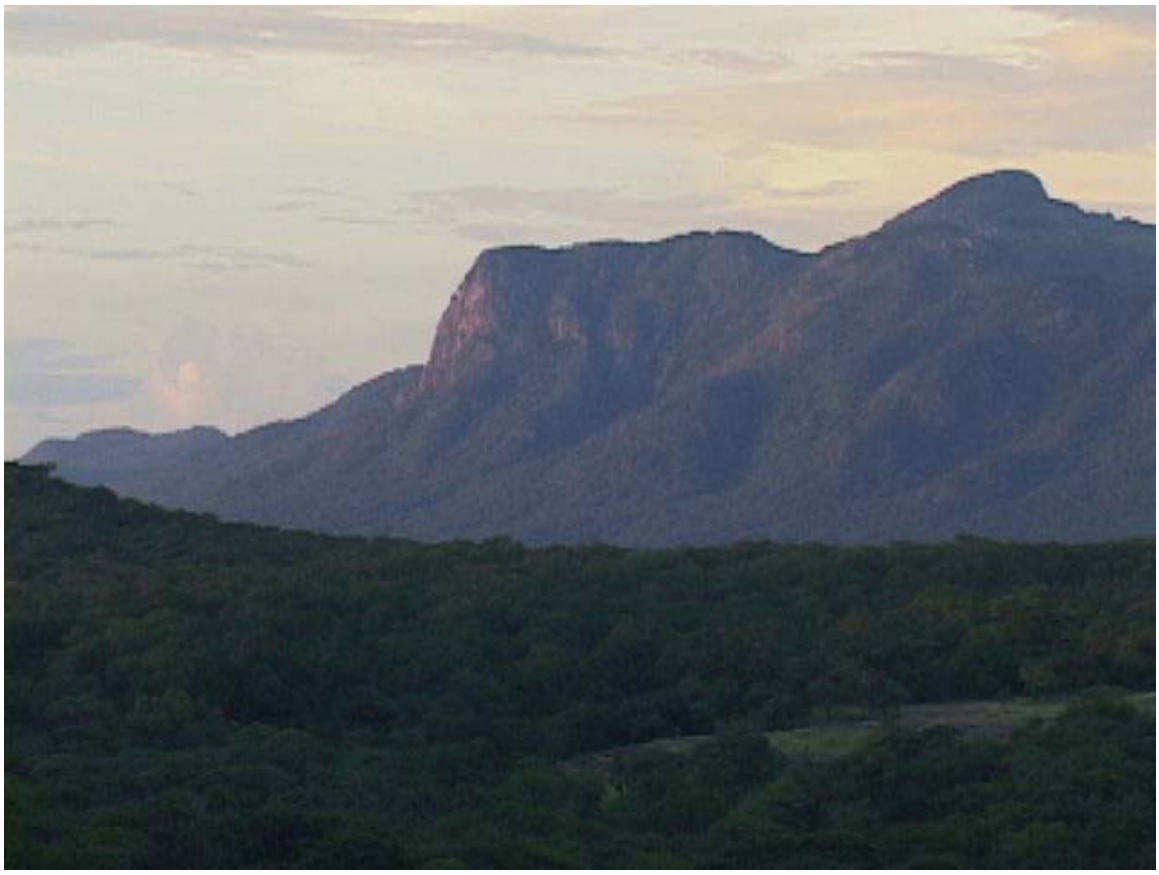
Elephant/human conflict and community development around the Niassa Reserve, Mozambique



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Consultancy for WWF/SARPO

MZEP
Mid Zambezi Elephant Project

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List of Acronyms

WWF	**World Wide Fund for Nature**
SARPO	**Southern African Regional Programme Office**
PAC	**Problem Animal Control**
MZEP	**Mid Zambezi Elephant Project**
GOM	**Government of Mozambique**
SPFFB	**Provincial Services for Forestry and Wildlife**
IUCN	**International Union for the Conservation of Nature**
PRA	**Participatory Rural Appraisal**
SGDRN	**Society for the Management and Development of Niassa Reserve**
HEC	**Human/elephant conflict**

Terms of Reference

Basic objectives

1) An assessment of the significance and nature (crop damage and human mortality) of elephant-human conflicts in the areas around Niassa Game Reserve to provide a basis for WWF planning and prioritising.

2) An exposure to MZEP methods for reducing elephant conflict and assessment of feasibility for commercial chilli production as a livelihood option for local farmers.

Methods and approach, outputs

1 An initial review of reports and literature on elephant conflict in Mozambique and specifically Niassa Province.
2 A field visit to Niassa to discuss current conflict situation with staff of the SGDRN, MFW and WWF. A field assessment of identified high conflict zones.
3 Practical exposure to key groups of MZEP methods of elephant conflict reduction (physical clearing, string fences, chilli use etc).
4 Assessment of feasibility and interest in commercial chilli production.
5 Main Output - Report on assessment and identified 'next steps' based on results of 1-4 above.

Specific tasks included:

- Assessing the level of conflict between elephants and people in the three study villages were WWF is operating.
- Give any background to the conflict and why it appears to be increasing and examine how this relates to conflict mitigation.
- Demonstrate system developed by MZEP.
- Propose training for staff to implement project.
- Provide materials to enable farmers to begin mitigation techniques.

Introduction

1) Background

Loki Osborn of the Mid Zambezi Elephant Project (MZEP) was requested by WWF to undertake a visit to Niassa Game Reserve, northern Mozambique to assess the elephant-human conflict issues there, identify potential solutions based on MZEP experience and suggest options for WWF assistance in regard to the existing WWF Community Programme for Niassa Reserve.

The goal of this first visit was to assess the scale of the conflict between elephants and people in and around Niassa Reserve and advise on methods to reduce this conflict. A series of field trips to assess possible interventions are planned and this report outlines the findings from the first trip and suggests a plan of action.

WWF/SARPO has identified HEC as a major constraint on development and sustainability of the Niassa Reserve. The conflict between elephants and people in Niassa Province on the whole is of some considerable political tension between the governor of the province and the GOM. The perception across the Province is that elephants are emanating from the reserve and it is the responsibility of those organisations working in the area interested in elephant conservation to solve the problem.

Poaching of elephant and all other wildlife is the major threat to these populations. These areas have survived relatively intact through the independence and liberation wars. The recent return of refugees and associated settlement coupled with an active trade to the north means this area is under considerable threat.

There has been no intensive survey of the level of conflict in the Province, but PRA's conducted in pilot villages suggest it is a major concern among farmers. Elephants eat most crops that are grown in this region including maize, rice, bananas groundnuts, mangos and beans. The conflict occurs mainly between November and June but dry season conflict has also been noted.

Farmers in this area suffer the normal range of constraints on agricultural production such as poor seed quality, access to chemicals, poor soil conservation, large distance to markets and post-harvest storage. In addition, most farmers reported losses to kudu, baboons, monkeys, wild pigs, porcupine other small mammals.

WWF's role in Niassa is to help understand the needs of the communities surrounding the reserve. Activities include research into fishing, income generation through handicrafts and consultations with traditional leaders.

