

The impact of Nile crocodile (*Crocodylus niloticus*) on the communal livelihoods: A case study of areas surrounding Ruti Dam in Gutu and Buhera districts in Zimbabwe

by

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Declaration

I declare that THE IMPACT OF THE NILE CROCODILE (*CROCODYLUS NILOTICUS*) ON COMMUNAL LIVELIHOODS: A CASE STUDY OF AREAS SURROUNDING RUTI DAM IN GUTU AND BUHERA DISTRICTS IN ZIMBABWE is my own work, and that all the sources I have used or quoted have been indicated and acknowledged by means of complete references.

by S. CHIHONA

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Thesis Dedication

This project is dedicated to my late uncle, Taona “Major” Bwakura who supported nature through research, my family and lovely daughter “Tino” for their support, encouragement and interruptions, that made the compilation easier than the intended thoughts.

Acknowledgements

John Muir said “As long as I live, I'll hear waterfalls and birds and winds sing. I'll interpret the rocks, learn the language of flood, storm, and the avalanche. I'll acquaint myself with the glaciers and wild gardens, and get as near the heart of the world as I can” (Molenaar, 1987:3).

I take note of blessings that the Lord has given us.

I thank the UNISA POSTGRADUATE RESEARCH FUND for funding the research, and both Gutu Rural District Council (GRDC) and Buhera Rural District Council (BRDC), for granting me permission to conduct the research. Norman Sharara gave me his personal car for my research, without being bothered by the fact that it was to be used on dusty, rough roads all the time. Nozwelo Nyoni, my wife, was highly helpful in data entry on analysis packages. To my assistants, Patrick Mararike and Alford Chihona: you made my research work enjoyable with your jokes throughout the way – you are unforgettable, and Gabriel Rusawo, together with Joseph Sowa, thanks for your constructive criticism throughout the project and Marlette van der Merwe for English editing: you made me an achiever. Mr Munyaradzi Musodza of Bindura University of Science Education, helped with the GIS maps.

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I salute all participating farmers, cattle herders and fishermen who graciously took the time to talk with me and answer my questions with cheer, besides fear of victimisation after interviews. Lastly, once again, I am grateful for the contributions and efforts of these farmers in making this project a success, and hope that I have been able to help them with other predator management methods, to reduce conflict and aid understanding of the uniqueness of the crocodiles in the wetlands and dams, at large.

My special thanks go to my mum, Angeline Mapurisa-Chihona, my sisters, Juliet, Alice, Annah and Beatrice for their moral, financial and continuous support and encouragement. To my late daddy “Simon Godfrey” and uncle “Major T. Bwakura”, I acknowledge both of you, as it could have been great to see me achieving “fire-fire”. Enjoy yourself on this short compressed dissertation.

.....*Maita Makumire*.....

Preface

The research work for the dissertation on human-crocodile conflict was carried out between June and July 2013 in Gutu and Buhera districts of Zimbabwe, under the supervision of Prof WAJ Nel and Prof RM Hendrick, who are all based at Florida campus (UNISA) in Roodepoort (Gauteng, South Africa).

Experiences of an African culture, as the researcher was born and bred in the remote areas of Buhera, and having prior knowledge of communal farming before kick-starting the research, helped a lot – coupled with the fact that the research was undertaken in the ethnic group similar to the researcher's, hence there was no need for an interpreter who might have exaggerated information during data gathering. All this led to easy and correct information gathering, using the respondents' own language – “Shona”. This report is my own original work, with the support of work from previous researchers, and every effort was made to acknowledge work from other sources.

Abstract

Ruti dam is located on the Nyazvidzi river, and is home to many Nile crocodiles (*Crocodylus niloticus*), which rely on fish and livestock for food. The community also relies on the dam and riverine for its resources. The investigation of crocodile impacts on humans and livestock, the trends and seasonality of attacks and identification of other predators resulted in formulation of research. The field interviews, using a structured questionnaire, field observation and focused group discussions were mainly used in data collection. Threats posed by crocodiles were identified as mainly human and livestock depredation, which has increased since the introduction of the crocodiles into the dam. The crocodile depredation varies between seasons, due to differences in water levels in the dam, and availability of alternative water sources. The attacks were mostly during the dry season and at the beginning of the wet season, when there were fewer water sources and when the water was dark and murky.

The study assessed the human-crocodile conflict situation, based on interviews with the local residents and focused group discussions with fishermen. The conflict arose with livestock farmers after animal kills and fishermen, in cases of death, injury or damage to fishing gear. The killing of either humans or livestock was during the early hours of the day. Hostile attitudes of the residents towards crocodiles were high (83.9%). The majority, given the chance to eliminate the crocodile, would do so mercilessly. These negative attitudes can only be ameliorated when the damage is adequately compensated. The absence of compensation has increased the conflict, though no retaliation is taken against the crocodiles.

The crocodiles prefer cattle in their kills (41% and 48%), followed by goats (38% and 25%), and, lastly, humans, in Buhera Rural District Council (BRDC) and Gutu Rural District Council (GRDC), respectively. Livestock farmers who stay close to the dam and Nyazvidzi suffer more losses, as their animals are more oftenly exposed to the dangers of crocodile predation, than those of farmers who stay far away, as they can use alternative water sources, and their animals are less likely to be exposed to the dangers of the crocodiles. The settlement pattern in BRDC has had an influence on predation. The farmers have also developed new livestock management techniques to reduce the loss of livestock.

The fishermen suffer net damage on most occasions of their fish catches, as the crocodile might have learnt to follow the plastic floats on the water for easier prey from the nets. The fishing strategies have been developed to reduce fish loss. The death of fishermen is mostly that of people who enter the dam without canoes; no deaths were recorded of fishermen in canoes. Also, no capsizing of canoes has been recorded in Ruti dam, as fishermen always move in groups. Attacks in the Nyazvidzi River were on women and schoolchildren.

Hyenas, as with the crocodile, have contributed to high kills of livestock (71.1%) and human kills were also reported in 2012 and July 2013. Though conflicts exist in the area, recommendations were made which might help to lower the conflicts. Educational campaigns and direct incentives from predator losses were identified as the main factors in conflict resolutions. The information on the importance of the predators and how or when it kills should be taught to respondents as they will be able to protect their livelihood.

Keywords: *Crocodylus niloticus; Crocodile; Livestock depredation; Livestock farmers; Fishing; Livelihood; Conflicts; Ruti dam; Nyazvidzi river; Fishermen; Conservation; Hostility.*

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Acronyms

BRDC	Buhera Rural District Council
CAMPFIRE	Communal Areas Management Programme For Indigenous Resources
CBNRM	Communal Based Natural Resources Management
CBO	Community Based Organisation
CEE	Crocodile Exclusion Enclosures
CITES	Convention on International Trade in Endangered Species
DNPWM	Department of National Parks and Wildlife Management
EMA	Environmental Management Agency
FAO	Food and Agricultural Organisation
GIS	Geographical Information System
GNP	Gonarezhou National Park
GRDC	Gutu Rural District Council
HCC	Human-Crocodile Conflicts
HWC	Human-Wildlife Conflicts
IUCN	International Union for Conservation of Nature and Natural Resources
KNP	Kruger National Park
KWS	Kenya Wildlife Services
MNP	Manapools National Park
MRDC	Muzarabani Rural District Council
MOMS	Management Oriented Monitoring System
PA	Protected Area
PAC	Problem Animal Control
PACL	Preventive Alertness Control and Learning approach

PCC	Problem Crocodile Control
PRA	Participatory Rural Appraisal
PWMA	Parks and Wildlife Management Authority
PWSNT	Parks and Wildlife Services of the Northern Territory
RDC	Rural District Council
SPSS	Statistical Package for the Social Sciences
SSQ	Semi-Structured Questionnaire
VIDCO	Village Development Committee
VWC	Village Wildlife Committee
WADCO	Ward Development Committee
WWC	Ward Wildlife Community
WWF-SARPO	World Wildlife Fund for Nature Southern Africa Regional Programme Office
ZDP	Zimbabwe Demographic Profiles
ZPWMA	Zimbabwe Parks and Wildlife Management Authority

Definition of Terms

Biodiversity: Living plant and animal matter (Bernhard, 2012:10).

Catchment area: An area with different water channels that drain into one main river (Mtisi & Nicol, 2003:10).

Crocodile conflicts: The conflicts differ from person to person. Generally, it refers to crocodile attacks, crocodile killings, fishing gear damage and loss of fishery (Aust, Boyle, Fergusson & Coulson, 2009:58).

Ecotourism: It is conservation with zero harm, and is also an income-generating programme for local people, through invitation of tourists. The tourists' money improves the livelihood of local people, thus promoting sustainability and development (Barkin, 2013:264; Giampiccoli & Kalis, 2012:101).

Farmers: Communal people who survive through growing of crops and rearing of domesticated animals (Chimedza, 2011:2).

Fishermen: Those responsible for fish harvests either in rivers or dam (Ratner, 2011:4).

Gifts: Locally made materials sold to tourists by rural people (Giampiccoli & Kalis, 2012:104).

Household: A homestead or family that shares all the resources, including land, income and livestock; generally, people eating from the same pot (Kideghesho, 2008:1866).

Livelihoods: Anything that can be an income to support the family. For rural people the livelihood is normally on livestock, crops grown, and fishing activities (Aust *et al.*, 2009:59).

Livestock: In this study, it means any animals kept by the farmer for livelihood purposes, which includes donkeys (*Equus africanus asinus*), cattle (*Bos indicus*), sheep (*Ovis aries*), goats (*Capra aegagrus hircus*), domestic pigs (*Sus scrofa domesticus*), chickens (*Gallus gallus domesticus*) and guinea fowls (*Numida meleagris*) (Aust *et al.*, 2009:62).

Natural resources: Any resource that is not man-made, but has value to the people living around it (Kideghesho, 2008:1866; Mapedza, 2007:4).

Protected Area: A demarcated area with restrictions on resource utilisation, for maximum biodiversity conservation (Aswani & Lauer, 2006: 83-90).

VIDCO: A village development committee responsible for solving village disputes involving customary law and traditions (Ncube, 2011:92).

Village: Area smaller than a ward, and consisting of approximately 100 households (Mashinya, 2007:61).

WADCO: The ward development committee responsible for organising development and solving disputes that have been unsolved at village level (Ncube, 2011:92).

Ward: An area in rural Zimbabwe that consists of six villages (Ngwerume & Muchemwa, 2011:78).

Water resource: A natural resource found in rivers, dams, springs, wells, etc. (Oki & Kanae, 2006:1068).

Water resources: Materials that arise due to the presence of water. The water resources include fish and reeds that grow in water (Ratner, 2011:4).

Wetlands: Areas that are continuously wet, or remain wet for a particular period, in association with rivers, dams, lakes and streams (Tiner, 2003:494).

Chapter 1: Introduction

The Nile crocodile numbers are decreasing throughout the world, due to increased human activity (Treves, Wallace & White, 2009:1583; Ross, 1998:2) associated with pollution (Ross, 1998:1), especially in the Okavango delta in Botswana (Bourquin & Leslie, 2011:2) and the Olifants River in South Africa (Ashton, 2010:490; Botha, 2010:232). Furthermore, extensive water extraction for consumption, irrigation and industrial use, coupled with a decrease in fish stocks in the wild, leads to habitat loss throughout the world (Botha, Van Hoven & Guillette, 2011:104; Botha, 2010:232; Shirley, Oduro, & Beibro, 2009:141; Okello, Ole Seno & Nthiga, 2009:126; Thorbjarnarson, 1992:2), and hence increased livestock predation, which will put the animal at risk of persecution (Woodroffe, 2000:170; Conover, 2002:120).

Most crocodilians are potential predators of humans and livestock, and the recovery of the wild population of crocodiles often increases the hurt rage, as it increases the human-crocodile conflict (HCC) – mostly for fishermen and livestock farmers, who might be driven to killing the animals (Barnes, 1996:69; Thorbjarnarson, 1992:3) and damaging their nests and/or eggs in an attempt to reduce their numbers (Shacks, 2006:41). In addition, competition for resources has appeared as a matter of concern for carnivore communities, with humans as well as crocodiles, as it affects distribution and behaviour of wildlife (Combrink, Korrubel, Kyle, Taylor & Ross, 2011:146; Ehrlich, 2009:409; Vanak & Gompper, 2009:270), due to either disturbance or shortage of a resource. The abundance of different fish types in Ruti Dam and the Nyazvidzi River led to removal of fish without permission, as a common resource, which was later termed fish poaching. However, The Department of National Parks and Wildlife Management (DNPWM), now the Parks and Wildlife Management Authority (PWMA), responded by relocating a handful of Nile crocodiles from Manapools National Park to Ruti Dam in the early 1990s, to curb the problem, after the local residents had physically assaulted the guards who were preserving the wildlife in the area.

The introduction of the Nile crocodile was not a consultative process, hence problems surfaced; as the local residents thought the crocodiles were brought in to destabilise the community by killing their resources as well as the people. Initiated by undocumented complaints from people living in the area, this research study by HCC was planned.

The main focus of the research was to identify levels of HCC arising from property damage, predation of livestock and humans by crocodiles, and how these were affected by location and livestock management methods. The research information gained will be used by the PWMA to implement appropriate management plans for maintenance and the protection of a sustainable crocodile population in Zimbabwe. However, for this research, the goal was to determine and investigate human-crocodile relations. The information gathered will be used in educational programmes to help decrease the HCC situation in the area, and, indeed, across the world.

