored annually.

d) Establishment of micro-finance schemes through NGOs or CBOs, monitored after 18 months, in a minimum of five communities. Reasons for success or failure assessed and remedial action taken before end of year 3.

Note: A similar project should be implemented for the Tana basin, with a stronger focus on disease transmission and recovery of biodiversity.

WORKING GROUP D

Region: Tanzania, Uganda, Albertine Rift

Prioritized Protected Areas/Complexes

1) Gombe/Bwindi

- Typifies "island" ecosystems in a sea of cultivation and high human density with a hard edge
- Great ape and human health issues foremost

2) Greater Maasailand/Serengeti

- Typifies intact migratory ecosystems in a sea of pastoralists with a generally softer edge for wildlife
- Pastoralist and livestock health linkages with wildlife and wildlife utilization foremost

3) Selous/Mikumi

- Intact ecosystem, large populations of endangered species (rhino, elephants, wild dogs)
- Migration routes
- Health issues: migration and livestock movements
- Giraffe ear disease

Potential areas for project development

- Bwindi/Gombe
- Mahale
- Parc National de Virunga
- Parc de Volcanes

Justification for all: Great ape area, Albertine Rift, high biodiversity, areas with severe threats and encroachment

Greater Maasai Land: (including Serengeti ecosystem, Loliondo, NCAA, Mkomazi, Tarangire, southern Kenya)
Pastoralist areas
Justification: Abundance, intact migratory system, World Heritage, interaction with pastoralists. Large interface between wildlife and livestock and people (zoonotic diseases). Prime example: buffer for rinderpest spread south from remaining foci in Horn of Africa, i.e., sentinel region. History of CBNRM and synergy between these approaches
Karamoja: pastoralist area, unrest

Lake Mburo: FMD focus. Also BTB, brucellosis.

Queen Elizabeth: BTB/FMD situation very different from Kruger, trypanosomiasis, fishing, cobalt mining
Akagera basin, savannah and wetland and transfrontier wildlife migrations

Budongo forest: Not protected, poaching, close to Murchison, rinderpest, game ranching starting

Selous/Mikumi: Miombo migratory routes into southern Africa/ Mozambique. Intact ecosystem. Important populations of rhino, elephants, and wild dogs. Development threats: transport routes. Ear disease in giraffe.

Nyungwe-Rwanda: diversity of primates, Eastern Arc Mountains: biodiversity hotspots, endemic species, high human population pressure, little protection

Issues: General approach to problems

- *Hard Edges:* Valuable isolated patches of high-value land/cultivation and human density "sea," unfenced (compared with areas of southern Africa)
- Gombe and Bwindi typifies problems of this issue faced by Virungas, Budongo
  - Great apes
  - Agriculture/alternative land uses
- *Soft Edge* (Hard Edges too): Functioning (migratory) ecosystems; hosts are vectors and sentinels. Sea of pastoralists.
  - Greater Maasailand/Serengeti, Selous
- Human health issues? Cross-cutting

How to set priorities? Ecotourism value, exceptional natural resource, but debate relative merits
Picking representative areas of general problems
Islands

"Votes"

Gombe 7
Bwindi 7
Virungas 5
Eastern Arc 2
N Crater 1

Migratory/intact ecosystems

Maasailand/Serengeti Ecosystem 13
Selous/Mikumi 7
Akagera/Lake Mburo 6
Bwindi 1

Challenges and Threats

Rank 1: Bwindi/Gombe

1. Lack of knowledge and capacity
Intervention
Prevention, particularly in wildlife sector health issues
Poor diagnostic services
Lack of employment for trained wildlife disease personnel

2. Public health issues
Poor services
Impact of HIV on society
Zoonoses and anthropozoonoses
Lack of health knowledge for communities
Lack of sanitation
Refugee issues; societal disruption, poverty, lack of ownership of resources
Different cultural attitudes
Tourist health

3. Land use and hard edges
Human/wildlife conflicts, crop raiding, human attacks
Fragmentation

4. Small population problems
Inbreeding
Fragmentation
Primate health and impact of disease

5. Wildlife utilization
Primate consumption (particularly refugees) ???

Bycatch from snaring
Rehab of confiscated animals from illegal trade (chimps, gorillas)
Trading route for international trade

6. Political awareness of issues

Rank 2: Maasailand/Serengeti

1. Wildlife/domestic animals- contact in and outside protected areas
Crop damage
Livestock predation
Blockage of migration routes and wildlife movements

2. Link between human poverty and public health and impact on wildlife (through low livestock numbers and demand for bushmeat)
Human disease zoonoses particularly for pastoralist communities, e.g., BTB, brucellosis; reservoirs

3. Land use conflicts
Habitat degradation by livestock overgrazing and tree felling leading to poor habitat for wildlife
Agricultural encroachment

4. Lack of capacity/knowledge
Lack of epidemiological knowledge
Lack of public awareness of health/conservation
Lack of coordination between responsible agencies (protected area management, other governmental organizations, agriculture, health agencies, NGOs; e.g., rangeland, conservation agencies)
Lack of transboundary communication
Lack of capacity to implement management actions (skill sets, equipment, staffing levels)

5. Other issues
Small populations problems, e.g., rhino (inbreeding)
Human disturbance
Intensification/restriction of movements of livestock and wildlife leading to increased parasite loads
Cattle trading movements poorly understood
Coordination of carnivore health programs within ecosystem, including transboundary
Public health
Incorporation of health issues into wildlife management area
Evaluate potential areas where hard edge needs to be defined
Infrastructure and equipment needs (local and regional level)

6. Political awareness
Regional, national, local government
Protected area managers

Rank 3: Selous/Mikumi

Lack of knowledge of issues

Giraffe ear
Lack of capacity
Encroachment across border with Niassa
Cattle trading route to southern Tanzania
Sleeping sickness in people in southern area: periodic outbreaks, wildlife reservoir? (issue of link with Akagera and Bwindi)
Human predation by carnivores (lions, crocodiles)

Proposed Projects

Project Title: **"Linking Human and Great Ape Health to Improve Conservation Effectiveness and Human Health and Livelihoods"**

Objectives:

1. **To improve public health of communities that are in contact with great ape protected areas "human health for wildlife health"**

   Primary health education including HIV prevention
   Identify and prioritize gaps and limiting factors for implementation (e.g., infrastructure, transport)
   Improve capacity to carry out recommendations
   Improve intersectoral collaboration at all levels

   Champions:
   Uganda: Conservation Through Public Health **(**CTPH) (Gladys), (Mountain Gorilla Veterinary Project) (MGVP) (Innocent)
   Tanzania: TANAPA (Titus), Jane Goodall Institute (JGI) (Anne Pusey)

   Key Players/Partners:
   Uganda: Uganda Wildlife Authority (UWA), Ministry of Health, Ministry of Agriculture, Animal Industry and Fisheries (MAAIF), district local governments, IGCP, health NGOs, National TB and Leprosy Program, universities, Healthnet Uganda, Uganda LIRI (Tororo), Uganda Virus Institute, CARE , PACE, Mgahinga and Bwindi Forest Conservation Trust (MBIFCT), Mountain Gorilla Conservation Fund
   Tanzania: TANAPA, Tanzania Wildlife Research Institute (TAWIRI), Ministry of Health, JGI, Japanese, Frankfurt Zoological Society (FZS) (EU project), University of Dar es Salaam, Lake Tanganyika Catchment Reforestation and Education program (TACARE) (reproductive and gender issues), United Nations High Commissioner for Refugees (UNHCR), PACE

   Methodology:
   CTPH and Uganda partners to link with JGI
   Workshop to scope project
   Identification of messaging systems for public health education
   Effective tools for messaging
   (Messaging methods from Winne Msoni at Dept of Women & Gender Studies, Makerere University). Baseline surveys of households and mapping (GPS) and attitudes and knowledge, household social and demographic characteristics, divide into different media (e.g., schools, radio, pamphlets, house-to-house), PRA and questionnaire methodology

2. **To improve occupational health of protected area and research staff**

   Champion: Innocent/MGVP

   Key Players/Partners:
   Uganda: CTPH, UWA, MGVP, International Gorilla Conservation Program (IGCP)
   Tanzania: JGI, TANAPA

   Methodology:
   Use MGVP model from Rwanda and apply to Tanzania, Uganda, and Congo
   Formalize agreement with UWA and Ministry of Health
   Budget: $100,000 set up, then annual costs
   Potential donors: Morris Animal Foundation (MAF), USAID (local mission level), IGCP, JGI, DFG Fund, FFPS, Drug companies (Glaxo)
   Lynne Gaffikin EARTH
   Timeframe: 6–12 months to begin

3. **To improve political awareness of policy/decisionmakers of public health issues in great ape conservation, including health services as a possible method to encourage settlement at an appropriate distance from park areas**

   Champions: Billy Karesh, Titus Mlengeya

Methodology: Collect information, field visits

Budget: US $15,000 per country

1. Initially: DG of TANAPA/ED of UWA and FD and TAWIRI Chairman of Board of Trustees, Anne Pusey (JGI rep)
2. Minister Natural Resource and Health and appropriate PS, US and Japanese ambassadors, EU delegation, Regional Commissioner, MPs, journalist, Japanese researchers (Nishida, Mike Hoffman)

Flying tour
Timeframe:
First trip: March 2004 for initial DG trip
Second trip: June–Oct 2004

4a. To improve communication between field managers

Methodology:
Set up Great Ape Health Alliance. Meet regularly (annually). Potential funding sources: zoos, Lincoln Park, MAF, JGI, Leipzig (Max Planck Institute), Great Apes Survival Project (GRASP)
Set up email network of great ape health specialists
Improve infrastructure to enable this in field, phone and email links, computer, power
To lay out lines of communication with responsible agencies for field managers

Key Players/Partners:
Titus, Gladys, Innocent, IGCP, Japanese, JGI, Mahale, CPWs UWA/TANAPA

Budget: Annual meeting: US $20,000

Infrastructure:
Total $18,000 first year, $6000 per area then $2500 annually (Mahale OK)

4b. To create database of great ape health and make it available to field managers

Timeline; contact next week, finish 6 months
Budget: US $2000 for photocopying and mailing
Champions: Innocent, Gladys, Titus
Implementers: Ask Elizabeth Lonsdorf if someone has done it; Anne Pusey
Investigate whether Wildlife Information Network would do this for great apes; budget

5. Improve surveillance and diagnosis of disease problems

Improving capacity of organisations $20,000 per site
Improving diagnostic facilities and routes ($3,000 per site)
Equipment and infrastructure **(**fridge, test kits [$20,000 per site])
Funding of new position and training costs of primate veterinarian for Tanzania

Champions: CTPH, MGVP, JGI
Partners: UWA, TANAPA, IGCP
Budget: US $175,000

6. Include health program in current and future Protected Area Management Plans

Mahale	Karen/Titus
Gombe	Titus, JGI, Billy=IUCN/VSG or WCS
Virungas	Karen (Congo)
Budongo	Gladys**,** UWA

***Goal*: Linking human and great ape health to improve conservation effectiveness and human health and livelihoods.**

See next page.