2) Trip report

- Monday 8 April – Tuesday 9 April: Travel from Harare via Tete/Malawi to Lichinga, provincial capital of Niassa. Meeting with Antonio Abacar Provincial Head of Wildlife and Forestry and coordination with provincial government re. objectives of trip.
- Wednesday 10 April – Thursday 11 April: Travel with Abacar and scout from Sanga District to Nipepe District – site of major elephant conflict in southern Niassa. Discussion

with District Administrator and demonstration of MZEP methods. Collect Nipepe District scout for more detailed exposure to methods in Niassa Reserve.

- Friday 12 April: Arrival at Niassa Reserve HQ (Mbatamila) and preliminary discussions with Baldeu Chande (Reserve Adminstrator) and WWF Niassa Team (Costa, Manuel, Naudga)
- Saturday 13 April: Demonstration and basic training in MZEP methods
- Sunday 14 April: Meeting to identify priorities, actions, budget etc.
- Monday 15 – Wednesday 17 April: Return to Harare via Malawi/Tete.

3) Key Issues

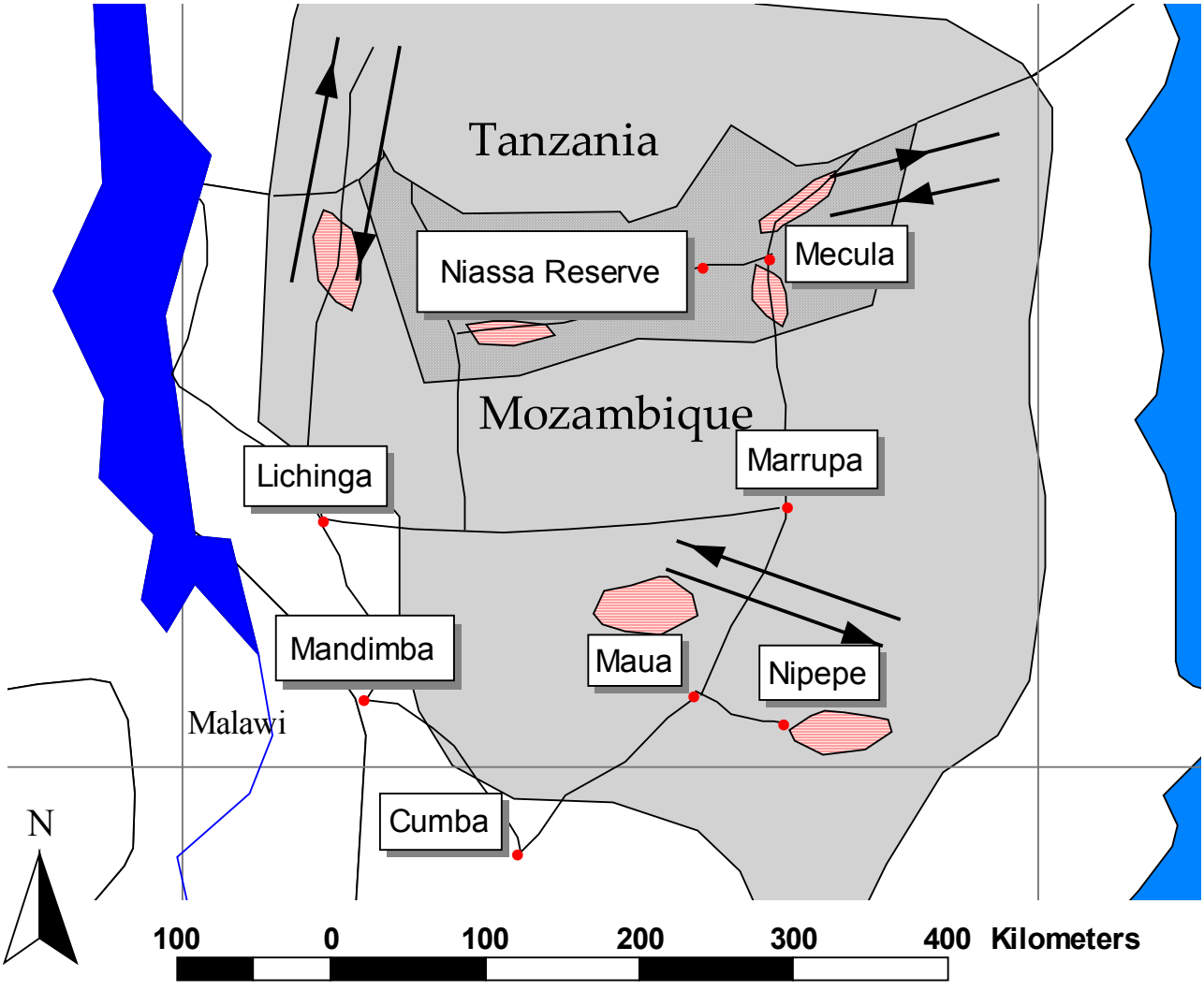
- Elephant-human conflict is a significant problem not only within the Reserve but in 9 of the 15 districts of the province. The elephant population is around 12,000 in the province with a range over around 70,000 sqkm. The major distribution is within the Reserve but considerable movements occur outside the reserve. It is unclear whether these are seasonal movements or whether a significant population is resident outside the Reserve boundaries (ie some conflict areas are 250km beyond the reserve). There are also elephant movements between Niassa province/reserve and Tanzania (eg the Selous-Niassa corridor) and between Niassa and the neighbouring provinces of Cabo Delgado and Nampula. *See attached map for details.*
- The key districts experiencing major elephant-human conflict are; Mecula (within Reserve), Nipepe, Maua and Sanga.
- Elephant-human conflict has become a priority issue for Provincial administration concern (Governor, Agriculture Director, District Administrators) and impacts appear to be rising. For example a recent provincial meeting of Administrators and Chiefs on local government issues was largely hijacked by discussions on elephant crop damage. In Nipepe district it was estimated that 18 tonnes of maize had been lost this year in the fields around the district centre and this had contributed to the recent riots in which the community attacked the administration.
- Within the Reserve the main technique to minimize elephant-human conflict has been large-scale electric fences – which now cover most of the community concentrations in Mecula district. These appear to have had some success but are costly to maintain (maintenance is paid for by communities from the dividend they receive from the buffer zone tourism/hunting) and difficult to expand to all elephant conflict areas. Outside the Reserve very limited techniques have been tried beyond scare tactics with firearms and a few elephants shot on PAC (eg Sanga, Nipepe).
- The participants (from Reserve, WWF Team, Government) were enthusiastic about the MZEP 'bundle of methods' both as an addition to what they were already doing (eg electric fencing) and its applicability to broader and cost efficient trials with possibilities for income generation from community growing of chillies/pipi-piri. Basic training and 'kits' for application were provided to both government and reserve staff and will be tried over the next few months in Mecula, Nipepe and Sanga Districts.

The final phase of the trip was the development by participants of a detailed and costed programme to take the process beyond the current reconnaissance phase.