1.1 Background to Area of Study

1.1.1 The Nile crocodile status

The Nile crocodile was once a common feature throughout Africa and the Middle East, but distribution has been radically reduced and fragmented since the 20th century because of killing of the animal (Whiting, Williams & Hibbitts, 2011:85). The animal was mainly hunted for its hide, meat and medicinal purposes (Whiting *et al.*, 2011:85; Thorbjarnarson, 1992:3). The Nile crocodile was also found in Algeria, Jordan, Israel and the Comoro Islands, but high temperatures, due to climate change, have caused the wetlands to dry out, subsequently affecting the survival of the animal (Urry, 2011:36).

The current global population is estimated to be 250,000 – 500,000 animals, mostly supported by crocodile farming (Hekkala, Amato, DeSalle & Blum, 2010:1436), protected areas, and sparsely populated areas with viable prey populations (Watson, Graham & Bell, 1971:25). The animal is found in Botswana, Ethiopia, Kenya, Egypt, Gabon, Cote d'Ivoire, Ethiopia, Zambia, Zimbabwe and parts of South Africa (Figure 1.1):



Figure 1.1: Distribution of Nile crocodile in Africa indicated in yellow. (Source: Fergusson, 2010:84).

In South Africa, Mozambique and Namibia, the Nile crocodile is listed as a threatened species (Appendix II), with an annual export of 1600 quotas (CITES, 2012:22) due to ongoing range contraction, illegal killings and disturbance of nesting areas (Van Vuuren, 2011:13). The South African wild Nile crocodile populations are controlled by national and provincial legislation (Combrink *et al.*, 2011:153). On 1 July 1975, the crocodile was listed as an Appendix I species, due to heavy hunting, especially in Zimbabwe, and hunting was prohibited at the Convention on International Trade in Endangered Species (CITES) of World Flora and Fauna, in 1975 (CITES, 2012:22; Revol, 1995:305).

Crocodile farming was introduced in late 1950, and on 29 July 1983 the Zimbabwean Nile crocodile status was lifted to Appendix II (CITES, 2012:22; Abensperg-Traun, 2009:954; Revol, 1995:300). The Nile crocodile is a keystone species, an indicator, and also a top predator in aquatic systems – which help in maintaining healthy ecosystems,

hence an important creature in the conservation of wetland biodiversity (Sergio, Caro, Brown, Clucas, Hunter, Ketchum, McHugh & Hiraldo, 2008:2; Glen, Dickman, Soule & Mackey, 2007:493; Ross, 1998:3). The top predators promote species richness by controlling community structure, hence preventing competitive exclusion processes where a certain group of consumers might be greater than others (Thorp, 1986:76). However, reports show that Ruti Dam carries a significant number of crocodiles in comparison to Lake Kariba which can be used as a source to boost other water bodies, and crocodile farming to improve the livelihood of the local communities, due to high temperatures and the abundance of small fish for young crocodiles to feed on (ZPWMA, 2006:10). Proper mitigatory measures to prevent the threats to crocodiles, are useful for protection of aquatic habitats at an ecosystem level.

1.2 Problem Statement

Throughout the world, predators are considered to be a nuisance, including crocodiles – which are dangerous, and abundant in fresh water outside protected areas (Aust, Boyle, Fergusson & Coulson, 2009:57; Michalski, Boulhosa, Faria & Peres, 2005:179; Ross, 1998:4). The hostile attitude prevailing among fishermen and livestock owners in Southern Africa poses a serious threat to predators, including crocodile populations outside protected areas (Holmern, Nyahongo & Røskoft, 2007:539; Ogada, Woodroffe, Oguge & Frank, 2003:1522).

Lack of permanent water bodies, increased water extraction and a decrease in available fish stocks, due to high levels of poaching, are the driving forces behind human-crocodile conflict, hence crocodiles are resorting to livestock and human killings as an alternative food source. Furthermore, Stander (1992:18) and Butler (2000:25) comment on the hunting success of lions in groups, and solitary, which increases capture efficiency for the solitary lioness in the dry season, due to little vegetative cover – which increases visibility to tracking of the prey.

In addition to this, crocodiles also hunt well in the dry season, as the prey, if thirsty, and due to the absence of shade, come within close proximity to them for water, and opportunistic kills occur. With the growing human-crocodile conflict situation over resources, all this pose challenges to environmental sustainability and food security

(FAO, 2013:6). This has led to poaching and indiscriminate killing of the threatened crocodile, as it is perceived to be a pest, and always lives in conflict with the rural communities (Van Vuuren, 2011:14; Fergusson, 2010:86; Treves & Karanth, 2003:1493).

But why in conflict? Is it that the PWMA tried to solve a problem with another problem? What might be the source of the problems? Is it that the crocodile numbers are beyond the natural carrying capacity of the wetland, or that they are problem animals or that there may be inflated perceptions of crocodile depredation due to attitude? All these questions remain unanswered; hence the PWMA faces a great challenge in the restoration and maintenance of crocodiles on its water bodies. The crocodile needs to be given a monetary value, and thereby prove to be beneficial to the local community, or these predators will always be regarded as a nuisance which deserves the death penalty whenever they meet with humans (ZPWMA, 2006:10).

There is a need for research, to compile and quantify data on HCC so that objective decision-making is facilitated. This task has never been carried out before in communal areas surrounding the Ruti Dam, hence the researcher focusing his research on these areas, though some information on human coexistence with crocodiles, as well as factors affecting the animal's survival, has been gathered in Zambezi Heartland, in parts of Zimbabwe and Zambia (Wallace, Leslie & Coulson, 2011:155), and in Zululand, South Africa (Van Vuuren, 2011:14). The information gained in their studies cannot be modelled to suit the situation in communal lands around Ruti Dam, due to cultural diversity and the environment itself. However, this research aimed at obtaining baseline information on the spatial distribution of human-crocodile conflict, and the level of conflict between crocodiles and humans in communal areas in eastern Zimbabwe, part of Manicaland and Masvingo Province, through a questionnaire-based survey. The results of the study have augmented information from other studies, to build on basic management plans for wild crocodile populations in Africa (Fergusson, 2010:87).

1.3 Justification and Scope

Africa has a diversity of wildlife, but the survival and behavioural characteristics of these animals differ. Researchers have, due to the availability of funding, made efforts to spent studies on how terrestrial predators affect farmers' lives. The lion (*Panthera leo*) and the cheetah (*Acinonyx jubatus*) are mostly studied, leaving a gap on aquatic predators, especially the crocodile, due to limited research funds (Garba & Di Silvestre, 2008: 33; Bauer & De Iongh, 2005:209). From literature surveys, there is little data available in Zimbabwe on Nile crocodiles in general, hence information is needed to provide data on the status of the Nile crocodile and the levels of conflict with humans (Aust *et al.*, 2009:57), since it is a least concerned-about species in conservation matters reliant on perennial water bodies.

The understanding of HCC around Ruti Dam will allow conservationists to implement focused crocodile education, and use sustainable mitigatory measures (Fergusson, 2010:87). The area has numerous subsistence farming communities that are greatly dependent on the dam and the Nyazvidzi River, therefore increasing both competition for resources, and fatalities due to Nile crocodile attacks (Aust *et al.*, 2009:66).

Furthermore, a successful management plan for a predator species is reliant on effective livestock husbandry, education, and financial incentives for the affected people and the community at large. Some surveys on crocodile status and distribution have been carried out in Hwange, Chiredzi and Mbire, in Zimbabwe (Le Bel, Murwira, Mukamuri, Czudek, Taylor & La Grange, 2010:300). The livestock and human killings by predators, without being compensated, have created tension in communal areas, leading to alteration in the conservation attitudes towards these creatures (Woodroffe, 2000:171; Kolowski & Holekamp, 2006:553; Holmern *et al.*, 2007:539); hence there is a need to evaluate livestock management practices and their efficacy, in order to ameliorate livestock losses to predators.

The irrigation programme in Gutu district has altered water levels and increased the fishing in the crocodile-infested dam, so it's important to determine what impact it has had on human-crocodile conflict. The communal areas surrounding Ruti Dam in Buhera Rural District Council (BRDC) and Gutu Rural District Council (GRDC) have not been previously investigated, although it is an area that is known by the local community to have many crocodiles that are causing havoc. The HCCs are not documented, due to fear of victimisation by the police; only deaths of humans are reported – animal losses are not reported.

The results of this project will help the scholars and conservation practitioners, locally and internationally, to develop sustainable management plans that cater for the people living with crocodiles.

1.4 Hypotheses

H₀: There is no association between population age and crocodile conflict level.

H₁: There is an association between population age and crocodile conflict level.

H₀: There is no significant difference between crocodile attacks and human activities.

H₁: There is a significant difference between crocodile attacks and human activities.

H₀: There is no relationship between the appearance of the water drinking place and crocodile damage.

H₁: There is a relationship between the appearance of the water drinking place and crocodile damage.

1.5 Aim

To determine the conflict distribution pattern and conflict level, and guiding principles for mitigatory measures.

1.6 Objectives

- i. To investigate the crocodile impacts on humans and livestock.
- ii. To assess trends and seasonality of crocodile predation.
- iii. To identify other predators that affect people's lives in the area.

Chapter 2: Literature Review

This chapter gives an overview of the Nile crocodile's hunting characteristics, and also a view of how the farmers, and the community at large, interact with this freshwater predator, as well as how their conflicts can best be reduced, and/or mitigated, to the mutual benefit of the crocodiles and the humans. Some mitigatory methods to reduce loss or damage to property are already in use in some communities, but, as a matter of concern, success always depends on bureaucracy in the government and the level of compensation to people living in close proximity to the animal.

The chapter will further analyse how community members benefit from conserving the crocodile, at a cost, and how compensation is spread to communities facing problems. Furthermore, it will show how crocodiles attack, and their main areas of attack in different situations. However, water is the main source of conflict, hence information on water management and water resources conservation will be given. Relevant matters and issues on various pieces of legislation will be highlighted. Issues on how conservation organisations, together with traditional leaders, are working together to reduce the conflict and the increasing survival of once feared resources, will be explained.

2.1 Crocodile Characteristics

The crocodile has been noted as dangerous animals when it reaches maturity. However, it has been noted to have no predators of its own. Its names in Zimbabwe are *Garwe* in *Shona*, and *Ngwenya* in *IsiNdebele* – meaning 'powerful and cruel'. It is classified under 'reptiles', as are turtles, snakes and lizards. It is comparable to a lizard, though it differs in size. Crocodiles are carnivores, with teeth designed to tear meat. The taxonomy under which crocodiles are classified, are as follows:

Kingdom: —————>Animalia

Phylum: —————>Chordata

Class: —————>Reptilia

Order: —————>Crocodylia

Family: —————>Crocodylidae

Genus: —————→ Crocodylus

Species: —————→ niloticus

According to Thorbjarnarson (1996:11), there are thirteen documented crocodilian species: American crocodile (*C. acutus*), Slender snouted crocodile (*C. cataphractus*), Orinoco crocodile (*C. intermedius*), Australian freshwater crocodile (*C. johnstoni*), Philippine crocodile (*C. mindorensis*), Morelet's crocodile (*C. moreleti*), Nile Morelet crocodile (*C. moreleti*), Nile crocodile (*C. niloticus*), New Guinea crocodile (*C. novaeguineae*), Mugger (*C. palustris*), Estuarine crocodile (*C. porosus*), Cuban crocodile (*C. rhombifer*), Siamese crocodile (*C. siamensis*), and African dwarf crocodile (*Osteolaemus tetraspis*).

The Nile crocodile is widespread in the African continent, and has a lifespan of 50 years in the wild, and 80 in captivity (Bishop, Leslie, Bourquin & O' Ryan, 2009:4). The longevity differs, due to diseases and prosecution. Nile crocodiles were first seen in Egypt, and kept as pets – hence the name *Crocodylus niloticus* – meaning 'stone' – as on the skin of a reptile, living in the Nile River (Hekkala, Shirley, Amato, Austin, Charter, Thorbjarnarson, Vliet, Houck, DeSalle & Blum, 2011:4208). The bodies are dark bronze, with yellow-green flanks and green eyes (Fig 2.1):



Figure 2.1: Nile crocodile lying on the bank of a river. (Source: Fergusson, 2010:85).

They are gregarious, and live in groups, depending on the availability of food in the area (Huchzermeyer, 2003:134). Like any other reptile, they are cold blooded, and bask to improve their temperature (Seebacher, Grigg & Beard, 1999:84; Ross, 1998:2). The energy gained is used for hunting, digestion and social behaviour, including mating. In the absence of water, they can aestivate by burrowing deep in the soil, where they can remain for up to two years without food (Walsh, 1989:68). Their good eyesight during day and at night, plus sharp teeth, have made them good hunters, accompanied by their salt glands – which maintain balance in saline waters (Beacham, 2000:530).

2.2 Crocodile Reproduction

Generally, male Nile crocodiles grow faster, compared to their female counterparts (Hutton, 1987:31). The rate of growth does not affect reproductive maturity age, as they both start to reproduce between 10 and 12 years. This varies according to the variance in geographical areas where they are found. Temperature, among other factors, is the main determinant factor in reproduction and growth, for males become potentially reproductive at three metres, and females between two to three metres long – of which the mass should be 500 kg, and above 250 kg, respectively. At maturity, males are slightly bigger than the females (Flamand, Rogers & Blake, 1992:63).