Challenge/threat to be addressed and why	Goal/objective	Basic methodology	Lead organizations	Initial time frame	Estimated budget (US$)	Project champion(s)
Inadequate health of park staff and researchers with closest contact to great apes	To set up an occupational health service for park staff and researchers in Bwindi, Gombe and other great ape protected areas	Carry out regular testing and treating of zoonotic diseases, and vaccinations	MGVP, CTPH, UWA, MOH, TANAPA, JGI, IGCP	1 year	$100,000	Innocent, Gladys, Titus, Anne Pusey
Limited understanding of the negative effects of zoonotic disease transmission at the interface of great ape protected areas on wildlife conservation, public health, and ecotourism	To improve public awareness of interrelated conservation and public health issues in communities in and around Bwindi, Gombe, and other great ape protected areas	Test the most effective method for public health awareness over 1 year and implement this over 5 years	CTPH, UWA, MOH, MAAIF, MGCF, IGCP, JGI, TANAPA	Phase 1: 1 year Phase 2: 5 years	Phase 1: $80,000 Phase 2: $1,000,000	Gladys, Titus
Poor public health of communities in contact with great ape conservation areas	To develop a regional action plan for integrating human public health and wildlife conservation	Conduct a regional workshop in Tanzania, building on previous efforts in Uganda (strengthening linkages between public health and conservation around BMCA - CTPH strategic planning and stakeholders consultation workshop)	TANAPA, CTPH, JGI, MGVP, IGCP, UWA	6 months	$25,000	Gladys, Titus
Lack of effective communication between field managers at great ape locations	To improve communication between field managers	Set up a Great Ape Health Alliance with regular meetings, email network, and a database	MGVP, CTPH, JGI, TANAPA, UWA, MGCF, IGCP	6 months	Annual meeting: $20,000 Infrastructure: Total: $18,000 Year 1: $6000 per area, then $2500 annually (Mahale ok) Database: $2000	Innocent, Gladys, Titus
Lack of capacity and resources to carry out effective health monitoring of great apes	To improve surveillance and diagnosis of disease problems	Train field staff (vets, rangers, trackers) and set up system for efficient diagnosis including facilities	CTPH, MGVP, JGI, TANAPA, UWA, IGCP, MAAIF	1–2 years	$175,000	Gladys, Titus, Innocent
Inadequate political awareness of the need for improved health services of people in and around great ape conservation areas	To improve political awareness of policy/decision makers of public health issues in great ape conservation, including health services	Collect information and conduct field visits with top politicians in the country	WCS, TANAPA, JGI, UWA, MOH, MAAIF, CTPH, MGVP, IGCP, MGCF, Minister Natural Resource and Health and appropriate PS, US and Japanese ambassadors, EU delegation, Regional Commissioner, MPs, journalists, Japanese researchers (Nishida, Mike Hoffman)	9 months	$30,000 for both countries	Billy, Titus

WORKING GROUP E[1]

Region: Tanzania

Prioritized Protected Areas/Complexes

1) **Greater Maasailand inclusive of Serengeti**
2) **Tsavo, Amboseli**
3) **Selous-Niassa-W. Tanzania**

Challenges and Threats

Rank 1: Greater Maasailand

- Lack of capacity/skills for wildlife/livestock/human health:
  a. delivery of health services
  b. diagnostic capacity
  c. logistic constraints
- Lack of epidemiological knowledge in terms of:
  a. wildlife
  b. livestock
  c. people and their interactions at the interface
- Political awareness:
  a. need for increased awareness of pastoral issues at the policy level
  b. need for intersectoral collaboration integrating medical, veterinary, and wildlife sectors

Proposed Projects

Project Title: "Evaluating Disease Status and Health Needs of Wildlife, Livestock and Pastoral People in Greater Maasailand"

Why?

Pastoral areas in Greater Maasailand are of highest conservation importance and economic potential in Tanzania and Kenya. They are World Heritage sites and the largest surviving intact migratory systems. These areas comprise pastoral communities that depend on the integrity of the systems for survival. Land subdivisions are identified as a major threat in Kenya to the integrity of these systems.

- Improvement of pastoral livelihoods required for co-existence
- Increasing levels of poverty and malnutrition among pastoralists
- Increasing demands for other forms of land use
- Increased bushmeat consumption
- Disease issues identified as major constraint to pastoral livelihoods

How?

- Improvement in veterinary health care
- Improved knowledge of epidemiology of key diseases at the interface
- Enhanced technical and community capacity for addressing interface disease problems
- Development of mechanisms for intersectoral collaboration

Phase 1: **Status Evaluation**

- Consultation and stakeholder analysis
- Identification of priorities

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[1]Working Group E was formed from Working Group C.

- Collating existing information, including research studies; identify biological data banks available for analysis
- Identify existing community-based animal health projects in region

Time frame: 2 years
Budget for Status Evaluation phase: US $50,000–$100,000
Indicators:

Priority list of disease threats in the region (from perspective of pastoralist communities, wildlife managers, Ministries of Livestock Development and Health)

Epidemiological data on infections/diseases of livestock, wildlife and people, seroprevalence data as a result of analysis of existing serum banks

Database of existing community-based animal health projects

Beyond Phase 1:

Component I: **Enhancing intersectoral integration**

- To promote awareness of pastoral/wildlife disease issues at policy level
- To facilitate mechanisms for bilateral institutional collaborations (including medical, veterinary, and wildlife sector), e.g., within framework of East African Cooperation
- To develop consultation forum between communities and policymakers (e.g., integration with wildlife forum – Kenya)

Time frame: 2 years
Budget: US $80,000
Indicators:

For example, agreed-on policies on pastoral health issues, cross-border harmonization of animal health policies

Component II: **Integrating epidemiological research with improved animal health services**

A. Identify and implement strategies for improved delivery of veterinary care for diseases with known impact e.g. tick-borne diseases (exact strategy will depend on legal framework existing within countries, East African Community [EAC])

Time frame: 2–3 years
Budget: US $150,000

B. Evaluation of these delivery systems

Time frame: 2–3 years
Budget: US $50,000

C. Epidemiological investigation of selected key diseases that are less well understood

- Quantify the impact on different populations
- Identify the role of wildlife in disease epidemiology of zoonotic infections (e.g., brucellosis, BTB, anthrax)
- Identify appropriate control strategies to limit impacts on livestock, wildlife, and human health

Indicators:

Implementation of disease control strategies

Improvements in livestock production and human health (e.g., incidence of specific diseases)

Time frame: 3–5 years
Budget: US $500,000–1 million? Depends on how many diseases are investigated. Would probably need to include cross-sectional and longitudinal studies, and involve human, wildlife, and livestock populations

Lead: Pete Morkel (Tanzania)?
Kenya?

Partners: Ngorongoro Conservation Area Authority (NCAA), TAWIRI, TANAPA, Tanzania's Naval Institute of Medical Research (NIMR), Ministry of Water and Livestock Development, Ministry of Health, AU-IBAR, PACE, KWS, Kenya Agricultural Research Institute (KARI), Kenya Medical Research Institute (KEMRI), University of Nairobi, Mara Conservancy, Trans-Mara Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) project, AWF, Sokoine University of Agriculture, NGOs (e.g., VetAid), Maasai Preservation Trust

Project Title: "Maintaining Savanna Ecosystem Integrity for Sustainable Livelihoods"

Threat: Unsustainable levels of wildlife utilization through illegal bushmeat hunting in the Serengeti-Mara and Tsavo-Mkomazi ecosystems

Conservation and development importance:

Justification as above

Serengeti: Illegal off-take of approximately 100,000–200,000 large ungulates per year

- Major threat to resident herbivores
- Migrants more resilient BUT very dependent on rainfall (levels not sustainable if rainfall low)
- Bushmeat hunting is carried out by the poorest members of the community with lowest livestock ownership
- Infectious diseases are a major constraint to livestock production
- Bushmeat hunting is a high-risk activity

Hypothesis to be tested:
Improving access to dietary protein and cash income through provision of animal health care will reduce the demand for illegal game hunting.

Project Proposal:
Evaluate impact of improving animal health services by comparing:

- income and diet of rural poor
- levels of bushmeat hunting
- incidence of food-borne zoonoses
- land-use practices in areas with and without improved veterinary services

Methodology:
Identify appropriate strategy for trial/evaluation (e.g., Newcastle disease vaccination, anthelminthic treatment of small ruminants, anti-predator strategies for poultry)
Select treatment and control villages
Compare pre- and post-intervention diet, income, land-use practices, incidence of food-borne zoonoses in treatment and control villages
Compare village origins of hunters before and after intervention
Leads: Titus Mlengeya, Robert Fyumagwa, Elizabeth Muthiani
Timeframe: 3 years
Budget: US $300,000
Partners: TANAPA, TAWIRI, Tanzania Wildlife Division, KWS, KARI, Regional and Local Governments, Maasai Preservation Trust, TRAFFIC, NCAA, NIMR, Ministry of Water and Livestock Development, KEMRI

WORKING GROUP F

Region: Zambia, Mozambique, and Malawi

Prioritized Protected Areas/Complexes

1) **Kafue Flats and Upland**
2) **Great Limpopo Transfrontier Conservation Area**
3) **Zambia/Malawi/Mozambique "Triangle"**
4) **Liuwa (Zambia/Angola)**

Challenges and Threats

Priority Areas (General)

- Need a relationship between the producers and government agencies (forum)
- Need inter-ministerial relationship, sharing of knowledge, best practices and lessons learned
- Anticipate problems to have adequate disaster prevention and management
- Need to identify experts and individuals with interest and passion for both wildlife and livestock
- Need ecosystem and problem-based research

Rank 1: Kafue Flats and Uplands

(Lessons from 10 years)

- Lack of stakeholder organisation and hence lack of communication
- Early warning
- Stakeholder coordination could have raised the funds required to undertake disease prevention. Expertise was there to handle the problem.