Map

Niassa Province, Mozambique

Elephant human conflict



Areas of high human/elephant conflict

Niassa Reserve

Elephant range

Lake Malawi

Roads

Rivers

Towns

Information provided by S. Anstey

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Meeting results: Human-elephant conflict programme proposal

This meeting was held on Sunday 14th of April with the following participants:

- **SGDRN** – Baldeu Chande (Director, Niassa Reserve); Adolfo Macadona (Head of Community Unit – Niassa Reserve)
- **WWF Niassa Reserve Programme** – Amando Dario Costa (Coordinator WWF Niassa); Joao Manuel (Community Officer); Albino Batista Naudga (Community Officer)
- **Niassa Provincial Services for Forestry and Wildlife (SPFFB)** – Antonio Jose Abacar (Head of SPFFB); Sr Rocha (Head of Wildlife Sub unit SPFFB)

The discussion of realities and priorities was facilitated by Loki Osborn (MZEP/WWF); and Simon Anstey (no fixed abode) facilitated the development of the plan of action or programme proposal.

The basic aim of the meeting was for the SGDRN/WWF and SPFFB staff to identify the main problems facing them in regard to human-elephant conflict and identify priorities and practical actions to resolve these problems. A secondary aspect was to encourage a collaborative process between the SPFFB provincial activities and priorities and those more directly related to the area within Niassa Reserve (SGDRN).

The meeting started with a general overview of the situation of elephant-human conflict in Niassa based on inputs from the participants and then moved onto a more detailed process of identifying a programme of action. This was an informal process based on logical framework planning and was conducted in Portuguese to ensure the full inputs of all those present.

A) Goals and Objectives

The basic goal of the programme was:

" To reduce the elephant – human conflicts in the Niassa Reserve area and Niassa Province through a package of methods, a collaborative approach and the generation of tangible benefits to affected rural communities"

It was noted that this goal should include the relevant neighbouring areas of Cabo Delgado once this was feasible.

The immediate objectives/outputs were identified as:

- The reduction of elephant- human conflicts within **targeted areas in Niassa Province** (a particular focus on Mecula, Nipepe/Maua, and Sanga Districts) in a pilot phase 2002 to 2003.
- The **identification** of a package of methods to reduce such conflicts that was effective and feasible to apply in the context of Niassa, the development of a basic **monitoring system** and the provision of **training** in such methods.
- The **implementation** and field testing of such methods in the targeted areas

- The development of **practical collaboration** between agencies involved in human elephant conflicts (especially SGDRN and SPFFB) and improvement of communication.
- The development of **income generation opportunities** for rural communities impacted by elephants (eg commercialisation of piri-piri).
- An **assessment and redesign** of the programme in 2003.

B) Activities, Timeframe and Inputs Needed

Phase 1 Identification and Training in Methods

Aim/Activities: Training in methods of reducing elephant conflict based on an incremental approach or a bundle of methods. This to include - basic open space clearings between forest and field, noise and olfactory deterrents (eg bangers, horns etc or burning of piri-piri with elephant dung etc) simple string barriers (with cow bells, piri-piri soaked cloth or string soaked with piri piri) to the pros and cons of electric fencing. Basic training in piri piri production techniques. Introduce and identify monitoring system for assessing conflict levels and impact. Identify and develop innovative methods for dissemination of these techniques (eg theatre and song).

Who: A total of 14 staff trained in these techniques (trainers of implementers). Comprising 5 staff from the Community Unit of Niassa Reserve (including scouts from various buffer zone blocks); 3 WWF staff (WWF Niassa Community Programme); 6 staff from SPFFB (including scouts from 3 to 4 districts).
Training to be provided by Loki Osborn of MZEP/WWF

When: Final weeks of May or early June 2002 with the Training Course scheduled for 7 days

Where: Mbatamila Camp – Niassa Reserve HQ.

Inputs Needed:
- Basic toolbox of equipment to demonstrate the techniques (string, bells, bangers, piri piri concentrate, seeds etc). Estimated cost – USD 150
- Pens, notebooks, workshop paper etc for the trainees. Estimated cost – USD 250
- Transport. Largely costs for the SPFFB staff from areas such as Nipepe, Maua, Sanga and Lichinga. Estimated costs – 3,000 km @ USD0.5/km = USD1,500
- Accomodation and food. 14 participants for 10 nights @ USD15/night = USD 2,100
- Training Consultancy – MZEP/WWF. Estimated costs – Transport (USD1,000) + Consultant Fee (USD2,000)

Budget
USD 4,000 (+ MZEP/WWF consultant costs of USD3,000) = **USD7,000**

Phase 2 Implementation

Aim/Activities
For the trained staff to implement and field test the techniques identified during the Phase 1 Training Course in the targeted areas (see "Where" below)

The development and testing of options for the commercialization of piri piri and the economic viability of this income generation option for rural communities.

Who
Niassa Reserve PAC Unit
WWF/Niassa Reserve Community Unit
SPFFB (Central unit Lichinga + Nipepe/Maua, Sanga Districts scouts)

When
June 2002 to May 2003

Where

▪ Blocks A to E and NR generally	Niassa Reserve PAC Unit
▪ Musoma, Negomano, Naulala	WWF/Niassa Reserve Community Unit
▪ Nipepe, Maua, Sanga Districts	SPFFB

Inputs Needed

- Provision of 'kits' for implementation by staff (kits to include basic equipment sufficient for field testing – eg string, concentrated piri-piri, seeds, grease, slashers etc). 5 kits for Problem Animal Control + Community Units of Niassa Reserve; 3 kits for WWF team; 6 kits for SPFFB = total of 14 kits. Estimated costs – 14 kits @ USD 150 each = USD 2,100
- SPFFB costs. The Niassa Reserve group (SGDRN and WWF) have allocated funds for transport, accommodation etc, but SPFFB has no budget to cover these aspects or implementation in 3 districts (Nipepe, Maua, Sanga). Component annual costs (2002-2003) are: Transport – repair of vehicle for PAC Unit = USD 2,500; Maintenance and fuel = USD 2,000; Field Operating costs (field equipment, basic food costs) = USD 2,000. Total = USD 6,500.

Budget
Total (including SPFFB costs) = USD 8,800
Total (excluding SPFFB costs) = USD 2,100

Phase 3 Assessment and Re-design

Aim/Activities
To assess the progress of the programme, identify the strengths and weaknesses and re-design for the next phase.

Who
Assessment carried out by staff of Niassa Reserve/SGDRN + SPFFB + WWF Niassa Programme in collaboration with WWF.

When
May 2003

Where
To be identified
Inputs Needed

Meeting and evaluation costs. Estimated local costs as USD 1,000
Budget
USD 1,000

C) Action Priorities and Overall Budget

Overall Budget

Phase 1	USD 7,000
Phase 2	USD 8,800 (or USD2,100 if SPFFB costs can be separately sourced)
Phase 3	USD 1,000
Total Budget	**USD 16,800 (or USD 10,100** if SPFFB costs can be separately sourced)

Action Priorities

1. Due to the limited timeframe available WWF needs to assess whether the existing funding within the Niassa Community Programme budget is sufficient to operationalise this programme.
2. If funds are insufficient WWF may wish to seek funds for the SPFFB component from other partners or sources.

Outline of approach used by MZEP

Problems with current responses to crop-raiding

Crop damage is a widespread and common problem across sub-Saharan region. There are a number of problems that compound the effects of crop loss upon rural farmers besides the direct impact on their livelihood. These are described below in brief.

Problem Animal Control
Farmers generally perceive the control of 'problem elephants' as the responsibility of the council central units. Crop damage is at its height during the wet season when the majority of crops are grown, and these units do not have the human or financial resources to attend to most incidents. The most common PAC method used is disturbance shooting, (firing shots over the raiding animal's head) but this becomes ineffective over time and often an animal has to be shot. Communal farmers commonly resort to their own methods to defend their fields by burning fires, beating drums and throwing stones, but these also loose effectiveness as the season progresses.