One male can have courtship with a sizeable number of females. The courtship and mating takes place in late winter (July and August), when the crocodiles bask in the sun. The eggs are laid in September, in nests made adjacent to the river, for easier monitoring by the female against egg-eaters (for example, lizards and hyenas). The female lays a clutch of 25 to 80 eggs in an approximately 0.5 metre deep hole (Kushlan & Mazzotti, 1989:12). The female frequently urinates or splashes water on the nest, to control the temperature of the hatchery, which is also determined by the nature of the nest. The hatching and sex of hatchlings after an incubation period of 90 days depends on the temperature, which ranges between 28.0°C and 34.5°C (Lang & Andrews, 1994:30). Below and beyond the range, no hatchlings will survive, which might help to explain why hatching is between November and early January. This is to ensure more food availability to juveniles, as they are strictly insectivores. However, if the nest is flooded, the hatchling might suffocate and die before the hatching time. It is the female crocodile that helps to evacuate the hatchlings, by digging up the nest and carrying

them to water, under her close monitoring, to avoid drowning of the hatchlings – which will be at least 30 cm long (Vergne, Pritz & Mathevon, 2009:394).

2.3 Crocodile Farming

The keeping of crocodiles is becoming a lucrative business, due to huge profits that are retained from the selling of meat for human consumption, and skins for luxury leather products. European and Asian markets are the major importers of crocodile products. The Nile crocodile is farmed on the African continent and elsewhere, including Brazil and Israel, but remains the most exploited species among the known crocodilians (Ganswidt, 2012:8; Table 2.1).

Crocodile farming was implemented in Zimbabwe in the late 1950s, when the Nile crocodile was classified as endangered, due to heavy hunting for its products (Revol, 1995: 304). The numbers had gone down, and breeding was interrupted, as hunters targeted big animals in the reproductive stream, to gain more money. Zimbabwe, together with South Africa, Zambia and Madagascar, are the main exporters of crocodile products (Caldwell, 2010:6). Zimbabwe exported 81,554 skins in 2008 from ranching and captive breeding (Caldwell, 2010:17) (Table 2.1). The export in Zimbabwe has gone down from 54% in 1993 (Collins, 1995:49) to 48% in 2008, when compared to percentage exports by other countries, though the number has gone up by 1554 skins. Thus, more countries are exporting more skins, due to high profits made in the industry (Table 2.1):

Table 2.1: Reported trade in Nile crocodile skins between 2001 and 2008.

Country	2001	2002	2003	2004	2005	2006	2007	2008
Botswana	152	0	0	0	0	0	320	374
Brazil	50	0	1	44	0	0	0	0
Ethiopia	42	220	900	300	347	727	594	492
Israel	2289	699	0	0	0	0	0	0
Kenya	3713	2317	1687	2850	9550	8710	6354	4504
Madagascar	9408	6936	7300	4760	4850	6660	5500	2640
Malawi	1256	120	301	100	1038	698	1350	3370
Mali	0	0	0	0	0	0	0	107
Mauritius	93	178	118	400	150	184	231	0
Mozambique	477	293	3160	0	1156	2000	179	566
Namibia	0	0	0	0	400	305	0	0
South Africa	33335	45755	31321	35760	35486	34203	36014	44697
Uganda	900	2	600	600	600	300	0	290
Tanzania	1498	1259	1439	1067	1584	1100	1556	1784
Zambia	20887	22259	28019	26353	33148	42266	44597	28917
Zimbabwe	76657	79932	73707	68263	63146	71616	64490	81554

(Source: Caldwell, 2010:12).

Farming of crocodiles is a long-term investment that requires excellent management skills for successful harvests. The skills should be linked to cleanliness and good handling of the crocodilians, which reduces spreading of diseases and stress among the animals (Ganswidt, 2012:8). The farm conditions should simulate the natural conditions, in that low levels of noise must be maintained to lower the expenses for rehabilitating and curing of sick animals, as business laws state that low expenses with high returns guarantee high profits.

2.4 Crocodile Prey

Nile crocodiles rely on a range of diets, mostly comprised of natural prey, ranging from insects and small aquatic invertebrates to larger vertebrates, as they grow, varying from impala (*Aepyceros melampus*) to buffalo (*Syncerus caffer*) (Wallace & Leslie, 2008:365). The diet changes with the age of the crocodile, and larger crocodiles feed on larger prey. They also practise cannibalism, and eat dead animals, but always avoid rotten meat. The recent world increase in human population growth, industries and agricultural development, have made the crocodiles shift from their preferred prey species. These developments have led to climate change, and affect the natural prey base, as different water sources dry out and force wild prey to migrate, due to agricultural development in wildlife habitats and wild meat poaching – which, in turn, increases HCC of communal dwellers (Aust *et al.*, 2009:63). Nile crocodiles are now turning to livestock as well as humans, as a substitute for natural prey (Scheiess-Meier, Ramsauer, Gabanapelo & Kong, 2007:1273). However, Dikobe (1997:81) notes that Nile crocodiles prefer goats (*Capra hircus*) and cattle (*Bos indicus*) during wet seasons, when natural prey is scarce, as the livestock is killed during water drinking in crocodile infested waters.

2.5 Nile Crocodiles' Hunting

2.5.1 Behaviour

The male crocodiles are territorial and status conscious – which shows a hierarchy (Gans & Pooley, 1976:840; Lang, 1975:7). The hierarchy in their families allows them to live without battles, just like the baboons (*Papio ursinus*). Order of life is maintained during mating, and older males attract females. Being opportunistic feeders which generally use a common strategy in search of prey, the approach is to remain silent in murky tea-coloured water, and the movement of prey is detected by the sensory pits along the sides of the jaws and also by smell (Fijn, 2013:6). Sometimes, crocodiles can lie in still waters, leaving their eyes, nostrils and ears out (Gruen, 2009:1555). Crocodiles can only catch prey in a two-metre radius, towards the front, dragging and suffocating the prey under water. The sequence of prey attack is the use of its legs and tail to move upward and forward, and then, lastly, the jaws.

2.5.2 Times

The preying abilities of Nile crocodiles depend upon their size before and the availability of preferred prey species. Their abilities are generally high at night, though killings can also be done during the day. Crocodiles behave differently at night, allowing them to remain undetected by the prey coming for, and drinking, water (FAO, 2009:5; Huchzermeyer, 2003:53). The targeted animal will instantly be attacked, being taken by surprise. Furthermore, more food is consumed in summer than in winter (Kofron, 1993:467; Hutton, 1987:34), due to different activities the animal is involved in. However, in winter, less energy is needed, as more time is spent on basking to raise the body temperatures (Downs, Greaver & Taylor, 2008:188).

In Kofron's studies of Nile crocodiles in Gonarezhou National Park (GNP) in 1993, the results showed that crocodiles in seasonal water bodies moved a long distance across dry land, in search of seasonal pools or prey carcasses. This was well supported by the findings of Hutton (1989:1040) and Rodda (1984:446), which showed that the home ranges of juveniles in the hot seasons tend to change as they move to different areas. The breeding females remain in their constricted home ranges, as they guard their nests from potential predators. The home ranges are not confined, but change, depending on the presence of the resources (Rodda, 1984:448).

2.6 Nile crocodile predation

There are no known predators that can kill and eat an adult crocodile – except the Nile monitor (*Varanus niloticus*) (Hutton & Child, 1989:63). The hippopotamus is also feared by the crocodile, but no cases of predation have been recorded on adults or sub-adults. The predation is mostly on juveniles, hatchlings and the eggs, even though they are monitored by the female. Juveniles can be predated until they reach one-and-a-half metres (Hutton & Child, 1989:63). This might be the reason why the hatching of hatchlings is in November-December – thus to facilitate fast growth of the hatchlings, as their digestive system will be active, due to high temperatures. The cold temperatures may result in bottleneck populations, due to death of the hatchlings and the juveniles. In areas where resources are scarce, cannibalism can occur when adults fight to defend their territory, and juveniles are also eaten by other members of the family (Huchzermeyer, 2003:53). This results in juveniles moving away as they do not

risk attack by adults. Generally, the cause of death in both captive and natural crocodiles is disease as a result of poor sanitation (Hutton & Child, 1989:74).

2.7 Fishing Techniques

In communal areas where security measures do not exist to scientifically manage fishing, the resources are managed by common property norms which do not restrict access to the resource. With the absence of scientific management, no one regulates fishing, and no one knows the quantity yielded per year (FAO, 2013:10). Due to the unavailability of fishing licenses and resource management, people resort to artisanal fishing (small-scale fishing), gillnets, *chingundenge* (group of men fishing) and any other methods that can remove fish from their habitat, as it is assumed that fish move up and down the river when it rains. Rivers pass from one area to another without restriction; hence there are relaxed laws regarding conservation.

2.7.1 Traditional Artisanal Gear

This method is commonly used in all Zimbabwean rural areas and is known as the use of rod and the line, and is frequently used by all age groups regardless of gender. Rod and the line are used in rivers and dams; since it's not licensed, it is cheaper, and easy to implement. The artisanal fishing implements are designed and made by the local rural community, as the materials are easily accessible in the country. However, the method selects bigger fish, depending on the hook being used. According to observations made at Mwenje and Mufurudzi dams, by Chimbuya (1993:4), traditional fishing methods used in small reservoirs in Zimbabwe, are categorised as follows:

- “*Gear used to restrain the fish from escaping include: Kamukore, a modified scoop net; Javu, the cast net; Chigubhu a plastic bottle trap; and, Chirauro, the hook and line.*
- *Fishing methods employed to catch fish include: Kamukodobo, a depression made in the soil to lure fish; and, Kagadheni, a reed enclosure fitted with a trap door.”*

2.7.2 Gillnets

The use of gillnets is not allowed in the rivers in Zimbabwe, while its use in dams is subject to a number of restrictions. A licence, which is renewable annually, is needed to own, buy or sell gillnets. The licence specifies the dimensions of the nets, their mesh size, and the dams where they can be used. Since legal gillnets frequently come in the stretched mesh sizes of 76 mm (3-inch), 102 mm (4-inch) and 114 mm (4.5- inch), they are used to catch large-sized fish such as_Mozambique tilapia (*Oreochromis mossambicus*).

As a matter of common property, people in rural areas have reverted to the use of sacks (small-meshed gillnets) (FAO, 2013:8), shore seines, and dip nets made of mosquito mesh, due to the lack of money to buy the expensive factory-made nets and, moreover, due to the frequent encounter of smaller fish in their rivers. These methods ensure maximum harvests, by extracting all fish types from small reservoirs and large dams, to improve their livelihoods. The use of unauthorised, and other illegal fishing methods, is a matter of concern for the fishery managers as well as the environmentalists, though the local people argue that fish are highly mobile (FAO, 2013:7). These methods can cause environmental harm and irreversible damage to the fish stock and the species diversity, as they do not support sustainable harvesting and result in the over-use of resources.

2.7.3 Chingundenge

This method is dangerous, and involves a team of three to four fishermen wading waist deep through deep pools, swimming and diving to flush fish from their hiding places while gradually pulling the net closed. All fishermen carry knives to protect themselves when employing this fishing technique and many fishermen has been injured. This method is the most dangerous method of all the other techniques stated above, because the fishermen come into contact with the water and its predators – especially the

hippopotamus (*Hippopotamus amphibious*) and the Nile crocodile. These animals are frequently cornered in the nets and injuries or death might occur; hence, fishermen are always equipped with knives, to protect themselves in case of attack.

2.8 Human-Crocodile Co-existence

2.8.1 Can Nile Crocodiles Attack Humans?

Yes, from documentaries, the Nile crocodile is considered as one of the most dangerous species of crocodile, and is responsible for many human deaths (Musambachine, 1987:197). Humans are only considered prey in the following instances:

- Opportunity feeders

Human beings are often killed when they accidentally cross the path of crocodiles that are hunting for food. Humans are considered easy and defenceless prey (Whitaker, 2007:4).

- Defending territory

Crocodiles are territorial animals that mark and defend their territory as they try to protect the nests and the young. Breeding females are especially defensive.

- Mistaken Identity

In cases where the crocodile attack other prey, such as feral dogs (*Canis familiaris*), which will be moving with human beings.

2.8.2 Why Nile Crocodiles kill Domestic Prey

Crocodiles live in rivers – which are a common resource (Van Oel, Karol & Hoekstra, 2009:350), as the rivers are used by humans, as well as livestock, for water and green grazing or pastures (Figure 2.1). The rivers are used according to traditional laws, to demarcate the boundaries. A river might pass through two villages – which make it unavoidable to cross in search of other resources – for example, fermenting rapoko (finger millet) for traditional beer. Crocodiles prey on domestic chickens, goats, sheep

and cattle, as they are easy prey, due to their limited escape abilities (Mishra, Allen, McCarthy, Madhusudan, Bayarjargal & Prins, 2003:1514). The size of prey on attack differs with the size of the crocodile in hunt, as young crocodiles will be overpowered by big prey.