- Veterinary Services under the Ministry of Agriculture, Zambia Wildlife Authority (ZAWA) under Tourism, and Police Services under Ministry of Home Affairs, but no forum to coordinate government agencies.
- Lack of markets contributing to disease problem
- Proposal in Ministry of Agriculture to establish an abattoir in Monze. Meat sold in Lusaka and Copper Belt comes from Southern Province, but no value added to local economy, as animals are sold live in these areas. An abattoir is needed to prevent movement of live animals to these areas to reduce disease transmission to these areas. An abattoir would give local people the opportunity to sell their produce directly to the abattoir, cutting out the middlemen and hence increasing income.
- Abattoir can be revived if the three stakeholders as per above (i.e., Police Services, Veterinary Services, and ZAWA) come together.
- Applied research in livestock sector is there, but lacking at the wildlife/livestock interface, hence there are unsubstantiated accusations of wildlife as the reservoir of diseases. The only research in wildlife is fragmented and serves agricultural/ veterinary interests. Work needs to be in the context of the ecosystem to meet the conservation objectives such as community needs, through wildlife-based income enterprises, the revenue of which could be ploughed into veterinary services in the area.
- Need to evaluate community perception to develop relevant responses.
- Direct benefits from wildlife use are once a year and marginal at individual level; therefore, there is a need to have additional alternative sources from other activities such as cattle rearing.
- Local knowledge is important in disease control. For example, cattle that go the flats acquire ticks either on the way to or from the flats and not at the flats.
- Cattle from upland move to watering points used by wildlife. Communities snare around these water points.
- Need alternative watering points to reduce disease transmission and conflicts
- Tick control strategies – burning. Need to understand tick biology and dynamics.
- Dipping versus burning
- Need tick control and not eradication to maintain the tick-host balance and avoid completely naïve animals that would immediately succumb to the new tick infestation.
- Need integrated approach that would combine dipping with immunization
- In livestock/wildlife interface will continue to be there.
- Coordination should not be led by government but by the producers. Need an agreement for bureaucrats to delegate some of their responsibilities.

Rank 2: Great Limpopo Transfrontier Conservation Area (also see Working Group A's notes)

- Dominance by South Africa
- Kruger: a source of diseases such as BTB, FMD, etc.
- Mozambique: Lost livestock and wildlife during war, hence need to repopulate
- Main rural economic activity is livestock
- Marromeu Gorongoza Complex
- Many tourism concessions
- Lack of in-depth risk analysis before setting up the TFCA. For example, BTB in Kruger could be exported to a new area where there is no capacity to deal with it
- Veterinary issues have never been given priority during formulation of TFCA
- Veterinary department in Mozambique weak and concentrated on building livestock populations, hence paid little attention to wildlife issues including the TFCA
- No practical solution as of yet to BTB issue on both sides (South Africa and Mozambique).
- Problem of ecologists' dominance over veterinary advice. For example, BTB problem was first detected in 1990, but ecologists dismissed the issue until it became a serious conservation problem. Only then were veterinarians called on to provide a solution.
- Disease (BTB) may threaten the TFCA concept
- In areas around the TFCA on the Mozambique side, BTB and anthrax were reported during the war. No outbreak of FMD in the last 10 years. Still have evidence of BTB in cattle.
- BTB-infected lions may prefer to kill livestock as they do not have enough energy to hunt.

Rank 3: Zambia-Malawi-Mozambique Triangle

- High poverty levels leading to conflicts with wildlife
- Appropriately targeted control of diseases that impact development in local communities (ongoing interventions)
  1. Tsetse and trypanosomiasis
  2. African swine fever

3. Relationship between livestock and wildlife authorities:
   a) Potential model
   b) Proactive vs. reactive
   c) Sleeping sickness: creating a balance for livestock/wildlife leads to fear that eradication of tsetse will lead to increased wildlife poaching
   d) Community needs to directly benefit from wildlife resource (holistic approach vs. sectoral)
   e) Need to justify why we still need to keep out agricultural expansion from wildlife areas and show that the productivity of these areas will benefit the local communities
   f) Links between livelihoods and conservation (balance, institutional boundaries and biases down, incentives, advocacy, monitoring and evidence, enforcement capacity, policy)
   g) Designate conservation livelihood areas in the triangle

Wildlife	Livestock
■ Not seen as viable alternative ■ Applied production skills for producers (harvesting technology and processing, better local protection from outsiders, better land use, marketing, monitoring numbers, counting) ■ Lack of incentives to the wildlife producer ■ Private sector dominance ■ Entrepreneurship skills ■ Access investment opportunity and tourism capacity ■ South Africa dominance ■ Ownership ■ Institutional inertia	■ Institutional bias ■ Professional arrogance ■ Change vet perception of wildlife ■ Applied production skills for producers (husbandry, disease control, etc.) ■ Markets – Diseases (FMD, ASF, etc)

- Existing programs are there to reduce poverty (in Zambia) but are uncoordinated
  1. What lessons can be learned by other two members if possible?
     a) Not donor driven
     b) Sense of ownership-producer driven
     c) Creation of ltd. company
     d) Shareholders-local communities
     e) Community proactive in minimizing threats on resource base
  2. Result has been increased community enthusiasm
- Ensuring of markets for the farmers
- Little work in Malawi related to parks conservation by communities leaving near the park, but there are programs targeted at poverty reduction aimed at reducing deforestation and addressing the ravages of HIV/AIDS on rural communities.
- Conservation farming and product labeling to increase household food security and incomes.
  1. Improved productivity in both livestock and wildlife sector
  2. Improve synergies between sectors, respective values in wildlife and livestock
     a) Include harmonious relationship
  3. Legal and economic incentives exist to develop households as producers of wildlife and non wildlife products
  4. Increased commitment to conserve natural resources at household level
     a) Sensitization/education
     b) Capacity/skills/training

How do we get to points above?
Productivity

1. Markets and skills drive productivity
2. Zambian model demonstrates result for productivity and conservation
3. Extension services at community level
   a) Animal health
   b) Animal husbandry
   c) Ongoing
   d) Training of trainers
4. Capacity building

Proposed Projects

Priority Area: Zambia-Malawi-Mozambique Triangle

Project Title: "Improved Wildlife and Livestock Productivity through Market Synergies"

Challenge/threat to be addressed and why	Goal/objective	Basic methodology	Lead organizations	Time frame	Estimated budget (US$)	Project champion
High poverty levels impacting on natural resources Human/wildlife conflicts Lack of effective disease control Tsetse and trypanosomiasis ASF FMD TBD Rabies and distemper Coordination of lessons learned and existing programs Improve markets	**Improve productivity in both livestock and wildlife** Improve synergies between sectors, particularly wildlife and livestock husbandry Develop legal and economic incentives for households as producers of wildlife and non wildlife products Increase commitment to conserve natural resources at the household level	Review the effectiveness of the Zambian trading hub with a view to making it a regional trading model as a way to sustain productivity in both livestock and wildlife and better land management As appropriate, implement recommendations from activity 1 above Establish/improve extension services in an integrated fashion: a. Veterinary b. Crop c. Wildlife d. Animal husbandry e. Human health Mobilize and support community producer Undertake market feasibility studies for alternative products and potential technologies as required	WCS, others not yet determined	3 years	$2 million	Dale Lewis

Indicators:

- Functional regional market networks in place
- Functional extension services in place
- Viable and sustainable producer groups in place
- Report on alternative markets and production technologies available
- Reduced incidence of diseases especially in livestock and people

Priority Area: Kafue Ecosystem

Project Title: "Kafue Integrated Livestock-Wildlife Management System"

Challenge/threat to be addressed and why	Goal/objective	Basic methodology	Lead organizations	Time frame	Estimated budget (US$)	Project champion
Lack of stakeholder collaboration to sustain livestock services Lack of adequate research at wildlife/livestock interface in context of the ecosystem and conservation goals Adverse attitudes towards wildlife and livestock problems by communities and other stakeholders Inaccessibility of markets due to livestock diseases Poor market development for producer groups	**Integrated approach to animal (livestock and wildlife) production and disease control**	Create a stakeholder forum for effective collaboration Undertake basic and applied research to enhance stakeholder animal husbandry practices in the context of the ecosystem Establish early veterinary warning systems Undertake effective epidemiosurveillance in wildlife and livestock Develop a sustainable animal health delivery system	ZAWA Veterinary Dept	2 years	$1 million	Victor Siamudaala

Indicators:

- Stakeholder forum created
- Data on wildlife and livestock diseases available
- Strategies for animal husbandry practices developed
- Effective and functional intersectoral epidemiosurveillance network in place
- Effective and functional community-based animal health delivery system in place

Postscript: *AHEAD* cross-cutting issues that could be further addressed

- Standards for disease-testing/quarantine for various taxa before and after translocations in southern and East Africa
- Vaccines to address the multiple FMD topotypes issue flagged by several speakers and working groups

Biosketches of *AHEAD* Launch Invited Participants

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Dr. Roy Bengis graduated from the University of Pretoria, Onderstepoort in 1971 with a B.V.Sc. degree and interned at the University of Pennsylvania in 1972–1973. He holds an M.Sc. in physiology and pharmacology (1975) and a Ph.D. in physiology from the University of Mississippi (1978). Dr. Bengis was a consultant for the Jackson Zoo in Mississippi. He is currently the Chief State Veterinarian of Kruger National Park, where he has worked since 1978. Dr. Bengis is an author or co-author of 72 scientific publications and is Africa's representative on the Office International des Épizooties (OIE) Working Group on Wildlife Diseases. He is an external examiner in wildlife medicine at the University of Pretoria and Chairperson of the Wildlife Disease Advisory Group and the Buffalo Committee of the National Directorate of Veterinary Services. Dr. Bengis's fields of interest are wildlife disease epidemiology, infectious disease risk assessment related to translocations, wildlife/domestic livestock interface issues, and chemical immobilization of free-ranging animals. His hobbies include reading, fly-fishing, fly-tying, snorkeling, target and wing shooting, herpetology, and bird watching.

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Dr. Philippe Chardonnet spent the last 20 years working for the Centre de coopération internationale en recherche agronomique pour le développement (CIRAD), being posted in a number of countries in Africa, Asia, the South Pacific, and South America. He works in developing countries and deals with different, although related, fields of activity including rural development, wildlife management, and wildlife/human interactions. In 2001, he joined a Paris-based NGO that is active in wildlife conservation worldwide, the International Foundation for the Conservation of Wildlife.

He has been active in numerous areas (not necessarily in order of importance): 1) deer farming and ranching under tropical conditions; 2) rinderpest epidemiology in African wildlife; 3) training of wildlife veterinarians and wildlife rangers in Africa and Asia; 4) game meat production and game ranching on communal land in Zimbabwe; 5) sustainable use of bushmeat in central Africa; 6) development of livestock production in Guinea-Bissau, Rwanda, Burundi, and Ethiopia under emergency and postemergency situations; 7) resolution of human/wildlife conflict in several countries such as Brazil (jaguar and puma) and Zimbabwe (elephant); 8) rescue operations, re-endangered taxa such as marsh deer (Brazil), kulan (Turkmenistan), northern black rhinoceros (Cameroon), Mesopotamian fallow deer (Iran), and birds endemic to South Pacific islands (New Caledonia); 9) improving sustainability of hunting by local communities in central Africa, Brazilian Amazonia, and New Caledonia; 10) designing new schemes of wildlife management within and outside of protected areas.

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Dr. Sarah Cleaveland is a veterinary epidemiologist based at the Centre for Tropical Veterinary Medicine, University of Edinburgh, UK. Over the past 12 years, her research work has been centred in northern Tanzania, focusing on the epidemiology of infectious diseases at the human/wildlife/domestic animal interface, including rabies, canine distemper, bovine tuberculosis, brucellosis, and echinococcosis. Key objectives of her research programme have been to improve our understanding of the dynamics of infectious diseases in complex, multihost communities, to identify risk factors for disease emergence in human and animal populations, to quantify the true burden of disease in human and livestock populations, and to optimise the design of zoonotic disease control strategies.

