CROP LOSSES CAUSED BY WILDLIFE & MITIGATION MEASURES IN KWANDU & MAYUNI CONSERVANCIES

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12th October 2003

Dear Chris,

Please find the enclosed report on 'Crop losses caused by wildlife and mitigation measures in Kwandu and Mayuni Conservancies' as agreed by NNF and myself in the conditions of the NNF Micro-Grant. I hope you feel the work is of use.

I have also included a copy of the report in electronic format on the enclosed CD and additionally I have put a copy of my MSc dissertation to which this research also went towards, on this CD (although to be honest the report probably provides more detail and less waffle than the dissertation!).

I would like to take this opportunity to thank you, not only for agreeing to help support my research financially, kindly providing me with office space and pointing me in the right direction at the beginning, but also for taking the initial chance with me. I realise you must receive many similar requests for support every year and I really appreciate the opportunity given. Personally I felt I learnt a whole lot more than just the research I covered in this report, a truly valuable insight into rural development through conservation efforts and additionally an enjoyable experience.

If you have any queries with the report please contact me at the above.

Best wishes,

Katharine Evans

Summary

This report considers the feasibility and economic viability of measures aimed at reducing wildlife caused crop damage in Kwandu and Mayuni Conservancies, Caprivi. Unless adequately addressed, human wildlife conflict could potentially jeopardise the outcome of the conservation efforts implemented by CBNRM schemes in the region.

Household interviews were conducted to estimate the cost of crop damage in each conservancy. Focus group discussions were held to discuss preferences and practicalities of conflict reduction strategies which could be implemented at household, village and conservancy levels.

Two estimates of total crop damage costs for all wildlife species are given, N$504,315[1] and N$382,135[2], for both conservancies in 2002/3. Whilst crop damage can be of considerable significance at household level, to the conservancy as a whole it appears to pose a lesser problem.

Top preferences for each implementation level were determined by FGDs to be for crop compensation, electric fencing and torches for execution at conservancy, village and household levels respectively. A compensation scheme offering a categorised payout, rather than offering a payout reflecting the exact value of crop loss, was developed, aimed at easing implementation. At village level, at least one mobile electric fencing unit, lasting a minimum of five years, was determined to be an economically viable option for all villages, assuming it successfully reduced wildlife caused crop damage by a minimum of 50%. At household level, wire fencing remained an economically viable option for all field sizes assuming a minimum of 50% effectiveness and a lifespan of at least 2 years.

Efforts, such as employing more Community Rangers, that are likely to significantly reduce indirect costs of living with wildlife, primarily stress, as well as contributing to the reduction of damage costs, are highly sought after by communities and could have a highly positive effect on improving relations between farmers and the conservancy.

[1] Estimate calculated using solely household interview data.
[2] Estimate calculated using MAWRD data to replace household interview data where possible.

Contents

List of figures

List of tables

List of maps

List of abbreviations

AfESG	African Elephant Specialist Group
CBNRM	Community Based Natural Resource Management
CGG	Community Game Guard
CR	Community Ranger
CRM	Community Resource Monitor
FGD	Focus Group Discussion
IRDNC	Integrated Rural Development and Nature Conservation
HH	Household
HACCI	Human-Animal Conservancy Compensation/Insurance
HWC	Human Wildlife Conflict
MAWRD	Ministry of Agriculture, Water and Rural Development
MET	Ministry of Environment and Tourism
NNF	Namibia Nature Foundation
NPV	Net Present Value
PAC	Problem Animal Control
SSI	Semi-Structured Interview

1 Background

Human wildlife conflict is believed to have increased in recent years in Caprivi where people and wildlife are competing against each other for the scarce resources of food, water and space (Lindeque, 1993; O'Connell-Rodwell et al, 2000). Although conflict is widespread, the Kwando River region has some of the highest numbers of reported problem animal incidents; consequently this report focuses on Kwandu and Mayuni Conservancies, which lie in this high conflict area. Many community members believe the problem to have escalated since the formation of the conservancies and are thus looking to the conservancies for help.

Wildlife damage in these areas largely involves the loss of livestock, human life and damage to crops. Some measures are in place to address these problems, including the employment of Community Rangers and a pilot Human-Animal Conservancy Compensation scheme which offers compensation to conservancy members for human death and livestock losses. However, at present the scheme does not compensate for losses of crops to wildlife. Trophy hunting is currently underway within Kwandu and Mayuni, which potentially will generate substantial financial benefits for the conservancies. However it is imperative that these benefits are relayed back directly and proportionately to individual conservancy members bearing the costs of living with this wildlife and/or invested in strategies aimed at alleviating these costs. Traditional deterrents used to scare problem animals from crop fields have been observed to become less and less effective as wildlife have habituated to them over time (Osborn, 1998; Sutton, 1998; Kamiss & Turkalo, 1999; O'Connell-Rodwell et al., 2000).

Consequently it is the damage to crops and methods of minimising this damage, which receive the attention of this report, the objectives of which are given below.

- To determine the economic value and significance of crops damaged by wildlife at household, village and conservancy level.

- To determine the economic viability of adopting crop damage mitigation measures in different locations and at household, village and conservancy levels.

2 Methodology

The research comprises of both quantitative and qualitative elements. Various methods were used to acquire these forms of data as indicated below. Although the household interviews formed the main part of the quantitative data collection, it was considered extremely important to crosscheck interviewees' results wherever possible to improve the validity and reliability of the data, hence the use of secondary data, physical measurements such as GPS and information from key informants.

2.1 Key informants

Conversations were initially held with key staff within the conservancies to gain an insight into the conflict situation that is being faced and to ensure an appropriate sampling method was adopted for the household interviews. When discrepancies later arose from the interviews and focus group discussions, these key informants were consulted on their reasoning for the inconsistencies, which also aimed to highlight any bias to which the study may have inadvertently been subjected.

2.2 Household semi-structured interviews

2.2.1 The sample

A stratified random probability sampling approach was adopted for conducting the semi-structured household interviews in Kwandu conservancy. This ensured that each of the village districts was represented equally within the survey and meant it would be possible to extrapolate the data to represent the situation for the entire conservancy. Although a proportionate sampling method could also have been applied and would have provided greater external validity of the data, it was felt more important to ensure the inclusion of enough voices from each of the village district areas, especially as some of these areas covered many smaller remote villages. In Mayuni Conservancy a proportionate stratified random approach was possible as the village districts here were smaller, therefore even when a proportionate sample was allocated, it still allowed several voices to be heard from even the smallest area.

To select the sampling units the Event Book Data was consulted as this provided information on all those individuals reporting crop losses in the conservancy. From this data a list (the sampling frame) of all the households who had suffered damage within the agricultural year from June 2002 to May 2003 (the study population) was determined, and the total number of households who had reported damage could be counted to give the study population size[3].

For each conservancy the sample consisted of a total of 25 households, constrained in size only by time. In Kwandu Conservancy five households from each of the five village districts of the conservancy (Singalamwe, Mwanzi, Sikaunga, Sesheke and Kongola) were selected. In Mayuni Conservancy, the proportionate random approach resulted in ten people being selected from two of the three village districts of the conservancy (Choi and Kapako) and five people being selected from the remaining one (Kayuwo). In both

[3] To determine this population was a feat in itself as many incidents reported in the Event Books were of repeated damage to the same household field, which may or may not have been reported by the same household member. Thus, to avoid counting households more than once, conservancy staff advised on those individuals who had reported incidents, who belonged to the same household.

conservancies, the sample included a range of households varying in their wealth, size, sex and age of household head and location (ie. distance from water supplies, river, forest, road etc).

There were few problems in contacting those included in the sample. Fortunately during the winter months of June and July, when these interviews were carried out, demands on people's time are not as huge as during the rest of the year and therefore everyone contacted agreed to be involved. One Community Resource Monitor (CRM) from each conservancy greatly aided the whole process by guiding and accessing those on the sample list and acting as a translator for the interviews. The success of the sample response was probably in large due to the involvement of these CRMs in the study which perhaps entrusted more confidence in the household interviewees, and additionally by arranging a day and an approximate time to meet with the sample households in advance, meant sample households could be easily found.

Throughout each of the conservancies there are no extreme differences between people, livelihoods, and villages, therefore using the sample to accurately generalise a situation for the sampling frame is promising. The sample includes people suffering damage over a period of a year, thereby including all variations in damage experienced in different months. The ability to generalise this sample to other years is doubtful however as external factors exist, such as low rainfall, which are likely to considerably influence the findings of this particular year.

However the ability to generalise this sample to the entire conservancy can be attempted soundly, but it is important to remember that the sampling frame from which the sample was determined comprises only of those households who reported damage to the CRs. Although at present this is the most comprehensive damage data, the possibility still exists that some households may not have reported damage to their fields, and therefore will not have been included in the study population. Amongst other reasons, damage may not have been reported if the household lives at a distance from the nearest CR, if damage was minimal, if they believe no good will come from reporting damage or if the species involved poses less of a threat.

Therefore, when extrapolating the sample to represent the study population it is important to bear in mind that the findings of the sample could present a picture slightly worse than the reality, due to the possible exclusion of unreported minimal damage, which would otherwise have pulled down the 'average damage' experienced by a household. On the other hand, the sample could be considered to present a picture better than reality in that the possible exclusion of some damaged households from the study population would mean an overall impression of fewer people than reality experiencing losses due to wildlife.

2.2.2 The survey

Before starting the interviews, the questions were piloted on the CRM to ensure they were appropriate, understandable, answerable, sensitive and formatted in such a way that would allow the conversation to flow and make the respondent feel at ease. The interviews were conducted on the day, time and place previously agreed with each respondent from the sample household. Most interviews took place within the household courtyard, but a few were held in the household's field. In both conservancies all interviews were completed within a two-week period. On arriving at the courtyard or field, greetings were exchanged, introductions made and a brief explanation of the study was given. Having the CRM translate the questions ensured they were phrased in a meaningful and sensitive manner. The questions were then asked, with further explanation, prompting by using Who? Why? What? Where? When? How? and probing to cross-check answers where necessary. Questions related to the qualitative topics were worded openly to allow the respondent the freedom to expand on issues that were of particular importance to him or her and to allow a better rapport to be built with the respondent (see Appendix 8.1).

Simpler questions about the respondent and the crop production for the last year were asked at the beginning. Following this were questions about the wildlife damage in particular, which led into the subject of deterrents. A concluding question regarding the perceived changes in wildlife damage over time was asked to round off the discussion. Following the pilot with the CRM, it was suggested that it would be insensitive to directly ask respondents if they had sold any of their crop (Qu. 13) as in general yields for the year had been particularly poor resulting in few farmers producing enough for their own consumption in the year, let alone producing any to sell. Hence, it was suggested that question 12, should be used as a filter question, so to avoid unnecessary embarrassment of the respondents.

It was felt too much to expect people to remember or estimate details about each individual problem animal incident they had reported between June 2002 and May 2003, especially as some households had made multiple complaints over the year. It was also considered unrealistic to ask respondents to differentiate the overall damage between, in some cases, several wildlife species. Therefore, it was decided that to ensure better validity of the data, the study could only aim to estimate the total damage per household for all wildlife species throughout the year, rather than trying to break it down to the damage at each incident, or the damage accountable to individual wildlife species.

It was anticipated that the responses from the farmers are likely to be subject to some bias. This may be both unintentional, due to unclear memories as time has elapsed since the raid and intentional, where for example farmers may try to exaggerate their losses to emphasis the problem or on the other hand, understate other issues due to pride so they appear better off than reality. Additionally bias may exist as respondents may try to gauge the responses they believe the study wishes to hear.

To minimise the unintentional bias, the questions regarding the crop quality (Qu. 9) and age of the crop (Qu. 21) were generalised into three categories for each so exact details were not required of the respondents. In attempt to minimise exaggerations, especially of the actual damage, questions were asked which intended to cross-check the answers given and where discrepancies were considerable further probing was used. Use of the CRM was extremely beneficial in these circumstances, as being a farmer in the conservancy herself, she could more easily recognise exaggerations and was in a better position to challenge dubious responses without causing insult or embarrassment to the respondent.

Many questions were designed so they could be linked together to cross-check. For example, question 25, asking the farmer to estimate the number of bags they expected to get from their field without wildlife damage is wide open to bias. However, by also asking question 23, about the area of field damaged, (which itself is cross-checked by asking question 24, about the proportion of the field damaged and calculating the damaged area from the known total size of field), allows the yield, which is calculated from the remaining undamaged area of field and the number of bags they received, to be applied to the whole field to give an approximation of the amount they could have expected to receive had they had no problems with wildlife. Additionally for example, if the figure they state they could have received is obviously extremely high, gentle reminding of how they had stated earlier in a previous question a problem of drought and to check again that their estimation was based only on a situation without problem animals, not also a situation without drought or any other constraints they may have mentioned. By adopting these approaches the aim was to increase the construct validity and reliability of the data. Where possible other methods were used to further triangulate some of the responses from the interviews.

2.3 Secondary data

Secondary data from MAWRD was used, which indicated the average yields of the three dominant crops that were achieved in the area of the conservancies during the year. The validity of using this data to represent the scenario in the conservancies is high as the MAWRD data, like the responses from those interviewed, relates to rain fed crops in that area only.

As little of the maize and millet and virtually no sorghum is actually traded, rather consumed within the household, the actual value of these crops is an unknown. The market price of the little bought and sold may vary considerably depending on the place and the time of the year; hence, the market floor prices for maize and pearl millet recommended by the Namibian Agronomic Board are used within the study, with the price for pearl millet recommended as a proxy for sorghum.

Data from the Events Books particularly regarding the distribution of damage incidents and species involvement were used to consider the suitability of strategies to particular locations within the conservancies.

Secondary data is also used for the costs of many of the deterrents. In many cases these costs of the deterrents are broken down to that of each component, this transparency making the appropriateness of the costs to the situation faced more verifiable. Costs calculated in previous years were brought up to date in line with inflation in Namibia.

2.4 GPS

GPS equipment was used to give more exact locations of damaged fields, particularly in relation to water supplies and villages. This allowed the estimates given by respondents in the interviews of the distances from the river and their village to be checked. Additionally it allowed the perimeter of the damaged fields to be mapped, thus allowing the area to be calculated. This acted as an extremely valuable check against the estimations of size given by the interviewed farmers.

A small number of households indicated that it was too far to walk to their fields as they were up to 10km away and without an access road. Due to the time constraint measuring these fields with the GPS had to be overlooked but particular special care was taken to cross-check interviewees estimates of the size of their field.