2.9 Implications of Crocodile Management

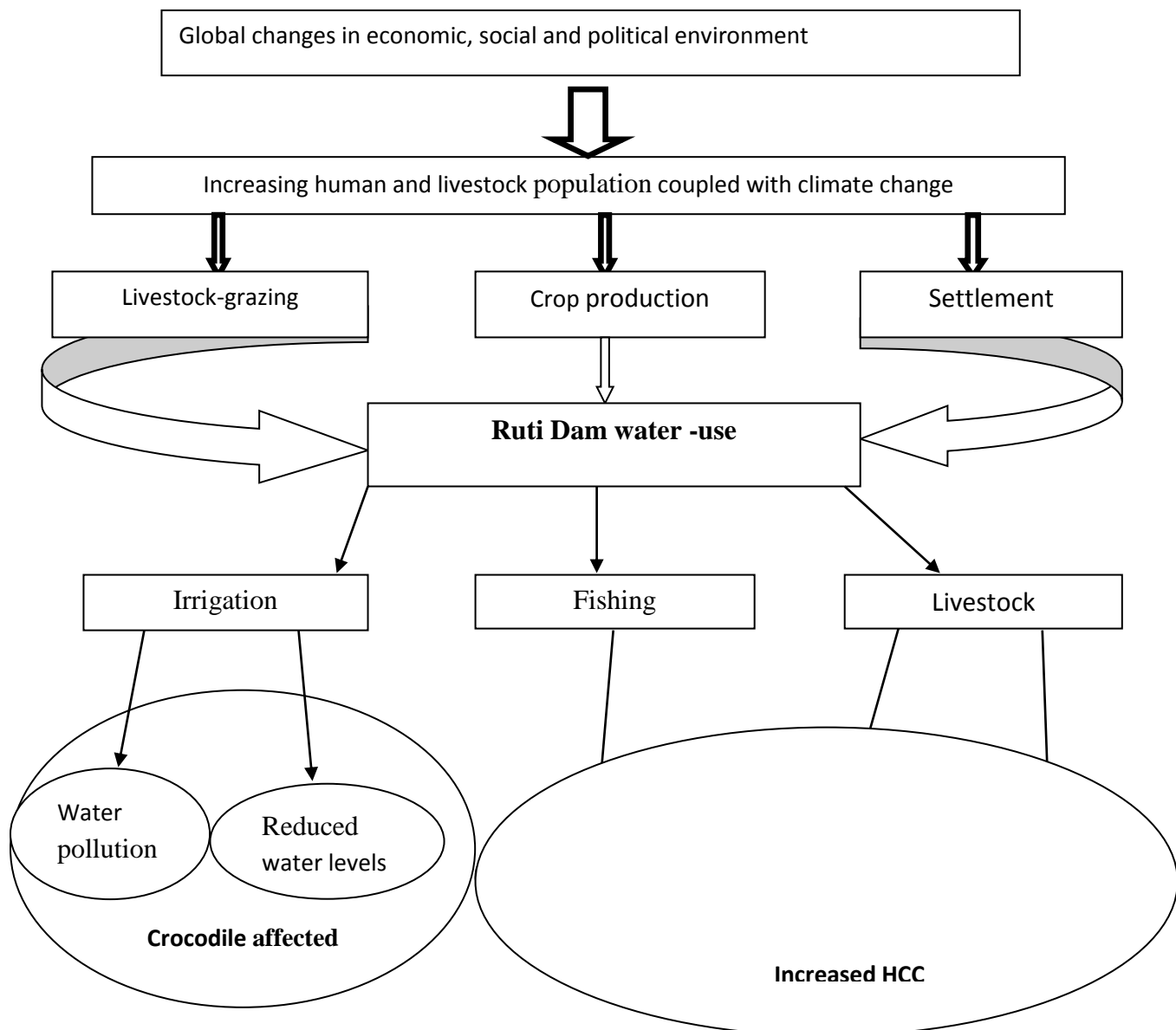


Figure 2.2: A conceptual frame outlining major factors behind HCC. (Source: Gandiwa, Matsvayi, Ngwenya & Gandiwa, 2011:28).

In most cases, wetlands are waterlogged during rainy seasons, which make them good sources for green pasture and vegetables for home consumption (Whitlow, 1990:191). As a result, they are regarded as the main source of livelihood for rural communities with limited resources (Chingwenya & Muparamoto, 2009:390), and as such, the RAMSAR Convention on Wetlands, in 1971, encouraged sustainable use of wetlands to supplement their small income (Bouare, 2006:100). Ruti Dam is the centre of existence for local people, who are extremely dependent on it for livestock production, cultivation, water supply and fish (Chingwenya & Muparamoto, 2009:392). Cattle graze on banks of rivers and dams, where green pasture always exists. The arid nature of the Buhera and Gutu districts, has leads to the extinction of wild prey as they compete for grass and water with domestic animals (competitive exclusion) (Richter, Postel, Revenga, Scudder, Lehner, Churchill & Chow, 2010:24; Mattee & Shem, 2006:7; Mishra *et al.*, 2003:1515).

This may not only lead to the attacks on livestock by the crocodile, but the movement of animals may impact on crocodile breeding sites, leading to reduced hatchlings and declining crocodile populations (Shacks, 2006:4; Koerth, Webb, Bryant & Guthery, 1983:385), as well as reducing their habitat (Combrink *et al.*, 2011:152) due to river siltation. This is caused by overgrazing, which increases the chances of erosion, as humans put pressure on land as a tragedy of the commons in communal lands, as everyone claim ownership (Mattee & Shem, 2006:16). The increased fishing and general human presence around the dam leads to continuous human encroachment into crocodile areas; hence disturbance to crocodile sites, and furthermore reduced fish stock attributed to water pollution results in negative effects on crocodile. Due to these abovementioned factors that work together in eliminating the crocodile from its natural environments, crocodiles in northern parts of Zimbabwe have regained their territory due community involvements in conservation issues (ZPWMA, 2006:10). The crocodile numbers in Kariba are increasing, after a slight decrease due to destruction of the nesting sites being used as a way of eliminating them. People now stay away from the crocodile areas, due to the monetary value attached to the crocodiles through identification of nests (ZPWMA, 2006:10).

2.10 Managing HCC

Through research, different measures have been suggested, and some have proved to be useful in reducing the impacts, as practice and application have shown that effectiveness is dependent on the combination of the methods applied (Le Bel *et al.*, 2010:313). HWC, as well as HCC, are complex, which requires simple, mutual inclusive approaches for the continued existence of both human (and their livelihood) and the so-called problem animal (FAO, 2010:30). The management plan should be designed in accordance with traditional rules operating in the area (Virtanen, 2005:9). With the local people formulating, administering and managing the strategies, there is a chance for survival of threatened species. This has led to the growth of Community Based Natural Resource Management (CBNRM) programmes in Africa (Boudreaux & Nelson, 2011:17).

2.10.1 Compensation

Compensation should be given for every fatal incident that has been caused due to crocodiles however prior assessment of the damage needs to be done, to avoid over-compensation and exaggeration of the incident by the affected people (FAO, 2010:31). Compensation can be in monetary form, or replacing of the killed livestock animal – though this method is ineffective, due to the budgetary constraints of developing countries (FAO, 2010:31). The payouts are poor, or too small to equate the damage or loss to an individual property. The system of compensating might be poor, leaving affected individuals not benefitting from it. In India, many processes are involved – which are costly and timeous, hence claiming for losses has become unpopular (Madhusudan, 2003:470). This was also found in Kenya, where pay-outs for losses are low (Ogada *et al.*, 2003:1523). Problems may only arise when human life has been lost, as money cannot be equated with life.

2.10.2 Physical Barriers

The use of barriers, also known as crocodile exclusion enclosures (CEE), works well when in combination with crocodile disturbance, and more effectively, when problem sites have been identified – as in Sri Lanka (Crocodile Specialist Group (CSG), 2011:30). The modern CEEs are similar to enclosures used at crocodile farms. Barriers include the erection of fences, packing of thorny branches and rocks in frequently used sites for bathing, washing clothes and house utensils. Danger warning signs, showing safe places, should be shown on entry points, and also how the CEE works (Parks and Wildlife Services, 2012:31). The CEE gate should always be kept closed, whether in or out of use (CSG, 2011:30). The noise made by humans will continuously affect the activities of the predator, reducing chances of depredation. This might negatively affect the crocodile population, as the nesting sites are affected, and breeding rates will decrease.

2.10.3 Problem Crocodile Control (PCC)

Problem crocodiles should be removed under guidance from specialised staff of PWMA. This is only effective if the PCC does not involve shooting and killing of the perceived guilty animal. When innocent animals are mistakenly identified, it becomes expensive as the procedure need to be repeated to cater for correct animal. PCC should be concluded with translocation (*in-situ* to *ex-situ*) or 'wild to wild', if unoccupied habitats exists, due to their social behaviour, although 'wild to wild' remains a problem as crocodiles normally return to their original habitat (Campell, Watts, Sullivan, Read, Choukroun, Irwin & Franklin, 2010:5). Permits granted to community-based ranger groups should only allow live capture of crocodiles and selling off them to crocodile farmers (PWSNT, 2012:30). If crocodiles are moved from 'wild to wild' where other crocodiles exist, they may suffer physical damage and predation, as they fight for control of territory (FAO, 2010:39; Treves & Karanth, 2003:1494). They will fight for limited resources, and this might hold implications for introduced populations. For successful PCC, effective communication links between governments, stakeholders, conservation groups and community, with proper monitoring, and awareness campaigns about dangers and the importance of predators if properly managed, need to be spread (Purchase & Vhurumuku, 2005:27; Griffiths, Scott, Carpenter & Reed, 1989:79). This encourages good management practices, with minimal damage to both

wildlife and livelihood, as outlined by the Preventive Alertness Control and Learning (PACL) approach. However, this is normally hampered by a lack of resources and poorly designed policies in developing countries, hence the development of the Management Oriented Monitoring System (MOMS) which allows immediate evaluation on loss or damage of property (Figure 2.3):

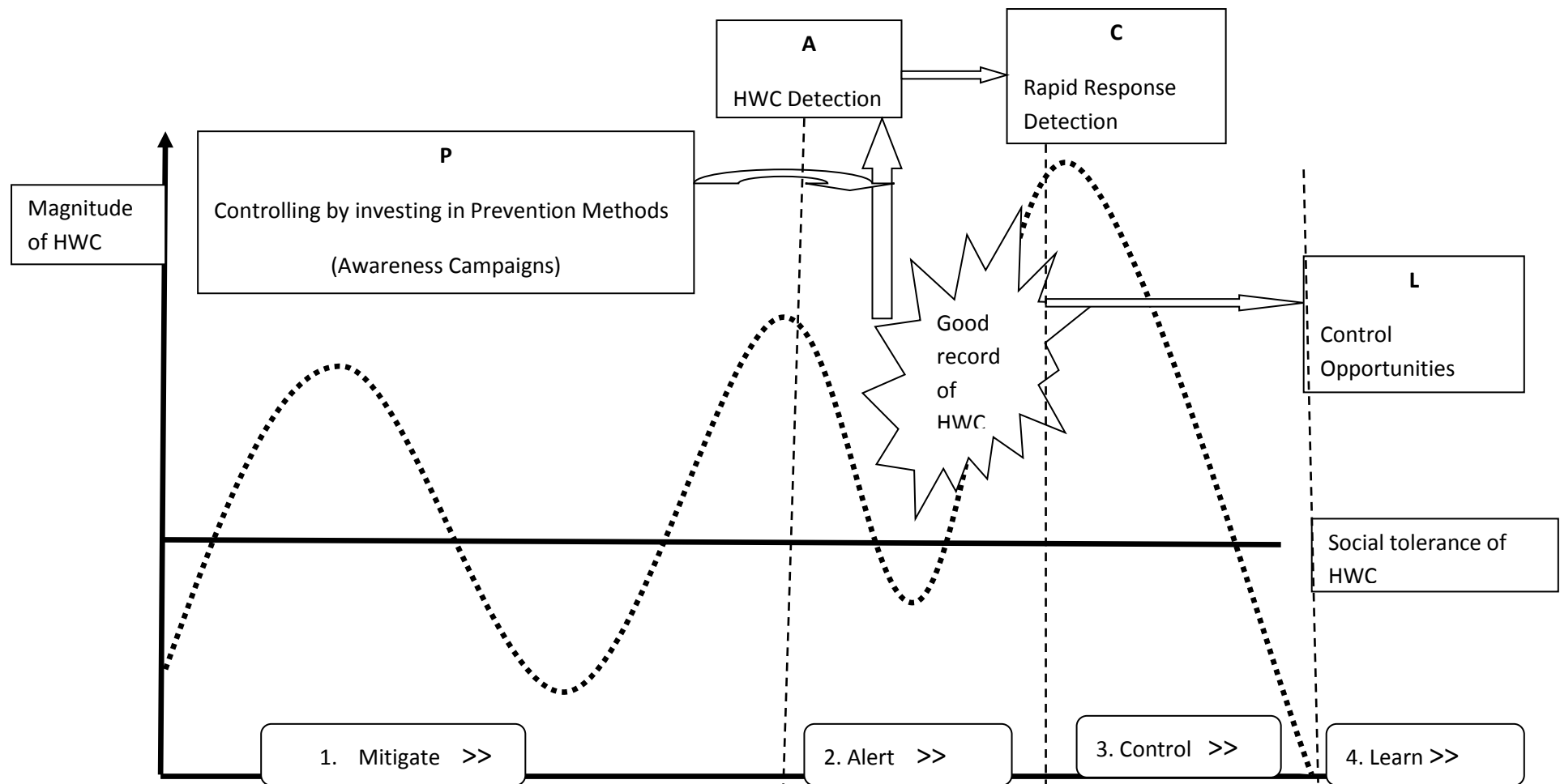


Figure 2.3: A PACL approach. (Source: Le Bel *et al.*, 2010:315).

