

Human Crocodile Conflict in the Chiawa Game Management Area, Zambia

Update report for the

IUCN-SSC Crocodile Specialist Group
Student Research Assistance Scheme

Kevin Wallace

Imperial College London

August 2010

EXECUTIVE SUMMARY

An increasing number of negative human wildlife interactions often cause problems with conservation strategy implementation. We conducted a questionnaire survey in the Western Chiawa Game Management Area, Zambia to establish the scale of human crocodile conflict, people's attitudes to wildlife and how mitigation measures could be implemented.

Attitudes to crocodiles and wildlife in general were negative with them being seen as a problem for the village community. Very few people suggested that either crocodiles or wildlife could be beneficial. Those that did were most often employed within the local tourism industry or with a crocodile ranch.

It was found that the majority of attacks targeted fishermen whilst they fished from canoes. The next highest risk group were women when collecting water from the river.

Elephants were considered most problematic being a threat to human life as well as causing significant crop destruction. Crocodiles were considered the second most problematic animal, followed by hippopotamus and buffalo.

The main mitigation measure suggested by respondents was to increase the number of boreholes in the villages thereby reducing the dependence of people on the river.

Traditional mitigation measures such as crocodile-proof river fences, cheap, quick and easy to erect which allow safer access to the river for people and livestock may not be as effective as previously thought.

The government was deemed to be the main body responsible for making the area safer to live in, although non-governmental organizations were also deemed partially responsible.

It is envisioned that this data combined with crocodile population data from the same stretch of river can be utilized in the mapping of current and future possible conflict zones. This information will be collated and offered to the wildlife departments responsible for this area as a form of human wildlife conflict strategy plan.

ACKNOWLEDGMENTS

Financial Support:

IUCN-SSG Crocodile Specialist Group Student Research Assistant Scheme
Earthwatch Insitute
National Environment Research Council, UK

Academic Support:

Dr Alison Leslie, University of Stellenbosch
Professor Tim Coulson, Imperial College London

Logistical & Research Support:

I wish to thank my wife and research partner Mme Audrey Detoeuf-Boulade for all her hard work above and beyond the call of duty during this project. To all the Earthwatch volunteers who supported us in Zambia and for the field assitance and data collection. For translating - Paul Mwale, Collins Mateo, Darius Massanga, Pepicho Mayenga, Amos Kalenga and Killian. To the people of the Chaiwa Game Management Area for their assitance and willingness to participate in the questionairre survey. Mr Reginald Mfula of Kwalata Lodge for allowing us to set up the research base camp on his property.

TABLE OF CONTENTS

EXECUTIVE SUMMARY ..... **ii**
ACKNOWLEDGEMENTS ..... **iii**
1.0 INTRODUCTION **1**
2.0 MATERIAL AND METHODS **1**
2.1 Study area 1
2.2 Questionnaire surveys 2
2.3 Archive data and crocodile attack incidents 3
2.4 Aims of the study 3
3.0 RESULTS AND DISCUSSION **4**
3.1 Villages of the Chiawa Game Management Area 4
3.2 Water collection 5
3.3 Fishing activities 7
3.4 Livestock and crops 8
3.5 Attitudes to crocodiles 9
3.6 Crocodile attack incidents 9
3.7 Responsibility and mitigation suggestions 11
3.8 Attitudes to wildlife 14
4.0 SUMMARY AND CONCLUSION **15**
4.1 Mitigation of human crocodile conflict 16
4.2 Loss of natural habitat within the Chiawa Game Management Area 16
4.3 Continued monitoring of the crocodile population 17
5.0 REFERENCES **18**

1.0) INTRODUCTION

With the obvious and beneficial exception of ecotourism, crocodile/human interaction is rarely positive (McGregor 2005). As human populations continue to increase and expand at alarming rates, so more of the already limited natural areas become colonized. This brings people into close contact with wildlife and competition for resources such as space, food and water becomes an issue. Human Crocodile Conflict (HCC) is becoming recognized as a social and conservation problem in many African countries due to conflict situations where predation of livestock and humans is occurring (Thomas 2006, Aust et al. 2009). The human population in the Chiawa Game Management Area (GMA) is expanding which in turn creates more pressure on the existing village boreholes as well as increasing the presence of people and livestock by the river. There is also an increase in agricultural practices and for ease of irrigation many of the fields extend right to the water's edge.

Nile Crocodiles, being cryptic, semi-aquatic and largely nocturnal, are able to inhabit water courses that are often in close proximity to humans even after other wildlife species have been extirpated. This provides the potential for conflict situations through the attack of humans and their livestock. The management of HCC can include both capture and removal (or relocation) as well as lethal control of crocodiles, although this should be carefully monitored due to crocodile ranching activities (Fergusson 2006) as crocodiles are an economically important species (MacGregor 2002). Crocodiles are considered a keystone species, helping to maintain the complex balance and biodiversity of wetland ecosystems (Thorbjarnarson 1992).

HCC has meant that some crocodile populations have been reduced by persecution to such an extent that conservation measures are becoming an issue (Santiapillai and de Silva 2001). One country where conflict is on the increase is Zambia where the Zambia Wildlife Authority (ZAWA) has reported HCC problems in the west and south of the country, where there have been calls for a reduction in the crocodile population. Developing ways to reduce conflict is essential if crocodile populations are to remain healthy and to mitigate the loss of human and livestock life (Fergusson 2002).

2.0) MATERIAL AND METHODS

The study proposal and methodology was reviewed and approved by the Ethical Review Process of Imperial College London, UK.

2.1. Study area

The Chiawa Game Management Area (GMA) is situated in the Lower Zambezi region of Zambia (Figure 1) and is IUCN category IV, defined as an area 'to maintain, conserve and restore species habitat'. GMA's in Zambia were principally established to act as buffer zones around National Parks, although they also support hunting and photographic safaris as well as settlement for local communities and agricultural activities (ZAWA 2010). The Chiawa GMA is 2,344km^2 and is divided into two areas, the Eastern GMA is designated a 'sanctuary area' to act as a further buffer zone between the Western GMA, which is becoming increasingly populated ~20,000 people (TNC 2010) and the Lower Zambezi National Park to the East. A long term view is to reclassify the GMA as the Chiawa Partnership Park which aims to utilise private investors to empower the local community and promote conservation within the area (TNC 2010). It is also part of the African Wildlife Foundation (AWF) Heartlands program which encompass a variety of landscapes including national parks, local villages, government and private lands as well as spanning international borders (AWF

2010). The concept of the Heartland projects is to balance the needs of both people and wildlife whilst working with stakeholders to develop conservation strategies. The area supports a diverse array of wildlife which is becoming increasingly threatened by the expanding human population. The main large wild animals in the area that potentially pose a human-wildlife conflict are baboon, buffalo, elephant, hippopotamus and Nile crocodile. The Lower Zambezi Valley is dominated by flood plains with rural communities making use of the fertile soils and good access to water to grow food crops. The area has a distinct wet season from November to April (mean 21.8°C), a dry season (19.3°C) from May to October and receives ~815mm/year rainfall (worldclimate.com).