The accuracy of the GPS readings was given between 8-10 metres on all occasions, which meant minimal significant errors are likely to exist within the measurements.

2.5 Focus group discussions

Focus group discussions regarding solutions to the problem of wildlife caused crop damage were held in each of the village districts in both conservancies so to gain the views of many in a short space of time. The first step in arranging these meetings was to approach the indunas of each of the village districts. Their permission was sought to hold the meeting and their help requested in informing people from the village of the event. Although ideally a maximum of 10-12 people were sought to take part, it was difficult to control the number of people involved in the discussion as the general belief and expectation is that meetings should not exclude any person.

Due to the escalating number of people wishing to attend the meeting, the intended open discussion of topics within the group was altered slightly in most of the villages so to ensure greater inclusion of people within the group. Hence when a larger than intended group formed, following the initial introductions and explanations, this group was divided into two, male and female. Again the CRM was used for translation and where possible the CR responsible for that area was present to help answer any questions that arose regarding problem animal control in the conservancy.

Each of the sub-groups were given a pencil and paper to write down ideas they had about deterrents and other conflict reducing strategies which could be implemented at the household, village or conservancy level. After allowing sufficient time to form these ideas, usually 30-40 minutes, each sub-group was asked to feedback their thoughts to the rest of the group. The advantages and disadvantages of each of these ideas were then openly discussed along with exactly how they believed each strategy could be implemented in practice. Any strategies that had not been proposed by the group but were on the topic list (see Appendix 8.2.1) were then suggested and again the group responded highlighting the advantages and disadvantages that they considered with these. Finally the group was asked to rank their preferences for each method from the most desirable to the least.

By conducting the same focus group discussions in each of the main village districts the representativeness of the groups to that of the whole conservancy was increased. By holding the meeting in the village reduced discrimination against those who otherwise could not have travelled far and by holding the discussion at the traditional meeting place made those who did not previously know of the event, aware and able to partake if they wished. In all but two of the meetings, both men and women were represented fairly. Although generally, few people tended to dominate the discussion, when necessary the opportunity was given for those who had not contributed their thoughts to do so if they wished.

The focus group discussions were all held within a week for each conservancy.

3 Economic value of crop damage by wildlife

The economic value of crop damage was calculated by multiplying the quantity of crops estimated to be lost by the market price of those crops. The responses given by households relating to the actual production of different crops they received for the year and the potential production they believed they could have received if they had not suffered wildlife damage were tabulated. The difference between the two gave the household estimate of crops lost to wildlife. The process was repeated but in place of the household estimate of potential production, the MAWRD average yield figures (see Appendix 8.4) were used to calculate the potential production of each field (the size of which had been measured using the GPS). Thus the results show estimates using both methods for determining the potential production for the year. Due to a lack of information regarding other crops, only the principle crops of maize, millet and sorghum could be analysed and included in the results.

Actual crop production and estimates of crop losses to wildlife for both Kwandu and Mayuni samples are illustrated in Appendix 8.3. The results using the two approaches, household interviews and MAWRD data, to estimate the losses are given. The total areas of crops planted and damaged in each conservancy HH sample are also shown in Appendix 8.3 using both estimation approaches. For Kwandu Conservancy the farmers' estimates of areas of different crops damaged are consistently higher than those estimated using MAWRD data. Whereas, for Mayuni Conservancy the household estimates of the area of damage are lower for maize and sorghum crops than the MAWRD data based estimates.

Using this sample data as a representation of damage in each conservancy, the results were extrapolated for the study population. Prices of the crops (see Appendix 8.4) were applied to the estimated amount of each crop lost using both approaches.

3.1 By household

Figure 3.1.1 below shows the average damage cost experienced by households who suffered crop losses to wildlife during 2002/3 in each of the conservancies.

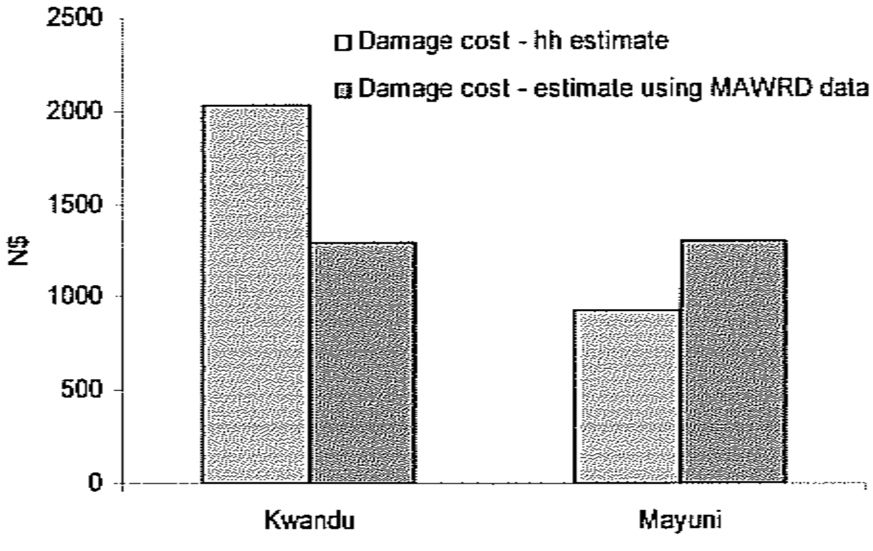


Figure 3.1.1: Average wildlife damage cost per household in each conservancy, 2002/3

3.2 By village

These costs can also be shown by village district. The villages in figure 3.2.1 below are shown in order of location, from Singalamwe in the north of Kwandu to Kongola in the south of the conservancy, followed by Kayuwo, in the north of Mayuni bordering Kwandu, to Kapako the most southern of the village districts.

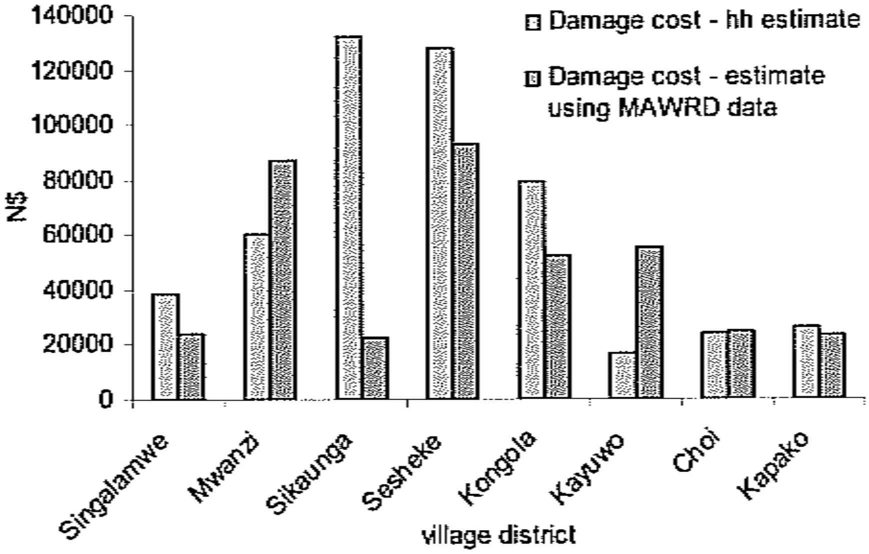
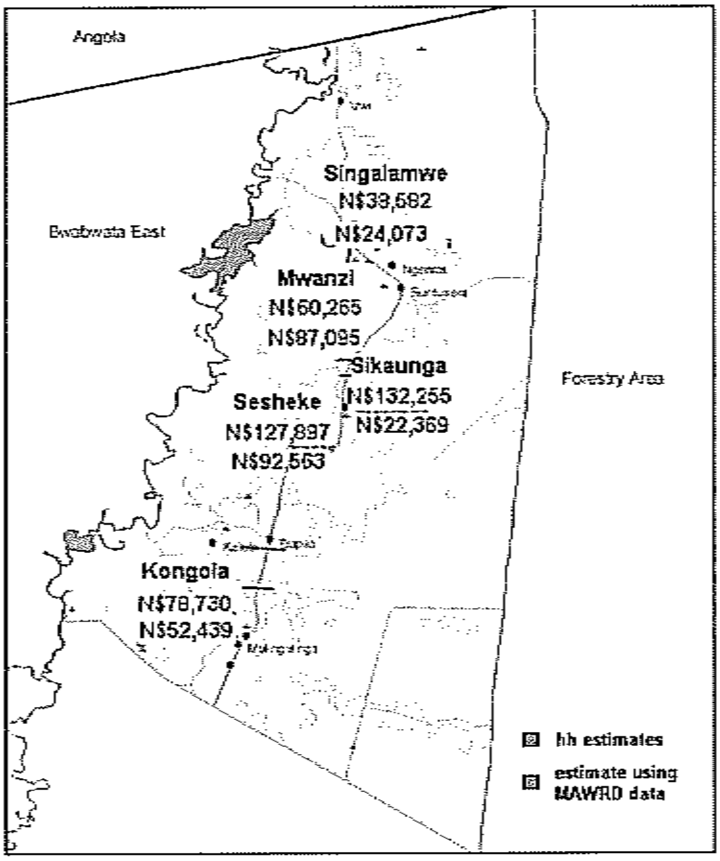
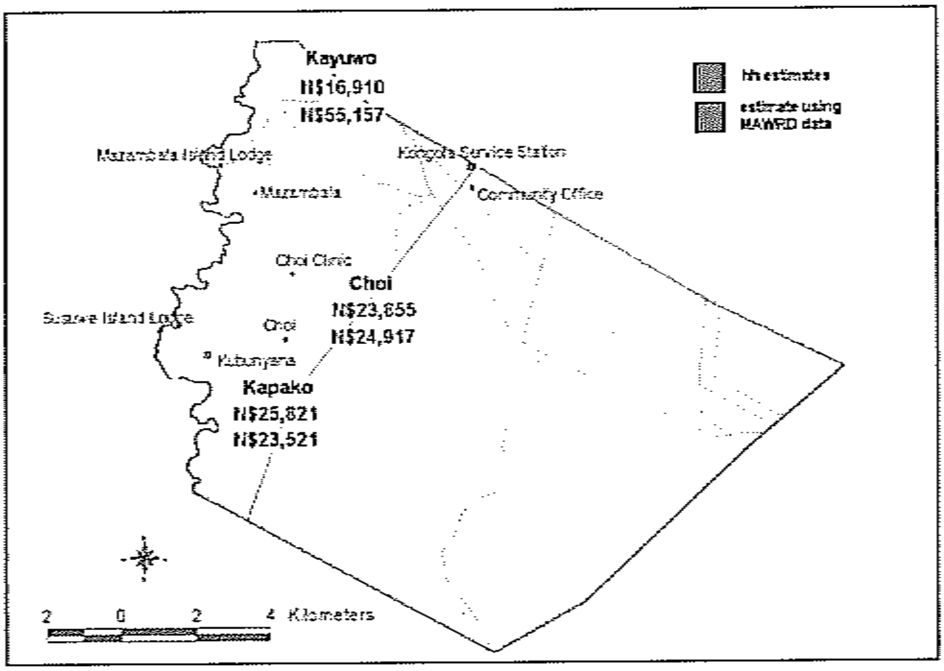


Figure 3.2.1: Wildlife damage costs by village districts for Kwandu & Mayuni, 2002/3

The maps below show the crop damage costs for 2002/3 determined by the two estimation methods and the approximate location for each village district.



Map 3-1: Crop damage costs (N$) by village district in Kwandu Conservancy 2002/3



Map 3-2: Crop damage costs (N$) by village district in Mayuni Conservancy 2002/3

3.3 By conservancy

Figures 3.3.1 and 3.3.2 show the estimated value of crop losses for Kwandu and Mayuni Conservancies respectively. Total damage costs for the two conservancies are N$504,315 and N$382,135 for the household and MAWRD based estimates respectively.

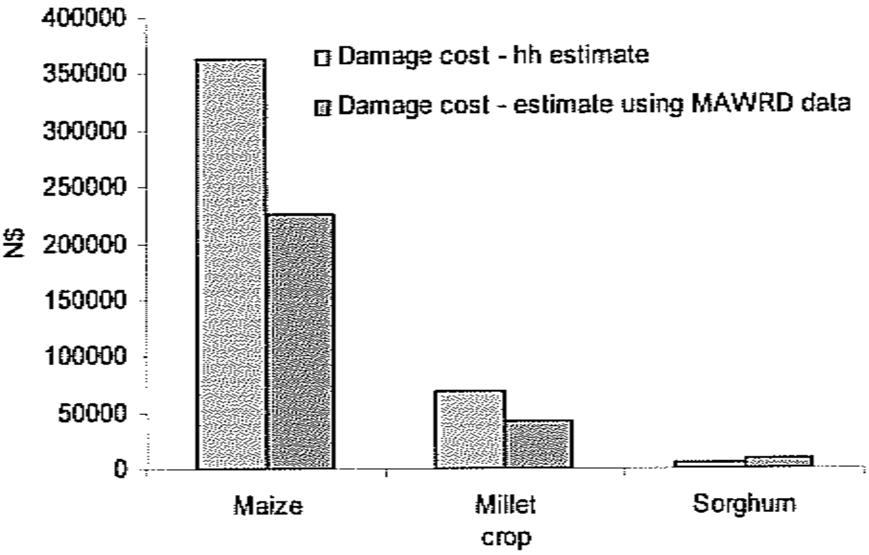


Figure 3.3.1: Wildlife damage costs by crop type for Kwandu, 2002/3

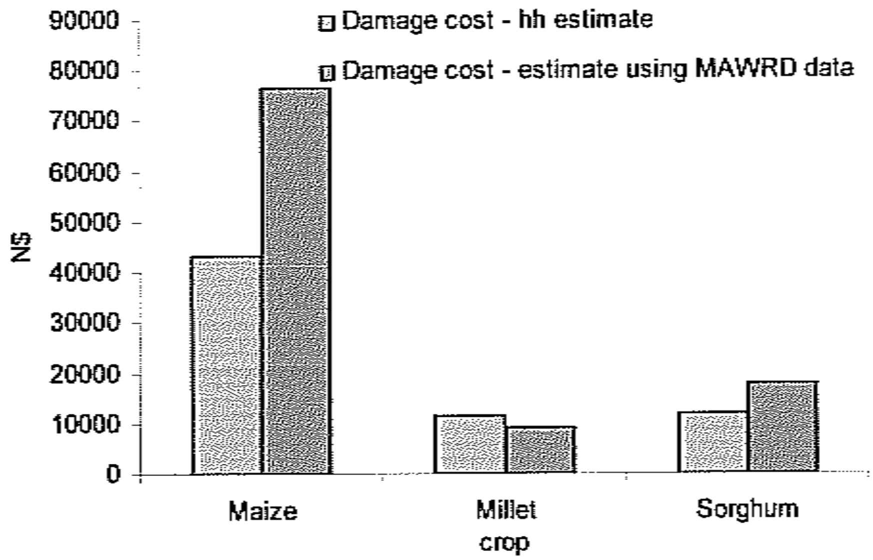


Figure 3.3.2: Wildlife damage costs by crop type for Mayuni, 2002/3

The breakdown of the damage costs shown above is given in table 3.3.1 below.