2.10.4 Prevention of HCC

Prevention is always better than cure, so every effort must be put in to encourage prevention. The costs of nursing and compensating the victims may be high. The funds could be used for other developmental projects for example if people were to receive educational awareness campaigns on how crocodile attacks can be prevented. Some of these preventive measures are the following:

- Humans should stay away from crocodile-infested waters (avoid predator territory).
- Humans to use crocodile repellents, for example protective mantras (charms) used by fishermen in Sri Lanka (CSG, 2011:29).
- Humans to be vigilant and always be aware of your surroundings.
- Humans should stay at least five metres away from crocodiles.
- Always avoid nesting areas, as they are always guarded by the female crocodile.
- Always be alert and avoid surprising the animal, as it might attack in self-defence.
- Run away from the animal, to avoid it drawing you into the water, as it is powerful in water.
- Humans should fight back if when attacked: check for soft parts of its body; rather go for the eye, the nostrils, ear or palatal valve (Whitaker, 2007:4).

2.11 Livestock Management Techniques

The HCC conflicts can also be much reduced if livestock practices are carried out in a more highly organised and controlled manner to reduce predation and loss of livestock. The implementation of a good animal husbandry system leads to survival of livestock, hence better social life. Due to the few resources owned, rural subsistence farmers normally suffer great losses when one of their livestock is lost. However, the livestock protection methods differ in terms of the type of animal, time of day, and the resources of the farmer. There are cheap methods, but their effectiveness is determined by correct and combined use (Le Bel *et al.*,

2010:313). In African communities, the frequently used methods are kraaling, herding, use of guarding dogs, and use of collar bells.

2.11.1 Guarding Dogs and Donkeys

The livestock guarding dogs are effective in protecting livestock, ranging from chickens to cattle, either at the homestead or in the grazing fields (Gehring, VerCauteren & Landry, 2010:302). The dogs differ in their size and physical strength, but all are able to bark. The continuous barking by guarding dogs deter predators by alerting people of danger (Lord, Feinstein & Coppinger, 2009:366), while donkeys bray to intimidate predators. The guard animals need to bond with the flock, when they are still young, so that they get used to attention and protection (Gehring *et al.*, 2010:306). Dogs should not be allowed to come back from the grazing animals during the day, and feeding should be done in the kraal (Henderson & Spaeth, 1980:16). Sometimes guarding dogs are highly susceptible to crocodile and hyena predation, if not well protected. Dogs work well when they are accompanied by the cattle herders, as the humans are able to chase the predators away or to drive the animals to safety.

2.11.2 Animal Herders

Herding is defined as the act of maintaining animals in a group and monitoring their movements from one place to another (Smith, 2014:2). This act is usually practised by a young man – thus ages, between 15 and 35 years, either working or helping the family. The herders direct animals to grazing fields and prevent animals from grazing on untrusted grazing areas, which have predators that can attack the animals. The effectiveness of herders is dependent on their age, their willingness to follow the animals, and the number of animals monitored by an individual. Paid herders tend to be more vigilant than unpaid herders, hence the former lower predation levels. In Zimbabwean communities, a boy's duties, from a tender age, include cattle herding and feeding of dogs. Protection is often less successful, due to the playful nature of the youngsters. Whistling is widely used in monitoring a flock, and as an alarm to deter predators; however, the nature of the whistles differ in meaning, and are well known by the community (Smith, 2014:2).

2.11.3 Use of Enclosures

Keeping animals in enclosures helps to reduce the predation levels. The enclosures are constructed differently, depending on the availability of resources. The main tools in poor rural areas are tree branches and stones. Cattle kraals are built close to the homes, for maximum protection of the animals, as predators fear encroaching on the residential areas. Fireplaces and humans are the cheapest form of deterrents commonly used. An increase in distance from the residential areas results in increased predation. The nature of construction influences the predator attack, as stone-built kraals are safer, compared to branch-built kraals, as predators are given a chance to see what is inside and what might lure them (Figure 2.4):



Figure 2.4: Kraal made of tree branch and stone built. (**Source:** Own source).

Though crocodiles move out of the water and travel during the night, their home ranges are limited. Furthermore, they don't normally feed on live animals, but on dead ones, during drought periods (Rodda, 1984:447). Crocodiles are weaker on land than in water and the presence of livestock carcasses made feeding easier as the feed was readily available.

2.12 Water

2.12.1 Water as a Resource

Zimbabwe lacks an underlying policy on water resource management. With the Zimbabwe National Water Authority Act (ZINWA), No. 14 of 1998, and the Zimbabwe Water Act No. 36 of 1998 (Chapter 20:24), clearly shows that the Zimbabwean water system is divided into seven catchment councils: Gwayi, Manyame, Mazowe, Mzingwane, Sanyati, Save and Runde (Mtisi & Nicol,

2003:12), based on hydrological boundaries for easier monitoring and management (Mtisi, 2011:11). Ruti Dam falls under the Save catchment. The councils develop water use plans, and issue permits on water-related activities (Mtisi & Nicol, 2003:11; Manzungu, 2001:104) under the guidance of the 1998 Water Act, which promotes sustainability (Figure 2.5):

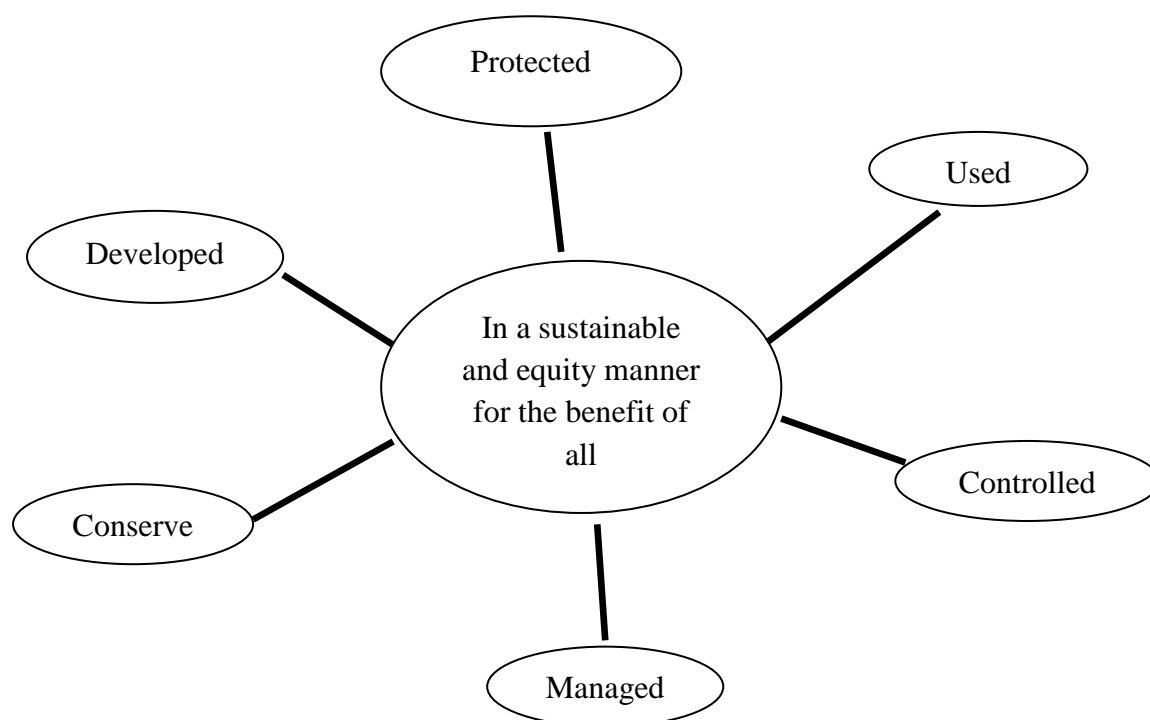


Figure 2.5: Purpose of the Water Act. (Source: Collett, Khumalo, Madiba, Sisitka, De Fontaine, Asafo-Adjei, Smuts, Strydom, Gcwensa & Tshabang, 2011:156).

However, pollution of aquatic environments in Zimbabwe is prohibited by the Environmental Management Act No. 6 of 2005 (Chapter 20:27), Section 28, and the person found guilty of the offence is liable to either a fine or imprisonment.

2.12.2 Rural Water Uses and Sources

The CAMPFIRE programme oversees the use and management of water resources as a matter of a community-based approach (Rusinga, Murwendo & Zinhiva, 2012:150), hence the construction of dams in Zimbabwe has been welcomed by many rural dwellers, for supporting livelihoods (Table 2.2, below). The water resources are known for alleviating poverty by improving community livelihoods

through livestock production (Inoni, Chukwuji, Ogisi & Oyaide, 2007:41), irrigation (Lipton, 2012:4; Balazs, 2006:48; Mokgope & Butterworth, 2001:8) and fishing projects (Ratner, 2011:4; Onuoha, 2009:53). This has been the case with Mhakwe Dam in Chimanimani district (Rusinga *et al.*, 2012:152) and Ruti Dam in Gutu district (Oxfam, 2012:2).

Table 2.2: Water source and uses, where people are in contact with crocodile habitat.

Water source	Water uses						
	Beer brewing	Vegetable garden	Irrigation scheme	Livestock drinking	Brick-making	Building	Basic needs (drinking, cooking, washing)
River	✓	✓	✓	✓	✓	✓	✓
Spring	✓						✓
Scoophole	✓	✓					✓
Borehole	✓	✓		✓		✓	✓
Rain	✓						✓
Dam	✓	✓	✓	✓	✓	✓	✓

(Source: Adapted from Mokgope & Butterworth, 2001:8).

2.13 Human-Wildlife Conflict Factors

Rural people who are dependent on one livelihood strategy for example livestock rearing or crop production are likely to have increased human-wildlife conflicts

(HWC) (Dickman, 2010:461). One type of production might frequently be attacked by wildlife always. However, HWCs are mostly greater for the rural poor living close to protected areas, as they are continuously in contact with wildlife. High costs of wildlife are frequently catered for by sales in livestock and crop (FAO, 2010:31). These rural poor are at greater risk of becoming poorer, due to their few living strategies practised, with very low income. They are highly dependent on those natural resources around them, to make a living (Bebbington, 1999:2031), hence putting pressure on resources, as they compete with wild animals (Whiting *et al.*, 2011:85). Humans control, and prioritise for their own purposes, the use of natural resources, hence living at the expense of wild animals. These increased harvests of wild populations, without scientific monitoring, have created imbalances in local viable populations, due to a constricted gene pool. Furthermore, they are affecting the wild population's reproductive capacity, due to increased demand of their resources on informal and formal markets which results on non-selective killing (Whiting *et al.*, 2011:91; Williams, Balkwill & Witkowski, 2007:152).

People living near fresh water bodies are dependent on fish, and those living near forests are dependent on forest resources. In fishing communities, conflicts arise when fishing gear is destroyed or fishermen are killed during fishing. Sometimes, Nile crocodiles are trapped and die in the nets.

The fertilisers applied in agricultural fields cause heavy pollution, hence affecting the productivity of aquatic animals, especially the top predators. This will negatively affect the life cycles of the aquatic ecosystem due to the impacts on the feed web (Bernhard, 2012:17).

Furthermore, livelihood, in the form of domestic animals, may be killed as they graze or drink water in the dam. This is affecting poor people more than more affluent people, as the richer can sink boreholes and wells to supply water for their daily needs – hence the variability in the conflict level, due to differences in economic scale. Thus, the HWC level varies among individuals, due to differences in their wealth and the type of the conflict (Okech, 2010:74; Naughton-Treves & Treves, 2005:257). The dynamics in communities, and the societal values, differ between one individual and another, due to differences in cultural and religious

beliefs. Politics of land management being endorsed by the land committees can also affect the management of wildlife resources, due to differences in land use. Generally, the factors leading to HWC can be grouped into environmental risk factors and social risk factors – which might lead to direct or indirect consequences (Dickman, 2010:463) (Figure 2.6):