Rabies has been a principal interest for many years, triggered initially by concerns about disease threats to African wild dogs in the Serengeti but now resulting in wider involvement in rabies control throughout Africa and Asia. The complementary aims of several current research projects are to provide information necessary for the development of

large-scale rabies control programmes in sub-Saharan Africa that will benefit both public health and wildlife conservation.

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Professor Koos Coetzer is currently Professor and Head of the Department of Veterinary Tropical Diseases, Faculty of Veterinary Science at the University of Pretoria as well as a part-time Professor in Tropical Veterinary Medicine at Utrecht University, the Netherlands, supporting collaborative research and postgraduate training between the two faculties. Some of Professor Coetzer's honors include the Research Award of the South African Veterinary Association for outstanding research published in scientific journals (1982); the Bill Venter Literary Award (1997); the Gold Medal of the South African Veterinary Association in recognition for outstanding scientific achievements and promotion of veterinary science (1997); the Malbrant-Feunten Award of the French Veterinary Academy (1998); and the International Award from the Faculty of Veterinary Science, Spain, for the production of a high-quality video on Rift Valley fever (1998).

Professor Coetzer holds a B.V.Sc. (1973), B.V.Sc. Honours (1980), and an M.Med.Vet. (Path) degree from the University of Pretoria.

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Robert A. Cook, V.M.D., M.P.A., is an Adjunct Professor of Environmental Affairs at Columbia University in New York City and the Chief Veterinarian and Vice President of the Wildlife Health Sciences (WHS) Division of the Wildlife Conservation Society (WCS). He has 20+ years of experience in zoo and wildlife medicine and has served in his present capacity as Chief Veterinarian for the last 13 years. It was under Dr. Cook's guidance that the Field Veterinary Program was established in 1989 as the first global effort to support the health and conservation of wildlife populations in native habitats. The WHS programs in clinical care, pathology, and field veterinary medicine are responsible for the health of over 23,000 animals in five New York facilities including the Wildlife Centers in Central Park, Queens, and Prospect Park; the New York Aquarium; and the Bronx Zoo. The WHS Division also oversees the health-related programs at the WCS Wildlife Survival Center on St. Catherines Island, Georgia. With the Field Veterinary Program taking the lead, WHS is deeply involved in the health aspects of the Wildlife Conservation Society's international conservation programmes, providing services and research to a number of the 300 WCS projects in 53 nations.

Dr. Cook graduated from the University of Pennsylvania School of Veterinary Medicine in 1980 and pursued a career in zoo and wildlife medicine thereafter. Recently he fulfilled his desire to have a more global impact on wildlife health issues by returning to school to receive his Masters in Public Administration from Columbia University in 2002. With his background in both wildlife health and associated global policy issues, he accepted an adjunct teaching position at Columbia University in its School of International and Public Affairs.

Dr. Cook is Chair of the Animal Health Committee of the American Zoo and Aquarium Association (AZA) as well as Chair of the Captive Wildlife and Alternative Livestock Committee of the U.S. Animal Health Association. He is a past President of the American Association of Zoo Veterinarians. Dr. Cook also has a long-standing interest in pain amelioration and is a scientific advisor to the Mayday Fund. In addition, he serves as a scientific advisor to the Morris Animal Foundation and as a member of the Conservation Endowment Fund Committee of the AZA.

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Dr. David Cumming has been working in wildlife research and conservation in Zimbabwe and southern Africa since the 1960s. He graduated in Zoology and Entomology from Rhodes University in South Africa, started work in fisheries research but soon joined Zimbabwe's Department of National Parks and Wildlife Management in 1964. After 12 years at the Sengwa Wildlife Research Institute in Chirisa (where he did his doctoral research on warthog ecology), he became Chief Ecologist and headed the Branch of Terrestrial Ecology. In 1988, he retired early as Deputy Director of National Parks to set up the WWF Multispecies Animal Production Systems Project. This grew into the WWF Southern African Regional Program, where he was Program Director until early 2001 when he became an independent consultant and a research associate in the Tropical Resource Ecology Programme (TREP) at the University of Zimbabwe. Dr. Cumming's main current research interests are in ecology and management of large mammalian herbivores, the influence of land-use policy and practice on biodiversity and resilience in social-ecological systems, and the conservation and management of elephants. Invertebrates remain an abiding interest and he works with his wife, Meg, on termites and spiders.

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Rod de Vletter, a Swaziland citizen, is a tourism and environment specialist who has worked for the World Bank since 1993. He is the owner of two nature reserves and an ecotourism lodge in Swaziland and is the founder of Swaziland's environmental NGO, Yonge Nawe. He is one of the originators of the Transfrontier Conservation Area (TFCA) Initiative and has been working on coastal zone management, biodiversity and tourism corridors, and tourism and conservation policy and programme development. His working experience covers Mozambique, Zimbabwe, Swaziland, Malawi, and Uganda. Recently, Mr. de Vletter has been working with the International Finance Corporation to design the South East Africa Tourism Investment Program (SEATIP) and with the Government of Mozambique to design its Sustainable Tourism and Conservation Program.

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Raoul du Toit is a Zimbabwean. He commenced his professional career in the field of environmental impact assessment (EIA), having undertaken postgraduate training at the University of Cape Town. He has been particularly involved in EIAs of large hydroelectric schemes on the Zambezi and Cunene Rivers. He diverted into rhino conservation work through his appointment in 1985 as Scientific Officer for the IUCN African Elephant and Rhino Specialist Group. For 3 years, he coordinated the conservation efforts of this group within Africa. In 1988, Mr. du Toit developed a WWF project to survey the status of black rhinos in the Zambezi Valley and since then has worked as a Project Executant with WWF. In 1990, he was seconded to the Zimbabwean Department of National Parks and Wildlife Management, where he worked for seven years to initiate and implement the Rhino Conservancy Project in Zimbabwe. This entailed establishing viable rhino breeding groups in semiarid areas of Zimbabwe, amalgamating game ranches into large conservancies to provide adequate habitat, setting up protection and monitoring systems, and helping to deal with the ongoing economic and political challenges to these private sector projects. He also helped to establish the regional rhino conservation programme of the Southern African Development Community and is involved in this programme as a technical adviser on rhino projects in several countries.

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Susie Ellis, Ph.D., is the Vice President for Conservation International's (CI) Indonesia and Philippines programmes, working out of Washington, DC. She oversees management and programme development, as well as the scientific integrity of field projects. Dr. Ellis also raises funds and increases awareness of the urgent biodiversity crisis currently facing both countries. Well known in the international conservation community, she has worked in more than 25 countries and has written more than 80 technical papers, proceedings, and book chapters.

Prior to joining CI, Dr. Ellis spent 10 years working for the IUCN Conservation Breeding Specialist Group, facilitating more than 100 collaborative biodiversity/species conservation and strategic planning workshops and securing the operation of the expert group. With David Wildt, Dr. Ellis co-led a 5-year collaborative interdisciplinary program for giant panda conservation in China that has enhanced collaboration among agencies responsible for their conservation, as well as among U.S.-based partners. She has also worked extensively with the Cheetah Conservation Fund (Namibia) to facilitate its long-range organizational and scientific strategic planning, which has resulted in funding for facility expansion and the organization's scientific direction.

Dr. Ellis is well known in the zoological community and has worked for the Minnesota Zoo, Lincoln Park Zoo (Chicago), San Diego Zoo, and Sea World, Inc. (San Diego), and as a consultant for the Aquarium of the Pacific (Long Beach).

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With broad experience with African, Middle Eastern, and Asian wildlife, Dr. Flamand has worked as a wildlife veterinarian in South Africa in Kruger National Park and on the Natal Parks Board. He was Director of both the National Wildlife Research Centre (Taif) and King Khalid Wildlife Research Centre (Riyadh), Saudi Arabia. Dr. Flamand was Veterinary Adviser to the Department of National Parks and Wildlife Conservation in Royal Chitwan National Park, Nepal.

His interests and the majority of his life's work entails wild animal captures; wild animals' adaptation to captivity, holding, and transportation; reintroductions and parasitism of game species, together with the interaction and the disease implications of game animals mixing with domestic stock; game ranching; and wildlife veterinary ecology. The genetics of small populations and the implications thereof, especially in the rhinoceros and lion, have been major subjects of his study. In Saudi Arabia, Dr. Flamand developed a protocol for the eradication of tuberculosis in a captive breeding herd of Arabian oryx held at Taif, the first such attempt in a wild ungulate anywhere in the world. His most recent posting in Chitwan was to establish a veterinary programme designed to address the veterinary concerns of both the wildlife and surrounding domestic livestock.

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Dr. Chris Foggin has spent most of his professional life in the service of the Zimbabwean Government. Prior to the establishment of the Wildlife Veterinary Unit within the Department of Veterinary Services (DVS), Dr. Foggin had been primarily involved in research within the DVS on rabies epidemiology and had also played a pioneering role in developing management practices for the intensive production of crocodiles and ostriches, in addition to undertaking emergency wildlife work on an irregular basis.

The foot and mouth disease-free buffalo programme emanated from Dr. Foggin's offices. As head of the Wildlife Unit, he has been responsible for veterinary regulations concerning the movement of wildlife both within the country and externally. The relocation of oxpeckers is an ongoing exercise, and with the promotion of venison production and marketing, Dr. Foggin has been called on to assist in developing this section.

The ongoing rhino snaring crisis and the pressures of dealing with wildlife/cattle disease problems in Zimbabwe's current economic situation have added greatly to the workload of the Wildlife Unit.

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Guy Freeland, B.V.M.S. (Glasgow 1965), M.Sc. (Edinburgh University, Centre for Tropical Veterinary Medicine 1978), M.R.C.V.S., has had a long and distinguished career in international veterinary medicine.

In the 1970s and early 1980s, his Overseas Development Administration (ODA) assignments took him to Swaziland, Sarawak, and Bangladesh, followed by a World Bank assignment in Nigeria. From 1983 to 1999, Dr. Freeland was the Senior Animal Health and Production Adviser to the British Government's ODA, (now the Department for International Development, DFID). His responsibilities included livestock project appraisal, monitoring, supervision, and review in some 45 countries in Africa; West, South, and Southeast Asia; and Pacific regions. He also had oversight of ODA/DFID's Animal Health and Livestock Production Research Programmes and provided advice on assistance to international research institutions.

Since retiring from the civil service in 1999, his freelance consulting has taken him to Botswana, Vietnam, Lao People's Democratic Republic, and Nepal, and has also included work in the United Kingdom. He is a member of the Board of Directors of VETAID, and Chairman of the Board of Trustees of Worthing Animal Clinic.