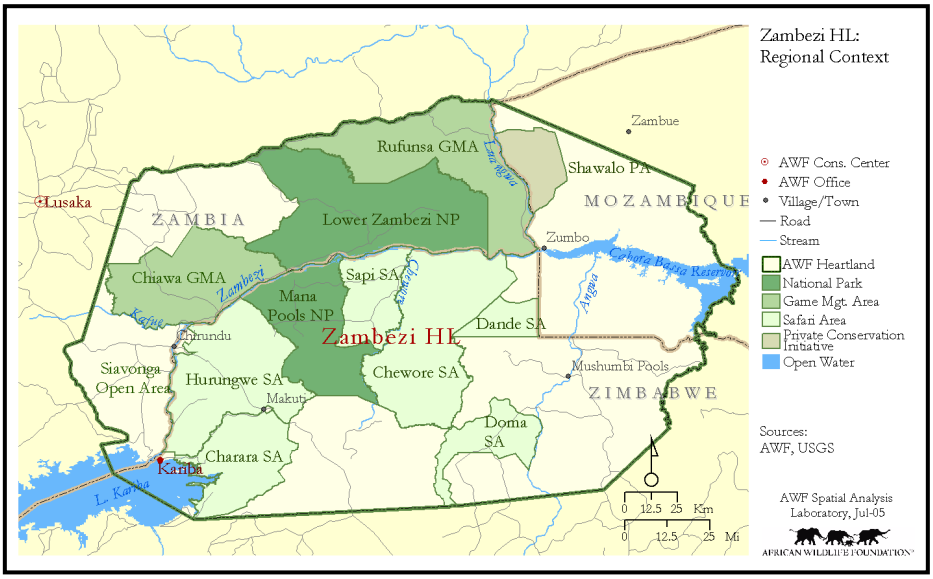


Figure 1. The Chiawa Game Management Area in the context of the Africa Wildlife Foundation Zambezi Heartland.

2.2. Questionnaire surveys

In order to minimize bias (Newmark et al. 1993, Willgerodt 2003) trust and credibility with the local communities was established by working/researching in the area for a year prior to the questionnaire survey. This also allowed the research team an opportunity to meet local headmen and interact with village communities - including informal presentations at local schools and lodges. Each enumerator was given training which included an explanation of the purpose of the survey, an explanation of the questionnaire, interview techniques and aspects of local culture.

The questionnaire (Appendix 1) included both open-ended and fixed response questions, and a single respondent from each household was interviewed. Interviews were conducted in 15 villages, beginning at the Western most village of the Western Chiawa GMA - Mafungausi, proceeding east until the last village, Mushonganende was completed, situated close to the Eastern GMA gate. The villages border the main Lower Zambezi road which runs approximately parallel with the Zambezi River. Interviews were conducted between 08h00 and 12h00, Monday to Saturday (excluding Sundays due to religious reasons) for 5 months from April through to August 2009. Each household in the village was approached and a request for an interview was made to a representative. Interviews were deliberately carried out with the headman and elders to ensure that key members of the village institutions were involved and aware of the survey (n=34). The remainder of the interviews (n=364) were carried out with a permanent resident representative of the household. Interviews took approximately 30 minutes to complete and all respondents were above the age of 18 years.

No incentives or rewards were offered for participation in the survey. The translator would explain the purpose of the interview in the native language (Shona, Nyanga or Tonga) and that participation was voluntary and that the respondent need only answer questions they felt comfortable with. It was also explained that the individual information collected would remain confidential. Unless the respondent was fluent in English, questions were then interpreted to ensure that the respondent fully understood.

During the course of the survey an additional questionnaire (Appendix 2) was formulated that focused on people's views towards the main problem animals of the area. This involved re-visiting the 15 villages of the GMA, the interview lasted ~5 minutes and spanned 2 weeks during October and November 2009.



Interview in progress at a respondent's household with the enumerator and translator in the background.

2.3. Archive data and crocodile attack incidents

Official data was provided by ZAWA of 44 crocodile attacks dating from 2000. This was then compared with the survey data for correlating information – name, severity, location, activity and date to identify if any of the reported incidents from the different sources were repeated.

The survey data regarding crocodile attack reports also had to be disentangled due to the possibility of replication of the same incident which may have been repeated by several different respondents. The data was cross checked for correlating names, age, gender, activity, location, date and severity of injury in order to indentify single incidents.

2.4. Aims of the study

- To determine the severity and extent of HCC along the middle reaches of the Zambezi river.
- To map current as well as future possible conflict zones and prioritize areas for conservation and mitigation plans.
- To develop a plan to mitigate the conflict as far as possible for the mutual benefit of stakeholders and crocodiles

3.0) RESULTS AND DISCUSSION

3.1. Villages of the Chiawa Game Management Area

Interviews were completed with 398 respondents in 15 villages of the Chiawa GMA (Table 1). The gender of respondents was biased, with more women (68%) interviewed than men (32%). The majority of the workforce for both the agricultural and tourist industry is male therefore women performing daily chores were most often encountered within the villages. The mean age of respondents was 33 years and the average length of time lived in the area was 14 years. The average number of adults per household was 3 (range 1-12) and 4 children (range 0-14). The number of households varied from 12 to 120 in each village. Only one village did not have a borehole due to the small population and at the time of the survey 3 village boreholes were non-operational. The number of households in each village per borehole varied from 15 to 162.5 (mean 66.2). Water consumption per day (for an average household consisting of 2 adults and 3 children) was estimated at a minimum of 125 litres, often collected and carried on foot in 25-30 litre capacity containers for ablutions, cooking, cleaning and drinking.

Table 1. Summary of villages in the Chiawa Game Management Area. *indicates the presence of a borehole albeit in-operational. Distance to Zambezi River was estimated using GPS coordinates as a straight line from the centre of the village to the river edge. Distance to the Eastern GMA gate was estimated using GPS coordinates as a straight line from the centre of the village to the gate. Household/borehole indicates the number of households per borehole for that village.