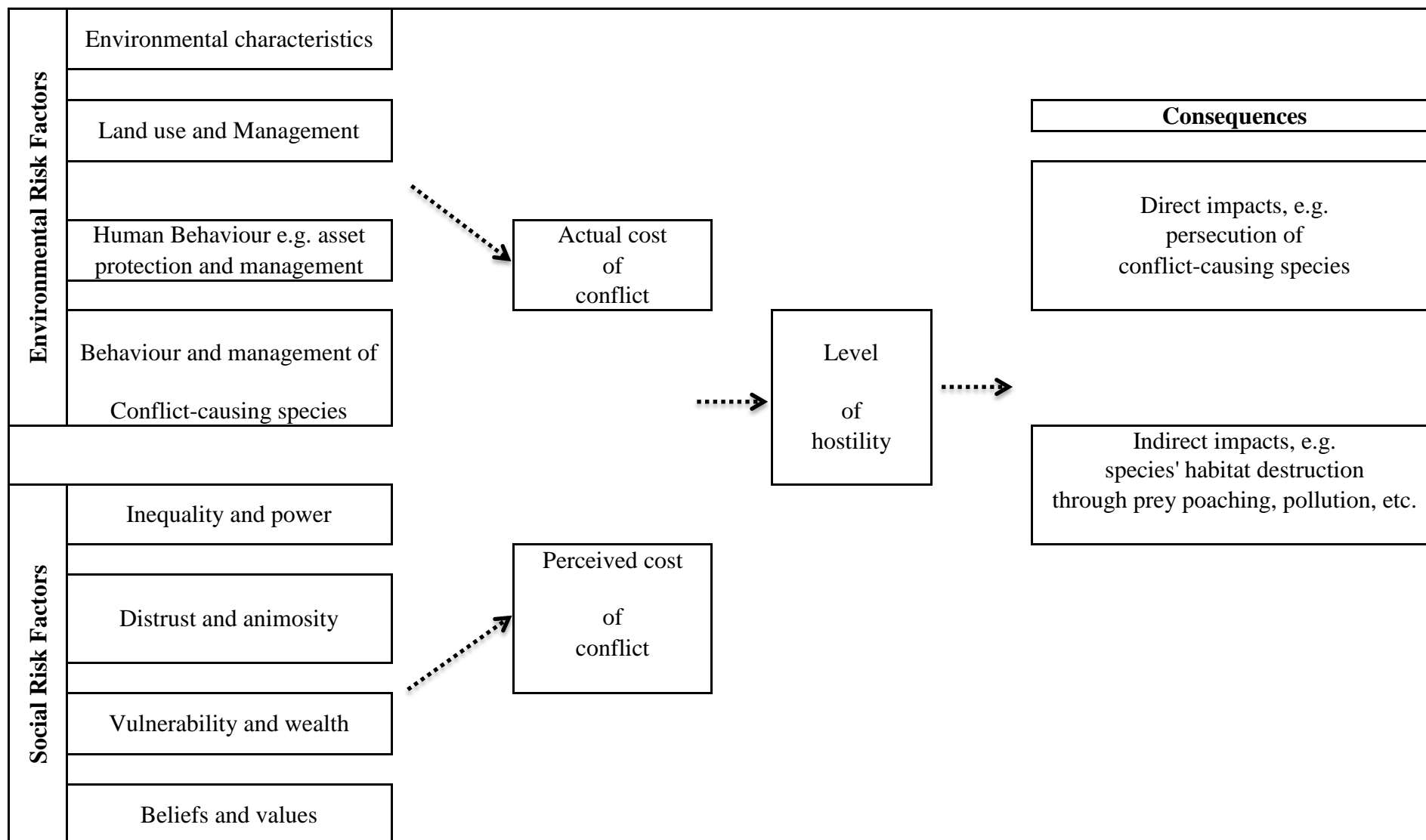


Figure 2.6: Conceptual framework of some factors likely to affect the intensity of HWC. (Source: Dickman, 2010:463).

The conflicts can, however, be ameliorated with cheap (cost-effective) methods, such as the use of guarding dogs, cattle herders, and secure enclosures at night, for good livestock management (Woodroffe, Frank, Lindsey, Ole Ranah & Romanach, 2007:1253; Chihona, 2006:28; Dickman, Macdonald & Marker, 2005:534; Marker, Dickman, Mills & Macdonald, 2003:408; Ogada *et al.*, 2003:1527). The guarding dogs only act as an alarm for approaching predators (Atickem, Williams, Bekele & Thirgood, 2010:1080), and should work together with other methods for effective control.

2.14 Resource Management at Community Level

2.14.1 Introduction of CBNRM

In Africa, CBNRM was formulated to allocate and manage the benefits of having resources at community level, through community participation, hence avoiding over-exploitation of local resources as a tragedy of the commons, where locals compete for use (Boudreaux & Nelson, 2011:17). It was formulated to reduce human impact on biodiversity (Munthali, 2007:52), thereby promoting co-existence. Human material existence is dependent on natural resources to achieve daily life needs (Figure 2.7):

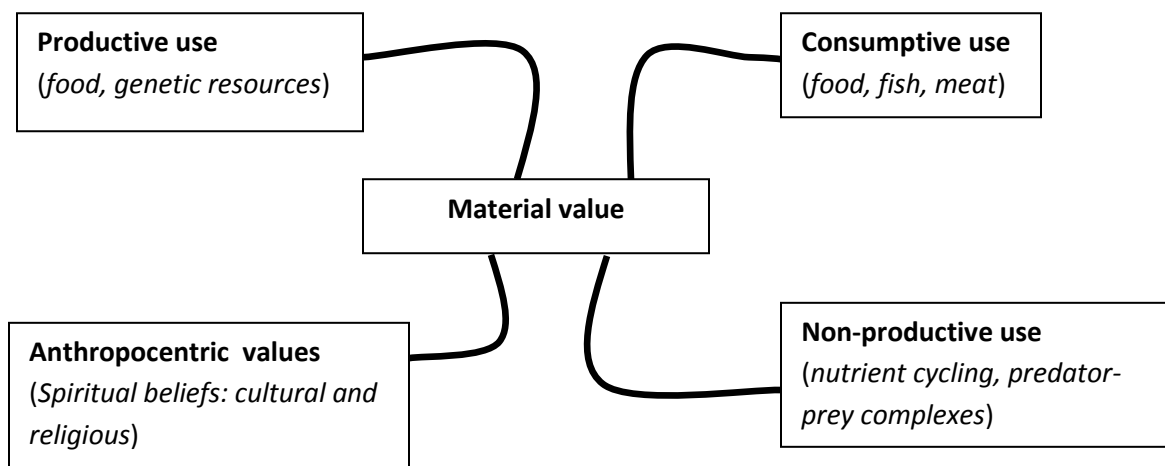


Figure 2.7: Material values that keep humans close to nature. (Source: Trim, 2008:17-21)

For effective nature management, conservation strategies are formulated and implemented by the local people, to suit their way of life and the type of animals they live with. As communities differ, more so do wild animals differ in their form and behaviour, when exposed to different environments, which differ in resource form and abundance (Stankowich, 2008:2166). The local people are given ownership rights, to stimulate decisionmaking, which, in turn, improves their personal, social and economic opportunities from the use of the resources (Boudreaux & Nelson, 2011:19; Virtanen, 2005:5). All is done sustainably, with the approval of leaders, policymakers and administrators.

The 21st century, conservation strategies have become a problem, due to the notion that wildlife is a source of protein and income for some rural households (Virtanen, 2005:7). Besides, CBNRM has further lifted the financial and social status of communities, through support programmes such as drilling of boreholes, scholarships, human-wildlife self-insurances, problem animal control (PAC) and cash support for traditional leaders (Jones, Davies, Diez & Diggle, 2012:198; Ngwerume & Muchemwa, 2011:80; Jones & Weaver, 2008:234; Conyer, 2002:15), through their continued co-existence with wildlife.

CBNRM programmes are widespread in developing countries, especially eastern and southern Africa (Newmark & Hough, 2000:590), and have led to the creation of Community Based Organisations (CBOs) (Giampiccoli & Kalis, 2012:107). The CBOs exist in remote areas which are still home to wildlife – for example, conservancy programmes in Namibia, the Tchuma Tchato in Tete province of Mozambique (Madope, 1999:217), Communal Areas Management Programme for Indigenous Resources (CAMPFIRE) in 25 districts of Zimbabwe (Murphree, 2005:121), and wildlife management administrative units in Administrative Management Design Projects (ADMARE) in Zambia (Nelson & Agrawal, 2008:570; Wright, 1995:23).

As a result, people have increased their love of wildlife, as benefits partially override the costs through harvesting and ecotourism. This has further increased the perception that wildlife is money, and money is wildlife (Lindsey, Roulet & Romanach, 2007:463). As the love of wildlife increases, local people will safeguard their existence in a traditional manner, with zero tolerance for poaching and destruction of their habitats (Giampiccoli & Kalis, 2012:115; Namibian Association Support of CBNRM Organisations (NASCO), 2010:18; Virtanen, 2005:9). A positive result for wild crocodile conservation has been the boost by farmers in Kariba (Zimbabwe), who give rewards for nest identification and egg collection in the area (ZPWMA, 2006:10; Revol, 1995:305). Generally, people have taken ownership of wildlife, to the extent of identifying and guarding the crocodiles from disturbances. To them crocodile nests, and the species, mean money, hence are now well protected, as they are of importance in the lives of local people.

2.14.1.1 Value of crocodiles to humans

The management of the crocodile needs to be done in such a way as to establish a positive regard and respect for crocodiles on the part of the local residents. The predation of humans and livestock by crocodile has led to humans having mixed reactions to the animal. The crocodile is disliked by many, which generally gives them little chance of survival (Kellert, 1997:25). The dislike is associated with fear for human death, as on the African continent the crocodile is regarded as a man-eater (Musambachime, 1987:197). Crocodiles cannot be easily killed, due to their way of life in water and lack of resources by the rural people, which search them in water. However, crocodiles hold moral and economic value for tribal people and the community (Kellert, 1997:23) but these values can only be considered if there are low or no conflicts.

2.14.2 CAMPFIRE Operatives

This operative came into effect in the early 1980s, to promote sustainable management (Ngwerume & Muchemwa, 2011:78; Frost & Bond, 2008:776). It was an idea born of

a radical shift from state ownership to community ownership, and it promotes ownership of, and direct economic benefit from, wildlife resources (Murphree, 2005:4). This initiative reduced over-exploitation and poaching of wildlife resources by the community. The use of natural resources in Rural District Councils (RDCs) of Zimbabwe is controlled by the RDCs Act (Chapter 29:13) of 1988 (Murphree, 2005:3). The CAMPFIRE is a beneficial institution run by people at different economic levels, and this has promoted the idea of proprietorship, as locals are directly involved in decisionmaking. Local people benefit through incentives, as the wildlife has a value attached (Johannesen & Skonhøft, 2005:212). The involvement of traditional leaders in the CAMPFIRE programme has had a positive impact on resource conservation (Figure 2.6, below). The traditional leaders are chiefs who control the wards and village heads who control the villages. Chiefs ensure sustainable use of land and its natural resources, while the village heads control and allocate residential, grazing and agricultural land (Mushuku, 2014:31; Adams, Sibanda & Turner, 1999:10). The leaders work under the guidelines of the Zimbabwe Traditional Leaders Act No. 22 of 2001 (Republic of Zimbabwe, 2001:Chapter 29:17).

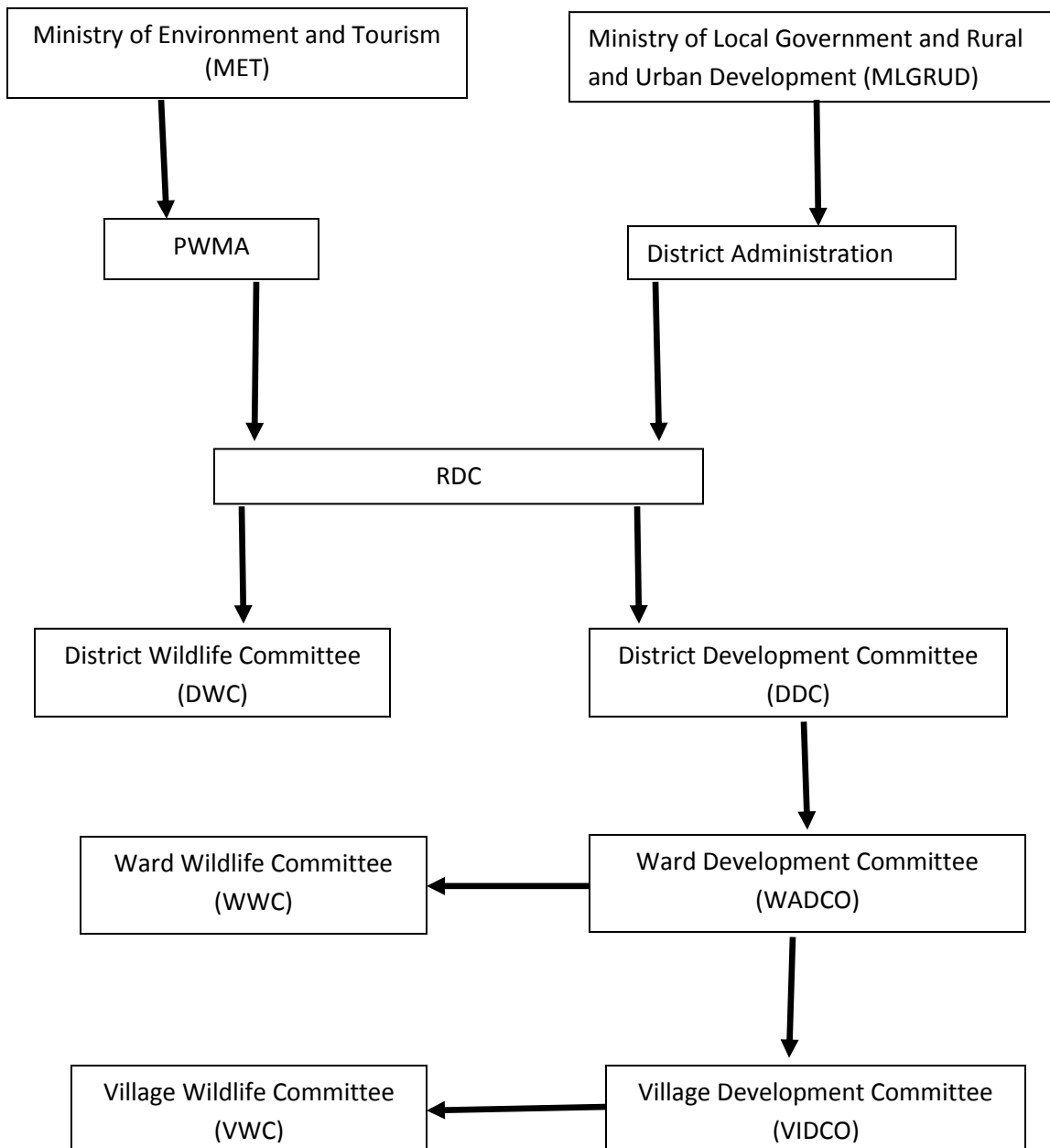


Figure 2.8: Organisational structure of CAMPFIRE. (Source: Adapted from Mashinya, 2007:62).