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Dr. Robert Fyumagwa received his B.V.M. degree from Sokoine University of Agriculture (SUA) in 1990. From 1991 to 1998, he worked as a private practitioner in a mixed veterinary practice in Dar es Salaam, Tanzania. From September 1998 to September 2000, Dr. Fyumagwa finished his postgraduate studies at SUA, specializing in parasitology. In October 2000, he joined Tanzania Wildlife Research Institute (TAWIRI) as a veterinary research officer – the

position he is currently holding. While in private practice, Dr. Fyumagwa participated in a rinderpest vaccination campaign for Masai pastoralists in 1997. After joining the wildlife sector, he completed a capture course in Zimbabwe in 2001. Dr. Fyumagwa attended the Envirovet course in 2002. His future plans include more training on wildlife disease and postgraduate training in wildlife management and ecology. Dr. Fyumagwa has been an active participant in the TAWIRI Annual Conference since December 2000.

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Dr. Wayne M. Getz was born in South Africa in 1950 and has been a faculty member of the University of California at Berkeley since 1979. He has a Ph.D. from the University of the Witwatersrand (Applied Mathematics, 1976) and a D.Sc. from the University of Cape Town (1995). He is a Fellow of the California Academy of Sciences, the American Association for the Advancement of Sciences, an Alexander von Humboldt U.S. Senior Scientist Awardee, a past Research Fellow of the Stellenbosch Institute for Advanced Studies, and currently is an Extraordinary Professor at the University of Pretoria Mammal Research Institute. Dr. Getz is a Past President of the Resource Modelling Association and has organized U.S.-NSF-funded workshops in southern Africa on the topics of "Resource Utilization" and "Community-Based Wildlife Management." His publications include a co-authored Princeton University Press monograph *Population Harvesting: Demographic Models of Fish, Forest, and Animal Resources*. His current research focuses on the application of mathematical modeling and analysis to problems in conservation biology, wildlife management, and epidemiology. Dr. Getz is the Principal Investigator of an ongoing U.S.-NSF funded study of the spread of bovine tuberculosis in the African buffalo population in Kruger National Park.

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Dr. George K. Gitau graduated with a B.V.M. from the University of Nairobi, Kenya, in 1987. He thereafter obtained an M.Sc. from the University of Guelph, Canada (1992), and a Ph.D. from the University of Nairobi (1997). Dr. Gitau currently works with the African Union/Interafrican Bureau for Animal Resources (AU/IBAR) and coordinates AU/IBAR's project on the Livestock, Wildlife and Environment Interface. Dr. Gitau is also a Senior Lecturer at the Veterinary School of the University of Nairobi and is currently on leave of absence. Dr. Gitau has specialised in veterinary epidemiology and has over 10 years field experience in smallholder dairy production systems in the highland ecosystems of Kenya. During the last 5 years, Dr. Gitau has been working in the pastoral rangeland ecosystems of Kenya, one of which is the Maasai pastoral ecosystem that has an extensive interaction of people, livestock, and environment. One of Dr. Gitau's interests and working areas currently is the livestock, wildlife, and environment interface, which is being pursued together with other scientists and stakeholders and with the support of UNEP-GEF.

Dr. Gitau is attending the World Parks Congress *AHEAD* forum as a representative of AU/IBAR, the coordinator for AU/IBAR's project on the Livestock, Wildlife and Environment Interface, and Thematic Programme Network 3 (TPN3) Focal Point for UNCCD that addresses the area of "rational use of rangelands and fodder management."

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Born in Johannesburg, Markus went to veterinary school with the objective of working with wildlife. During university years he worked as a guide in Pilanesberg National Park, and during holidays at various game reserves. After qualifying as a veterinarian, Markus worked at a variety of practices and went to Canada for a few months where he gained some North American wildlife experience. Back in South Africa, a stint in exotic animal medicine (dealing with birds, monkeys, and snakes) was an important step for him.

In 1995, Markus began working for the Madikwe Game Reserve, where the largest animal translocation in the world was taking place at that time. In the five years he spent there, he gained a tremendous amount of ecological, veterinary, and management experience in wildlife translocations and the running of a large game reserve. From there, he moved to Kruger National Park, where he currently holds the position of Principal Scientist-Veterinary Services.

One career highlight has been his involvement with the reintroduction of the endangered African wild dog into Madikwe Game Reserve. The experience gained with the work done in Madikwe has improved our knowledge of wild dogs and has been used extensively in other introductions of wild dogs elsewhere in South Africa.

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Dr. Gladys Kalema-Zikusoka worked as Veterinary Officer of the Uganda Wildlife Authority from 1996 to 2000. During her tenure, Dr. Kalema-Zikusoka was involved in setting up veterinary programmes and developing a policy framework for wildlife conservation to support the timely and efficient delivery of veterinary services including translocation and reintroduction, and problem animal management.

As part of her zoological medicine residency program through North Carolina State University, Dr. Kalema-Zikusoka received the African Wildlife Foundation Charlotte Fellowship Conservation Award in 2000. This led to new research on tuberculosis at the human, wildlife, and livestock interface in Queen Elizabeth and Bwindi Impenetrable Forest National Parks in Uganda in 2001 and 2002.

Following up on the research findings and recommendations, Dr. Kalema-Zikusoka became Founder and Chief Executive Officer of Conservation Through Public Health, an international grassroots NGO, established in 2002, to promote conservation with public health by improving primary health services for people and animals around protected areas throughout Uganda.

Dr. Kalema-Zikusoka obtained a B.V.M. from the Royal Veterinary College, University of London, in 1995. She completed a zoological medicine residency and Masters in Specialized Veterinary Medicine at North Carolina State University and North Carolina Zoological Park in the U.S. in 2003. She also obtained a Certificate in Non-Profit Management from Duke University in the U.S. in 2003.

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William Karesh, D.V.M., heads the Field Veterinary Program (FVP) of the Wildlife Conservation Society (WCS), which has over 300 field projects in 50 countries around the world. Dr. Karesh was hired to develop this program in 1989 to address health-related issues among field biologists and conservationists. The program provides services overseas for WCS field staff as well as for workers from government agencies and non-governmental organizations. The FVP also conducts research on the health status of free-ranging wildlife populations, provides training for foreign veterinarians and biologists, and frequently assists overseas organizations and agencies with wildlife translocations, as well as confiscation and rehabilitation issues. Major initiatives of the FVP include the development of multinational wildlife/livestock/human health programs and policy consultation for developing-country governments and bilateral aid organizations.

In 1999, the Wildlife Conservation Society's FVP initiated the first comprehensive preventive health program for free-ranging lowland gorillas aimed at protecting populations in three range states (Gabon, Congo, and Central African Republic) from the risk of exposure to emerging or introduced diseases. This program was created in response to the growing interest in gorilla ecotourism, proliferation of ecological/wildlife research, and expansion of human communities in and around the forests of central Africa. This program was up and running during the recent Ebola outbreaks that have swept across northern Congo and Gabon, allowing FVP veterinarians and collaborating scientists to respond quickly to the crisis.

Dr. Karesh is also Co-Chair of the IUCN Species Survival Commission (SSC) Veterinary Specialist Group.

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Dr. Michael Kock is a veterinarian who works as a conservation practitioner, with a particular interest in the issues of ecosystems, wildlife, and their relationship to human health and well-being. His career as a wildlife veterinarian has spanned several continents, but Africa is his home, and the African people and wildlife provide his sustenance. Dr. Kock was born in South Africa, but grew up in Zimbabwe, travelling from there to pursue his veterinary degree in England. He did veterinary work in America and the Middle East before he returned to Zimbabwe, where he was heavily involved with rhinoceros work during the poaching heydays of the 1980s and 1990s. His work has carried him across Africa to Cameroon and throughout southern Africa. He believes that the future of conservation lies in winning the hearts and minds of the rural people of Africa and supporting their aspirations and improving the health of their livestock. Dr. Kock has broadened his horizons by involvement with organizations such as Theatre for Africa in educating people on conservation and health issues; he is a member of the Southern Africa Sustainable Use Specialist Group (SASUSG). He believes the key to success in conservation in the developing world is by adopting a participatory approach, building capacity, educating, and supporting homegrown solutions.

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Dr. Richard Kock is a British (M.R.C.V.S.) veterinarian who has spent over 20 years in the wildlife field attached to the Zoological Society of London (ZSL), initially as a veterinary officer for its captive collections and subsequently on conservation and animal health programmes around the world.

In 1991, he was seconded from ZSL to the Kenya Wildlife Service (KWS, a parastatal institution mandated to manage and conserve all wildlife in Kenya) to head a new Veterinary Unit (five veterinarians, two technicians, 30 officers and field staff) for seven years. The programme was successful with a now functional and sustained Unit at KWS. From November 1998–2000, he was seconded to an African regional body, the Organisation of African Unity/Interafrican Bureau for Animal Resources (OAU/IBAR) Pan African Rinderpest Campaign. This has involved the organisation and implementation of extensive serosurveillance and disease investigation in nondomestic ruminant species throughout eastern Africa and also in the Central African Republic. This activity continued from July 2000 to the present, setting up the wildlife component of the Epidemiology Unit of the new AU/IBAR Pan African Control of Epizootics (PACE) programme, involving 30 countries in Africa. His area of responsibility is eastern Africa and the activities include strategic planning for epidemiosurveillance amongst wildlife species, especially at the wildlife/livestock interface; training of national staff in the appropriate veterinary techniques at national and regional levels; and practical support to field surveillance.

Dr. Kock has consulted for the IUCN (elephant), the World Wide Fund for Nature (rhino), the World Bank (Uganda Wildlife Authority development), and the Food and Agriculture Organisation of the United Nations (Global Rinderpest Eradication Programme). He is Co-Chair of the IUCN Species Survival Commission (SSC) Veterinary Specialist Group, and a member of the Cat and Antelope Specialist Groups of the SSC. He is well travelled, having been involved in a variety of conservation-related initiatives in Europe, Africa, the Middle East, Eurasia, and the Caribbean. He promotes wildlife veterinary matters through extensive publications and at professional meetings. Dr. Kock is a registered specialist in Zoo and Wildlife Medicine with the Royal College of Veterinary Surgeons of England, and a member of the Wildlife Disease Association, the British Veterinary Zoological Society, the World Association of Wildlife Veterinarians, the American Association of Zoo and Wildlife Veterinarians, and the British Veterinary Association.

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Dr. Karen Laurenson qualified as a veterinarian from Cambridge University in 1987 and then spent three years in Tanzania studying cheetah behaviour and ecology for a Ph.D. Thereafter, she combined her interests in disease and ecology by conducting postdoctoral research on wildlife disease epidemiology, particularly at the wildlife/domestic animal interface, with a long-term study of louping-ill dynamics in wild and domestic species (red grouse) in the United Kingdom and with shorter projects in Namibia and South America. Since 1996, she has been involved in research and conservation programmes to reduce the threat of rabies and other canine diseases to Ethiopian wolves. Dr. Laurenson was based at the University of Edinburgh Veterinary School as a research fellow and then as a lecturer since 1997. Currently, she is also working part-time for Frankfurt Zoological Society as a Programme Officer for their Africa program, with particular responsibility for projects involving veterinary issues in Ethiopia and Congo.