Table 3.3.1: Damage cost estimates (N$) by crop type, by conservancy, 2002/3

Conservancy		*Maize*	*Millet*	*Sorghum*	*Total (N$)*
Kwandu	Damage cost - hh estimate	363,500	68,591	5,638	437,729
	Damage cost - estimate using MAWRD data	226,033	42,851	9,655	278,540
Mayuni	Damage cost - hh estimate	43,209	11,466	11,911	66,586
	Damage cost - estimate using MAWRD data	76,714	9,200	17,681	103,595

Although maize crops suffered the most damage, table 8.3.1 in Appendix 8.3 shows that damage occurred to crops in proportion with the total area of these crops grown and therefore there is little evidence of all wildlife having a preference for certain crops. However it was indicated during some household interviews that individual wildlife species may have their own preferences for particular crops.

The value of crop damage in each conservancy varies considerably depending on the data used in the calculation for the potential crop production without wildlife damage. The estimations based on MAWRD early warning data of expected yields were less than two-thirds of those based on farmers' estimates of potential production for Kwandu Conservancy. This was not surprising as it was anticipated that some respondents may either intentionally exaggerate the potential yields they could receive from their fields or they would find it difficult to distinguish between other factors that may have influenced their production.

However in Mayuni Conservancy surprisingly the opposite occurred, where the value of damage based on the farmers' estimations was just over two-thirds of that calculated using the MAWRD data. Several reasons may exist for these variations. Firstly, it may be that the potential yields do in fact vary across the two conservancies, something which is not reflected by the MAWRD data yield estimate, therefore implying that yields were generally worse in Mayuni than Kwandu. This may actually have been the case with the households sampled, as far fewer people interviewed (and generally) in Mayuni plant fields near the river as compared to Kwandu. Therefore generally yields may have been higher for Kwandu as more people in the conservancy were taking advantage of the better soils at the riverside. Alternatively, it may be that people interviewed in Mayuni were generally more honest in their responses than those in Kwandu, or perhaps the use of different translators in each conservancy in some way influenced the responses given.

The nature of this study is such that the estimations of the value of crop losses determined are only applicable to the two specific conservancies involved and cannot be extrapolated to represent other conservancies, villages or the entire region. However when comparing the results with those of previous studies, the cost of damage per household determined in this study appears far greater. This may be due to a combination of reasons. Firstly, the area in which this study was conducted is known to be an area of high human wildlife conflict. The study by Sutton (2001), which found crop damage by wildlife to be N$98,217 for 165 households, was determined from six villages spread throughout East Caprivi, however none of these villages were in the same particularly high conflict area along the Kwando River as the villages included within this study were. Secondly, the drought experienced in this year is believed to have accentuated the problem as a lack of lush vegetation forces more wildlife into the conflict with farmers. Thus when comparing results from 2002/3 to previous studies conducted in better yielding years, the situation would be expected to appear bleaker.

O'Connell-Rodwell *et al.* (2000) estimated total damage costs of N$21,560 and an average cost of N$244 per damage incident, for crop raiding elephants in the Kwando River region in 1995. This was based on an average area of damage of 0.5ha, far below the average of 3ha as determined by this study. However the 3ha figure is a average per damaged household, not per damage incident and additionally included all wildlife damage not solely that by elephants, therefore it is not possible to infer from this whether there really has been an increase in wildlife damage. Although, many believe that with the increase in conservation and subsequent increase in wildlife populations since the conservancies were registered in 1999 has come an increase in crop damage.

Using the MET dataset, which shows crop-raiding incidents occurring throughout Caprivi, Mulonga *et al.* (2003), estimated damage costs for years 1996 to 2001. They found the most significant year for damage to be 2000, when crops worth an estimated N$87,956, were lost to wildlife. However, as is stressed within the paper, there are many reasons to believe these estimates based on MET data may be conservative. As Mulonga *et al.* (2003) observe, it is interesting how the estimate by Sutton for just six villages, exceeds the estimate for all Caprivi, determined using MET data. MET data estimated the average area of elephant damage in the entire region between 1996-2001 to be 2.2ha.

The increase in the market price of crops is another reason contributing to the higher costs of damage found by this study than previous studies. For example, maize prices have risen by 56% between 2001 and 2003 and millet prices by 20%.

One area in which weakness may possibly have occurred, which would have caused the costs of wildlife damage estimated by this study to appear greater than expected, is that of the differentiation between wildlife damage and damage caused by other factors. Participants in the household interviews were asked about other problems they faced with crop production in the past year and whilst every respondent cited the lack of rain as a constraint, only a few mentioned damage by livestock. Livestock damage tends to be settled between farmers and therefore although it may be more widespread than was depicted by the household interviews, farmers do not therefore perceive it as a major problem (CRMs, pers. comm.).

If farmers were compensated for the livestock damage in bags of grain (which is most common), then the validity of these results should not have been compromised as the total amount of grain the farmers would have received in the year will then be as if he had not suffered any livestock damage. However, if compensation was not given in bags of grain, then the amount of grain these farmers stated they received will be minus that they lost to livestock damage, consequently making the amount lost to wildlife appear larger. In short, the possibility, albeit small, exists for some estimates of wildlife damage to potentially be estimates for wildlife and livestock damage. Pest damage was not considered a major threat to the validity of the results as households did not mention it as a serious constraint to production and MAWRD early warning reports stated only a minor problem of grasshoppers to exist in the floodplains of Caprivi and not in the conservancies where interviews were held.

Therefore despite a few minor reasons for cautiousness with the results, the findings are those intended of the first study objective, that of the economic value of crop losses to wildlife.

4 Significance of crop damage by wildlife

4.1 By household

The estimated area of crops damaged and associated costs to each household that reported problem animals to conservancy CRs is given in table 4.1.1 below. In particular, the results for Mayuni Conservancy from the two estimation methods are especially close, suggesting greater reliability of the results.

Table 4.1.1: Significance of wildlife damage to average HH in each conservancy, 2002/3

Kwandu	*based on hh estimates*	*based on MAWRD data*
Ave. area/hh of damage (ha)	2.86	2.44
Ave. cost/hh of damage (N$)	2027	1290
Ave. % of total crop lost by hh	71	57
Mayuni		
Ave. area/hh of damage (ha)	1.74	1.74
Ave. cost/hh of damage (N$)	928	1306
Ave. % of total crop lost by hh	79	67

Overall the MAWRD data based estimates show the wildlife damage to be less significant to the individual household than the results based solely on the household estimates. This indicates that on average, the minimum percentage of the crop that a household lost to wildlife, was over half amongst Kwandu farmers and two-thirds amongst Mayuni farmers. As on average field sizes are not extensive, many households interviewed stated they were not left with enough crops to last them a few months, let alone the entire year.

Interestingly, the results show the average cost of damage to households in Kwandu to be more than double that suffered by households in Mayuni Conservancy using the household estimations. However, the loss of crops may be felt more by Mayuni households as it represents a greater proportion of their field.

The results here found that the significance of wildlife damage to the individual household suffering damage was on average high, with estimates ranging between 57% and 79% of the total crop planted being lost to wildlife. As mentioned previously, the expected yields were particularly poor for crops anyway due to the lack of rain in the year, hence magnifying the problem. Therefore although in this year the problem appears particularly harsh for the households who suffered damage, it is unlikely to be as significant in 'normal' years.

4.2 By village

An estimation of the significance of wildlife damage to each village was not attempted. In addition to the lack of data on the exact numbers of households in each village district, it was also often found that households living in one village would not necessarily have their fields close by to that village. Some fields were several kilometres away from where the household lived and therefore technically these fields may have fallen under a different village district.

4.3 By conservancy

The average field sizes from each sample, calculated using GPS data, were multiplied by the estimated number of households in each conservancy to give an indication of the total area planted during the 2002/3 period in both Kwandu and Mayuni (see Appendix 8.5). The significance of wildlife crop damage in light of all farming that has taken place in each conservancy is shown in table 4.3.1 below. Additionally the area of damaged cropland is shown as a percentage of the total area of land the conservancy covers thus indicating the wider extent of conflict over land.

Table 4.3.1: Significance of wildlife damage to each conservancy, 2002/3

Kwandu	*based on hh estimates*	*based on MAWRD data*
Area of damage as % of total area planted	17.7	15.0
Area of damage as % of conservancy area	3.3	2.8
Mayuni		
Area of damage as % of total area planted	7.8	7.8
Area of damage as % of conservancy area	0.9	0.9

The results of this study suggest that wildlife damage to the conservancy, as a whole is less significant. Estimates of losses ranged between 7.8% in Mayuni and 17.7% in Kwandu of the total area planted with crops. However again, in years without drought it would be expected that this significance would be less as the actual damage would be expected to be less as greater natural vegetation would give less reason for wildlife to turn to eating crops, and in a non-drought year all farmers would be expected to achieve better yields, subsequently meaning wildlife damage would be less significant or threatening to livelihoods.

5 HWC reduction strategies

5.1 Preferences

A summary of the ranking of human-wildlife conflict reducing strategies determined by village focus group discussions is given below, where the most preferred option is indicated by '1st' and the least preferred by '5th'.

Table 5.1.1: Preferences for conflict reducing strategies in Kwandu villages

Strategies	*Singalamwe*	*Mwanzi*	*Sikaunga*	*Sesheke*	*Kongola*
Compensation	1st	3rd		1st	1st
More CRs	2nd	1st	2nd	4th	2nd
Hunter - past system	3rd	2nd	1st		4th
Trophy hunter	4th	4th		2nd	
Torches	5th	5th			
Trip alarms			4th		3rd
Electric fencing			3rd		
Trenches			5th		
Water supply at forest side				3rd	5th
Protected wildlife corridor				5th	

Table 5.1.2: Preferences for conflict reducing strategies in Mayuni villages

Strategies	*Kayuwo*	*Choi*	*Kapako*
Compensation	1st	1st	2nd
More CRs	3rd	2nd	1st
Trophy hunter	2nd		
Torches	4th		4th
Trip alarms	5th	5th	5th
Electric fencing		3rd	3rd
Normal fencing		4th	

It can be seen from the above tables that preferences vary from village to village, however the general consensus is that compensation for crop damages is the most favoured option, with five of the eight villages placing this in the top position. The need for more Community Rangers, equipped with rifles and flashlights to guard fields particularly at harvest time, is ranked as the overall second most important strategy. Some strategies were not considered by any of the villages to be in the top five most important strategies and a few were considered by some villages to be of 'no use' at all.

Some strategies are more applicable to Kwandu rather than Mayuni due to the individual circumstances the conservancy faces, which is reflected in the results of the focus group discussions. For example, the lining of wildlife corridors with electric fencing to deter elephants from straying into neighbouring villages and fields is only ranked in the top five by one village, Sesheke. This is likely because the village is situated close to two wildlife corridors and elephants are seen near the village on a regular basis.

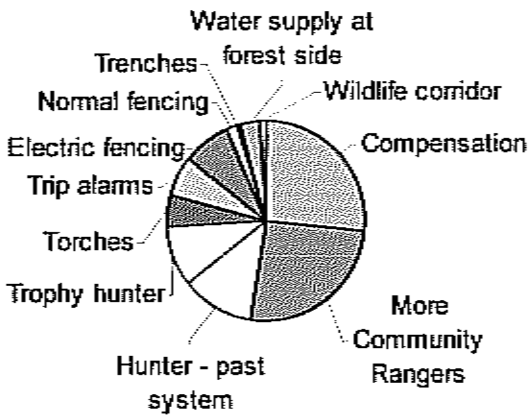


Figure 5.1.1: % of weighted preferences for conflict reducing strategies

Using the scale given in Appendix 8.2.3, the preferences shown in the tables above were weighted and totalled to give the overall preferences for strategies for all villages, given in table 5.1.3; the proportions of which are given in figure 5.1.1.

Table 5.1.3: Weighted preferences for strategies for all villages

Strategy	*Level of implementation*	*TOTAL*
Compensation	Conservancy	64
More Community Rangers	Conservancy	62
Hunter – past system	Conservancy	28
Trophy hunter	Conservancy	24
Electric fencing	Village	18
Trip alarms	Village	16
Torches	Household	12
Water supply at forest side	Conservancy	8
Normal fencing	Household	4
Protected wildlife corridor	Conservancy	2
Trenches	Household	2

Preferences determined by this study for conflict alleviation measures were not surprising. Many people described the situation as one where they were making a sacrifice of their crops to wildlife for the conservancy's benefit, but they personally did not feel they had received any individual benefits back from the conservancy. Thus it was expected that compensation for their losses would be of prime importance. Meetings held by Odendaal & Diggle (2001) also found compensation to be the first strategy mentioned by any group visited in Caprivi. However contrary to their findings that a communally protected area for fields was considered possible in Kwandu conservancy, the results of this study did not find any support for the idea. This discrepancy may just be a reflection of the particular individuals present at the meetings of either study and consequently this idea should not be totally dismissed from further investigation, as the results of this study alone would suggest.

A summary of the advantages and disadvantages of strategies as identified by the eight groups of villagers, on which the above preferences were made, is given below.