Village	**total households**	**interviews**	**% of total households interviewed**	**boreholes**	**clinic**	**school**	**distance to Zambezi River (km)**	**distance Eastern GMA gate (km)**	**household/ borehole**
Mafungausi	40	25	62.5	2	1	1	0.6	30.6	20
Makenya	139	45	32.4	1	1	0	0.6	26.7	139
Kabwadu	325	74	22.8	2	0	1	1.2	23.7	162.5
Muzama	65	24	36.9	1	0	0	2.4	21.9	65
Gunduza	28	12	42.9	1	0	0	2.5	21.3	28
Chilimanga	57	26	45.6	1	0	0	0.6	18.8	57
Chiawa	120	57	47.5	2	1	1	0.9	15.4	60
Mauda	20	5	25.0	1	1	1	2.2	14.1	20
Kandoko	60	18	30.0	2*	0	0	2.5	13.4	na
Chiuye	20	10	50.0	1*	0	0	2.4	10.2	na
Chapanga	32	13	40.6	1*	0	0	1.5	8.5	na
Kambanja	12	4	33.3	0	0	0	1.2	7.4	na
Mugurameno	120	48	40.0	3	1	1	0.9	5.9	40
Chimosamba	57	10	17.5	1	0	0	1.3	5.4	57
Mushonganende	30	27	90.0	2	0	0	1.4	2.3	15
TOTAL (mean[*1])	1125	398	41.1[*1]	17	5	5	1.48[*1]		66.2[*1]

3.2. Water collection

Having to collect water is a necessity for people of the Chiawa GMA as none of the households were known to have any form of running water within the house itself. Water had to be collected from either the local borehole or the river. Local residents are expected to pay between Kwa 5,000-20,000 per month (~1-4 USD) for use of the borehole. This money is kept by the headman and used for maintenance and repair work. The amount of finance available for borehole upkeep will vary with the size of the village, from 65.3 USD to 261 USD (mean 163 USD) per month. The cost of a borehole is approximately 4,000-5,000 USD including materials, construction and labour. It is expected that the population pressure exerted on a borehole will correlate to the how often maintenance is required, this varied between 15 households (~39 adults and ~60 children) to 162.5 households (~423 adults and ~650 children). If 125 litres is the assumed daily water requirements of an average family then the boreholes are required to supply between ~1,875l to 20,312l of water per day.

The majority of households (84%) had a borehole closer than the river, the mean distance from a respondent's house to the nearest borehole was 411m, the river was 1368m, yet many people still utilise river water. This is because either the borehole is broken or it is quicker to perform the activity at the river, as it elimiates the queing system found at the borehole. Water for daily activities such as drinking (potable), washing clothes, washing dishes and bathing is collected primarily by the women (79.4%) of the household (Figure 2). The majority of potable water is collected from the borehole whilst washing water is equally distributed between boreholes and the river. When utilising river water, people have two choices which have varying degrees of risk, either to briefly collect water from the river and perform the activity on the bank (or transport the water back to the house), or complete the activity in the river itself. Many respondents replied that although they collect water from the river they actually wash or bathe either on the bank or back at the house. Although slightly less risky than actually washing or bathing in the river itself, they all pose an initial risk associated with the exposure to possible crocodile attack. A total of 34 attacks were recorded for people washing utensils or clothes in the river, 32 of these were on women as this is also a female dominated activity.

A high percentage of households (69.3%) collected river water and an additional 9.0% would also utilise the river for water collection if the borehole was in-operational. The remaining households claimed they would either dig for water in a dry river bed (4.9%) or travel to a neighbouring village borehole (14.9%) or a mix of both (1.5%). A small percentage (4.3%) of households were unconcerned as the borehole never broke.

Just under a third of the households (27.4%) had someone who bathed in the river and of these 67.9% bathed daily. The preferred bathing time was during the afternoon 42.9%, followed by morning (33.1%), evening (13.5%) and midday (10.5%). A total of 7 attacks were recorded for people bathing in the river.



Manually operated borehole water pump found in the villages of the Chiawa Game Management Area.

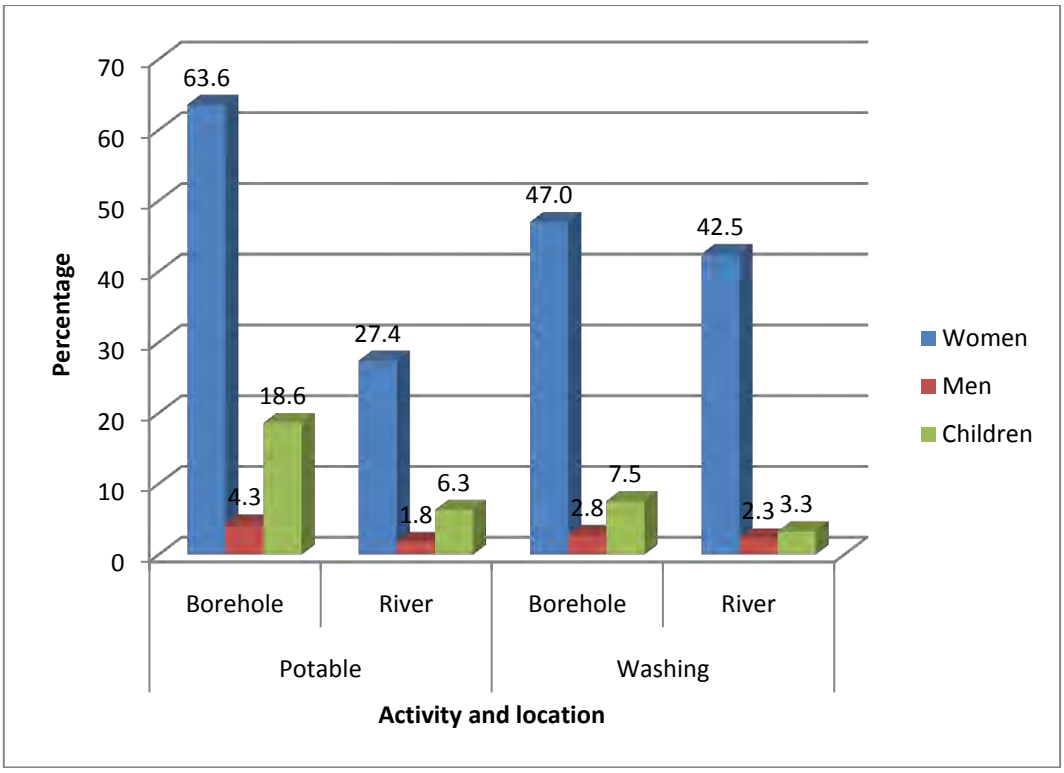


Figure 2. Percentage of people (adult women, men and children) of the Chiawa Game Management Area and water collection activities. The percentages for each activity (potable water and washing water collection) exceed 100% as some households utilize both borehole and river water collection.

3.3. Fishing activities

Many people fish in the Zambezi River such as local fisherman who fish for subsitence (and sell excess catch to the local markets) as well as tourists that holiday in the lodges and fish for sport.