Vigilance and co-operation between farmers
Elephants enter fields that are poorly defended and crop loss is correlated to a farmer's vigilance (Osborn, 1998). We found that farmers did not regularly defend their fields during the night when most raiding occurs. Lahm (1996) found that 36% of farmers in Gabon whose crops were destroyed by elephants did nothing to deter them. Being aware of the presence of elephants is therefore a key component toward improving the effectiveness of PAC.

Agriculture organisation
The majority of crop-raiding incidents involve elephants eating mature food crops which are highly nutritious and palatable to elephants. In Guruve district 73% of damage incidents were to food crops, including maize, sorghum and groundnuts (MZEP, 2001). In many communities,

maize and sorghum crops are grown in newly cleared fields abutting the forest. These crops are particularly vulnerable to elephants as they grow over two meters tall and conceal elephants as they enter the fields.

Project strategy

The project aimed to improve the livelihood security of communal land farmers in wildlife conflict areas, first through the development of an effective PAC methodology, and second through the establishment of wildlife resistant crops. To overcome the problem of elephants habituating to any single method, we used a combination of methods and ensured that all farmers took part in PAC activities. To address the issue of vulnerable crops, MZEP reorganised food crops and introduced chillies as a cash crop that is unpalatable to mammals. The methods are separated into two approaches, the first deals with PAC and the second addresses the introduction of a new growing plan.

Farmer-based PAC

Meetings were conducted throughout the year and all farmers in the affected areas discussed the problem and formulated plans for PAC. Central to these discussions was agreeing that they have to take responsibility for their own crop protection and that co-operation between farmers is essential for deterring elephants.

The PAC methods were divided into three categories. First, vigilance methods were designed to alert the farmers to approaching elephants and increase the chance of farmers spotting elephants as they approached the fields. Second, passive systems were designed to impede a crop-raiding elephants' passage into the field using simple physical barriers and deterrents. These were established at the onset of the rains and required no attention other than maintenance. Third, active PAC methods to be used by farmers to chase crop-raiding elephants and included chilli-based chemical deterrents and noisemakers.

Vigilance methods

***Buffer Zones**: Farmers were asked to clear a five metre wide buffer zone around their fields (or in some cases along the edge of the whole village) to increase sightings of advancing elephants.

***Watchtowers**: Farmers with fields on the forest boundary built watchtowers at approximately half-kilometre intervals to increase their vigilance capacity.

***Whistles** were distributed to farmers along the boundary so they could alert other farmers when elephants were approaching the fields.

***Fires** were kept burning all night in areas where elephants came regularly. These fires were also used to burn the pepper dung (see below).

***Cowbells** were placed at 30m intervals along a string fence (see below) to alert farmers when elephants came to the fields.

Passive methods

***String fences:** Farmers cut three metre poles and placed them at 30 metre intervals along the buffer zone. Bailing twine was strung between them and squares of burlap were tied at 5 metre intervals along the string.

***Grease and hot pepper oil** were mixed together and applied to the string. As elephants made contact with the string, the grease caused irritation to their skin.

Active methods
***Pepper dung:** Elephant dung was mixed with ground chillies by the farmers then dried in the sun. These bricks were burned in fires along the field boundaries to create a noxious smoke.
***Whips** made of bark were made by the farmers that, when used properly, made a loud 'crack' similar to a gunshot.
***Fire crackers** were used by farmers to chase elephants from the fields by throwing them above the animals.
***Pepper spray** was used on occasion when the elephants did not respond to bangers (Osborn 2000).

People contacted during visit
Chande, Baldeu (Director, Niassa Reserve)
Abacar, Antonio Jose (Head of SPFFB)
Macadona, Adolfo (head of community Unit, Niassa Reserve)
Costa, Amando Dario (Coordinator WWF Niassa Reserve)
Manuel, Joao (Community officer)
Naudga, Albino Batista (community officer)
Rocha, Sr (head of Wildlife Sub-Unit SPFFB)
Benson Kaputi Guard from Chipanje Cheu Programme (north Sanga District)

References
Strategy for the management of elephants in Mozambique DNFFB Ministry of Agriculture April 1999 (National plan for the reduction of HEC (ID Problem areas)

Aerial Survey of Wildlife in the Niassa Reserve and hunting concessions (Oct-Nov 2000)

Community-based natural resource project (CBNRM) in Niassa Reserve Mozambique SGDRN/WWF SARPO Nov 2000

Selous-Niassa wildlife corridor UNDP/GEF June 2001

Appendix 1 General recommendations on human/elephant conflict issues

This document reviews the current literature on the subject and makes recommendations for the incorporation of a variety of methods to be used to either augment existing fencing schemes or to act as alternatives to fences.

Introduction

Animal damage control is a means to accomplish an objective and never an end in itself (Hawthorne 1980). If the objective is to 'reduce the conflict', then raising tolerance to the damage is as important as reducing the damage itself. In some cases a pest animal is legally protected or simply cannot be repelled from fields. In some countries, a multi-faceted approach is adopted where farmers are compensated for their loss, attempts are made to repel pest species and the communities are 'educated' to the values of living with this animal. Thus, these points highlight not only the technical problems with controlling predation, but the social costs as well.

Wild animals and rural people

The relationship between most wild animals and rural people has, historically, been antagonistic. Either people hunted animals for food or animals ate peoples' crops and livestock, or occasionally the people themselves. There are a few exceptions where a 'neutral' relationship exists, usually for religious or cultural reasons (Crosby 1986). Yet there are few examples where wildlife and humans, living in close proximity, coexist without conflict. Almost all wild animals are potential competitors or threats. Birds of prey eat chickens and ducks, other birds eat grains, reptiles are generally feared and most mammals will feed on either livestock or crops. Wild animals that directly compete with humans for resources such as food or water quickly become 'problem animals' (Eltringham 1980). Traditionally, a balance could be reached in which people were compensated for their losses by hunting the animals that consume human foods. During the colonial era, legislation in developing countries was enacted that outlawed this subsistence hunting. Some countries are attempting to redress this imbalance by allowing communities to manage their own wildlife. This point is central in addressing the frustrations and subsequent lack of co-operation which can occurs between the institutions tasked with managing elephants and the affected farmers.

Problem animals

Controlling damage by wildlife has been the subject of research by biologists for decades. Wildlife managers are often confronted with a situation in which a resource, either naturally occurring or farmed, is consumed by wildlife. Essentially to 'control' problem wildlife simply means to reduce the impact of the wild animal on the resource to within tolerable limits (Monaghan & Woodgush 1990). Wildlife damage control is, essentially, the art of trying to reduce the impact of a particular species' natural habits on an item which humans value (Dolbeer *et al*. 1994). In the past, efforts were made to destroy the 'pest' species entirely, but this often proved to be more difficult than it first appeared. For example, thousands of elephants were shot in the forests of Uganda because they fed on tree species which were valued as timber (Laws *et al.* 1975). Even under sustained hunting, all the elephants could not be eliminated from the Ugandan forests. Smaller and faster reproducing creatures are nearly impossible to destroy completely. Eventually, a cost/benefit analysis must dictate the value of a sustained assault on pests. We have, grudgingly, to be satisfied with limiting the impact of their predation. Ethics are increasingly included in the decision making process regarding 'pest management'. Endangered animals that are also pests, present a particularly troublesome problem philosophically as certain sectors of society may want a

species to be preserved, while communities affected by the damage want them eliminated. Therefore, controlling pests is not merely a technical problem, but a social and ethical dilemma as well.