Table 5.1.4: Advantages & disadvantages of strategies as determined by FGDs

STRATEGY	ADVANTAGES	DISADVANTAGES
Compensation		
In form of money or food to those who have lost crops to wildlife in the Conservancy.	Gives those who have suffered the losses a way to survive.	It does not deal with the cause of the problem only the effect. Difficulties in ensuring fair distribution. Source of finance.
More Community Rangers		
Equipped with rifles & flashlights to sleep in fields, especially during harvest time, guarding crops.	Prevention of the cause of the problem. Increased employment. With more CRs can cover a greater area & be more accessible to the community.	Sometimes even CRs cannot do anything, as some elephants are no longer even deterred from fields by the sound of the rifle.
Hunter - past system		
Local member of community to be appointed as hunter and given right to kill problem animals, esp. elephants as in past, and for the meat to be given to those suffering damage.	Immediate compensation to those suffering damage. Local communities managing the cause of the problem. Relatively inexpensive.	Not acceptable under current Namibian law. Potential for excessive killing of animals viewed as 'problem' leading to a compromise of the conservation objectives of the conservancy. Benefits of meat, hide & tusks do not represent true value that elephant holds, meaning untapped benefits eg. tourism, trophy hunting, will not be realised.
Trophy hunter		
Conservancy to employ a trophy hunter to kill problem animals.	In operation now! Provides conservancy with considerable source of income with which to implement other strategies. Meat is given to community, albeit small, more people therefore receive benefits which consequently should improve community's views of the conservancy.	Current quota is considered by some not to be enough to significantly reduce the overall conflict in the conservancy. Trophy hunter is not immediately accessible to deal with problem animal when raiding crops.
Torches		
To be available for use by individuals so to scare off problem animals	Allows individuals to take action against their own problem without having to wait for CRs. If solar torches were available, then would be a one off-capital investment and more likely to be useful for a longer timespan. Brighter than using fire and would give farmers more confidence in attempting to defend their crop, when they can see exactly what they are dealing with.	Unlikely to be a successful deterrent when used alone, habituation may occur after a short time.
Trip alarms		
Wire that surrounds field or part of field which wildlife enters by, which when tripped causes a siren to sound.	Suggested that village could communally possess a few of these, which can be moved to fields experiencing problems. Allows community to take control of cause of problem. Siren can be altered so emit different sounds hence reducing the chances of rapid habituation. Can be solar powered.	Repair & maintenance constraints of the device.
Electric fencing		
Surrounding either individual fields, a number of fields, or entire village &	Likely to be successful for a while. No need for farmers to be involved or	Elephants are known to have found ways to get round these. Regular

fields.	present at time of attempted raid. Can be solar powered.	checks and maintenance are required. High cost. Permanent fencing no good, as many farmers like to expand field or change area planted every year.
Normal fencing		
Wire with tin cans attached.	Considerably cheaper than electric fencing. Effective against many wildlife, noise of tins acts as deterrent. Can be implemented relatively simply by individual.	No use against elephant. Contrasting views on its effectiveness against hippo – some stated habituation to the noise. Again movement of fencing needed as field size changes.
Trenches		
Digging of trenches around field.	Prevents hippo and bushpig from entering field as unable to jump the gap. Could be implemented & maintained by individual, time and strength rather than money needed. Suggestion that conservancy could hire the young unemployed to carry out the work.	Unlikely to prevent elephant. Sandy soils could mean trenches are easily eroded, requiring regular maintenance. Considered too much work & unachievable by many. Not an option for weak or disabled. Changing field sizes could mean repeated efforts needed every year.
Water supply at forest side*		
For the conservancy to supply a water point in the forest side.	Allows those farmers who have fields close to the river or in wildlife corridors have the option to cultivate land away from these high conflict areas.	Problems in accessing land on forest side. Ancestral rights. Effort required to clear land. People simply not wishing to move their homes or fields. Not a feasible option for disabled due to long distances from current settlement areas. Some believe wherever they farm, the elephants will come.
Protected wildlife corridor		
For wildlife corridors existing in the conservancy to be lined with electric fencing.	Offers protection to villages and fields from wildlife that may otherwise have strayed from the corridor route. Offers clearly designated area for wildlife. Could be solar powered.	High cost of fencing. Some people would have to move fields from corridor. Dislike of fencing across a large area. Felt too many other areas in which wildlife could get round and still destroy crops. High maintenance requirements.
Protected communal intensively cultivated area**		
For an area of land to be managed by the community, which is protected using electric fencing and intensively cultivated using irrigation, fertilisers and improved seed.	Guarantees community would have a source of food even in drought years.	Lack of available land. People like their independence, would not want to work communally. Lack of time to work on the communal area and own individual fields. Difficulties in managing the scheme. Expensive to initiate.

* The idea of placing water points at the forest side in Kwandu Conservancy is part of their overall Management Plan, which incorporates a zonation plan for land use within the Conservancy. This strategy was ranked lower down in the list by FGDs, which may be because this approach could take a few years to yield benefits to the community, whilst other strategies offer more immediate individual gains. Despite this, both conservancies felt it was a measure which would help to alleviate conflict in the long term and thus applications to the Game Products Trust Fund to be made for financial assistance for the implementation of these strategies.

** This was the only strategy to be considered an impracticable option by all the village groups. A sense of want for independence came across in many of the FGDs, which was also specifically voiced when the groups were considering the strategy of electric fencing.

6 Economical viability of HWC reduction strategies

The net present value of the costs and benefits associated with adopting the strategies below (with the exception of the compensation scheme) were calculated using the following equation:

$$NPV = \Sigma_t (B_t - C_t)/((1 + r)^t)$$

(Perman *et al.*, 1996)

Where, B_t is the total benefits[4] from the device over time, ie. the value of the abated crop damage[5] over the lifespan of the project; C_t is the total costs of the device over the lifespan of the project; r is the discount rate and t is the lifespan of the project in years.

A standard discount rate of 8% was assumed. The point at which each line on the graph crosses the x-axis, ie. when the NPV = 0, is the point at which the benefits and costs are equal and the device becomes an economically viable option.

It is important to remember that the indirect and environmental costs associated with wildlife damage have not been included in these scenarios. It is likely that the inclusion of these factors would cause all mitigation measures to become favourable options at an earlier point in time or for a smaller area of cropland protected, than indicated by this study based on direct costs alone.

However as the costs of damage may not be as great in non-drought years as they have been estimated here for 2002/3, consequently depending on the environmental conditions in the years after construction it might in fact take longer for the devices mentioned here to become economically viable.

6.1 Conservancy level

6.1.1 Crop compensation scheme

Most focus groups stated a preference for a monetary compensation scheme as this would give them the freedom to allocate funds as they desired towards food, school fees, clinic fees or other essentials, however many agreed that even if compensation was given in the form of food, it would still be satisfactory as they would be able to sell this to create cash for other expenses. Focus groups generally felt that compensation in the form of seed was not be particularly beneficial as this could not be used until the following year which is useless for those suffering the immediate problem of hunger. The compensation scheme proposed in this study results in a monetary payout, however this could simply be transformed to its food grain equivalent if the conservancy feels weary about giving lump sums of cash to its members.

Although in theory an equitable form of compensation scheme may be viewed as one which balances the exact costs of damage experienced by the individual with benefits from the scheme, in practice this would leave the individual indifferent between scenarios of 'damage' and 'no damage', which could lead to exploitation of the scheme. As funds to finance the scheme are unlikely to be exhaustive it is in practice imperative that the

[4] MAWRD estimates of the average cost of crop damage to a household (based on both conservancies sample household data) were used, as this was lower than the average cost of crop damage to household as calculated using household estimates. Therefore it can be assumed that if anything these benefits may be slightly pessimistic.
[5] Values of crop damages used were those estimated using MAWRD data

benefits the scheme offers, ie. the payouts, do not exceed the benefits that the claimant could have received if they had not suffered damage. In other words, the incentives to take responsibility for one's crops and to achieve a good harvest, must outweigh the incentives for poor or mis-management of their crops.

Although it is simple to state the payouts from a scheme must not exceed the actual value of that which it is compensating, in reality, the difficulties associated with accurately determining the cost of damage, make it hard to guarantee this is the case. An outline of one proposed scenario is given in figure 6.1.1 below which aims to partially address these potential problems.

The scheme is based on three factors, yield, area of damage and price, to determine an appropriate level of compensation to offer.

					Price N$/kg crop lost			
Quality of crop before damage	For MAIZE apply yield (kg/ha) of:	For MILLET/ SORGHUM apply yield (kg/ha) of:	Area of damage	Apply area (ha) of:	For MAIZE apply price (N$) of:	For MILLET/ SORGHUM apply price (N$) of:	Compensation for MAIZE (N$):	Compensation for MILLET/ SORGHUM (N$):
GOOD	800	500	above 1.75 ha	1.75	1.997	1.5	2796	1313
			0.65ha up to 1.75ha	1.2	1.997	1.5	1917	900
			0.1ha up to 0.65ha	0.375	1.997	1.5	599	281
MEDIUM	400	300	above 1.75 ha	1.75	1.997	1.5	1398	788
			0.65ha up to 1.75ha	1.2	1.997	1.5	959	540
			0.1ha up to 0.65ha	0.375	1.997	1.5	300	169
POOR	225	150	above 1.75 ha	1.75	1.997	1.5	786	394
			0.65ha up to 1.75ha	1.2	1.997	1.5	539	270
			0.1ha up to 0.65ha	0.375	1.997	1.5	168	84

Figure 6.1.1: Possible strategy for crop compensation scheme

As yields are affected by a variety of factors and therefore vary between individuals and from year to year, the yields used for calculations in this scheme are simply expected average yields, as suggested by MAWRD, for the different crops in a 'good' year, 'medium' year and 'poor' year.

At first it was hoped for the scheme to allow the differences in yields between individuals' crops to be recognised, (i.e. 'good', 'medium' and 'poor' crop) however after holding discussions with key informants, it seemed too open to bias to risk its inclusion. It is therefore suggested, that perhaps one value for the yield of each crop type would be decided upon using MAWRD early warning data, and this would be applied for all claims for that year but would be reviewed annually. This approach allows any loss of crops caused by factors other than wildlife, such as drought, to be reflected in the expected yield and consequently excluded from the compensation payout, thus ensuring the scheme aims to compensate only for the wildlife damage as is intended.

The second factor, the area of damage is almost impossible to calculate accurately and to do so would be extremely time consuming. The problem is that when many wildlife species damage crops it is more likely to be sporadic patchy damage to parts of the field, eating crops here and there rather than an easily calculable area. To avoid this, the above scheme proposes three categories of area (just for simplicity but could be increased or decreased in number), into which the estimated damaged area, can be placed. Therefore, the exact damage area is not needed just an approximation. It is worth mentioning here, that the wildlife species proposed to be covered by such a scheme are elephant, hippo and bushpig. Conversations with CRs concluded that despite feeling confident in their ability to tell the difference between damage caused by different wildlife species after the event, they felt that they could only confidently pace out damage caused by elephant, hippo and bushpig to give the approximation needed.

The boundaries of the categories were chosen as the 33rd and 66th percentiles of all the damage areas, based on the estimates made using MAWRD data, for both conservancy household samples. Again these boundaries can be modified, but by using these percentiles, it allows an assumption to be made that approximately one third of all claims will fall into each category. For each of these categories a fixed damage area is applied, which for the two lower categories, the fixed area is the average of the boundary areas, whilst for the open-ended, largest category the lower boundary area of 1.75ha is used. The lowest boundary of 0.1ha was chosen, as this was the smallest area of damage reported by any of the sample households. By stating a minimum amount of damage necessary in order to make a claim reduces the ability of farmers to cheat or play the scheme to their advantage.

The third aspect is the price attached to different crops. The prices used here are the market floor prices suggested by the Namibian Agronomic Board. Although there seemed to be mixed views regarding which crops were of greater worth within the villages themselves, it was felt that it was simpler to use the market floor prices that could easily be modified in the future as and when the Agronomic Board changes these prices, so to keep the scheme up to date.

Following across the chart from left to right, in accordance with the circumstances of each case, leads to an amount in Namibian dollars, based on the three factors, as an appropriate compensation payout. This scheme is not intended to give an accurate payout corresponding to the exact value of crops lost to wildlife, instead the approximated nature means that some households may gain a little whereas others may lose out a little but at least some benefit will be received by those suffering damage.

Figures from 2002/3 were inputted into the above scheme in order to estimate the sum of money that would be needed to cover all expected claims. As 2002/3 was considered a poor year, all claims would receive the levels of compensation indicated in the blue section of chart. As previously explained a third of all claims could be expected to fall into each bracket of damage area and the division of the incidents, which, in the case of 2002/3, were 53% maize, 47% millet and sorghum, were also accounted for in the calculations. The results are shown in the table below.

Table 6.1.1: Costs of compensation for crops, 2002/3

	Maize	*Millet/Sorghum*	*Total*
Compensation N$	77,599	34,459	112,057

The equation below can be used to give an estimate of the size of compensation fund needed in a given year, if the above compensation scheme was adopted.

Equation 6.1.1: Sum of compensation payouts

$$\text{Sum of compensation payouts} = \frac{3.325HH_d}{3}\left[Y_m P_m C_m + Y_{mil} P_{mil} C_{mil}\right]$$

Where, HH_d = total number of household damage claims
Y_m = expected yield of maize (kg/ha)
P_m = price of maize (N$/kg)
C_m = % of total claims for maize crop
Y_{mil} = expected yield of millet (kg/ha)
P_{mil} = price of millet (N$/kg)
C_{mil} = % of total claims for millet/sorghum crop

Certain principle conditions were determined, which key informants felt were essential if the scheme was to be implemented and successful in practice. These are shown in the table below.

Table 6.1.2: Conditions for compensation scheme

	Compensation scheme conditions
1	Compensation will only be considered for claims by Conservancy members
2	Compensation applies only to damage by elephant, hippo and bushpig.
3	Compensation will only be given for maize, millet and sorghum.
4	Where mixed cropping in field, compensation will be given based on the dominant crop.
5	No compensation will be given for an area of less than 0.1 ha damaged.
6	No compensation will be given for grain damaged in storage.
7	Compensation will only be given for crops damaged within the Crops, Livestock & Settlement zone of the Conservancy.
8	Complaints must be verified by CR within 3 days of incident.

The scheme could make good use of current CRs, who are already recording in the Event Books much of the information needed to determine the appropriate payout. Therefore implementation of the scheme would not require new staff, just a minimal amount of extra training to be given to the existing staff. To minimise disputes that may arise over the CRs' judgement of the area of damage, a second member of conservancy staff should also be present to double-check each claim. For Kwandu a conservancy committee member may be most appropriate as only one CR works in each village district and therefore secondary verification by another CR could hinder the scheme due to the time taken in travelling between villages. In Mayuni, this secondary verifier could be another CR as two CRs work in each village district. To avoid other social disputes over compensation, it is imperative that all conservancy members are well informed of the conditions and the workings of the scheme.

Other problems with compensation schemes as indicated by AfESG (2002) include that of corruption. The proposed scheme aims to minimise this by setting conditions such as excluding compensation payouts to damaged fields situated in any of the wildlife zones of the conservancy thus avoiding a potential problem of deliberate cultivation in high conflict areas. It would be necessary for the scheme to initially be funded in the same way as the current livestock and human death compensation scheme. The most part of the fund would be sort from an external donor, however as the conservancy starts to generate income from its tourism and hunting, a premium must be paid in order to take part in the scheme. This thereby reduces the incentive to rip off the scheme as this would result in the conservancy 'shooting itself in the foot'. Additionally with the scheme being administered by the conservancy and verification conducted by local community members, it will hopefully mean corruption is minimised. Like the HACCI scheme, the proposed crop compensation scheme could be initially conducted for one year after which any modifications could be made if necessary or the scheme dissolved.