The VIDCOs and the WADCOs are planning and administrative units which, in turn, form VWC and WWC, made up of six members, respectively (Ngwerume & Muchemwa, 2011:78; Ncube, 2011:92; Chingwenya & Chirisa, 2007:37). The main purpose of VWC and WWC, together with the RDC, is PAC: payment of ward dividends and wildlife population management through population registers (Mashinya, 2007:63). This will allow effective quota setting at district level, leaving a sustainable gene pool after trophy hunting. Furthermore, with local people involved in decisions for production and control, this leads to effective management of the whole system.

2.15 Ecotourism as a Management Tool

Ecotourism is a form of tourism that is designed for rural areas, with plenty of resources to reduce harm to the environment, through continued monitored harvests. It focuses on nature, thus promoting conservation and development with input from the western countries (Barkin, 2013:264; Chiutsi, Mukoroverwa, Karigambe & Mudzengi, 2011:15). European countries directly inject into the programme through tourist visits. Ecotourism supports the principles of the Convention on Biological Diversity (CBD), which promotes conservation and sustainable use of biodiversity (Fig 2.9, below), which literally means continued existence with minimum harvests of wildlife. This will directly promote genetic diversity in the world.

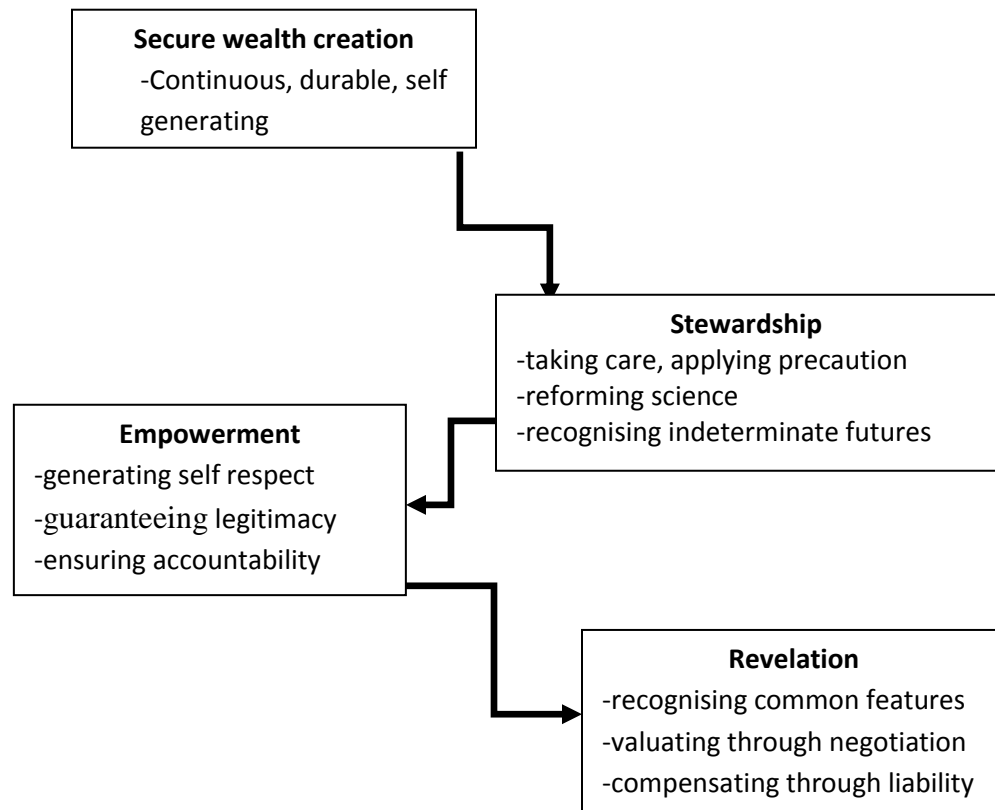


Figure 2.9: Four components of sustainable development. (Source: O’Riordan & Voisey, 1997:7).

Local communities consider conservation of biodiversity with minimum benefit to improve their livelihoods (Weaver, 2008:7), two cases being those of Mahenye in Zimbabwe and Makuleke in South Africa. With ecotourism, visitors in an area are controlled, and their movements monitored (Chiutsi *et al.*, 2011:16). Weaver (2008:10) notes that the success of ecotourism is dependent on the closeness of a local community to a protected area (PA), and the availability of a good road network

system. In addition, the political and economic situation of the country can affect the inflow of tourists. The Zimbabwean situation needs no explanation as to how political instability has influenced the number of tourists (Chiutsi *et al.*, 2011:17). Tourists are naive and they flock where there are good security measures and where their lives are not threatened. The community harbouring the PA, where ecotourism exists, normally benefit through cultural displays, accommodation for tourists, and selling of locally made gifts.

2.16 Culture

Cultures differ among communities. Societal values and beliefs change with time, as environmental, economic and political factors shift (Sterling, Gomez & Porzecanski, 2010:1095). Successful modern conservation practices and different cultures need to be integrated. Understanding human values and behaviours, prior to implementation of conservation tools, is the keystone to success. Correct incorporation of human factors in conservation strategies leads to increased species richness (Sterling *et al.*, 2010:1095).

2.16.1 Culture as a Conservation Tool

Integration of customary management into modern management has been found to be effective and instrumental, even in marine biodiversity conservation (Cinner & Aswani, 2007:205), where compliance is much greater than in PA (McClanahan, Marnane, Cinner & Kiene, 2006:1409). PA works on harsh principles that always favour nature and affect the lives of rural people. Kideghesho (2008:1869) and Shirley *et al.* (2009:143), also noted, in their studies, that totemic species were respected and worshipped. The killing or wounding of a sacred animal was taboo – a violation of a customary rule, which attracted a heavy penalty to deter perpetrators from repeating the same issue (Negi, 2010:194).

In the village of Paga in Ghana, and Manobo in the Philippines, it was noted that the Nile crocodiles were attached to religious and cultural issues, and they were also used as a guardian of community grain stores (Shirley *et al.*, 2009:143; Gonzales, Manalo, Alibo, Mercado, Belo & Barlis, 2013:85). In support of conservation principles, the Akan cultural group regarded Tuesdays as the day of the sea god, when fishing was not allowed (Opoku, 1982:491). Besides animals, some sites were considered sacred (Marumbi Karivara rain cult, VaZizi and Devure rivers in GRDC), as they were reserved for rituals (Mujere, 2007:2). Sacred areas were separated from human settlements, fishing, cultivation, livestock grazing and menstruating women (Negi, 2010:189; Kideghesho, 2008:1869), thus securing the limitation of both habitat encroachment and poaching of wildlife. This has had a considerable effect on the management of natural resources, by preventing habitat loss through encroachment, competition for resources, poaching through bush meat consumption, and pollution of aquatic environments. With the above factors there was an assurance for the survival of species in the wild. Furthermore, death, loss of livestock or disease outbreak, would affect one's family if the cultural laws were poorly observed, and could only be reversed by a cleansing ceremony organised by one's family to appease the spirit (Westerman & Gardner, 2013:5; Kideghesho, 2008:1869). If the ceremony has not been organised, this would mean continuous loss of livelihood, in terms of livestock and poor harvests, as a result of disobedience.

2.16.2 Disappearance of Traditional Management Systems

The indigenous knowledge has been eroded in conservation and local people feel excluded– hence the rise of poaching activities due to colonialism, globalisation and modernisation (Eyong & Foy, 2006:143). The cultural differences no longer exist as people are mix in inter-marriages and what used to be important in one culture might not be important in another hence children will be neutralised. Furthermore, the creation of nature conservancies and parks brought some changes in the settlement pattern of different ethnic groups, which resulted in the relocation of individuals and the demarcation of boundaries. Poaching is a result of sharing the previously called

“privilege resources” (Kideghesho, 2008:1874). This came into effect after a discontinuation of cultural practices, when Africans were denied access to their wealth of knowledge in a bid to promote access to European researchers (Eyong & Foy, 2006:143).

The promotion of modern conservational methods by formal education has resulted in cultural practices being regarded as primitive and barbaric by the western communities (Mutshinyalo & Siebert, 2010:158), hence the non-consideration of societal values, such as norms and beliefs, by the young generation regardless of the teachings by the elders.

2.17 Summary of Chapter

The chapter managed to review information on crocodile characteristics, managing the HCCs and its economic viability on the market at local and international level. The scientific and traditional approaches used in conservation were also shown on how humans can effectively reduce the levels of conflicts with the crocodile. Also information on the survival strategies of the crocodile were shown, which clearly showed that in presence of the wildlife, local farmers are likely to experience lower predation level. However the fishermen, who always compete for fish, had developed mechanisms to reduce loss of life during fishing. This has further given the researcher to be equipped with the methods to be used in research to answer questions on HCC which will be addressed in the next chapter.

Chapter 3: Research Methodology

The chapter will give an overview of the study area, thus the resources, climatic conditions and the population group. It will further show the approaches to research techniques to be used in the study thus the sampling techniques and the research tools such as the questionnaire and the collection of secondary data. It will further clarify why a structured questionnaire will be used in the study and how the samples will be drawn from the ward. This will also include the programme of the researcher in the field and how the ethics will be considered.

3.1 Study Area

Zimbabwe is a landlocked country with a population of 13 061 239, comprising 98% Africans, with less than 1% Whites, and other races which include Indians and Chinese at slightly above 1% (Republic of Zimbabwe, 2012:16). The country is dominated by the Shona tribe (10 710 216 = 82%), Ndebele (1 828 573 = 14%) and other Africans (261 225 = 2%). The Whites are mostly of British origin, who were farmers on commercial farms before the fast-track land resettlement programme. The Shona generally grow crops, while Ndebele are cattle owners; 67% of the population stay in rural areas (Republic of Zimbabwe, 2012:25), as the majority survive on agro-activities. Though the HIV/AIDS prevalence is high, the life expectancy is high, at 51,95% for males, and 51,68% for females. The surface area is approximately 390 757 km² with a population density of 33 persons per kilometre (Republic of Zimbabwe, 2012:13).

The area is located within four major river systems: the Zambezi in the north, the Limpopo in the south, the Save in the south-east, and the Shashe in the south-west (Muyambo, Lacroix & Euvrard, 2003:54). The biome is mainly savannah woodland, with an altitude ranging from 300m to 2800m above sea level (Murphree, 2005:1). The majority of the population relies on subsistence agriculture, with 70% being agrarian, in a country with one rainfall season – between November and March. The rainfall in the Ruti catchment area is low, with an average of 820 mm per annum.

The Ruti Dam is the fourth largest inland dam in GRDC in Masvingo province, and was built by the government in 1979, on the Nyazvidzi River, 40 km south-east of BRDC in Manicaland province, and 80 km from the Save river confluence (Muyambo *et al.*, 2003:54). The dam is located on latitude 19° 35' 00" S and longitude 31° 46' 46" E. The total capacity of the dam is $140 \times 10^6 \text{ m}^3$, the surface area is 15 km^2 and the overall catchment area is $2\,615 \text{ km}^2$ (Figure 3.1, below).

3.1.1 Buhera and Gutu Districts

BRDC is located in the south-eastern part of the country with an area of $5\,357,27 \text{ km}^2$ and an estimated population of 245 878 (Republic of Zimbabwe, 2012:135), constituting 14,04% of the provincial population. While GRDC is adjacent to BRDC, only separated by the dam and/or Nyazvidzi River, it is bigger, compared to BRDC, with an area of $7\,053,53 \text{ km}^2$ and a population size of 203 083 (Republic of Zimbabwe, 2012:138).

According to the population statistics, BRDC is highly populated, with a population density of 46 people per km^2 compared to 29 people per km^2 in Gutu district. The districts lie in natural agro-ecological regions 111, IV and V, which receive very little rainfall annually. The inhabitants endure numerous hardships, as they are forced to travel long distances in order to access clean and safe water. This has been exacerbated by continuous drought in past years. The place is 100% communal; the people grow maize (*Zea mays*), finger millet (*Eleusine coracana*) and groundnuts (*Arachis hypogaea*). Livestock production of cattle, sheep, goats and domestic chickens is practised, which helps to sustain income. Donkeys (*Equus africanus asinus*) also constitute a livelihood, as they are used for draught power and are cheaper to buy, compared to cattle.

The ethnic group, Vahera, of the Museyamwa totem, are widespread in Buhera South, under chief Nyashanu, while the Karanga dominates in Gutu North, under the Gumbo clan. The consecutive droughts experienced from 2005 to date resulted in pronounced lowering of groundwater tables and therefore resulted in some sources of water drying

up (Chimedza, 2011:3). This further increased poverty levels which were already soaring, due to high unemployment in the area (Republic of Zimbabwe, 2011:3). Some respondents in this area have no livestock, and therefore find fishing to be their only source of income to support their families, who are already starving, due to the prolonged droughts. Data was collected in a 30 497,85 ha area (Figure 3, below) that covers both sides of the Ruti Dam, incorporating Ward 13 in GRDC (18 757,38 ha) and Ward 19 in BRDC (11 740,47 ha).