Rodents and invertebrates receive the greatest attention within the vast literature on modern pest management (Naughton-Treves 1996). Rodents cause an estimated $60 million worth of damage to forest plantations in the north-west of the USA annually (Dolbeer *et al.* 1994). It is estimated that bird damage to agricultural crops is a multi-million-dollar problem in the United States (Dolbeer *et al.* 1994). Larger animals are, however, of increasing concern and considerable research has recently focused on reducing the losses incurred through large mammals. Wild ungulates damage thousands of hectares of trees in plantations and forage on commercial crops. Annual losses of livestock to mammalian predators is estimated to be $150 million in the western USA (Wade 1982). Leopards are a serious source of revenue loss on commercial ranches in Kenya (Mizutani 1995). In sub-Saharan Africa, lions, leopards and other predators kill substantial numbers of livestock that often leads to the destruction of the animal in retaliation (Stander 1990).

Crop damage in Africa by potentially life threatening species such as hippos, buffalo, rhinos and elephants poses a particularly difficult problem. These animals can be extremely dangerous to hunt by 'traditional' methods (snares and spears) and farmers can be killed trying to defend their crops from them. These species are generally perceived by people as property of the State. The State institutions responsible for protected areas are, therefore, considered responsible for control of *their* animals. These institutions are generally ill equipped to do this and in turn are blamed for losses to crops and property. Rural farmers are, for the most part, left to their own devices to defend their crops. The problem escalates when an animal, wounded by snares or spears, ultimately kills a person.

The need for new approaches

The loss of available habitat for elephants through agricultural encroachment has intensified friction through increased contact with humans and competition for natural resources (e.g. water, crops). Wildlife barriers, such as electric fencing and moats, have met with success in protecting small areas or cash crops (Blair and Noor 1980, Hoare 1992) but the materials, installation and maintenance costs make these methods impractical for large-scale applications in poorer developing countries unless funded by international aid agencies.

Traditional methods for repelling elephants from fields such as beating drums or pans, shining torches and throwing rocks are generally ineffective, and many people are killed by elephants in the process. The solution often employed by wildlife managers for habituated crop-raiders is to shoot the offending animal. In many situations the individual elephant responsible cannot be re-identified, and a token animal is killed to appease local people. This 'solution' does little to deter other crop-raiders.

Conflict between elephants and people is growing in many countries for three general reasons. Firstly, tremendous human population growth and subsequent demand for land has isolated many elephant populations. Secondly, demands on resources of National Parks agencies throughout Africa have increased, while budgets and staff numbers have declined. Thirdly, the specific reasons why elephants raid crops, and cost effective methods of deterring this behaviour have not been fully explored.

General pest control techniques
Prevention of many conflicts between animals and people can be achieved by excluding unwanted animals from a resource or decreasing its attractiveness to the animal (Hunt 1984). The technique selected to limit crop damage is often specific to the species involved. Thus the first step in developing a strategy for controlling pests is a broad understanding of the ecology of the target species. Generally, three methods of control are available to wildlife managers; habitat modification, lethal action against the pest species and non-lethal action.

Modification of habitat has proven effective for reducing damage caused by avian pest species. Modifications include making roosting and feeding sites less attractive to birds by removing preferred trees and planting 'lure' crops near commercial fields (Dolbeer *et al.* 1994). Planting forbs preferred by deer and elk in areas with seedlings of forest plantations has been reported to reduce damage to seedlings (Campbell 1974). In India, bamboo has been dispersed by dropping the seeds from a plane over the forest to provide more forage for elephants (R. Sukumar pers. comm.). These methods are not generally practical for large scale applications in developing countries and may have limited long term effectiveness, if any, towards reducing crop loss.

Lethal methods of control
Lethal controls are usually used for animals that are common, such as certain rodents, small carnivores and some bird species. Methods include a variety of traps and snares, poisoning a carcass and 'baiting' or calling a predator and then shooting it. The response to crop-raiding elephants has been to send wildlife personnel to the location to assess damage then attempt to kill one or more from the problem group. It is generally believed that shooting an elephant at night while it is raiding was the best way to 'teach' the other elephants to stay away. The meat is then given to the people to appease their anger and compensate for crop losses. While this method is still practised to some degree throughout much of the elephant's range, most wildlife managers feel that it is generally of little long-term effect and is a drain on a valuable resource. In many situations, the elephant responsible for majority of the damage cannot be identified, and a token animal is killed. Discussions with problem animal control officers across the southern African region indicate that shooting an elephant while raiding can have some deterrent effect on other raiders in certain situations, but the effect is temporary. Bull groups seem not to be as affected as cow groups, but often the reaction is merely to change areas of raiding rather than to stop altogether.

Non-lethal control methods
Non-lethal methods of controlling animals require a more detailed understanding of the behaviour and requirements of the pest animal. The removal of a problem animal through **translocation** is widely used with large carnivores such as leopards and lions in Africa, tigers in Asia and bears in North America. This technique is successful in reducing livestock loss to lions if the individuals are 'occasional' raiders (Stander 1990). More information on elephant translocation can be found elsewhere in this report.

Repellents and deterrents
Other non-lethal methods include systems that repel or deter animals. It is necessary to make a distinction between a repellent (something that wards off, or repulses) and a deterrent (something that hinders or discourages). Hunt (1983) offered two definitions in the context of capsaicin spray research on bears; "repellents are activated by humans and should immediately turn an animal away in a close approach or attack. A deterrent should prevent undesirable behaviours by turning

an animal away before a conflict occurs. Deterrents need not be monitored or manually activated by humans ".

There are three basic types of repellents, all of which attempt to 'frighten' an animal from an area to be protected. The simplest are **visual repellents** and are used mostly for birds that cause crop damage. A range of 'scare crows' or balloons with 'predator eyes' painted on them can have a temporary effective in reducing crop loss. **Acoustic repellents** are also commonly used for birds and include propane cannons which produce loud explosions at timed intervals. Recorded alarm or distress calls of birds broadcast over a speaker system can also frighten birds (Bomford & O'Brien 1990). Some success has been reported with acoustic systems but if they are not regularly moved and maintained they quickly diminish in effectiveness. **Chemical repellents** are used extensively for the control of crop damage by insects, birds and mammals. The use of long lasting, passive deterrents is an active area of research in Europe and North America. A variety of non-lethal repellents specific to birds have been used to protect important agricultural crops (Avery 1989, Mason 1989, Nolte *et al*. 1993b). Apples poisoned with methiocarb are effective as a repellent to black birds by eliciting conditioned (*i.e.* learned) avoidance of treated foods via post-ingestional malaise (Conover 1984). When 'Avitrol', a chemical widely used for bird pests, is ingested, an affected bird emits distress cries while flying in erratic patterns before dying. This behaviour frightens the rest of the flock away from the targeted fields for some time (Dolbeer *et al.* 1994).