One area of the proposed scheme that needs clarification is when it is appropriate to calculate the area of damage and administer the payout. Many households reported repeated damage incidents to their field throughout the year. Two options exist here, either to give payouts for each individual claim or to give one payout for a total of all claims for each household at the end of the agricultural year. Both options have their pros and cons but the intention of this scheme was to adopt the latter option. This would mean all claims would be verified and recorded for each household over the course of the year, totalled and if all conditions are met, then the payout should be administered as soon as possible after the end of the harvest. Although time consuming, it would be less so than having to administer payouts for claims of individual incidents. It may be wise however to limit the number of damage incidents one can total at the end of the year. This would discourage farmers from reporting trivial damage as they would have to gamble on whether they may have worse incidents in the future they would be better off reporting than the minimal damage they face at present. Additionally it should minimise the time-consuming surge of wildlife damage claims that might otherwise occur once people hear that compensation may be available. An additional benefit from limiting the number of incidents one can put forward to their total end of year claim is that, as only the larger incidents are likely to be put forward, it means these should hopefully be easier for the CR to measure.

However, as compensation targets the effects of the problem and not the cause, it is imperative that measures are taken to reduce the actual damage inflicted, at the same time as implementing a compensation scheme. Conditions of the scheme limiting payouts only to fields in the cropping zones of the conservancy could however encourage people still farming at the riverside in high-conflict areas to move their fields away, thus freeing up the area for the conservancy to maximise on the tourism potential this riverside area offers. In Kwandu Conservancy some people have been reluctant to conform to the conservancy's land use zonation map as they are unsure if all the hard work and risk undertaken in moving to cultivate a new area will actually be worthwhile to them as individuals. Hence by making a compensation scheme available it may offer some reassurance to individuals and thus aid the implementation of the conservancy's overall management plan.

There is a fear however that compensation may reduce the incentive for farmers to defend their fields themselves. Two measures can be taken to reduce this problem. Firstly it is essential to ensure payouts always remain lower than what the farmer could have expected to get from his crop. However, it is also important that the level of compensation given is not so low that it does not do anything to improve relations between those suffering damage and the conservancy, as was cited as the major flaw in the Botswanan scheme (Envik, 2000). Secondly, it may be appropriate to consider adding a condition to the scheme, which requires the farmers to use available deterrents. This second measure could pose a problem in verifying, especially the use of traditional deterrents where many loopholes could exist. However, if an investment were made in deterrents that were for communal use, such as mobile electric fencing units, then it would be easier to verify whether or not a farmer had made the effort to access the deterrent.

6.1.2 More Community Rangers

The employment of more CRs by the conservancies was the second most desirable strategy to reduce HWC as determined by FGD. Although generally CRs were considered to provide invaluable help to individuals who suffered from problems animals, the unanimous view amongst FGDs was that there simply were not enough of them. With large areas to cover, the CRs' assistance may be demanded in many far-apart places on the same night. This led to frustration on the part of the individual who had stopped defending his field in order to seek help, only to find the help was not there. On the other hand even the CRs admitted that in a few incidents they had run out of methods to scare off the wildlife, in particular elephants. Even firing shotguns in the air, now required several shots to be fired before elephants moved out of the field.

The figures below show scenarios which are based on the employment of an additional CR for each village district, consequently five and three, for Kwandu and Mayuni respectively, for a year[6]. Each figure shows the NPV assuming the additional CRs are effective at reducing overall costs of crop damage by 50%, 30% and 10%.

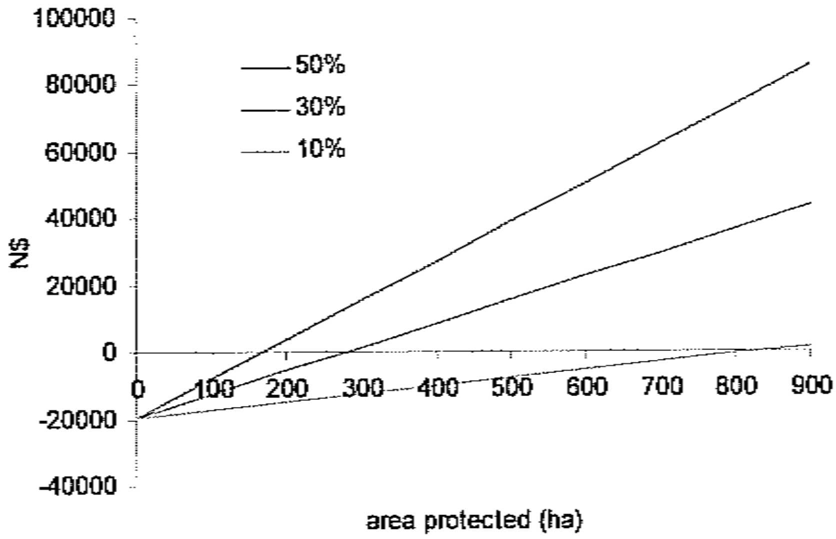


Figure 6.1.2: NPV (N$) of employing five more CRs in Kwandu for three levels of effectiveness

As the area of fields needing protection from wildlife damage in the entire conservancy is 842ha[7], it means that even if these additional CRs were only to reduce the damage to crops by 10%, it would still be an economically viable option to employ them.

[6] An annual salary of N$4,200 was used in the calculations.
[7] the average size of field in the conservancy which experienced damage (3.9ha) multiplied by the number of households experiencing damage in 2002/3 (216).

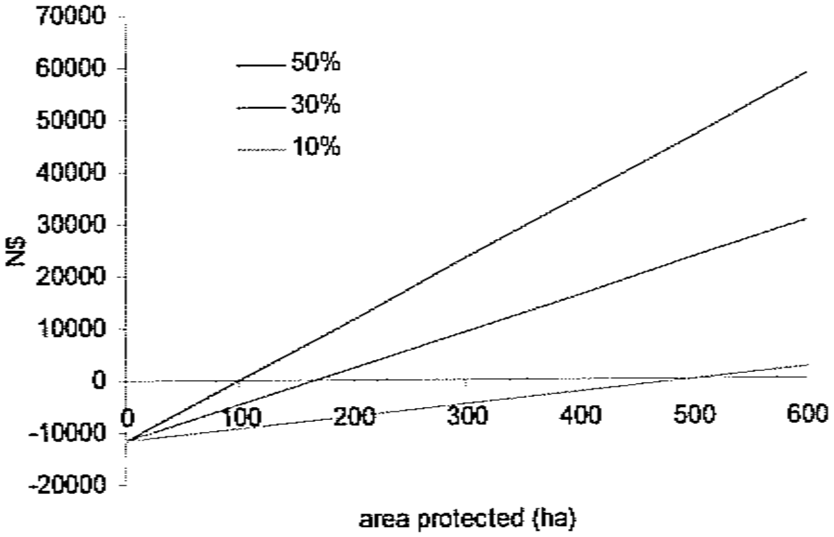


Figure 6.1.3: NPV (N$) of employing three more CRs in Mayuni for three levels of effectiveness

However in Mayuni, where the area of fields needing protection from wildlife damage is lower, at 179ha[8], the employment of three more CRs would only be viable if they were expected to reduce total crop damage by 30%.

6.1.3 Permanent electric fencing

The costs of providing electric fencing along the sides of the three main wildlife corridors within Kwandu Conservancy and along part of the riverside in Mayuni Conservancy, were balanced against the benefits these measures could provide for given assumptions of efficiency and device lifespan. A breakdown of the costs used in the calculations is given in Appendix 8.6. The maps in Appendix 8.7 highlight the areas in each conservancy experiencing the most problem animal incidents (illustrated using Event Book data) and subsequently those areas in need of protection using electric fencing.

- along Kwandu wildlife corridors

A total length of fencing needed was estimated at 42km to line both sides of the corridors between Sesheke-Kalubi and Kalubi-Kongola as well as the southern side of the most northern corridor between Singalamwe and the Zambian border. The length of fencing allows for a funnelling design at either end aimed at channelling wildlife through from the riverside far into the forest side. Accentuated problems of wildlife damage at either end of the corridor, as has been a resultant factor in other opened fencing projects, hopefully would not pose as much of a problem in this scenario as if the Conservancy's zonation plan is adopted, there will not be any fields in close proximity to the ends of the electrified corridor.

[8] [8] the average size of field in the conservancy which experienced damage (2.3ha) multiplied by the number of households experiencing damage in 2002/3 (78).

However as the actual success of dividing the corridors from cropping areas and the consequent reduction in damage to crops is debateable, three scenarios of resultant effectiveness are illustrated, 80%, 50% and 30%. Each of these scenarios of efficiency is expressed in a situation where the electric fencing is expected to last 2, 5 or 10 years. These scenarios are shown in the figures below. As the area of fields needing protection from wildlife damage in the entire conservancy is 842ha, the electric fencing project becomes viable only if the NPV becomes positive at an area equal to or less than this figure.

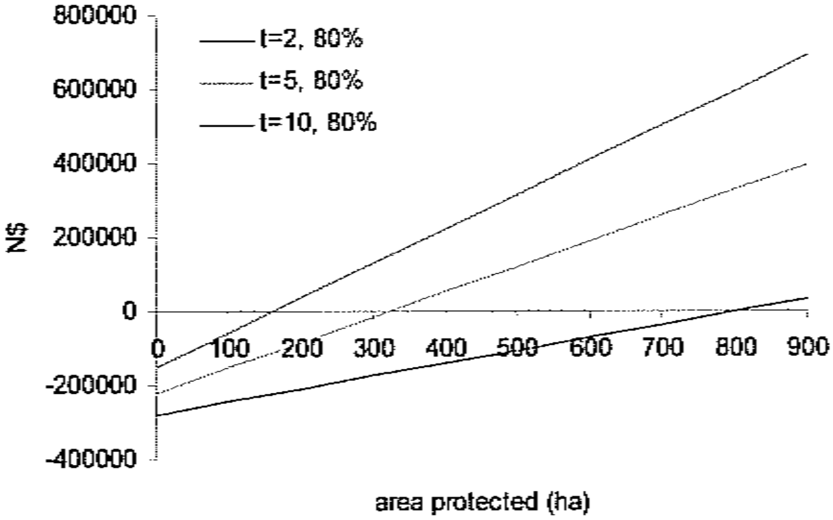


Figure 6.1.4: NPV (N$) of electric fencing along Kwandu's wildlife corridors, assuming 80% effectiveness at reducing wildlife damage costs

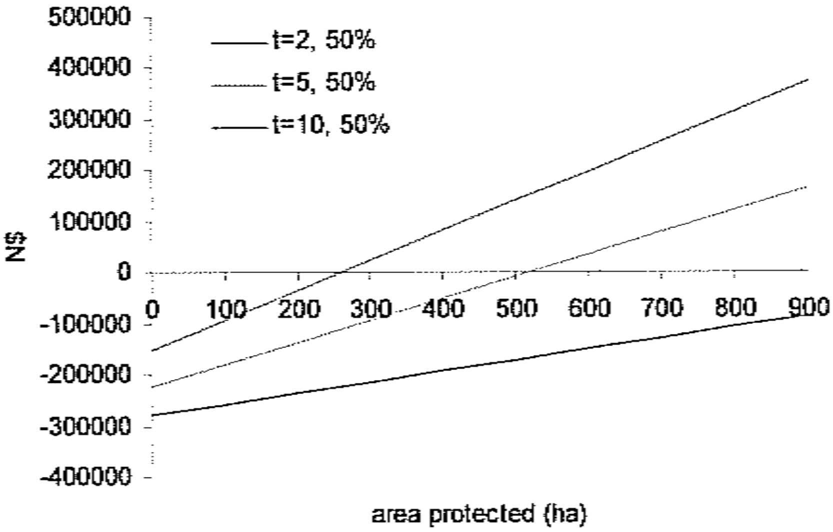


Figure 6.1.5: NPV (N$) of electric fencing along Kwandu's wildlife corridors, assuming 50% effectiveness at reducing wildlife damage costs

The above figure shows that even if the fencing were operational for just 5 years, it would still be a viable option as long as it reduced the overall cost of damage to crops in the conservancy by 50%.

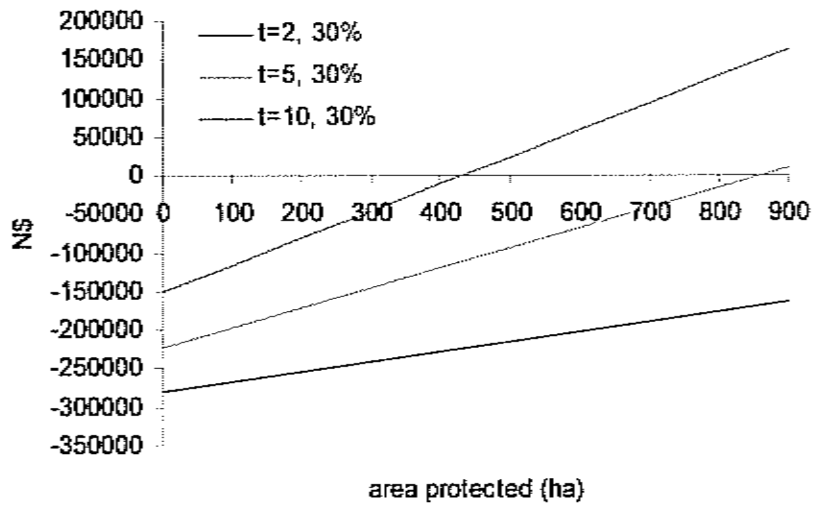


Figure 6.1.6: NPV (N$) of electric fencing along Kwandu's wildlife corridors, assuming 30% effectiveness at reducing wildlife damage costs

For the fencing project to be an economically viable option when 30% effective at reducing conservancy crop damage, it would need to be operational for a period longer than 5 years.