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Dr. Dale Lewis has worked as a conservation scientist for the Wildlife Conservation Society in Zambia for over 20 years. He has contributed to applied research in elephant and hippo management, and to such efforts as the establishment of a college for promoting community leaders in wildlife conservation, improved legislation on wildlife management policies, and development of community-based management systems and institutions. Dr. Lewis works in close collaboration with the Zambia Wildlife Authority as Technical Advisor for Community-Based Natural Resource Management (CBNRM). Results emanating from his work include the national village scout programme, an integrated

database for studying wildlife management approaches in rural areas outside national parks, a national programme for CBNRM referred to as ADMADE, and large-scale pilot schemes for testing development models that promote wildlife conservation.

In recent years, Dr. Lewis has undertaken an initiative to link households that are vulnerable to poverty and hunger with a regional trading centre through a programme that promotes alternatives to poaching by improving market access and producer prices. The programme integrates a variety of disciplines that enable household livelihood needs to be better addressed in ways that lead to decreased human conflicts with wildlife and to increased wildlife production. In his spare time, he fly-fishes and roams around the African bush with his wife, Julia.

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Dr. Tim Leyland is a veterinarian with an M.Sc. in tropical animal health and production, currently working with the Tufts University School of Nutrition and Policy, Boston, seconded to the African Union.

After experience in private practice, he has worked in underserved livestock-rearing areas for the past 15 years in Papua New Guinea, Afghanistan, Mozambique, Sudan and all the countries of the Horn of Africa. With experience in NGO, government, and international agency projects and programmes, he has specialized in community-based livestock projects and veterinary service delivery in developing countries. Dr. Leyland's current activities revolve around researching and implementing field-based animal health delivery systems in order to bring about institutional, policy, and legislative change at national, regional, and global levels. Over the past ten years, he has used community-based livestock initiatives to resolve and manage armed conflict, improve livestock marketing and trade, improve disease surveillance, and ensure appropriate emergency relief interventions in remote, marginalized livestock-rearing areas. More recently, his work within AU/IBAR has concentrated on the institutional development of African livestock organizations.

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Dr. Neo Mapitse is a Principal Veterinary Officer with the Botswana Department of Animal Health and Production within the Ministry of Agriculture. He currently works as the Department's wildlife veterinarian heading the Wildlife Unit, which among other things, provides advice on wildlife-related issues to the Department. His work has mainly been on disease surveys in various antelope species, with emphasis on diseases shared by both domestic and wild animals. In the past two years, as Botswana has had foot and mouth disease (FMD) outbreaks in cattle, his work has focused on FMD and antelope in areas of concern. He believes that an efficient and effective disease management strategy in domestic animals should be influenced by knowledge of pathogen behaviour in wildlife and the environment.

Neo graduated with a B.V.M.S. from the University of Glasgow in 1996, where he also attained membership in the Royal College of Veterinary Surgeons. He worked for two years as an official district veterinarian before enrolling for an M.Sc. in wild animal health with the University of London in 1998.

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Rowan Martin qualified at Manchester University in the 1960s as an engineer and physicist and switched his career to wildlife and environmental issues in 1970. He worked for the Department of National Parks in Zimbabwe for 25 years and was head of wildlife and fisheries research in the department from 1987 to 1997. Since then, he has been working as a freelance consultant in the southern African region on a range of conservation and development projects.

Apart from wildlife ecology, his interests lie in land-use planning and institutional structures. He is the author of the well-known Communal Areas Management Programme For Indigenous Resources (CAMPFIRE 1986) and has recently been advocating new models for state-protected area management in southern Africa.

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Dr. Anita Luise Michel matriculated in 1982 and obtained the qualification as a veterinarian in 1987 from the Ludwig-Maximilians-University of Munich, Germany. She completed a doctoral thesis on molecular studies on coxsackie virus at the Max-Planck-Institute for Virology in Martinsried, Germany, for which she obtained the degree Dr.Med.Vet. cum laude from the same university in 1989. Also in 1989, she joined the research team concerned with viral diseases of

animals at the Onderstepoort Veterinary Institute near Pretoria. Her main research fields included diagnostic methods and epidemiology of malignant catarrhal fever in wildebeest and sheep. In 1995, Dr. Michel joined the tuberculosis laboratory of the department of bacteriology at the same institute and became head of this department in 2002. Her main research activities focus on the improvement of diagnostic methods for bacterial diseases and the research on tuberculosis in domestic and wild animals. Dr. Michel is the author or co-author of 21 scientific papers and 36 conference presentations.

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Fumi Mizutani, D.V.M., M.Sc., Ph.D., studied veterinary medicine at Hokkaido University and worked for the scientific committee of WWF Japan before she studied tropical resource ecology at the University of Zimbabwe. Her specific subject was the reproductive success of foot and mouth disease virus-free, semi-domesticated African buffalo compared with that of wild herds. Following her growing interest in mixed livestock/wildlife systems and particularly on disease transmission between domestic stock and wildlife as well as livestock predation by carnivores as major conflict areas, she subsequently studied predators on a working ranch in Laikipia, Kenya. Under the guidance of the late Professor Peter Jewell at the University of Cambridge, she did her Ph.D. on the impacts of predation in wildlife and domestic stock. Since 1996, she has implemented the Lolldaiga Research Programme at Lolldaiga Hills Ranch, a beef-dairy working ranch in Kenya. Dr. Mizutani is also working as a livestock/wildlife consultant at the Kenya Agriculture Research Institute and the International Livestock Research Institute.

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Dr. Titus Mlengeya obtained his B.V.M. degree from Sokoine University in 1988 and an M.Sc. in veterinary epidemiology from the University of Reading, UK, in 1994. He received a certificate for competency with dangerous drugs from the Zimbabwe Veterinary Association in 1997. Dr. Mlengeya served as a wildlife research scientist at Serengeti Wildlife Research Institute from 1987 to 1989. In 1989 and 1990, he was District Livestock Development Officer for the Tanzanian Ministry of Agriculture and Livestock Development. From 1990 to 1993, he established and managed a veterinary clinic in Dar Es Salaam, and from 1994 to 1996, he served as Wildlife Epidemiologist for the Tanzanian Ministry of Agriculture & Livestock Development in Dar Es Salaam. Since 1996, he has worked at Serengeti and other Tanzanian National Parks as a wildlife veterinarian. Dr. Mlengeya currently heads TANAPA's Wildlife Veterinary Unit.

Dr. Mlengeya is a member of the Wildlife Conservation Society of Tanzania, the Society for Veterinary Epidemiology and Preventive Medicine, and the Wildlife Disease Association. His current activities include rinderpest surveillance in wildlife (buffalo, other ungulates); treatment of endangered animal species (black rhinos, wild dogs); snare removal (lions, buffalo, hyaena, zebras, other species); vaccination of domestic animals to control rabies, rinderpest, foot and mouth disease, and canine distemper; training of park rangers for animal health monitoring; training of local communities in animal husbandry; and conducting post-mortem examinations (with diagnostic sampling and related laboratory work) of wild animals that have died.

His goals are to continue to monitor and mitigate diseases, conduct necessary research, and maintain healthy wildlife populations in a healthy ecosystem. Dr. Mlengeya provides support for community-based livestock projects to fight poverty in local communities and involves local people in conservation programs.

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Pete Morkel qualified from Onderstepoort in 1984 and has been working as a wildlife veterinarian since 1986. He started with the Game Capture Unit of the Ministry of the Environment in Namibia. After 4 years with the Unit in Namibia, he moved to Etosha National Park as the park veterinarian. After leaving Etosha in 1992, he did private wildlife veterinary work before joining the South African National Parks in 1994. He was tasked to develop their Kimberley Capture Unit and was responsible for all capture and veterinary work in the national parks outside of Kruger. He left South African National Parks in early 2001 and worked with a private game capture team in South Africa for a year before moving to Ngorongoro Crater in Tanzania, where he now works for the Frankfurt Zoological Society as the rhino coordinator for their various projects in a number of African countries.

Most of Pete's experience has been with the capture and translocation of the larger wildlife species. He has also had the opportunity to participate in capture operations in more than 14 African countries. Much of this work has involved the translocation of black rhino. Giraffe is another species with

which he has had a particular involvement. Pete's particular interest has been developing better techniques for the capture of wildlife. He has also been very involved in the training of wildlife veterinarians.

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Norman Mukarati, B.V.Sc., M.Sc. is a wildlife veterinarian with 11 years of experience in the field, most of which was acquired in Zimbabwe. A 1991 graduate of the University of Zimbabwe, Dr. Mukarati then became a resident veterinary surgeon (intern) there with the University Veterinary Hospital, Faculty of Veterinary Science. This ten-month position focused mostly on small-animal surgery.

In 1993, Dr. Mukarati joined the Wildlife Unit of the Department of Veterinary Services, Zimbabwe. This position provided intensive hands-on wildlife veterinary training. Duties included wildlife veterinary medicine and surgery (disease investigation, medical and surgical treatments); disease research; capture and translocation exercises, including those involving endangered species such as rhinoceroses; coordinating implementation of official regulations related to wildlife keeping and movement; as well as assisting with the administration of the commercialised Wildlife Unit. During this time, Dr. Mukarati travelled extensively within and outside of Zimbabwe on duties that included consultancies in Nigeria, Swaziland, and Zambia. He also organised training of veterinarians in wildlife medicine, with a focus on ostriches. From January to September 2002, Dr. Mukarati was a lecturer teaching wildlife sciences at Bindura University, Zimbabwe. He continued to be active in wildlife practice as an independent consultant for the private sector, NGOs and government. In October 2002, he joined the Botswana Department of Wildlife and National Parks as their Wildlife Veterinary Officer. Future aspirations include attaining a Ph.D. and gaining more international experience through professional association activities and fieldwork.

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Dr. Mullins has lived in sub-Saharan Africa for 18 years, 14 of which have been spent in applied agricultural research. Animal agriculture and mixed animal production systems, including wildlife, are his specialty, with an emphasis on natural resource management, conservation, and household welfare economics. He worked as a research scientist for the International Institute of Tropical Agriculture in Nigeria, Tanzania, and Uganda, and later in Kenya for the International Livestock Research Institute. He was a founding member of Botswana's first Veterinary Epidemiology and Economics Unit, and from 1996 to 2000, headed its Economics Section. In addition, Dr. Mullins has been a Visiting Scientist at Colorado State University's Natural Resource Ecology Laboratory. He most recently served as Office Chief for Agriculture and Natural Resource Management at the U.S. Agency for International Development's Regional Center for Southern Africa.

He holds a Ph.D. in agricultural economics from Oklahoma State University and a Master's degree in International Development from American University's School of International Service (Washington, DC). Besides English, he speaks French, Kiswahili, West African pidgin and Swedish.