Approximately a third of households (34.4%) had at least one person who fished in the Zambezi River (Figure 3). Approximately 60.0% of these people fished from the bank, mostly men and women with a few children. The remaining 40.0% fished from a canoe and was dominated by men. A total of 7 crocodile attacks were recorded on people fishing from the bank, whilst there were 69 incidents of fishermen attacked whilst in a canoe.

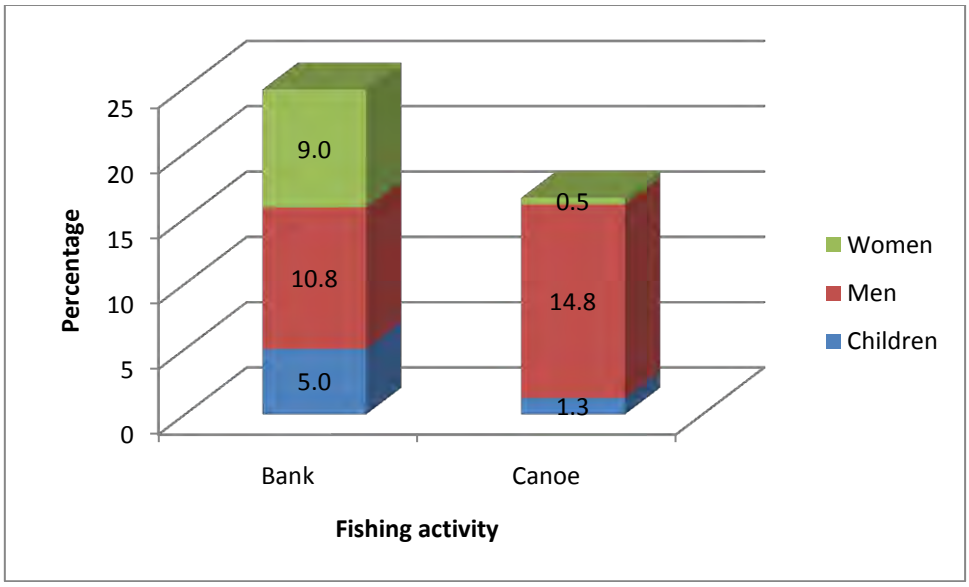


Figure 3. Percentage of households in the Chiawa Game Management Area involved with certain types of fishing activity.



Fishermen at a sand bar in the Zambezi River.

3.4. Livestock and crops

Most households (83.2%) have agricultural fields, maize being most common crop grown. For ease of irrigation many of the fields are located by the river (away from the village) and extend to the edge of the river. Three attacks have been reported on people whilst conducting activities related to farming. Traversing a foot bridge that spans a tributary of the Zambezi to access the fields was required by 31% of households. Four incidents of crocodile attack have been recorded on people that cross foot bridges. A significant number of respondents with fields (91.9%) had experienced crop damage by one of the large herbivores, elephant 67.1% or hippo 77.0%, the total exceeds 100% as many respondents experienced both animals in the fields.



A footbridge that spans the Kabwadu tributary of the Zambezi River. This allows access to agricultural fields on the other side which are easier to irrigate being closer to the river. The tributary itself is heavily vegetated with grasses, reeds and papyrus. During times of high water parts of this bridge become submerged.

Approximately half the households (53.8%) kept livestock, of these 85.5% kept poultry (either ducks or chickens), 38.8% kept goats and 0.1% kept cattle (the percentages exceed 100% as some households kept more than one type of livestock). There are very few cattle in the area due to a low presence of the Tsetse fly which can cause animal (and human) trypanosomiasis. Of the households that kept livestock, 32.2% of these lost animals to a crocodile (69.1% goats and 29.1% dogs, 1.8% poultry). It was difficult to establish the exact date of these incidents but most appeared to be isolated and infrequent, occurring from once a year to once in 10 years. A crocodile was witnessed attacking livestock in approximately a third (29.6%) of the incidents and the remainder deduced by supposition. Other predators in the area that accounted for livestock losses were bush cats (wild cats and/or genets), lion and baboon (Figure 4).

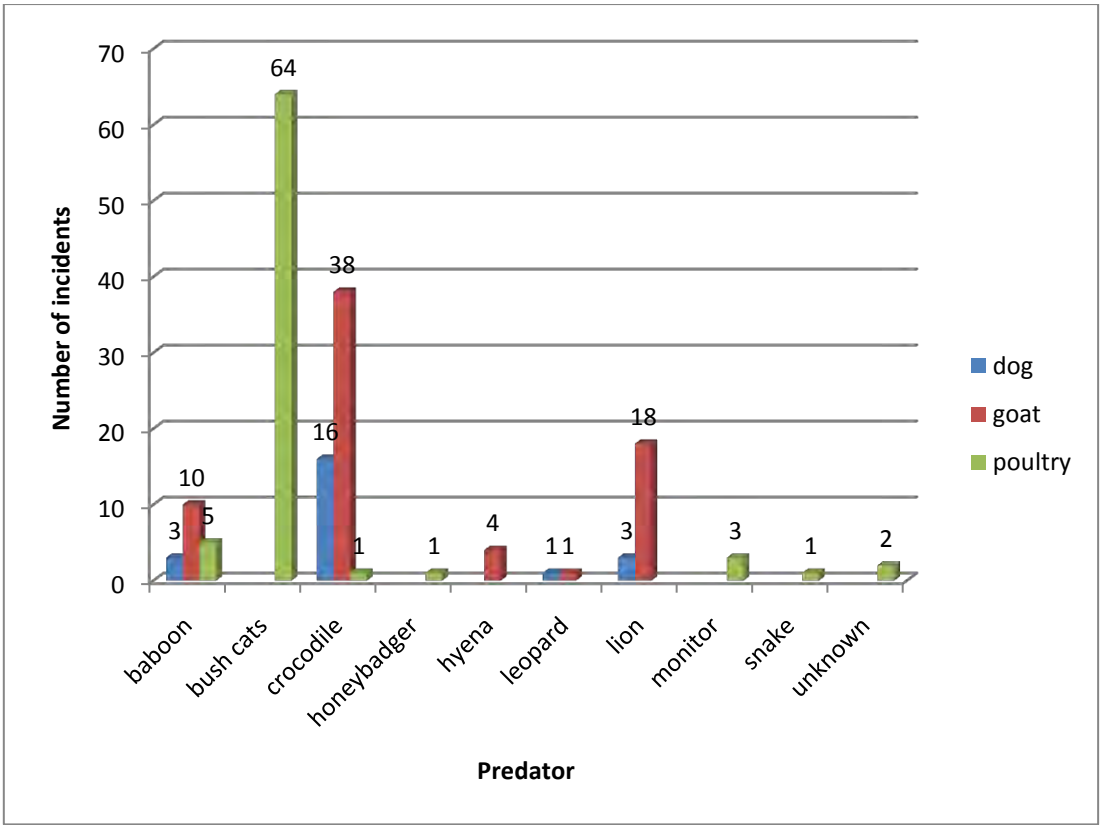


Figure 4. Depredation of livestock (dog, goat or poultry) by various predators of the Chiawa Game Management Area.