- along riverside in Mayuni

The total length of electrified fencing required for this scenario was estimated at 12.8km to run from the southwestern corner of the conservancy along by the riverside, northwards between the river with its tourism enterprises and the villages of Kapako and Choi, ending in the now uncultivated area between Mazambala and Kayuwo. The northern village district of Kayuwo experienced the least cost of damage during 2002/3 as determined using the household estimates and only a few households are still planting fields by the riverside of this village district. This would hopefully mean little consequent damage if the fence was to end in this area. However many villagers of Kapako have their fields right next to the riverside in this southwestern corner of the conservancy and claim to have little option of moving their fields from where they currently are due to the ancestral rights over land, hence the need for the electric fence to start close to the riverside and again curve round slightly at the end, to channel animals coming from the south onto the riverside of the fence.

The effects of the design of this fence are however an unknown. It may result that it would be less effective than the fencing along the Kwandu wildlife corridors as elephants in Mayuni tend to move through the conservancy in all directions, west-east as well as south-north. Additionally, there seems more chance of causing a concentration of damage at either end of the fence than the Kwandu scenario or simply causing a shifting of the problem as other farmers are in relatively closer proximity. Consequently the scenarios displayed below have been based on assumptions of 50% and 30% effectiveness at reducing overall crop damage in the conservancy. A supplementary beneficial effect of the fence is that it may result in higher numbers of wildlife within the riverside tourism areas, thus increasing viewing opportunities and potentially revenues too. However it could be argued that the fence would in fact detract from the whole natural wildlife viewing experience sort after by tourists to the area.

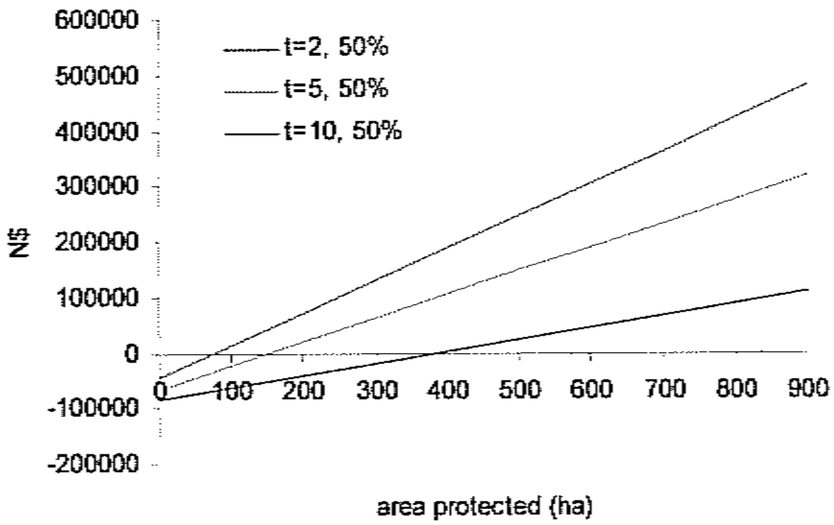


Figure 6.1.7: NPV (N$) of electric fencing project in Mayuni, assuming 50% effectiveness at reducing wildlife damage costs

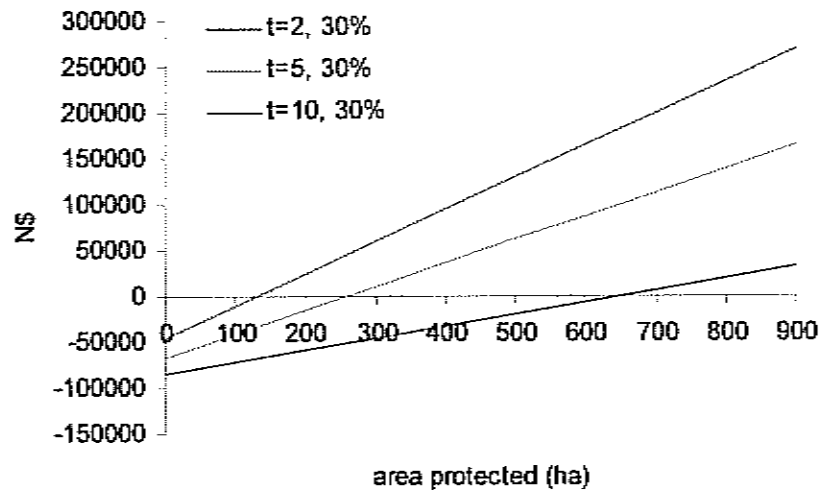


Figure 6.1.8: NPV (N$) of electric fencing project in Mayuni, assuming 30% effectiveness at reducing wildlife damage costs

As the area of fields needing protection from wildlife damage within the conservancy is 179ha, the electric fence would be a viable option if it were operational for five years and 50% effective at reducing wildlife damage. If the effectiveness were lower however, at 30%, the device would still be economical if it were in operation for ten years.

6.2Village level

Although not discussed here, the concept of communal ownership of mobile electric fencing could also be considered for other similarly expensive devices such as flood lighting and trip alarms, thus making them more cost-effective.

6.2.1 Mobile electric fencing

Considering the points raised by the FGD regarding the feasibility of electric fencing, a scenario is considered where a mobile electric fencing unit could be made available for a village district, which could be moved from field to field as necessary as the route of elephants is anticipated. A mobile unit has several benefits over a permanent fence. It can be shared by the community therefore making it more cost-effective but it still allows the individual to have responsibility and choice over the way in which they protect their field. The manoeuvrability of the device is extremely beneficial regarding the changes in field size and location which may occur year on year.

Figure 6.2.1 illustrates the NPV of the costs and benefits of one mobile fencing unit, the breakdown of the costs of which are given in Appendix 8.6. If electric fencing is installed correctly and well maintained it can be highly effective for at least a few years. Subsequently the calculations here were based on an assumption of 100% effectiveness for the device. The graph shows that even with a pessimistic lifespan of 2 years, the device would be economically viable so long as the area of land it protects is equal to or exceeds 46.75 ha.

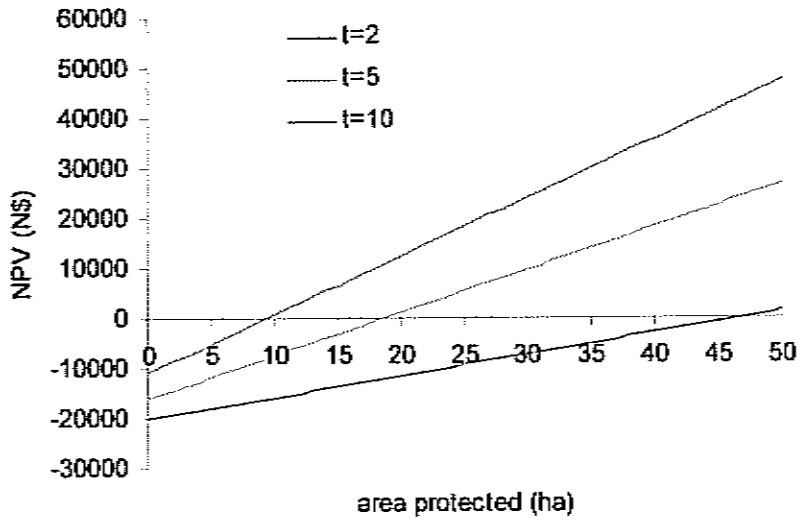


Figure 6.2.1: NPV (N$) of mobile electric fencing by area of protected fields

Table 6.2.1 below shows the estimated total area of fields planted in each of the village districts, which were reported to CRs to have suffered crop damage by wildlife. This gives an indication of the area of crops that would have benefited from protection and subsequently the economic justification for at least one mobile electric fencing unit in seven of the eight village districts, if the device were expected to be operational for more than two years.

Table 6.2.1: Total area of fields needing protection in each village district in 2002/3

Village	*Total area of fields in need of protecting in 2002/3 (ha)*
Singalamwe	60
Mwanzi	117
Sikaunga	147
Sesheke	93
Kongola	231
Kayuwo	42
Choi	93
Kapako	99

In some circumstances however, it is unlikely that the device would be 100% effective against all wildlife damage as a fence set up to deter elephant and hippo may not simultaneously be able to deter bushpig or porcupine due to the different heights and characteristics of these wildlife. Additionally in reality there are likely to be a times when animals pose a problem to multiple fields in different areas of the village at the same time thus leaving some fields unprotected and subject to damage. Therefore the scenario illustrated below is based on the assumption of a lower effectiveness of a mobile electric fence unit, where it reduces all wildlife damage by 50%.

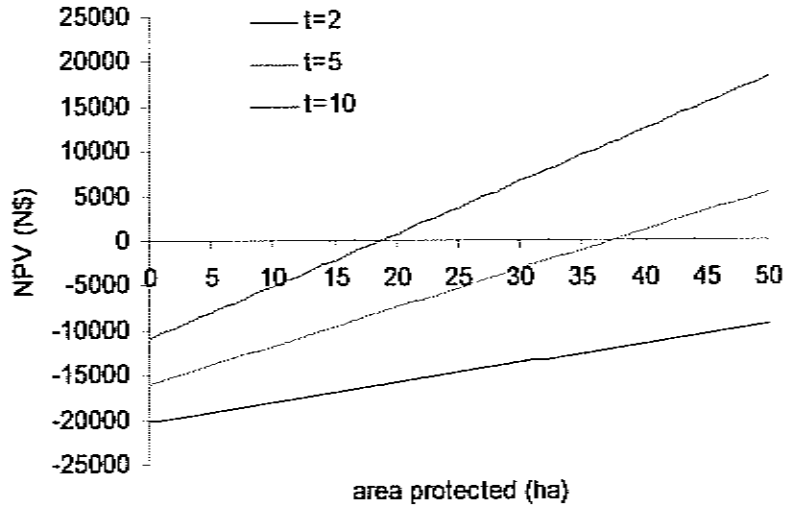


Figure 6.2.2: NPV (N$) of mobile electric fencing by area of protected fields at 50% effectiveness

Under this scenario, if the unit last for just two years is not economically efficient unless it offers protection to 93.5ha or more of crops. This would still make it an option for several of the villages, however, it the device worked for five years or longer, it would immediately be an option for all villages, with some villages justifying two or more of the devices. With more devices, the project is likely to be more successful as logistical difficulties which could otherwise potentially arise, are likely to be minimised.

6.3 Household level

6.3.1 Fencing

The figure below shows the NPV of 3-strand barbed wire fencing[9] assuming a lifespan of 2 years, at 100%, 50%, 30% and 10% levels of effectiveness.

[9] Based on a fixed cost of N$0.57/m of fence including wire, poles and labour. An additional 25% of the fixed cost was estimated as the variable cost of repair and maintenance in each year.

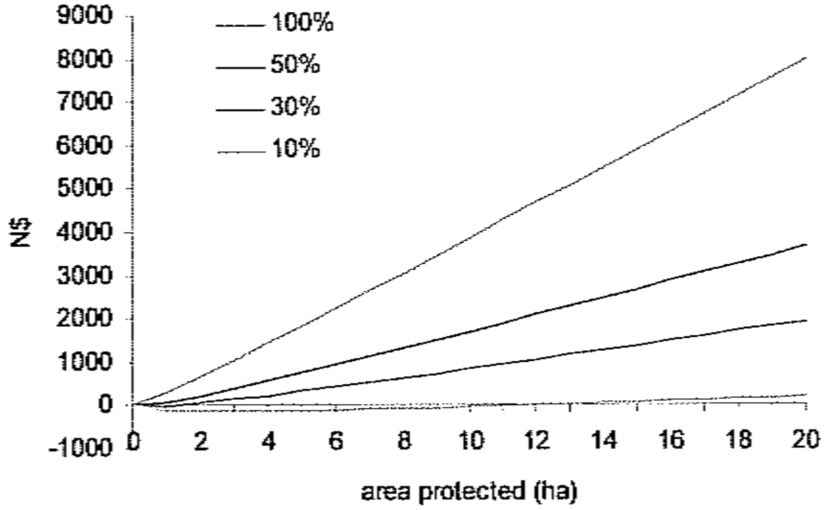


Figure 6.3.1: NPV (N$) of wire fencing assuming a lifespan of 2 yrs at different levels of effectiveness

At 50% effectiveness the barbed wire fencing would be a viable option for all field sizes. However as the assumed effectiveness lessens, the area of field needing protection must be of greater size to still be an economically viable option. For example, at 30% effectiveness the field would need to be of 1.3 ha or larger to make the investment in fencing justifiable. Whereas if the effectiveness of deterring wildlife was assumed to be just 10%, then fencing would only be viable for a field of 11.6ha or greater.

The household interviews resulted in mixed views to wire fencing. Whilst all farmers were in agreement over the fact that it would do nothing to stop elephant, some believed it to still provide a reasonable defence against hippo and bushpig especially when old tin cans were hung from the wire. Others were in disagreement, stating that it no longer deterred hippo from the fields and whilst the crops were young and of a height accessible to hippo and bushpig, they would often find their fences broken. A few farmers felt there to be little point in repairing the fences, as they believed it would only be a short space in time before they were broken again.

6.3.2 Trenches

The viability of digging trenches around fields to prevent hippo and bushpig from entering was considered. Even when assuming a low cost of labour (N$30/day), a high digging rate (5m of approx. 1m wide x 0.8m deep trench/day) and a high level of effectiveness (80%), the trench does not present itself as a viable option on a household level. However, if considering this scenario but where the labour was provided by the household owning the field and not by hired people external to the household, then it is likely that there would be periods during the year in which the opportunity cost of the owners' labour would be lower than the labour cost used when assuming employment from outsiders which may cause the scenario to become viable for some larger fields, where the predominant problem animals are bushpig or hippo. However, when this option was considered during the FGDs, it was evident that people were reluctant to consider doing this work themselves even though the many thought in practice it could work.

6.3.3 Solar torches

As most of the wildlife incidents occur during the nighttime, solar torches, used in combination with other deterrents, may help to deter wildlife from fields. Those farmers who currently possess a torch considered it to be a useful tool in preventing crop damage and stated the only problem to be the cost of and access to new batteries. Even if wildlife became habituated to the torchlight over time, it would still provide essential light to locate the wildlife species in the field. Many farmers stated, either during the household interviews or the FGDs, that even if they guarded their fields and slept there overnight, they may not see or hear the problem animals until it was too late and part of their crop had already been destroyed.

The net present value of the costs and benefits of one solar torch[10] is given below based on an assumption that it would reduce crop damage by 10% in the average household field, and has been given for three different lifespans, 10 years, 5 years and 2 years.