Among mammals, mink and coyote urine deterred mountain beavers from damaging Douglas fir trees in the western United States (Nolte *et al*. 1993a, 1993b). North American deer have also been shown to avoid predator urine (Melchiors & Leslie 1985, Muller-Schwarze 1972, Sullivan *et al.* 1985, Swihart *et al*. 1991). Elk were deterred from feeding on alfalfa by coyote urine (Andelt *et al*. 1992). In addition, many naturally occurring plant secondary compounds are known to deter feeding in herbivores. Plants which produce phenolic compounds appear to repel vertebrates without being toxic (Crocker *et al*. 1993) and could be a fruitful source of chemical repellents in the future.

The results of chemical tests aimed at repelling elephants involving a German manufactured deer repellent "HATE-C4" placed around fields in Malawi and South Africa were equivocal. In Malawi, Bell (1984) reported no significant decrease in crop damage but in South Africa, La Grange (1989) reported positive results with "HATE-C4" although no details were given.

Traditional ways to control crop damage by elephants

Currently, the options for reducing conflict between elephants and people fall into two general categories; passive and active. **Passive systems** are permanent and do not have to be administered by a person. These include a wide array of physical barriers to elephant movement such as trenches and fencing. **Active systems** include traditional methods of chasing elephants or killing individual 'problem animals'.

Passive barrier systems

A large body of work exists on various experiments with passive systems, especially fences. Fencing is dealt with extensively in other sections of this document, but are mentioned here to lead into a discussion of 'traditional barriers' (e.g. thorn and stone barriers). There are two types of fences for elephants; electrified and non-electrified. Strong, **non-electrified fences** have been used successfully to restrict elephant movements in many parts of Africa and Asia. These fences are usually built with wooden or steel poles or railroad tracks driven vertically into the ground.

Heavy gauge wire or cable is strung between the poles and drawn tight. While these fences do meet with some success, they can be expensive to erect and maintain. Currently most efforts to control elephants use electrified fences that have been well-tested in zoos, game ranches and protected areas.

Electric fences have also been successful in protecting small farms or cash crops. However, the materials, installation and maintenance costs make these methods impractical for large-scale applications in poorer developing countries unless funded by international aid agencies. Thouless and Sakwa (1995) concluded that elephants can overcome each modification, meaning that a fence's effectiveness is not determined by design, construction and voltage. Rather than an expensive 'arms race' with crop-raiding elephants over fence features, efforts are better invested in active management of low-cost, low-technology fences, including vigourous treatment of fence-breaking elephants from the start, to instill recognition in the elephants that the fence demarcates a 'no-go' area.

In Asia, digging **trenches** along a Park boundary or around water points has been pursued with varying degrees of success. The goal is to dig a trench which is wide and deep enough that an elephant cannot step over it (elephants are not able to jump). In some places, trenches are filled with pointed sticks to further deter elephants from crossing. Trenches, in conjunction with electric fences, have worked well if both are well maintained. The major drawback with trenches are that, if dug on a slope, they encourage soil erosion. Elephants have also been known to fill them in by kicking soil from the edges into the trench, thereby filling it and enabling them to cross (Sukumar 1989).

Other barriers

As noted above, there are many types of barriers designed to restrict elephant movements. Across Africa and Asia, farmers attempt to construct barriers around their fields and homesteads to deter elephants. Often these barriers have little effect and elephants walk right through them, but there are barriers that do appear to have some effect. Rural farmer's experiment with different types of barriers and these designs need to be studied and tested. One of the most common barrier materials used is made from thorn branches. Logs and sticks are also piled up around the edges of fields. In some areas farmers simply run bark ropes from tree to tree and hang pieces of white cloth from the line. None of these barriers can stop a determined elephant but any boundary to cultivated area creates a psychological barrier that can have some impact to limit incursions. The most important aspect is the availability of the materials to build the barriers.

Active systems

The most common way that farmers attempt to chase elephants out of fields is by shouting and banging metal objects to make loud noises. This is known as the **'drive them away' defence**. Farmers use a range of noisemakers, such as beating drums and tins, 'cracking' whips in addition to yelling and whistling to chase elephants. These noises are usually accompanied by fires, either located on the boundaries of fields or as burning sticks which farmers carry with them. They may also throw rocks, burning sticks and, occasionally, spears. These methods have a varied range of effectiveness depending on how and when they are applied. Traditional methods (as they will be referred to henceforth) for repelling elephants from fields tend to lose effectiveness after repeated exposure. Many authors note the plasticity of elephant behaviour (*e.g.* Moss 1988, Sikes 1971). Some crop raiding elephants quickly **habituate** to 'empty' threats (*e.g.* drum beating, shouting, *etc*.), and, in some cases, persistent bulls are not deterred by gunfire, including shooting one of the group.

Traditional repellents and cooperative defences
Some traditional defences are better than others at reducing crop loss. In fact, farmers do not regularly defend many fields in Africa during the night. For example, Lahm (1996) found that 36% of farmers in Gabon whose crops were destroyed by elephants did nothing to deter them. Although no deterrent efforts are entirely effective, they may considerable reduce the amount of crops lost to elephants. Thouless (1994b) points out that old established villages in Sri Lanka people are accustomed to working together and have an understanding of the habits and movement routes of elephants. Some communities have established community-based approaches toward reducing conflict with elephants. Farmers cooperate by a system of rotating 'guard duty' whereby only a few farms patrol during the night and when an elephant is sighted; other farmers are woken to chase them away.

Options for reducing conflict
The causes of conflict are complex and difficult to resolve. There is a need for short-term immediate measures to be taken in some areas, as the political pressure to 'do something' is very high. However, it should be recognised that it is more important to address the underlying causes of the conflict if a lasting solution is to be found (see section on long-term solutions). This section examines some 'quick fix' options that can have some impact in reducing crop-damage.

Working with an affected community
First, it may seem obvious, but it is essential to bring farmers into the process of solving conflict situations. When elephants destroy crops or damage property the pressure on wildlife authorities to react can be very great. Farmers generally feel that wildlife managers are responsible for crop losses to elephants and expect some form of compensation. Farmers who are losing crops to elephants feel powerless to combat the problem. One way rural people can show their anger is to stop cooperating, or even sabotage government or foreign-funded development projects.

Community members in conflict areas often voice 'research fatigue' (i.e. 'lots of researchers ask us what we think but nothing happens'). Researchers often promise or suggest unreasonable solutions to the problems between the Park and community. Permission to conduct research should be granted in consultation with the organisations working in the communities. This research can be very political and only projects that benefit development efforts should be allowed. Also, most research tends to be focused on the communities that are easily accessible. It is important to educate local people to take responsibility for the problems of crop pests, as, realistically, no agency has the resources to solve the problem. However, various 'tools' can be provided by donors for farmers to use to reduce crop loss.

It is essential to have accurate information about when and where the conflict is occurring. Simple crop damage monitoring schemes are very important for gathering information that can be used in drawing up a strategy to combat the problem. Effort should be put toward getting a community to try to anticipate periods and areas of conflict. Research suggests that the same fields usually get raided every year. Also, it is generally far more effective to try to prevent crop loss before it happens. Once elephants taste crops it is far more difficult to deter them. Preventative control is most effective in the long-term as it leads to general awareness among people

Experimental methods for deterring elephants: passive and active
No one system will stop the problem altogether, so a combination of techniques can be employed to reduce the conflict and increase tolerance to crop loss.