3.5. Attitudes to crocodiles

Determining the attitude of people to crocodiles is an important facet to be taken into consideration when formulating and implementing a conservation plan and/or mitigation measures.

Unsurprisingly, 92% of respondents deemed crocodiles to be a problem in the area and 85% if given the choice would like them to be removed. Respondents were then asked "if there was a possibility of a financial incentive would they consider keeping the crocodiles in the river", only 29% said that this would be acceptable. A greater number of men (40%) thought that a financial incentive would be acceptable compared to 23% of women. Women often cited "that human life was more important than money" as the main reason for not wanting crocodiles in the river.

Only 2.8% of respondents suggested that crocodiles were a benefit, most were employed within the local tourism industry and 1 household was employed by a crocodile farmer and therefore directly benefited from the presence of crocodiles and the crocodile ranching industry.

3.6. Crocodile attack incidents

Crocodile attacks on a household member were found to have occurred in 19% of the households interviewed. A total of 127 individual attacks were identified. The date was unknown for 6 incidents, 3 classed as 'long ago', 21 from 1989 to 1999 and 97 from 2000 to 2009 inclusive. Sixty-three percent of these attacks resulted in a fatality, 30% some form of injury, 5% were unharmed and 2% of unknown outcome. For purposes of analysis only the attacks that occurred during the past 10 years (2000 to 2009 inclusive) were utilised (Table 2) as the discrepancy between dates of the same incident but from different respondents increased with time since the attack occured.

Table 2. Crocodile attacks in the Chiawa Game Management Area between 2000 and 2009 inclusive, from a questionnaire survey and Zambia Wildlife Authority records. Injury includes minor to disabilitating wounds, none indicates that the potential victim escaped unharmed, unknown indicates an incident but the extent of the injury was not know.

	Outcome of incident				
Activity and gender	**Death**	**Injury**	**None**	**Unknown**	**Total**
Bank fishing	**4**				**4**
female	3				3
male	1				1
Bathing	**2**	**1**			**3**
female	1	1			2
male	1				1
Canoe fishing	**37**	**16**	**1**	**2**	**56**
male	37	16	1	2	56
female					
Crossing footbridge	**2**		**1**		**3**
female	1		1		2
male	1				1
Farming		**2**	**1**		**3**
female		2			2
male			1		1
Washing utensils	**15**	**12**	**1**		**28**
female	15	10	1		26
male		2			2
Total	**60**	**31**	**4**	**2**	**97**

To ascertain the risk of crocodile attack, the percentage of households that have a family member involved in river-based activities were compared to the average number of attacks (during 1999 to 2000 inclusive) that have occurred on pople involved in that particular activity (Figure 5). Canoe fishing appears to be the highest risk activity, only 16.3% of the housholds had someone who canoe fished yet also had the highest crocodile attack rate resulting in an 8.6% percent chance of an attack per year on a member engaged in this activity. Not all of these incidents were visually confirmed, it should be noted that many of the canoes often have holes and it is not uncomon to see canoes being paddled and water

being bailed out at the same time. Very few people can swim, and it is possible that some of these fatalaties may be attributed to canoes capsizing and the indivudual drowning.

It was suggested by respondents that crocodile attacks would increase at the end of the dry season (October) as this is the hottest period of the year and many people bathe in the cool waters of the Zambezi. No correlation between mean monthly temperature or wet/dry season and the number of attacks was found.

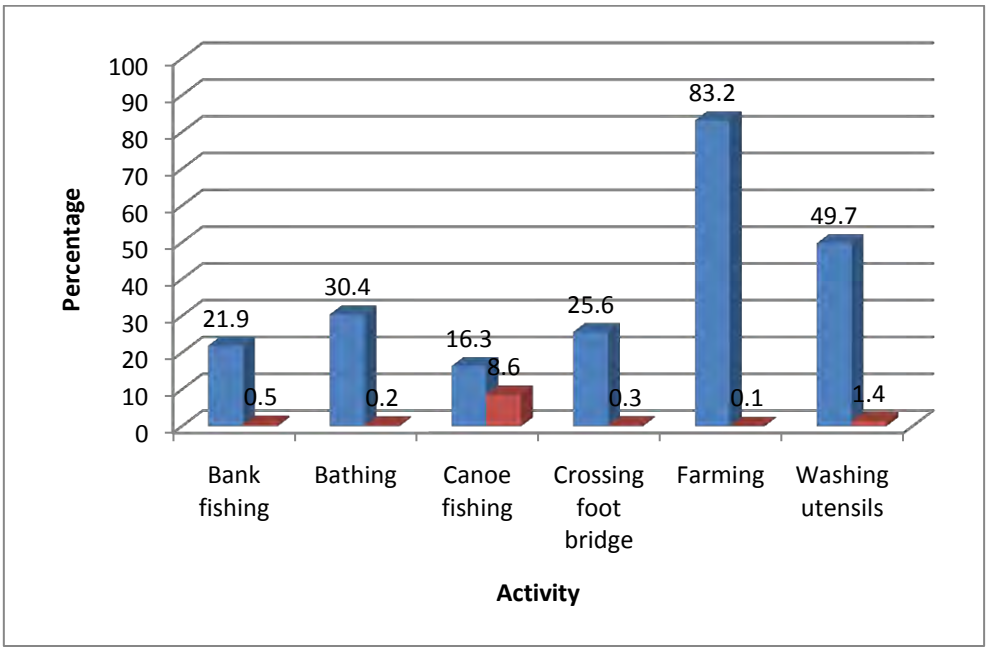


Figure 5. Percentage of respondents who have a member of the household involved in an activitiy associated with crocodile attacks and the percentage of attacks that occur on a victim involved in that activity per year (estimated from the past 10 years of crocodile attack data). The blue bars show the percentage of households that have a resident involved in one of the activities. The red bars indicate the likelihood of an attack occuring on a person involved that particular type of activity per year.

Of the 127 attacks revealed by the survey, only 53 were reported (41.8%) to either ZAWA or the police and of those reported, only 3 were found on the ZAWA data. There was a correlation between the severity of the attack and the likelihood of it being reported 58.5% of reported attacks were fatal, 32.1% involved some form of serious injury, 9.4% involved a minor injury and none of the attacks that resulted in no injury were reported.