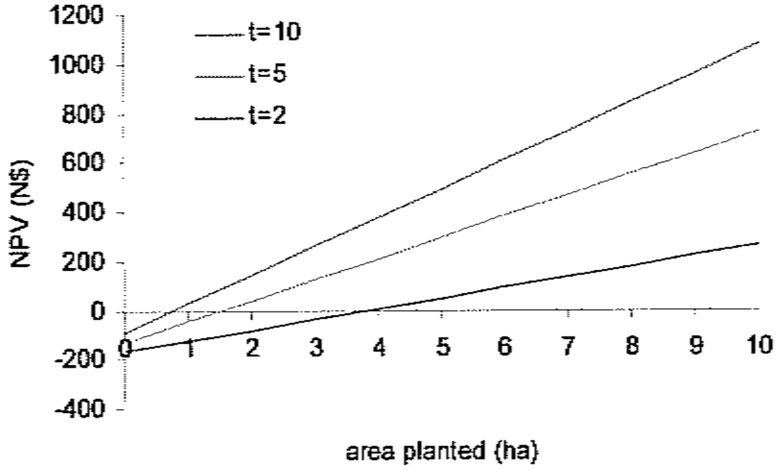


Figure 6.3.2: NPV (N$) of solar torch assuming 10% effectiveness at reducing crop damage

Figure 6.3.2 shows that it is a viable option for households with fields of 3.9 ha or greater if the device lasts for 2 years and is viable for smaller fields if the lifespan is longer.

If its effectiveness as a deterrent was assumed to be lower, at just 5%, it is still a viable option for field sizes of 3.1 ha or larger if used over a 5 year period as shown below.

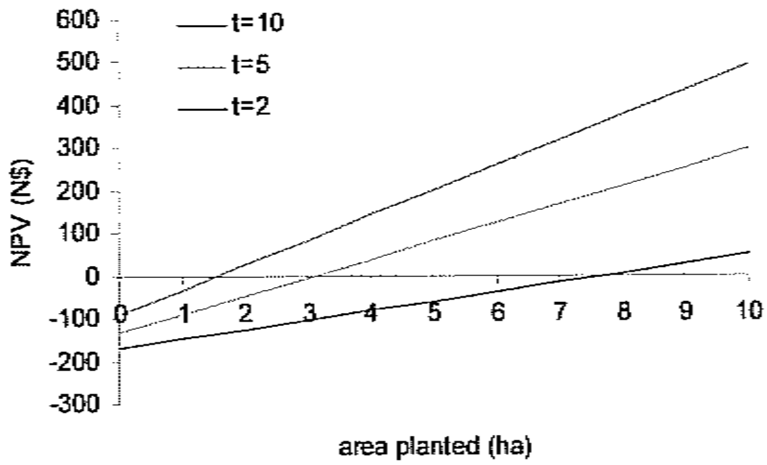


Figure 6.3.3: NPV (N$) of solar torch assuming 5% effectiveness at reducing crop damage

[10] £15.50 per solar torch (Solar Energy Alliance, www.gosolar.u-net.com) + £1.20 international surface mail postage = £16.70 or N$196.50 cost per unit (exchange rate £1= N$11.76675 as on 07/09/2003, www.ft.com)

Although the actual success solar torches may or may not have at deterring wildlife is an unknown, this study illustrates how even if such a device has a small affect it still very quickly pays for itself. Therefore their use could be implemented as an economical component of a combination of strategies aimed at reducing wildlife damage.

7 Conclusions & recommendations

This study produced estimates of wildlife damage costs per household, per village district and for both Kwandu and Mayuni Conservancies. Damage was found to be considerably threatening to some households' livelihoods. However, at a conservancy level the problem appears less significant as relatively few households of the total conservancy population experience substantial wildlife damage. The damage costs were used to determine the economic efficiency of adopting conflict mitigation measures at household, village and conservancy levels.

This report proposes a possible method for determining and allocating compensation to conservancy members suffering crop damage in a fair but simplistic and manageable way. If certain conditions are attached to the scheme, it is likely that a crop compensation scheme could also help the conservancies to achieve other management objectives aimed at addressing human-wildlife conflict and promoting wildlife conservation in the long term. This report also provides an estimation of the monetary fund that would have been needed to ensure all payouts were met for 2002/3 and an equation that can be used to determine the funds needed in future years.

A combined approach is recommended for successful conflict reduction in these two conservancies. Although deterrents and compensation are both feasible individually, the success of either is likely to be accentuated by the concurrent adoption of the other. Community support for the conservancies and consequently future developments may possibly be hindered if help is not given to address the conflict, which is perceived by some to be a problem exacerbated by the conservancy.

Interestingly the study found preferences for more CRs amongst villagers were almost as strong as they were for the first choice of a compensation scheme. This option is possibly the only one mentioned in this study, which is likely to address the considerable threat posed by wildlife that contributes substantially to the indirect costs of living with wildlife. This option could subsequently yield benefits far greater than the abated damage costs alone and is worthy of further investigation.

Mobile electric fencing units communally owned at the village level perhaps offer the greatest overall advantages of the deterrents considered here and additionally pose few risks, a significant benefit where so many unknowns exist. The initial costs are shown to quickly pay for themselves. As few electric fences have been used previously in the area, it is likely to provide protection for a number of years before wildlife find ways to overcome the device. Additionally the device offers choice and independence to the individual, can be manoeuvred to target the worst-hit areas and can provide a totally enclosed area, which is believed to provide the best defence (Hoare, 2003). Although perhaps not a long-term strategy, its immediate use as a short-term measure is justifiable especially whilst other longer-lasting and more sustainable approaches, such as the conservancies land use plans, are being considered and implemented.

The conservancies could additionally benefit from field trials of deterrents not covered by this study such as burning of chilli infused dung and growing chilli peppers, for which a potential market needs to be sought.

In conclusion, this study has reported the results of primary and secondary research within a high human-wildlife conflict area in Caprivi. Despite the limitations of time and resources, it has yielded some important findings on which further work can be built to implement appropriate conflict alleviation measures and consequently assist in the conservation of wildlife, in particular the elephant, a valuable keystone species.

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8 Appendices

8.1 Questions/topics for household interviews

1. Conservancy:
2. Village:
3. Name of interviewee:
4. GPS co-ord:
5. No. in HH:
6. Crops grown this year?
7. Size of field if known?
8. How much of the field was planted with each crop?
9. What was the quality of the crop: good, medium or poor?
10. How many bags of grain did you get for each crop?
11. How many kgs were these bags?
12. How long did/do you expect this crop to last your household?
    If they indicate they have excess for the year, then ask:
13. Have you or are you planning to sell any of your crop?
14. If so, how much, where and at what price?
15. Comparison of above to previous years
16. Plans to change cropping system in the future – any changes planned in response to problem animals?
17. Problems/difficulties in farming here?
18. Location of and distance to nearest water supply?
19. Crops damaged by wildlife?
20. Which wildlife did damage? If more than one species, then rank them into most damaging to least.
21. Age of crop when damaged: seedling, interim, mature?
    If damage occurred early, then:
22. Was it possible to replant?
23. Estimated area damaged?
24. Estimated proportion of field damaged?
25. Estimated no. of bags that would have been achieved if there had not been any wildlife damage to the crop?
26. Nature of damage: visit, feeding, trampling?
27. Did the wildlife do damage to anything else?
28. Were any deterrents used? Costs? Effectiveness? Disadvantages of use?
29. What do you think could be done to reduce the problems with wildlife?
30. Has the damage to crops by wildlife got better, worse or stayed about the same in the last 10 years?

8.2 Focus Group Discussions

8.2.1 Topics

Traditional deterrents
Trip alarms
Electric fencing
Protected communal intensively cultivated area
Wildlife corridors
Zonation – water points for people & wildlife

Discussions about chilli pepper spray, chilli pepper as a buffer crop and compensation for crop losses were advised not to be ventured into unless the participants themselves raised these subjects so not to get peoples' hopes up on measures which are not currently guaranteed to succeed and that are in need of piloting first.

8.2.2 FGD participants

Table 8.2.1: Details of focus group discussion participants

Conservancy	*Village*	*No. of people*	*No. of groups*	*No. of women*	*No. of men*
Kwandu	Singalamwe	41	2	24	17
	Mwanzi	23	2	14	9
	Sikaunga	9	1	3	6
	Sesheke	11	2	6	5
	Kongola	24	2	15	9
Mayuni	Kayuwo	15	1	3	12
	Choi	8	1	0	8
	Kapako	40	2	17	13

8.2.3 Weightings applied to ranked preferences

Table 8.2.2: Weightings applied to preferences ranked by FGD

Ranking	*Weighting applied*
1st	10
2nd	8
3rd	6
4th	4
5th	2

8.3 Sample data

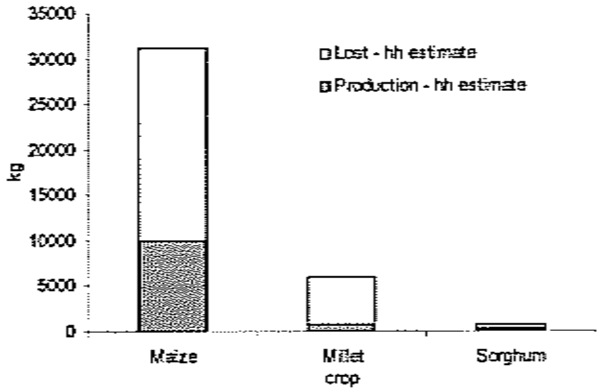


Figure 8.3.1: Production & losses to wildlife by crop type, estimated by Kwandu sample HHs, 2002/3

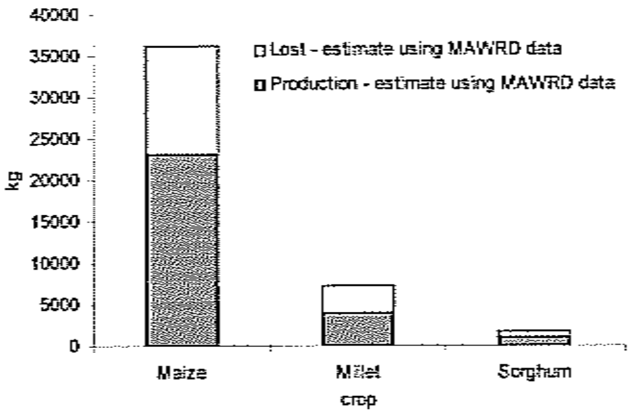


Figure 8.3.2: Production & losses to wildlife by crop type, estimated using MAWRD data for Kwandu sample HHs, 2002/3

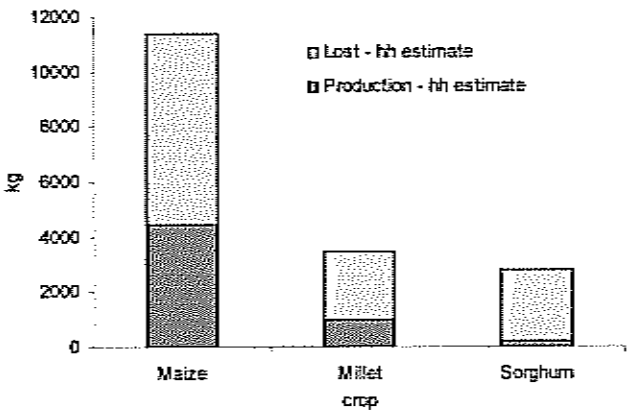


Figure 8.3.3: Production & losses to wildlife by crop type, estimated by Mayuni sample HHs, 2002/3

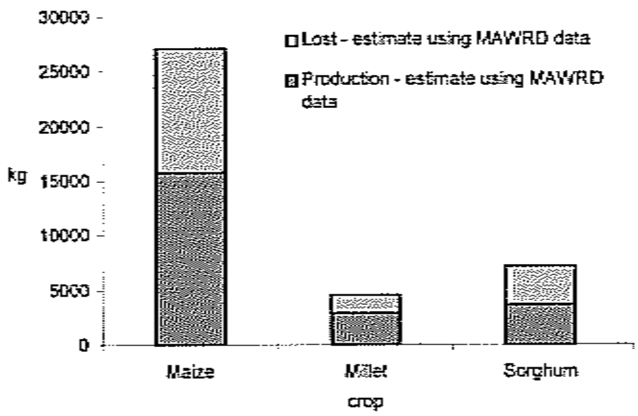


Figure 8.3.4: Production & losses to wildlife by crop type, estimated using MAWRD data for Mayuni sample HHs, 2002/3

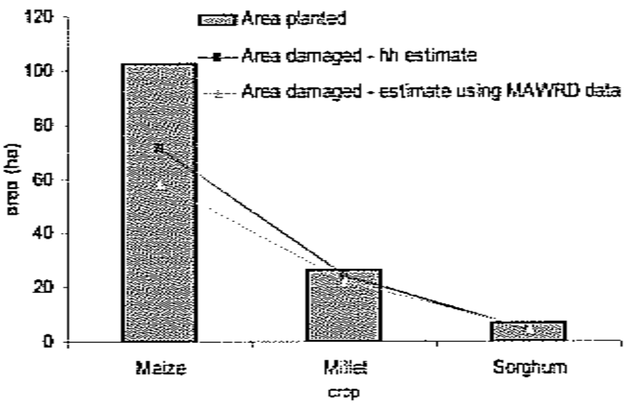


Figure 8.3.5: Area planted & damaged by crop type in Kwandu sample HHs, 2002/3

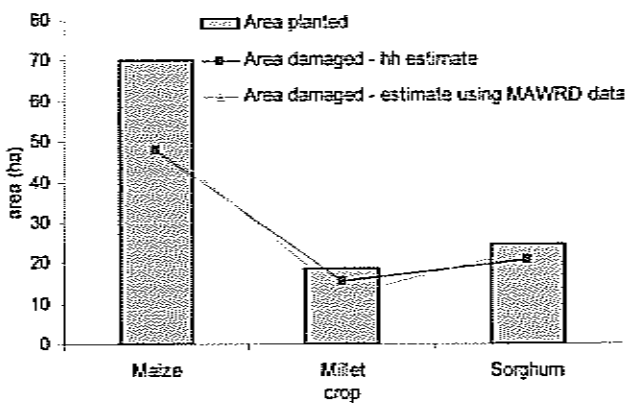


Figure 8.3.6: Area planted & damaged by crop type in Mayuni sample HHs, 2002/3

Table 8.3.1: % of crop type planted in both conservancy samples damaged by wildlife

	based on hh estimates	*based on MAWRD data*
% area of maize damaged/planted	79	63
% area of millet damaged/planted	79	74
% area of sorghum damaged/planted	91	94