Unpalatable crops and barrier vegetation
Little research exists on elephant 'preferences' for particular crops, but there are a few crops that elephants appear not to eat. An obvious way of reducing the attractiveness of cultivated areas is to plant crops on the edges of protected areas, such as tea or oilseed, which are not consumed by elephants. A barrier of distasteful crops, of at least 1-km width, should be grown around areas of tempting crops (Santiapillai 1997).

Mauritius thorn (*Caesalpinia decapetala*) has been planted in a number of locations in Africa to act as a 'natural barrier'. However, there is very little data to suggest that this barrier is effective against elephants. If a programme is to be introduced, monitoring should include an assessment of the effectiveness of the thorn as a 'pest control' fence. It is not clear that the fence will deter elephants and there is little conclusive evidence that this fence will work against primates or bush pigs. This plant is known to be very invasive in other areas of Africa and its distribution by animals (through eating and depositing the seeds) into a protected area should be closely monitored. Cactus and sisal have also been tried but little systematic research exists on the effectiveness of these plants. Also, it appears that in some areas farmers do not participate in a barrier-planting scheme due to a concern that it will restrict their access to the forest.

Alarm systems
There is often some distance between the homestead of a farmer and their fields. A watchman must stay awake all night in anticipation of a visit by elephants. The loss of sleep by farmers defending fields and the subsequent consequences on their other activities can be measured as one of the social costs of crop-protection. Simple alarm systems can be set up using string and tin cans that will be disturbed when an elephant tries to enter a field (see Osborn & Welford 1996 for a design)

Drive them away defences
There is a wide range of noisemakers and visual repellents that do appear to have some short term repellence for elephants. One system that works particularly well involves a number of people with well constructed whips and a long pole on to which a large bundle of dried grass is tied. Some whips are able to make a sound similar to a gun shot and five or six people snapping these can make a substantial amount of noise. Reports from India suggest that elephants are frightened by fires on the top of a long pole. If used together, whips and fire on a pole, this makes an effect repellent. However, as with all 'false threats' persistent elephants will eventually habituate to this system.

Acoustic deterrents
Kangwana (1993) played-back recordings of Maasi cattle noise to elephants in Amboseli NP, Kenya. These elephants are periodically hunted or injured by the local Maasi tribesman. She concluded that elephants retreated from the recordings because of an association made between the danger posed by the Maasi, and the sounds of their cattle. A number of studies of elephant communication have demonstrated possibilities for manipulating elephants' behaviour with playbacks of vocalisations (Langbauer *et al.* 1991). Bull elephants were attracted by playbacks of recorded 'post-copulatory rumbles'. There are a number of other calls that could be used to attract or repel elephants that are less well understood, but perhaps could be used in the future. Whyte (1993) suggests that elephants may be emitting low frequency distress calls when they are being culled. If true, these vocalisations could be very useful for repelling elephants. The problems with using elephant vocalisations as a repellent are: 1) most are of very low frequency and thus require

expensive equipment to record and playback; 2) that a large repertoire of recordings would probably have to be used to avoid habituation, and 3) the potential exists for disrupting normal communication and social systems.

In Namibia researchers tested a system using sirens that were triggered when elephants made contact with the trip wire. They reported some success (O'Connell 1995).

Chemical repellents

Protecting a resource item (such as crops) from animals with a chemical compound with which the animal is unacquainted may be less effective than a biological product that the animal has repeatedly encountered in its environment. These responses are dictated by genetic selection pressures, learning experiences and instinctive propensities of particular species (Bullard 1985). Understanding the repellent and attractive properties of natural scents and their components is in the initial stages of development. Tests are planned to assess the effectiveness of chemical repellents that include natural products such as elephant pheromones or other semio-chemicals. Such chemical communicators could prove to have long-term biological effectiveness and, as with insect pheromones, could be synthesised and used in economically viable pest control programmes.

Chemical compound(s) with potential species-specific deterrent capabilities may prove an effective way to deter elephants. Gorman (1986) tested African elephant temporal gland secretion as an elephant repellent with somewhat ambiguous results. However, areas of potential research include the recent study of the chemical senses of Asian elephants and the way in which female elephants communicate sexual receptivity (Rasmussen *et al*. 1993, 1996, 1997). The ongoing studies of female elephant awareness of chemosignals emitted by Asian bulls in *musth* (Perrin & Rasmussen 1996) also offer possibilities for future elephant attraction, repulsion and containment. The avoidance reactions exhibited by female elephants to atomised secretions collected from the temporal glands of *musth* bulls (Perrin & Rasmussen 1996) are also potentially useful as a repellent for non-*musth* bulls. Recent tests with chemicals present in *musth* secretions, one ketone in particular, seems to prevent elephants from consuming food items encircled by rings of dilute concentrations of this naturally occurring ketone (L.E.L. Rasmussen pers. comm.).

It has also been suggested that elephants secrete different chemical components through the temporal glands depending on differing situations. Male African elephants secrete different hormones from their temporal glands when they are in and out of musth (Rasmussen *et al*. 1996). Stress, which is known to alter hormone levels in elephants (*e.g.* female Asian elephants during childbirth, ill health or disruption of social organisation), could potentially influence the composition of chemical signals (L.E.L. Rasmussen pers. comm.). Synthesised temporal gland secretions from periods of intense fear (*i.e.* culling) could be used as a repellent, if elephants produce a 'fear pheromone'.

Mason *et al.* (1993) states that often the avoidance of repellent chemicals is immediate and without the *ingestion* of the chemicals by the animal. This would suggest that the senses of taste and smell are not involved as the repellents act by stimulating trigeminal pain receptors in the eyes, nose and mouth. (Mason *et al.* 1996). This fact may have implications for understanding the reaction of elephants to capsaicin spray (see other attached document).

Medium and long term solutions

Buffer zones

The 'hard edges', or boundaries of dense human settlement abutting a protected area, tend to be areas of high conflict between wild animals and people. Numerous park planners have suggested the creation of a buffer zone around protected areas where human influence is graduated, thus relieving the pressure on both the protected area and the surrounding human population.

The concept of buffer zones denotes different meanings to people who are involved with the management and utilization of protected areas. All unfenced wild areas have zones along their boundaries, in some cases quite small, which are affected by human activities. A buffer zone is defined as a "physically delineated area, either within or adjacent to a protected area, which may or may not be formally gazetted" (Buckley 1990).

In Sri Lanka, buffer zones were created by establishing grasslands adjacent to protected areas that were heavily over-grazed by domestic livestock (Seidensticker 1984). These wide-open areas were intended to deter elephants from leaving forests. It is surprising that this idea was suggested as it is unfeasible in the developing world where land is at a premium and there is no evidence that this type of buffer zone has any impact as a deterrent. This typifies misconceptions about buffer zones and their management and has given the concept a negative image among many rural people.