Of the 276 households that utilise the river in some way, only 18.8% (n=52) utilised a form of protection whilst at the river to prevent an attack by crocodile. Only 38 (13.8% of the households that utilise the river) of these utilised a physical river fence barrier. The remaining preventative strategies consisted of carrying a catapult to being careful or quick!

3.7. Responsibility and Mitigation suggestions

The majority of people of the Chiawa GMA (41%) thought that the government (deprtments such as ZAWA) should be responsible for reducing the risk of crocodile attacks (Figure 6). However, 23% deemed conservation NGO's (such as the Zambezi Crocodile Research project and Conservation Lower Zambezi) to accept some of the responsibility, the reasons stated were that these were the people who wanted conservation in the area, therefore they should take an active part in reducing the conflict between wildlife and people.

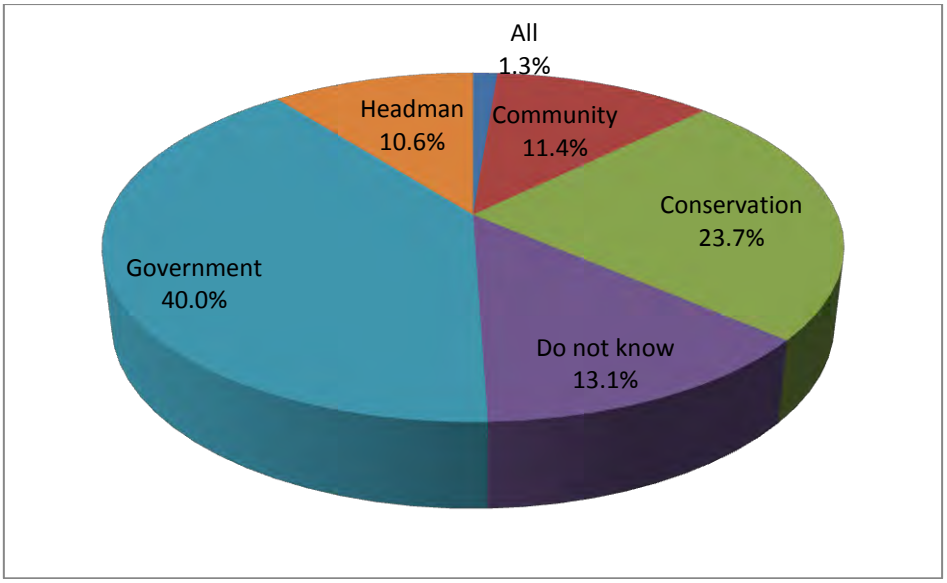


Figure 6. Proportion of respondents and whom they deemed to be responsible for safety of people concerning Human Wildlife Conflict in the Chiawa GMA. All included each of the following organizations; Community included community based organisations as well as the local residents themselves; Conservation included Non-Governmental Organisations such as the Crocodile Research Project and Conservation Lower Zambezi; Government includes the Zambia Wildlife Authority and Headman is the local village chief.

Approximately half of the respondents offered constructive mitigation suggestions (Figure 7), although 52.5% responded by saying that there was "nothing that can be done to prevent a crocodile attack'. This substantial negative response indicates a lack of mitigation measures. The construction of more boreholes was the most common answer (50%) and could have a number of effects. Firstly, this would reduce the number of people that went to the river to collect water by making boreholes more accessible, i.e. less people queuing at each borehole. It would also limit the pressure placed on each borehole by reducing the number of people that utilized each one.

The removal of crocodiles was suggested by 23.6% of respondents, this varied from total eradication of all the crocodiles to selective removal of larger animals or those identified as being a 'problem animal'. This technique of removal/relocation and its success as a tool for mitigation is often debated. Removal of an animal may make room for another and possibly larger animal to move-in. Relocation may not be an option depending on the crocodiles ability to navigate back to the point of capture and the original home range (Read et al. 2007). The ZAWA data indicated that only 1 of the 41 incidents resulted in the crocodile being shot and killed between 2000 and 2009 inclusive.

Only a minority of people requested for an increase in the number of river fences or crocodile proof barriers. As a mitigation measure a basic river fence can only offer limited protection from an attack and are often damaged by hippopotamus as they leave and enter the river. Some of the wooden fenced structures, although they may deter an attack would not actually prevent a determined large crocodile from breaking through. Crocodiles do pick up on habits, such as people and/or livestock utilizing an easily accessible place at regular times, utilizing a river fence does in some way promote this type of behaviour. These fences are also underutilised even when they are available people are often seen fishing, washing or bathing just a few meters from a river fence that has no one inside it. Possible reasons for river fences not being favoured are that there have been reports of crocodiles exiting the river and moving

across land, trapping people within the river fence, turning what should be a deterrent for crocodile attack into a trap for people. One last point with river fences is that at times of extreme low water (owing to the water level being controlled by Kariba Wall and Cahora Bassa Dam's, the river fence can not be utilised. However, as a mitigation measure they are surely better than nothing as well as being easy, cheap and quick to construct.

One of the interesting suggestions was to develop community based fish farms, a cheap and plentiful source of fish would not only feed the local populace but could also be used for economic gain by supplying lodges, etc. Another aspect is that it would reduce the local fishing pressure on the river and also reduce the number of fisherman exposed to attack from crocodiles. This in itself is a whole project, and investigation is required to see how viable such a venture would be, initial capital investment, stocking, maintence, feed supply etc. This method is also debatable as to how effective it would actually be as a mitigation measure. Although it may prove to be a potentally cost effective source of fish, but would it actually reduce the number of fisherman? Once constructed there would only be a limited employment opportunity. Many of the local populace fish for subsistance, but fishing is also a form of 'relaxation' and the possibility of river fishing continuing even with the existance of community organised fish farms is quite high. Fishing fom the river would then be an additional source of fish on top of that obtained from the fish farm. Another point to note is that fish farms, unless properly fenced can become a source of easy food for crocodiles if the location is discovered. Twice during 2009 the Zambezi Crocodile Research project removed crocodiles from a privately owned fish farm in the area.