8.4 Crop yields and prices

Table 8.4.1: MAWRD average forecast crop yields, 2002/3

Crop	*MAWRD ave. yield forecast (kg/ha)*
Maize	225
Millet	150
Sorghum	150

Table 8.4.2: Crop prices, 2002/3

Crop	*Price (N$/kg)*
Maize	1.997*
Millet	1.5*
Sorghum	1.5

* Namibian Agronomic Board floor prices, valid until end August 2003

8.5 Background data on conservancies

Table 8.5.1: General data on Kwandu & Mayuni Conservancies

	Kwandu	*Mayuni*
ave. size of field planted (ha)	3.9	2.3
no. of conservancy members	1800*	1500*
no. of conservancy member hh**	900	750
total area of land planted by conservancy members (ha)	7003	3476
total area of conservancy (ha)	19000	15100

*taken from 'Conservancies facts & figures' webpage, DEA, MET. www.dea.met.gov.na

** based on an estimate of two conservancy members per household.

8.6 Costs of deterrents

Table 8.6.1: Costs of permanent electric fencing & components

Electric Fencing - permanent	*N$32,565
Solar power source (75Wpanel, 105AH battery and regulator)	7150
Energizer (B1600 - 16 Joule)	5850
Stand and Brackets	1430
2,4mm steel wire (8 rolls of 1,6km each)	3250
Corner Posts (8 x 1.8m tar poles)	1664
Stay (100 x 2m)	8840
Pedestrian Gate	455
Insulators (nail on)	1300
Straining Insulators	650
Super strainer	104
Lead out cables	260
Voltage tester	832
Tools	780

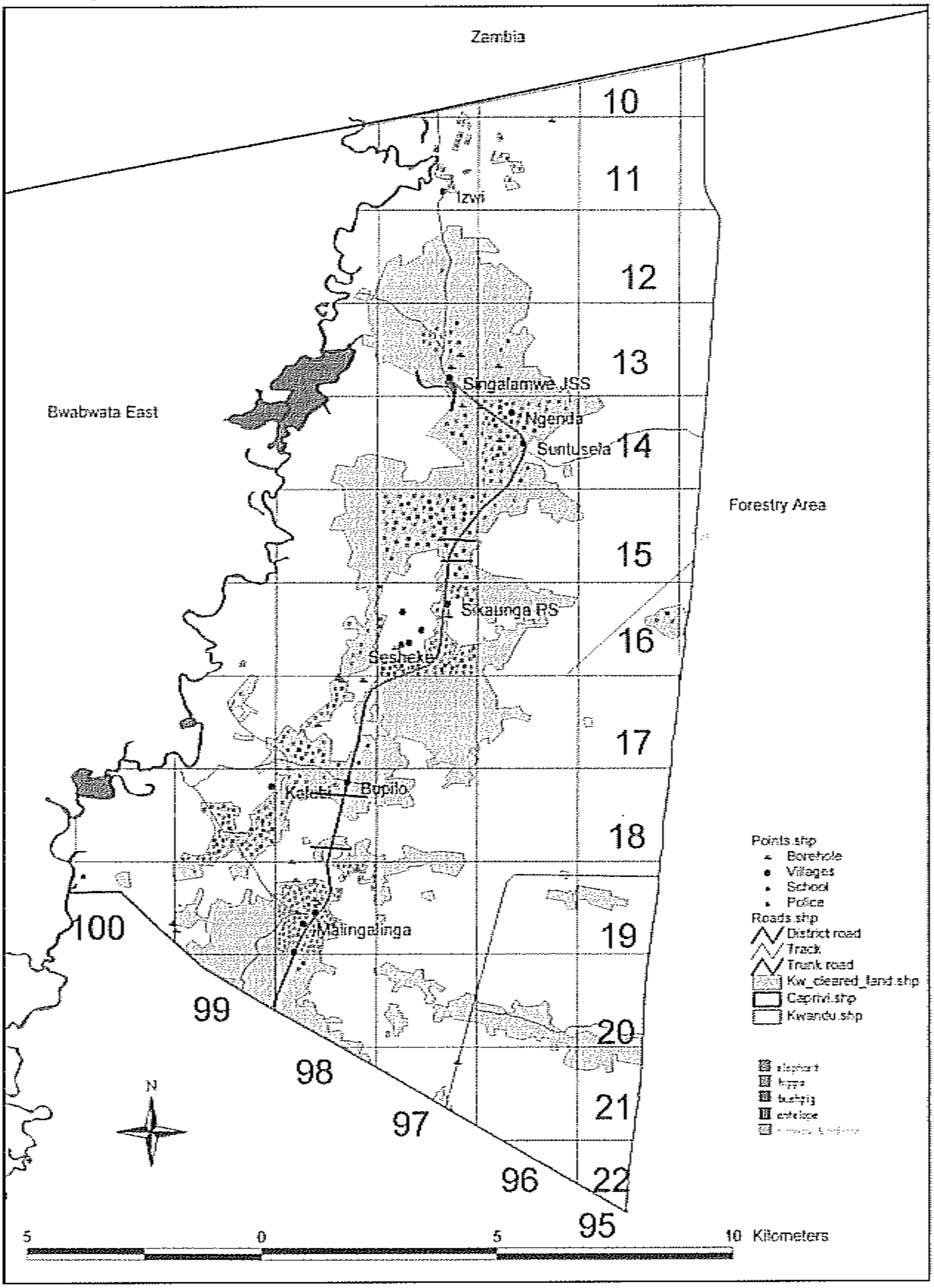
*corresponds to a distance of 4.267km if 3 strand fencing is used therefore the cost/km is N$7,632.

Table 8.6.2: Costs of mobile electric fencing unit & components

Electric Fencing – mobile (cost for 1 unit)	*N$ 23,556
Solar power source (75Wpanel, 105AH battery and regulator)	7,150
Energizer (B1600 - 16 Joule)	5,850
Stand and Brackets	1,430
Braided wire on rollers	5,200
Insulators (nail on)	1,300
Straining Insulators	650
Super strainer	104
Lead out cables	260
Voltage tester	832
Tools	780
Construction and maintenance workshop x 4	2,600

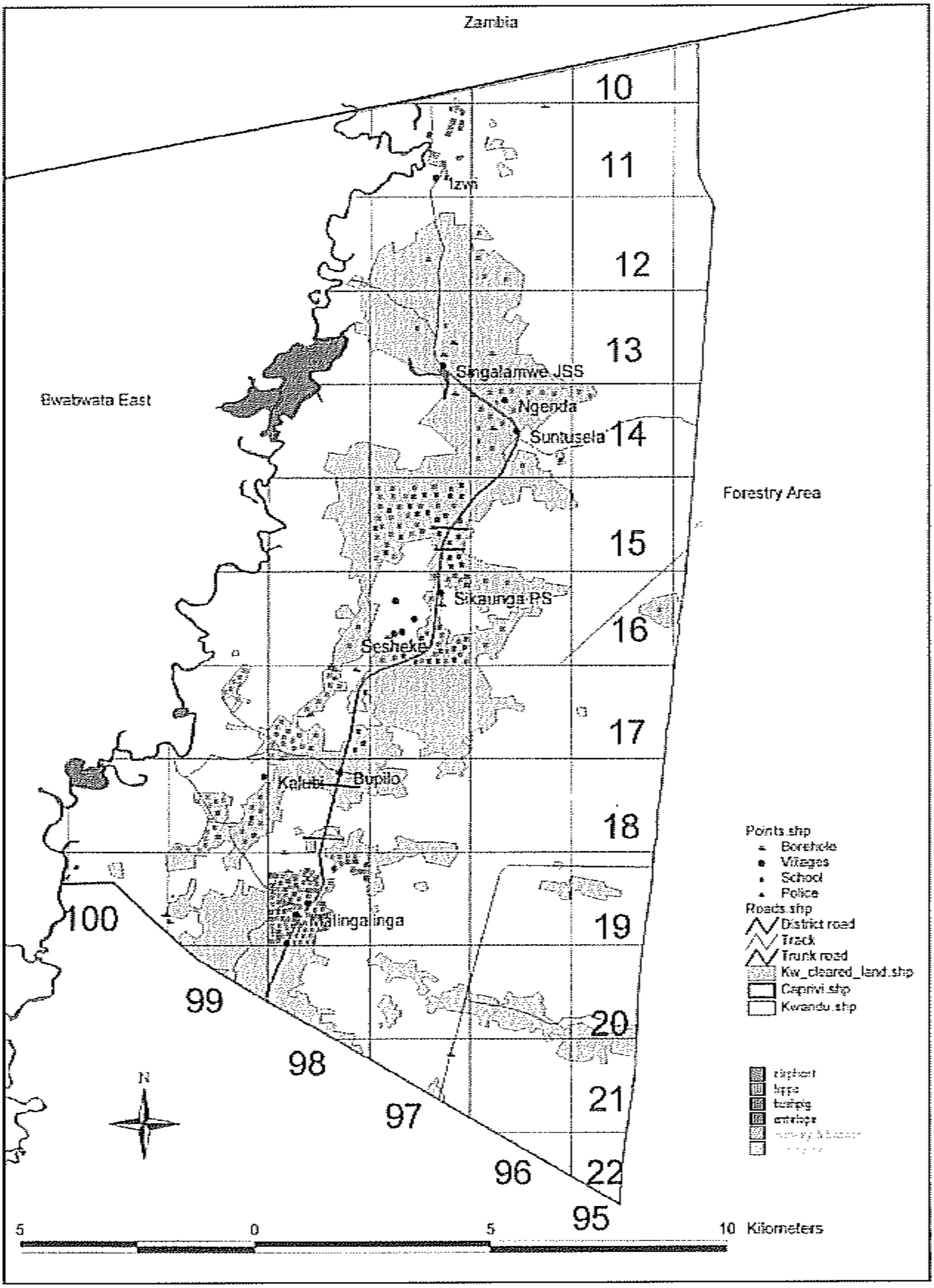
* costs taken from GPTF proposal budget (Odendaal, 2001) with 30% added to bring up to date with inflation.

8.7 Maps of wildlife damage incidents[11]

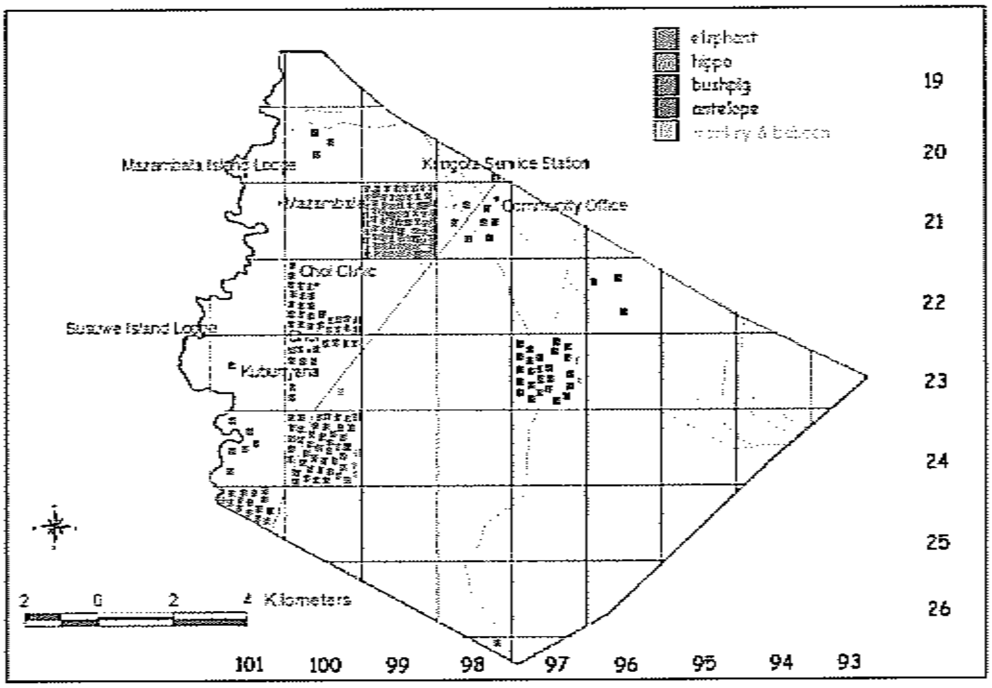


Map 8-1: Damage incidents by wildlife species in Kwandu Conservancy 2002

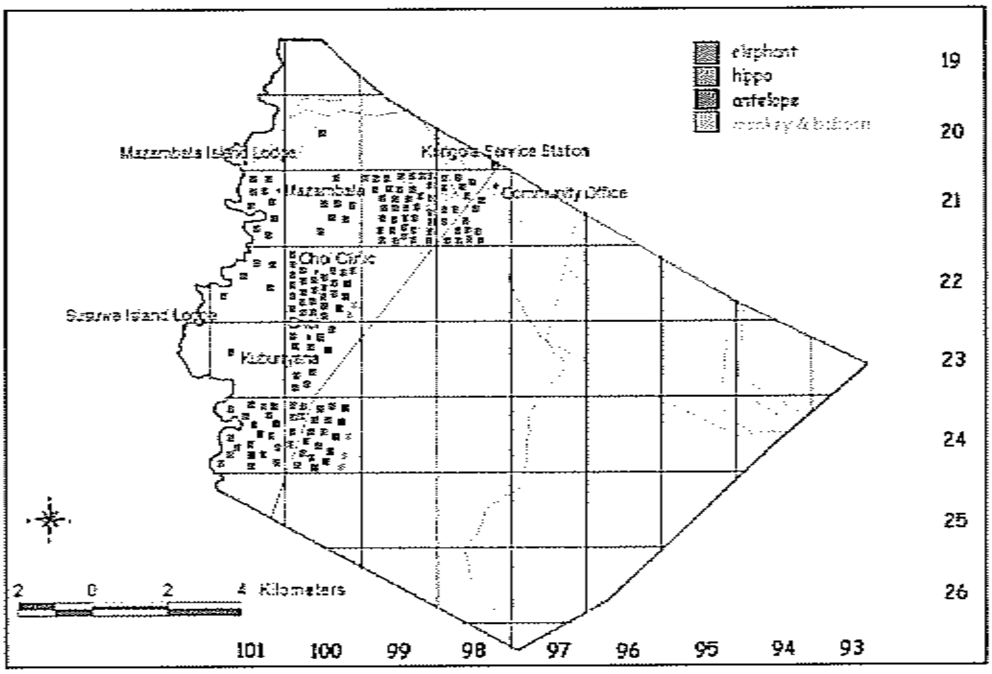
[11] Location of damage incident correct to the 2x2km grid square in which it is placed.



Map 8-2: Damage incidents by wildlife species in Kwandu Conservancy 2001



Map 8-3: Damage incidents by wildlife species in Mayuni Conservancy 2002



Map 8-4: Damage incidents by wildlife species in Mayuni Conservancy 2001