Taylor (1983) addresses the issue of buffer zones in the context of National Parks and rural Africans in Zimbabwe. With the progressive eradication of the tsetse fly in the Sebungwe region of Zimbabwe, large numbers of people have moved into this region. The immigrants have tended to aggregate along the fences that have been erected to limit the movement of game animals that are hosts for the fly. The old policy of game elimination in these tsetse-free zones and the prohibition of cattle precluded livestock production, thus obliging locals either cultivate or to hunt illegally to survive. The maintenance of these rigid barriers between national parks and the rural population will eventually create "islands {protected areas} surrounded by ecological slums" (Taylor 1983).

There are two approaches to buffer zones with regards to elephants. The first is to create a zone of reduced attractiveness between the protected area and the surrounding crops (Thouless 1994b, Seidensticker 1984). This involves clearing secondary forest on the boundary and creating some physical distance between the boundary and cultivation. An optimal buffer zone should contain unpalatable crops (such as sisal) grown adjacent to sub-optimal elephant habitat (Thouless 1994b). There is, however, no evidence that such boundaries make the slightest difference to elephant movements as the elephants can just pass through them to the cultivation.

Taylor (1982), on the other hand, suggests that a multi-use buffer zone concept that allows limited exploitation of game in areas which are poor agriculturally and where livestock are restricted. Removal of fences, and thus the 'hard edge', would relieve compression on the game as they would be free to disperse. Animals would be hunted in this area and the benefits would go to the local population. This option for elephants, is however, not culturally acceptable in most of Asia for religious reasons. A marriage of the two buffer zone concepts, where elephants are harassed in a multi-use zone may be useful in the Asian context.

Management of elephant populations

Throughout the elephant's range, human pressures (*e.g.* poaching and agricultural encroachment) have disrupted elephant dispersal and the use of available food resources (Laws *et al*. 1975, Hanks 1979, Lewis 1986a). There may be no place in Africa where there is sufficient space for an elephant population to exist without experiencing human pressures of one type or another. This pressure acts, in turn, as a modifying agent to patterns of range utilization by elephants (Lewis 1986a). Problems with the management of elephants are a manifestation of the growing human pressures on the lands over which elephant's range (Taylor & Cumming 1993).

Protected areas that are used by elephants are difficult and complex to manage. Elephants alter landscapes by consuming vast amounts of food and require large areas in which to roam. It is, therefore, considered necessary to maintain elephant populations so that habitat change is kept within specified limits or risk irreversible modification of the protected area (Taylor & Cumming 1993). Many protected areas in Africa are not big enough to cover the ranges that elephants need for their maintenance, especially in times of drought (Hanks 1979, Western & Lindsay 1984).

A considerable amount has been written on the philosophy and practical application of management decisions (*e.g.* MacKinnon *et al*. 1986, Dublin & Taylor 1996, Lusigi 1992, Bell 1984). Most authors agree that there are both objective and subjective aspects to management and the key is to be clear about what the management objectives are for a particular area. Decisions which managers of protected areas implement, may have long reaching implications not only for the reserve, but also for the surrounding areas where people live. It is, therefore, essential, to take the effects of decisions on surrounding people into consideration when developing management plans (Dublin & Taylor 1996).

Many protected areas with elephants are experiencing vegetation change caused by a combination of elephant feeding and fire. Different approaches are adopted by managers depending on ethical and/or scientific considerations. The most contentious issue that bedevils decision makers is whether a population of elephants should be allowed to grow and destroy woodlands, or if it should be removed by culling.

If, however, when over-utilization occurs, elephants are motivated to exploit unbrowsed vegetation that exists outside the confines of a protected area. Thus, allowing elephant populations to exceed the food available to them, in the hope that elephants and woodlands will some day reach a balance, could be fuelling elephant/human conflict.

Land-use planning

Conservation of elephants in areas where they live side-by-side with people will depend on an integrated approach to land use and the elephant's productive role in the local economy (Taylor 1993). Unfortunately, land-use plans are rarely implemented in Africa, but are still of value as a guideline for development. In the Sebungwe, Taylor (1993) outlined macro and micro plans for the district that included the designation of multi-use wildlife areas within this district. On the micro scale, the siting of fields in relation to elephant movements may be easier to implement then district wide schemes. In Sri Lanka, for example, an effort has been made to concentrate homestead gardens closer to villages where they are less likely to be damaged by elephants (Thouless 1994b). Secondary growth on the edges of forests in Sri Lanka is prime elephant food and gives them cover when approaching villages. Farmers are clearing this thick growth around the edges of fields. Elephants were most likely to raid fields next to patches of jungle and fields that are planted some distance away from houses (Thouless 1994b).

Bell (1984) states that as elephant density is related to landform (*e.g.* elephants are found in higher densities in 'valley' landscapes than 'plateaus'), farms in valleys are subject to more crop-raiding pressure. Elephants also tend to approach agricultural areas along streamlines, a trend that is seen throughout southern Africa (Osborn & Welford 1987). Levels of damage vary widely, depending on the location of the field, the crop grown and the vigilance of the farmer.

Some Recommendations

- Address farmers' complaints about crop loss
  - Local authorities should respond swiftly to requests, using the appropriate central body to resolve the situation.
  - The decision to kill problem animal(s) should be made officially, not in unilateral rural action.
  - Educate local people to take responsibility for the problems of crop pests, as, realistically, no agency has the resources to solve the problem.

- Suggest a range of options for deterring elephants
  - Identification of 'hot spots' for 'low tech' deterrents
  - Encourage 'low tech' options for reducing crop loss

- Educate farmers, game rangers and community conservation staff about elephant ecology
  - Instruction of staff in skills for dealing with affected farmers and strategies for reducing negative attitudes toward elephants
  - Conflict occurs in complex ecosystems and knowledge of the basic biology of these elephants is a key component in the development of a predictive system for reducing conflict.

- Explore ways to make a community benefit from living with elephants

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Appendix 2 Photos

Demonstration in Nipepe Village

Demonstration in Niassa Reserve with scouts

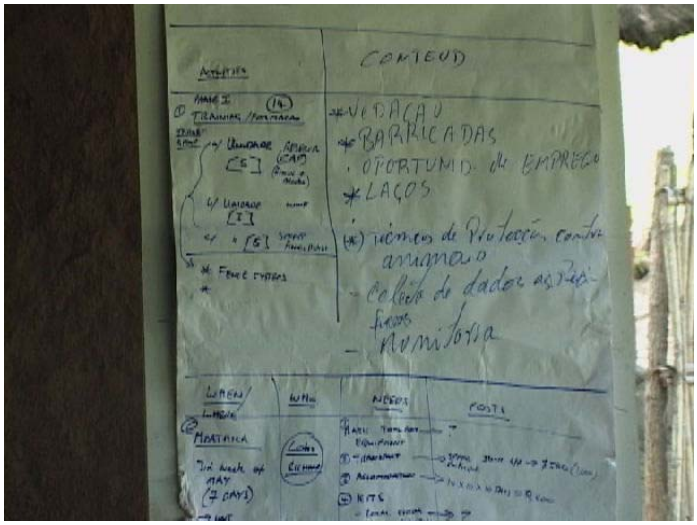
New WWF computer equipment

WWF truck and staff leaving for a field trip

Native Chilli peppers in Nipepe

The roads of Niassa

Meeting with stakeholders in Niassa Reserve



Findings of the workshop

Participants in the workshop

Gate for one of the three electric fences

Applying chilli grease to string fence

Farmers tending chilli seedbeds in Zimbabwe