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Since January 2002, Dr. Misheck Mulumba has been the Director for the African Union/Centre for Ticks and Tick-borne Diseases (AU/CTTBD). His primary duties include production of tick-borne disease vaccines for livestock, training (epidemiology and diagnostics), supervision of post-graduate students, coordination of regional livestock disease work, and participation in policy formation at the livestock/wildlife interface.

Between June 2000 and December 2001, Dr. Mulumba held the position of Deputy Director at AU/CTTBD. He was Chief Veterinary Officer and Subprogram Manager, Animal Production and Health, for the Ministry of Agriculture, Food and Fisheries in Zambia from September 1997 to May 2000. Dr. Mulumba was the Senior Veterinary Officer for the Ministry of Agriculture in Zambia between May 1995 and August 1997, and helped oversee the translocation of more than 2,000 game animals within the country. From December 1993 to December 1999, he was the Counterpart Project Manager and later Project Manager for ASVEZA (Assistance to the Veterinary Services of Zambia), a Belgium-funded animal health project. Between October 1989 and November 1993, Dr. Mulumba was a Government Veterinary Officer for Zambia.

Dr. Mulumba is a founding member of the African Chapter of the Wildlife Disease Association and a member of the African Association of Insect Scientists, the IUCN Veterinary Specialist Group, the Veterinary Association of Zambia, and the African Tick Group.

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Dr. Simon Munthali, a Malawian, has 22 years experience in protected areas and wildlife management; formulation of wildlife policy; research in the ecology of terrestrial wildlife, ichthyofauna, and the socio-economics related to wildlife utilisation (including studies of economic incentives for nature conservation and the formulation of co-management plans for natural resource management). He was Chief Technical Advisor for the GEF (Global Environment Facility)/ World Bank Transfrontier Conservation Areas project in Mozambique, from 1998 to 2003. This project was aimed at promoting transborder ecosystem management. Dr. Munthali's qualifications include a B.Sc. in agriculture, a B.Sc. (Hons.) in wildlife biology, and a Ph.D. in ichthyology.

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Michael Murphree has 16 years of experience in the field of community-based natural resource management. Born in Zimbabwe and educated in Zimbabwe and the United States, he was employed by the Department of National Parks and Wildlife Management (Zimbabwe) in 1987 as an ecologist to work on the CAMPFIRE programme. In 1994, he took a position in Mozambique as Wildlife Policy Advisor through IUCN (Regional Office Southern Africa), where he was involved in the development of Mozambique's first community wildlife management project, Tchuma Tchato.

In 1996, he became the Executive Officer of the Southern Africa Sustainable Use Specialist Group (of IUCN), a position held until May 2002. Mr. Murphree has worked with and on community-based natural resource management projects in southern and West Africa. In 1999, he was invited by the Ghana Wildlife Division to assist in developing Ghana's first community wildlife management programme through the establishment of Community Resource Management Areas and continues to provide periodic inputs into this programme.

As an independent consultant based at the Institute of Natural Resources in Natal, South Africa, he has been closely involved in collating, analysing and disseminating information on community-based wildlife management systems, and in developing new mechanisms and approaches for project implementation. Mr. Murphree is working on policy and legislative reform issues and is currently involved in developing new approaches to communicate environmental and developmental issues through theatre and exchange visit programmes.

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Dr. Jacob Mwanzia, currently the Senior Wildlife Veterinary Officer for the Environment and Wildlife Management Section, in the Emirate of Abu Dhabi, United Arab Emirates (UAE), is responsible for the medical care of a wide range of mammals and birds throughout the Emirate's wildlife sanctuaries. He implements national wildlife research plans, manages staff, oversees the budget and training, and develops health protocols, in addition to acting as a liaison with the scientific community and the public. In the field, Dr. Mwanzia provides technical support during wildlife capture attempts and translocations. He graduated from the University of Nairobi in 1989 with a B.V.M. and in 1992 he received his Master's degree in Veterinary Public Health (M.V.P.H.). After graduating, Dr. Mwanzia was a field veterinarian with the Kenya Wildlife Service where, for six years, he worked with a diverse cross-section of species. Other projects he is currently involved with include health monitoring of semi-captive Arabian oryx in the UAE, disease surveillance of desert hare (*Lepus capensis*), and management and nutritional assessment of semi-captive wildlife in UAE. Dr. Mwanzia has a special interest in conflict resolution in wildlife management based on his experiences in Africa.

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Dr. Laurel Neme is the Senior Policy Advisor for FRAME, a program of USAID aimed at combining web-based knowledge and an expert community of practice to help decision-makers and practitioners working on environment and natural resource management analyse issues, plan strategically, and advocate their positions more effectively. FRAME, short for

FRAMEwork for improved environmental decision-making, has evolved into an unusual melding of a website and resource/advisory group, designed to improve natural resource management and environmental programs and projects. Dr. Neme is an independent consultant for both public sector and non-governmental clients, including USAID, the World Bank, the WWF, and others. Before working on FRAME, she served as an international economist with the U.S. Treasury Department's Office of Multilateral Development Banks, where she oversaw the social and environmental aspects of projects and policies at the World Bank Group and regional development banks (including the African Development Bank), and directed the actions of the U.S. executive directors for those institutions. In particular, she advised the multilateral banks on environmental impact assessment, information disclosure, institutional issues, and incentives structures all designed to facilitate public participation in the design and implementation of development programs. Dr. Neme holds a Ph.D. from Princeton University's Woodrow Wilson School of Public and International Affairs.

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Dr. Jesse Njoka works as a senior lecturer at the University of Nairobi in the Department of Range Management. He has been a chairman of the East Africa Wildlife Society for seven years. Dr. Njoka has a Ph.D. from the University of California at Berkeley in the College of Natural Resources.

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Philip Nyhus, Ph.D., is Assistant Professor and Co-Chair of the Environmental Studies Program, Department of Earth and Environment, Franklin and Marshall College. From 1999 to 2001, Dr. Nyhus was a postdoctoral research and teaching fellow funded by a National Science Foundation (NSF) Award for the Integration of Research and Education at Colby College. In his interdisciplinary research, he bridges the natural and social sciences to address human interactions with the environment. He has studied tiger and large mammal conservation in Indonesia and China and is exploring how linkages among coupled human-natural systems can be used to improve biodiversity risk assessment to inform conservation policy at regional and global scales. Dr. Nyhus is Principal Investigator on a grant from NSF's Biocomplexity in the Environment Program, "Models and Meta-Networks for Interdisciplinary Research in Biodiversity Risk Assessment," and Co-Principal Investigator on a proposal under review in the same program, "Biocomplexity and Biodiversity: An Interdisciplinary, Integrated, Multi-Model Approach to Endangered Species Risk Assessment and Education." He has collaborated on developing new models of population viability analysis, disease risk, and spatial analysis. Funding for his research has also come from, among other sources, National Fish and Wildlife Foundation, US Fish and Wildlife Service, National Security Education Program, and The Tiger Foundation (Canada).

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Steve Osofsky, D.V.M., first experienced East Africa in 1984–1985 as a Harvard University Traveling Fellow, observing wildlife species in Kenya, Tanzania, and Rwanda while examining conservation challenges from a variety of perspectives including those of local people, NGOs, and governments. As a veterinarian, he has worked in a variety of domestic and international contexts, with his most recent overseas post being that of the first Wildlife Veterinary Officer for the Botswana Department of Wildlife and National Parks. Dr. Osofsky worked directly for the Government of Botswana, and had an active role in hands-on wildlife management as well as policy formulation. He has also worked in the zoological community, and served as the Director of Animal Health Services at the Fossil Rim Wildlife Center in Texas. As an American Association for the Advancement of Science (AAAS) Science and Diplomacy Fellow, he served as a Biodiversity Program Specialist at USAID and focused on ground-truthing Integrated Conservation and Development Projects; providing technical advice on wildlife management; and working with the US Fish and Wildlife Service on the Rhino-Tiger and African Elephant Grants Programs, on CITES policy, etc.

Dr. Osofsky's program/policy interests include park/buffer zone management and planning; linking wildlife conservation and sustainable development; conflicts at the livestock/wildlife interface (problem predator issues, disease concerns); endangered species management; linking wildlife research to management needs, as well as *in situ* and *ex situ* wildlife veterinary medicine. He is an Adjunct Assistant Professor at the University of Maryland, and also serves on eight IUCN SSC Specialist Groups. Dr. Osofsky had been

with WWF since 1998, serving as their Director, Field Support for species programs in Asia and Africa. In December 2002, he left WWF to join the Wildlife Conservation Society's Field Veterinary Program (FVP) as the Society's first Senior Policy Advisor for Wildlife Health. Helping the FVP to expand into the policy arena is an exciting challenge, one that logically builds upon the scientific and hands-on fieldwork that has long been the FVP's hallmark.

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Dr. Craig Packer graduated from Stanford University in 1972 and completed his Ph.D. at the University of Sussex in 1977. He studied nonhuman primates in Gombe National Park, Tanzania, off and on from 1972 to 2000, and has headed the Serengeti lion project since 1978. Dr. Packer currently has students working on lions in Tarangire and Serengeti National Parks as well as Ngorongoro Conservation Area, Tanzania. In South Africa, he collaborates with Dr. Rob Slotow, University of Natal-Durban, and is involved in projects at Hluhluwe-Umfolozi and Pilanesberg Parks, as well as a number of private reserves. In addition to his lion work, Dr. Packer is the Principal Investigator of collaborative research projects in the Serengeti that are funded by the National Science Foundation (NSF) program in the Ecology of Infectious Diseases and the NSF initiative on Biocomplexity.

Dr. Packer is currently Distinguished McKnight Professor in the Department of Ecology, Evolution and Behavior at the University of Minnesota. He was elected to the American Academy of Arts and Sciences in 2003.

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After an honours degree in wildlife management (University of Pretoria), Dr. Banie Penzhorn joined South African National Parks, where he worked as a researcher in the Eastern Cape Province. During this period, he was granted study leave and obtained an M.Agric. in wildlife science at Texas A&M University. He used his research on ecology and behaviour of Cape mountain zebras for a Doctorate (Pretoria). After eight years with SANParks, Dr. Penzhorn left to study veterinary science. He has been teaching at the Faculty of Veterinary Science, University of Pretoria, since 1981. His current research focus is protozoal diseases of wildlife and domestic animals. Dr. Penzhorn's list of publications in refereed journals stands at more than 90. He is the current president of the South African Veterinary Association (SAVA) and is also secretary of the SAVA Wildlife Group. Dr. Penzhorn is also an honorary life member and past president of the Southern African Wildlife Management Association.

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Mary Phillips, D.Phil., B.Sc., received her undergraduate training in physiology at University College in London and did her doctoral work and began her subsequent academic career in the University Laboratory of Physiology, Oxford. Dr. Phillips' research was on endothelial and epithelial membrane transport, and she moved to scientific administration at the Wellcome Trust in 1989. She initially managed the Physiology and Pharmacology portfolio, but more recently became responsible for the International Biomedical programme, which funds basic biomedical science in resource-constrained countries. Also recently, she assumed responsibility for the management of the Animal Health in the Developing World Initiative.