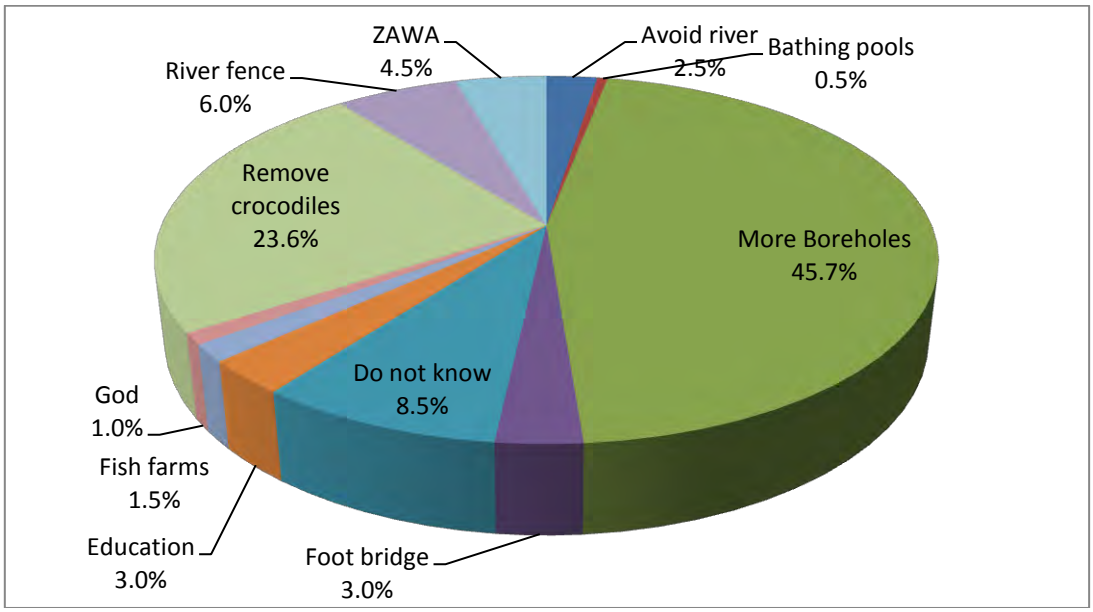


Figure 7. Suggestions by respondents of potential mitigation measures for Human Crocodile Conflict in the Chiawa Game Management Area. Avoid river and so reduce attacks; Bathing pools were to be artificially constructed pools to allow residents to bathe away from the river; More boreholes to increase the number of water access points in each village; Foot bridge were requests for bridges to traverse small tributaries that people have to cross to access farming areas; Education so that people understand more and so can better protect themselves; Fish farms were to reduce the reliance of fishermen on the river; God, that god created the animals but will also save the people; Remove crocodiles or at least the larger or 'problem' individuals; River fence are fences in the river that offer some form of protection against crocodiles; ZAWA that the Wildlife organization should do more to prevent attacks.



A river fence or crocodile-proof barrier constructed of locally sourced timber. This allows people to enter shallows of the river with relative safety.

3.8. Attitudes to Wildlife in the Chiawa Game Management Area

Although the majority of people perceived crocodiles as a problem, they are not the only large and potentially dangerous wild animal in the area that people may encounter. There are three other animals in the Chiawa GMA known to cause conflict, the buffalo, elephant and hippopotamus. People were asked to rate these animals in order of danger, which included the threat to human life, crops and livestock (Figure 8). Elephant were regarded as causing the biggest problem in the area, possibly because it is difficult to prevent them going where they choose, they are numerous, often encountered and attracted to the crops that are grown, increasing the potential of encounters. Crocodiles are the next biggest threat, although one of the reasons often cited by the respondents was that exposure to crocodiles can be negated or at least limited by reduced exposure to the river. Hippopotamus appear to pose less of a problem. Buffalo were viewed most often as the animal that caused the least problems, although they are also the least numerous of these animals in the area. Care should still be taken when viewing these results, all of these animals can potentially cause loss of life. Categorising buffalo as the animal that caused the least problems should not diminish the possible damage and loss of life that this animal can cause.

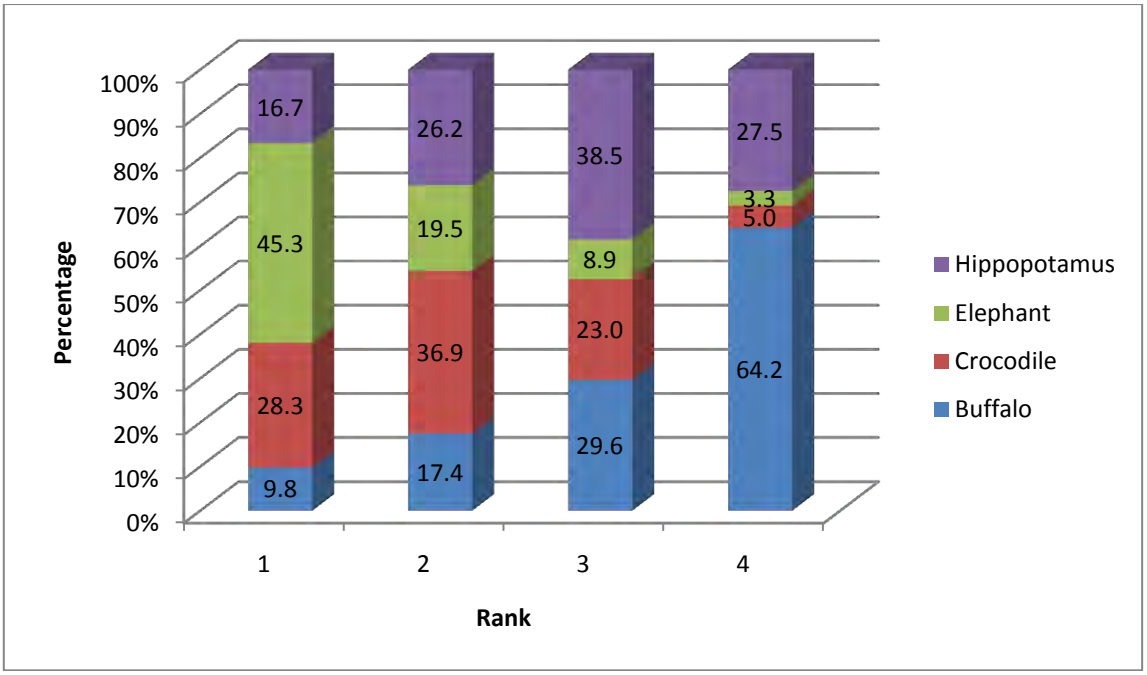


Figure 8. Attitude of respondents towards the 4 main large animals of the area. The x axis ranks in order of (1) the most dangerous to (4) the least dangerous.

4.0) SUMMARY AND CONCLUSIONS

People in the Chiawa GMA currently have a relative high dependency on the river, from washing clothes/utensils and bathing to fishing. Some activities are easier to mitigate than others. The provision of boreholes in the villages will go some way to reducing peoples reliance on the river, but this will not prevent people from collecting potable water because "river water tastes better than borehole water" which was one of the reasons given that people wash and clean with borehole water but collect potable water from the river. We take running water for granted in many of our homes, using the river is sometimes the most efficient method for washing and cleaning rather than a bowl of water from a borehole. It is difficult to mitigate attacks on people that go fishing, fishing from a canoe is the highest risk activity that is undertaken, short of providing some form of crocodile-counter measure i.e. ultra-sonic sound or chemical repellent it is difficult to see what can be done for this group of people that are at high risk. Scaling and gutting fish at the same location where the fishermen congregate could also be an attractant to crocodiles especially if this done following a regular pattern which the crocodile can learn.