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Dr. Delphine Purves is the Project Manager for Science and Funding at the Wellcome Trust. She joined the Trust in 1999 as a Science Programme Officer in the Careers and Clinical Initiatives Department, having spent 18 months on secondment as the Executive Assistant to the Director of the Wellcome Trust. Her previous posts include the Scientific Editor of the *European Journal of Cancer* and various research posts in oncology, particularly neuro-oncology, neuropathology, and microbiology.

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Helga Recke, M.Sc., Ph.D., obtained her first degree in horticulture at Hannover University and her Ph.D. in soil

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Robin Reid, Ph.D., is a systems ecologist, leading research on livestock and environment issues at the International Livestock Research Institute (ILRI) in Nairobi, Kenya. She began her research career as a biologist in the U.S. National Park Service working on plant-herbivore interactions. For the last two decades, she has worked in subhumid and semi-arid lands in Africa, focusing on why and where land use changes and how such changes affect ecosystems. She currently leads a global pastoral systems project at ILRI that attempts to balance pastoral development and ecosystem conservation. The pastoral team works with NGOs, government, communities, and private industry to bring the best science (field studies, GIS, remote sensing, and simulation modelling) to bear on critical conservation/development issues.

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Dr. Chris S. Rutebarika received his B.V.M. from the Makerere University, Kampala, Uganda, in 1979 and his M.Sc. from the Royal Veterinary College, University of London, in 1990.

He worked as a field veterinarian for ten years and is currently in charge of disease control at the Department of Livestock Health and Entomology, where he has worked in various capacities since 1991. He is the National Coordinator of the Pan African Control of Epizootics (PACE) Programme in Uganda.

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Dr. Innocent Rwego holds B.V.M. and M.Sc. degrees from Makerere University in Kampala, Uganda. His professional experience includes veterinary extension work treating domestic animals and conducting elephant crop damage assessments. Dr. Rwego currently works for the Morris Animal Foundation's Mountain Gorilla Veterinary Project as a field veterinarian. He recently completed the Envirovet 2003 Summer Institute Course in Terrestrial and Aquatic Ecosystem Health. His goal is to become a wildlife veterinary epidemiologist, examining disease transmission between wildlife, domestic animals, and human communities. Dr. Rwego also wants to work to help ecosystem restorations in Africa.

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Since 1998, Dr. Wilna Vosloo has been Deputy Director of the Exotic Diseases Division (EDD) at Onderstepoort Veterinary Institute, the quarantine facility where research, diagnosis, and vaccine production are focused mainly on foot and mouth disease (FMD) and African swine fever. She is the

programme manager and project leader of several programmes and projects at the EDD, and has managed to procure outside funding from international agencies and pharmaceutical companies for various research projects at the EDD. Dr. Vosloo has spent various periods at different internationally acclaimed laboratories for scientific visits. She was appointed as Honorary Lecturer in the Department of Medical Microbiology, University of Cape Town, Medical School (1996–1999). Dr. Vosloo was appointed as Honorary Lecturer in the Department of Tropical Diseases, Faculty of Veterinary Sciences, University of Pretoria (2002–current). She acts as supervisor for a number of honours M.Sc. and Ph.D. students. Dr. Vosloo was awarded the Bronte Steward Research Prize for the most meritorious thesis for the degree of M.D., Ph.D., or Ch.M. in the Faculty of Health Sciences at the University of Cape Town during 1998.

Dr. Vosloo has presented more than 40 papers and posters at various international and national congresses. She has published 14 papers in international journals on FMD research, and is the author of a chapter in a book on the natural habitats of FMD. Dr. Vosloo has been invited to several national and international meetings to provide expertise on FMD and its control. She has been invited by the FAO on consultancies to African countries for FMD control and training. She has also been invited to serve on the FMD Advisory Committee for the Directorate of Animal Health, South Africa.

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Kenneth Waithiru, B.A., B. Phil. Econ., obtained both of his degrees in economics from the University of Nairobi. He first worked in a commercial bank before joining the Government of Kenya as an economist in 1993. Since then, Mr. Waithiru has worked in the National Council of Population and Development as a Population Planning Officer, in the Human Resources Social Services Department as a Senior Economist, and now works with the Ministry of Finance serving as the EU Desk Officer coordinating, on behalf of the Government of Kenya and the EU, the following programmes (among others): Tourism Trust Fund, Kenya Agricultural Research Institute, Kenya Tourism Board, Kenya Wildlife Society, The Elephant Conservation Project, and the Biodiversity Conservation Programme.

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Dr. Elizabeth Wambwa is a graduate of the University of Nairobi (B.V.M.) and a holder of an M.Sc. in wild animal health from the University of London's Royal Veterinary College. She has over ten years hands-on field experience in wildlife health management working at the Kenya Wildlife Service (KWS) and collaborating with other institutes and veterinary departments in the region. She is the current chairperson of the Wildlife Disease Association-Africa and Middle East Section.

Dr. Wambwa currently heads the KWS Veterinary Unit based at its headquarters in Nairobi. KWS is the lead government corporation in Kenya that is mandated to manage and conserve wildlife. The Veterinary Unit supports the mission and goals of KWS and is responsible for ensuring healthy wildlife populations in the country and for managing human/wildlife conflict. Dr. Wambwa organises and oversees all veterinary intervention for wildlife including treatment of sick and injured wildlife, disease outbreak investigations, disease serosurveillance and translocation of various species of wildlife, among other activities. She contributes to the development of relevant guidelines for the management of wildlife and to the formulation and implementation of research projects of importance to wildlife health. She also supervises veterinary projects undertaken by KWS veterinary officers. Dr. Wambwa has special interest and participates in fora that seek to encourage and develop community-based wildlife enterprises and utilisation of wildlife to improve livelihoods.

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Chris Weaver is a rangeland ecologist with 26 years of experience in working with a wide range of common-property natural resources in the United States and southern Africa. Mr. Weaver's career commenced in 1976 on the arid to semi-arid rangelands of the southwestern United States, where he was responsible for managing and undertaking a variety of resource inventories (rangeland, wildlife, water, soils, etc.), environmental impact assessments, and ranch management plans. Clients included the Bureau of Land Management, USDA Forest Service, San Carlos Indian Tribe, Tono O'dom Indian Tribe, Navajo Indian Tribe, Hopi Tribe, Mobil Oil, and numerous private landholders.

From 1982 to 1992, Mr. Weaver was based in Lesotho, southern Africa, where he initially worked as a Range/Livestock Specialist and Manager for the Land Conservation and Range Development Project, and thereafter, the Lesotho Agricultural Production and Support Project. Since 1993, Mr. Weaver has resided in Namibia, serving as the Chief of Party for the highly successful WWF Living In a Finite Environment (LIFE) Project. In this role, Mr. Weaver oversees a team of technical staff who provide support and assistance to the Namibia National CBNRM Program and communal area conservancies in their efforts to sustainably manage and benefit from their wildlife, rangeland, and tourism resources through such income-generating enterprises as trophy hunting, game production and cropping, community-based tourism, joint-venture lodge developments, and crafts production and marketing.

In addition to the above long-term assignments, Mr. Weaver has worked throughout the southern Africa region, participating in an assortment of assignments in Botswana, Malawi, Mozambique, South Africa, Zambia, and Zimbabwe, as well as Kenya in East Africa.

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Dr. Sue Welburn is a reader in molecular epidemiology based at the Centre for Tropical Veterinary Medicine, University of Edinburgh, United Kingdom. Over the past 15 years, her research work has been centered on southeast Uganda and Tanzania, focusing on the epidemiology of human sleeping sickness and interactions at the trypanosome/tsetse fly interface. Key objectives of this research programme have been to quantify the importance of the animal reservoir of disease for human sleeping sickness and to delineate the policy implications for control options. Sleeping sickness has existed in southeast Uganda for more than 100 years, but little effort or resources have been applied to controlling the principal parasite reservoir of the disease in domestic livestock or in wildlife. Control options have instead focused on controlling tsetse flies. Considering that up to 18% of cattle in southeast Uganda may be infected with the human parasite whilst less than 1:1,000 tsetse flies are infected, it would seem appropriate to target interventions towards controlling the animal reservoir of disease.

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Dr. Michael Woodford graduated at the Royal Veterinary College, London, in 1946. After 20 years in rural agricultural practice in Dorset, UK, he spent 4 years working for the Nuffield Unit of Tropical Animal Ecology on tuberculosis in the African buffalo in the Queen Elizabeth National Park, Uganda. In 1971, he joined FAO and served for five years on the Kenya Wildlife Management Project. When that project terminated, he was posted by FAO to Afghanistan and later to Mozambique and Kenya. He retired from FAO in 1984 and since then has worked as an independent wildlife consultant for a wide variety of international agencies in 27 different countries, ranging from Greenland to the Philippines. He is a member of the Office International des Épizooties (OIE) Working Group on Wildlife Diseases and now lives in Portugal. He was the founder and first Chair of the IUCN SSC Veterinary Specialist Group.

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For the past 18 years, Angela has worked with animals in captivity at the Stanley Park Zoo (Vancouver), Dallas Zoo (Texas), and Disney's Animal Kingdom (Florida). Her interests are in animal behaviour, and she has worked closely with African ungulates for many years. More recently, Angela has been involved with *in situ* programs in Africa, South America, and Australia. She has been traveling to Peru to organize a program called "Zookeepers Without Borders" for the Detroit Zoo. Angela graduated from the University of British Columbia with a B.Sc. in wildlife management/animal behaviour. She joined the Wildlife Conservation Society's Field Veterinary Program as the assistant coordinator in May 2003.

IUCN Species Survival Commission

The Species Survival Commission (SSC) is one of six volunteer commissions of IUCN – The World Conservation Union, a union of sovereign states, government agencies and non-governmental organizations. IUCN has three basic conservation objectives: to secure the conservation of nature, and especially of biological diversity, as an essential foundation for the future; to ensure that where the earth's natural resources are used this is done in a wise, equitable and sustainable way; and to guide the development of human communities towards ways of life that are both of good quality and in enduring harmony with other components of the biosphere.

A volunteer network comprised of some 7,000 scientists, field researchers, government officials and conservation leaders from nearly every country of the world, the SSC membership is an unmatched source of information about biological diversity and its conservation. As such, SSC members provide technical and scientific counsel for conservation projects throughout the world and serve as resources to governments, international conventions and conservation organizations.

SSC Occasional Papers cover a broad range of subjects including conservation of groups of species in a particular geographical region, wildlife trade issues, and proceedings of workshops.

IUCN/SSC also publishes an Action Plan series that assesses the conservation status of species and their habitats, and specifies conservation priorities. The series is one of the world's most authoritative sources of species conservation information available to natural resource managers, conservationists and government officials around the world.

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