Some tourist lodges have also reported occasional incidents of crocodiles targeting fishing boats as a source of food, witnessing crocodiles chasing and trying to take a fish once it has been hooked and is being reeled to the boat. This habituation of crocodiles to fishing boats as a source of food is concerning and it is possible that this could be one of the reasons why canoe fishing has the greatest attack rate from crocodiles.

There are a range of measures that could be implemented to mitigate HCC, however, funding and the logistics of getting such programmes started and then allowing for continued monitoring or upkeep is the next step. A mitigation measure that involves the local community in some way should achieve a higher level of success as the community then has a vested stake in the continuation or improvement of the measure. We discuss here a few of our initial thoughts based on the preliminary data and a final management plan will be submitted to the various government bodies towards the end of 2010 upon completion of additional aspects to the project.

4.1) *Mitigation of human crocodile conflict.*

The problem of people living in close proximity to wild animals and the associated conflict is well documented but is not an easy problem to find a solution for where all parties benefit. The local populace, tourism industry and agricultural practices of the area all rely on the Zambezi River to a certain degree. Some measures however can be considered:

a) Constructing more boreholes at the villages to reduce the reliance of local people on the river. This appeared to be the most popular mitigation measure.

b) Constructing crocodile-proof barriers at water collection locations which are well used by the local populace. This is a cheap, quick and easily implemented measure. Further studies are required to determine their actual effectiveness.

c) Building suitable foot bridges across tributaries to allow safe access to agricultural fields. Although there are some of these in the area improved initial construction and continued maintenance could ensure that these are safer to traverse.

d) Education, simply by varying the locations and times when visiting the river can reduce the chance of crocodile attack. Education could also help in a more fundamental way, by realizing the potential economic and ecosystem gains from having wildlife could increase the tolerance of people to animals. This has been proven to have a beneficial effect on people's attitude to wildlife and the success of conservation ideals.

e) An improved system of reporting crocodile (and other animal) attacks so that potential danger zones can be identified and monitored. Quite often, attacks were not reported especially when the person escaped unharmed. It is important these areas are identified to prevent future problems. This also includes cross-border co-operation between Zambia and Zimbabwe so that the true extent of human crocodile conflict is realised.

f) Increased communication between the local community the wildlife department and involving crocodile farms/ranches to relocate or remove 'problem' crocodiles. The follow-up of reported incidents and feedback is important for involving the local communities who are responsible for the initial reports.

4.2) *Loss of natural habitat within the Chiawa Game Management Area*

This area is developing rapidly, both with regard to human population and agricultural practices. Yet the Chiawa GMA is also potentially an important area for game viewing, hunting and tourism based activities. It is also an important area for the Zambia Crocodile Farmers Association (ZCFA), five crocodile farms utilise this area for harvesting wild crocodile eggs and adults. Uncontrolled development of this area will

further cause habitat destruction and fragmentation which in turn could increase the number of negative human-wildlife encounters. Most of the river frontage land is privately owned, and so collaboration is required between the wildlife department and the stakeholders to maintain a GMA that incorporates conservation strategies.

4.3) *Continued monitoring of the crocodile population*

This is essential and a common concept in crocodilian management plans, but it is not always financially or logistically possible to put into practice. The Lower Zambezi system is possibly an example where such a plan may prove difficult to implement, where a single resource is utilised by two countries, Zambia and Zimbabwe. The international border mid-river, although not a barrier to the crocodiles can impede co-operation between the two governments. Both countries monitor the crocodile population but information is not always disseminated. Realising potential crocodile attack 'hot-spots' and areas with high densities of crocodiles, nesting areas, etc are important for both the mitigation of human crocodile conflict as well as the continued conservation of crocodiles. This requires a degree of harmonisation between the management plans of both countries, as a strategy practiced on one side of the river can affect those on the opposite side.



Ecology and Conservation presentation to students at Kabwadu school by the Zambezi Crocodile Research project.

5.0) REFERENCES

Aust, P., B. Boyle, R. Fergusson, and T. Coulson. 2009. The impact of Nile crocodiles on rural livelihoods in northeastern Namibia. South African Journal of Wildlife Research **39**:57-69.

AWF. 2010. African Wildlife Foundation: The African heartlands - A new approach to African Wildlife Conservation http://www.awf.org/section/heartlands.

Fergusson, R. 2006. Populations of Nile crocodile (*Crocodylus niloticus*) and Hippopotamus (*Hippopotamus amphibious*) in the Zambezi. African Wildlfe Foundation, Zambezi Heartland.

Fergusson, R. A. 2002. Living with a wild predator: managing human-crocodile conflict in Africa. Crocodile Specialist Group Newsletter **21**:16-20.

MacGregor, J. 2002. International Trade in Crocodilian Skins: Review and analysis of the trade and industry dynamics for market-based conservation. Pages 1-63 http://iucncsg.org/ph1/print/Publications/index_p.html.

McGregor, J. 2005. Crocodile crimes: people versus wildlife and the politics of postcolonial conservation on Lake Kariba, Zimbabwe. Geoforum **36**:353-369.

Newmark, W. D., N. L. Leonard, H. I. Sariko, and D. G. M. Gamassa. 1993. Conservation attitudes of local people living adjacent to five protected areas in Tanzania. Biological Conservation **63**:177-183.

Read, M. A., G. C. Grigg, S. R. Irwin, D. Shanahan, and C. E. Franklin. 2007. Satellite Tracking Reveals Long Distance Coastal Travel and Homing by Translocated Estuarine Crocodiles, Crocodylus porosus. Plos One **2**:5.

Santiapillai, C. and M. de Silva. 2001. Status, distribution and conservation of crocodiles in Sri Lanka. Biological Conservation **97**:305-318.

Thomas, G. T. 2006. Human-crocodile conflict (Nile crocodile: *Crocodylus niloticus*) in the Okavango Delta, Botswana. MSc Thesis, University of Stellenbosch, South Africa.

Thorbjarnarson, J. B. 1992. Crocodiles: An Action Plan for Their Conservation. IUCN-The World Conservation Union, Gland, Switzerland.

TNC. 2010. The Nature Conservancy - Exploring Parks and Partnerships along the Zambezi. http://www.nature.org/wherewework/africa/wherewework/art30703.html.

Willgerodt, M. A. 2003. Using focus groups to develop culturally relevant instruments. Western Journal of Nursing Research **25**:798-814.

ZAWA. 2010. Zambia Wildlife Authority - Game Management Areas. http://www.zawa.org.zm/game_management.htm.