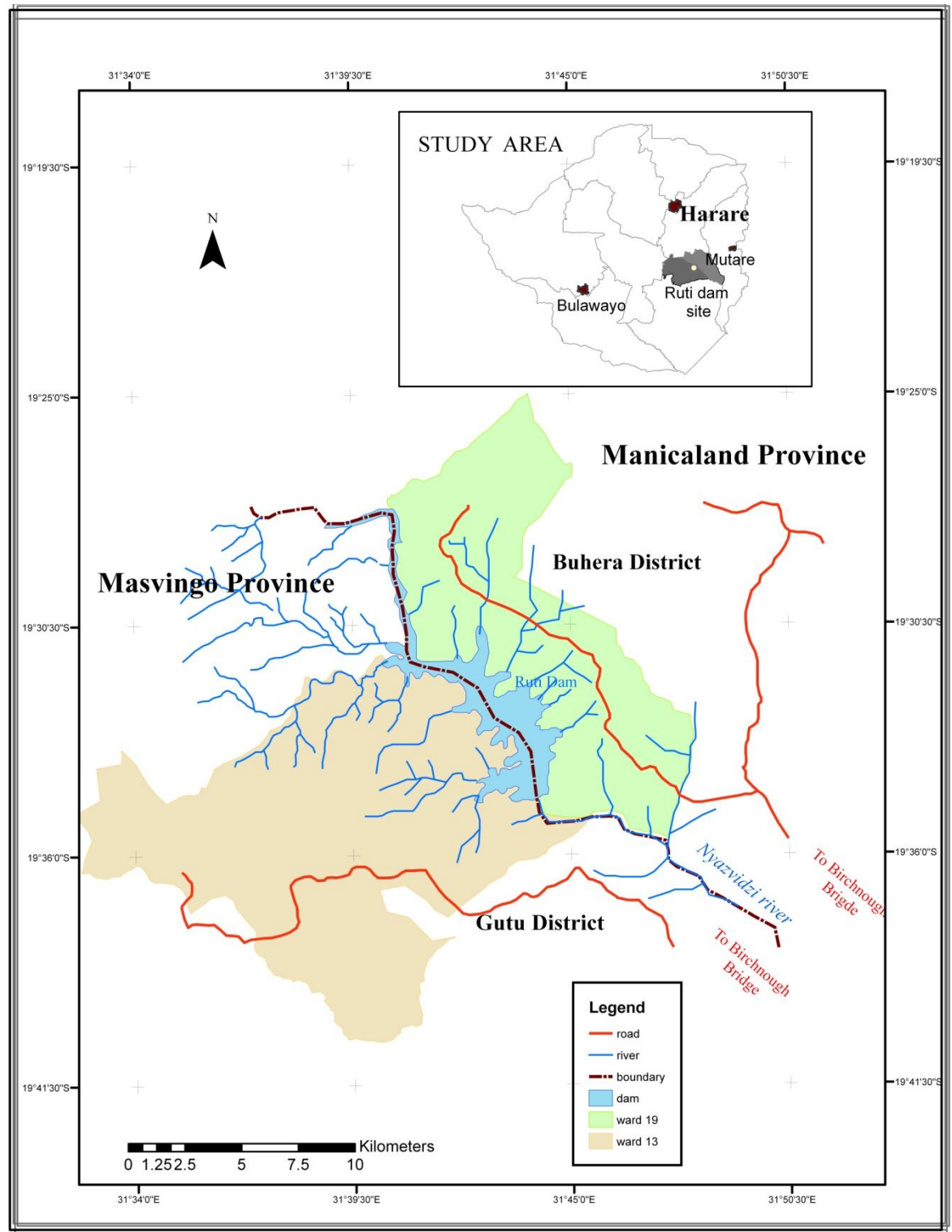


Figure 3.1: GIS Arc view map showing study area. (Source: Own source).

3.2 Research Method

3.2.1 Sampling Technique

Simple random sampling was used in the collection of household information, which guaranteed that every household in each village close to the dam, from the two wards, had an equal chance of being selected and evaluated. A total of 95 questionnaires were used in analysis. The population size was 756 house-holds and interviews were done with different age groups, to allow for clarity. 33 interviews from respondents above 45 years, 27 respondents of ages between 36 to 45 years, 22 respondents of ages between 26 to 35 years and 13 respondents between 15 to 25 years but all who have stayed for at least five years in the area. The selection of households was independently and randomly done, to avoid bias and to cater for a large sample population that exists in these two wards. Headmen selection was based on systematic sampling, which allowed all headmen to be interviewed with the purpose of obtaining all reported cases of human-crocodile conflicts, as each village had one head, and these were the immediate traditional leaders who interacted with the villagers on a daily basis.

3.2.2 Prey Species Abundance

Road strip counts were used for assessing wild species abundance. Opportunistic observations of the game (Buckland, Anderson, Burnham & Laake, 2006:1), faecal deposits and spoor, were recorded with a hand-held GPS device (Garmin GPSIII Plus, Garmin Corporation, USA), and a range finder (Bushnell) was used to measure the distance from the sampling line to the observed animal. Compass bearings and the distance from the observer enabled the researcher to calculate the perpendicular distance from the line. The transect walks were done in the early hours of the day, at least one hour after sunrise, and during each sampling occasion the observers were travelling at a speed of between 1.5 and 2 km/h, and paused at regular intervals to scan the habitat with binoculars. To improve precision, transect walks were done twice, to

ascertain the previously gathered data, and observations were also made at the dam where animals normally drink water.

3.3 Data Collection Methods

3.3.1 Data Sources

Data was collected from both primary and secondary sources. The primary data was collected directly from the respondents (communal farmers, herdsman and fishermen), using a semi-structured questionnaire (SSQ) (Appendix 1) designed using the approach of Aust (2009:122), who studied Nile crocodile status and conflict distribution in north-eastern Namibia, together with field observations and focused group discussions with the affected residents. The structured questionnaire was the main tool for the research. The secondary data sources were compiled from :- a) CAMPFIRE files

b) District files

c) PWMA files

Moreover, the files contained information that was reviewed by the respondents, as adults have poor memories in recalling the dates of issues that took place in the past five years. The district also supplied records of the changes in the water level of the dam over the past five years.

3.3.1.1 Field Interviews

Households were randomly selected as independent units, to ensure that everyone had an equal chance of being interviewed (Maddox, 2003:57). The SSQs were used on selected individuals, targeting the head of the sampled household, who had lived in the area for five years or more and was above 18 years of age. In the case of absenteeism, the eldest son or the housewife was chosen, to prevent duplicative data from respondents of the same household, which would have exaggerated the results. In the

case of informants who were under 18 years old, consent was obtained from parents or from anyone above 18 years old residing at that homestead. The SSQs were designed to gain information directly from these key informants, as well as from fishermen and cattle herders. Interviews were, however, guided with more than one person being interviewed in each area, to provide opportunity for cross-checking on the consistency of information (Kideghesho, 2008:1868). Interviews were done in such a way as to allow free flow of information and to gain as much data as possible.

Traditional leaders are community individuals who, by virtue of their power, are legitimate cultural leaders in their positions. Village heads were purposefully selected to guarantee uniformity in the collected data, as well as to obtain the views of individuals at community level, on crocodile impacts. The village heads were the source of immediate reports made to them, as opposed to the police. Only human deaths were reported to the police, for fear of victimisation when reporting other incidents.

3.3.1.2 Field Observations

Field observations made in the area were useful as a way of triangulating data that was gained through interviews and focused group discussions, after getting an insight on problematic locations in the study area – such as permanent water sources which might be home to problem crocodiles. The focused group discussions targeted the victims of crocodile attacks, livestock farmers and the fishermen. The livestock farmers and the fishermen were in two different groups, as they experienced different problems. Meetings were arranged independently of each other to discuss their problems, and questions were not confined; it was an open discussion with the intention of gleaning correct data from these affected individuals.

Furthermore, additional questions were formulated and other data collected. Different fishing methods used by fishermen were identified by the researcher, which they had never told the researcher about, as they knew they were not allowed to use them and they were extremely dangerous to their lives. Moreover, observations made it possible

to record incidents of animal attacks and as well as graves of crocodile fatalities. With this, a broader base for understanding the farmer-crocodile and fishermen-crocodile conflicts was gained. The discussions and field observations made the researcher check the crocodile hotspots, as well as evidence of crocodile attacks – which were used as a measure to cross-check and validate the reliability of the data gathered.

3.3.1.3 Document Analysis

Relevant information was searched for at district level CAMPFIRE and PMWA offices, to support the primary data. Collected data included crocodile attacks, crocodile killings, and people killing crocodiles – which all comprised HCC in the study area. The method was quick and effective, as it corroborated information from meetings held by stakeholders.

3.4 Pilot Study

A pilot study was conducted in Muzarabani Rural District Council (MRDC) in the eastern Zambezi Valley in Mashonaland Central Province of Zimbabwe, from 12 to 15 April 2013. The preliminary study involved 15 people, which included community farmers, two game rangers from MNP, two cattle herders and one personnel member from CAMPFIRE. The aim of the pilot study was to assess the validity of the questionnaire, to correct mistakes in the questionnaire, and to gain knowledge of the duration of the group discussions and interviews with the informants. Furthermore, questions were rephrased for easy answering, and rearranged for logical and follow-up answers. The pilot study also equipped the researcher with the formalities of good Participatory Rural Appraisal (PRA), which is a requirement in fieldwork of this nature.

3.5 Field work

The data collection for the study was undertaken from 21 June to 31 July 2013, and duties were executed as indicated in Table 3.1. The data was obtained from two wards – one from each of the two districts, and, mostly, villages close to Ruti Dam and the Nyazvidzi River in these wards were surveyed as the area of focus. To answer questions on conflicts, a field interview survey based on questionnaires, focus group discussions and field observations, were used to answer the questions on HWC in areas around Ruti Dam. The questionnaire was divided into four sub-sections: biodata, water use, human-crocodile interaction and crocodile attacks.

The effectiveness of the method lay in assessing the attitudes and farmers' perceptions regarding carnivores (Dickman, 2008:118; Conforti & De Azevedo, 2003:2; Marker, Mills & Macdonald, 2003:1292), as there were chances for probing for more information on perceptions – hence flexibility and reliability in the collected data from maximum data gathered. The focused group discussions were conducted in the native language (Shona), and with the help of two research assistants who helped with the recording of the discussions. Direct questions were avoided during discussions, to avoid defensive reactions which would compromise the results (Westerman & Gardner, 2013:6); however, perceptions of the community's attitude towards crocodiles were probed. People were asked if they were experiencing conflicts with the crocodiles, as a result of livestock and human predation, as well as fish and fishing gear loss. Livestock losses to other carnivores were quantified, and the crocodile losses in the two district areas compared. This also gave an approximate monetary loss per farmer in the whole area. Furthermore, respondents who had lived there for more than five years, and with the knowledge of crocodiles in the area, were asked what they thought about trends in crocodile numbers (for example – increasing, decreasing or remaining constant). Nevertheless, respondents were told that “I do not know” was acceptable, if they had no idea about wildlife issues.

To gain an insight on how farmers protected their livestock from predation, interviewees were asked whether they used any management technique, and whether they had learnt or developed any new management method in the past five years, as a

way to reduce predation. Lastly, respondents were asked to give their views regarding the usefulness of new methods in use.

Table 3.1: Field work sessions executed.

Date	Task
21-30 June	Interviews with farmers in BRDC
31 June -01 July	Focused group discussions in BRDC
03 – 10 July	Interviews with farmers in GRDC
11 – 13 July	Focused group discussions in GRDC
15 – 20 July	Data gathering from CAMPFIRE, district offices and PWMA
21 – 26 July	Thanks given to the district officials and chiefs for allowing my research

(Source: Own source).

3.6 Data Analysis

Analysis of the collected data involved categorisation, collation and filtration, for the purpose of identifying and extracting dominant themes as per question and responses. Since most of the data was qualitative rather than quantitative, it was mostly shown in

a descriptive manner, although further analysis of categorised and coded quantitative data was performed using the Statistical Package for Social Scientists (SPSS) and the Microsoft Excel Data analysis package 2007. SPSS was used to show the relationship between the spatial patterns of HCC, age and attack, gender and attack, and households' characteristics that included sources of livelihoods (Le Bel *et al.*, 2010:301).

This was done to gain an insight of how the household characteristics were related to the distribution of HCCs, and also to check if there were differences in perceived conflicts among different groups of people. The HCC distribution was shown on geographic maps created on Geographical Information System (GIS Arc view 3.2a). Further non-parametric tests were also chosen for analysis, as they do not make any assumptions. The Chi-square test was used to test for the differences between the gender and crocodile attack, and Mann-Whitney was used to analyse the impacts of Nile crocodile and the hyena in both BRDC and GRDC. Furthermore, the test was also used to check whether the appearance of a place where the animals drank water, was linked to predation. Chi-square tests were used to determine whether the age of the person and the activity of the person were related to any crocodile attack.

3.7 Field Research Challenges

Challenges in research vary from one piece of research to another, and the variability depends on the concerned cultural group and the level of acquired information, exacerbated by the current socio-economic and political situation in the area. However, every effort was made to avoid the anticipated problems such as not asking identity, and preventing the issues of socio-political questions, to avoid biased answers. The informants were told, and consistently informed, that the research is independent of politics in the area and the country at large.

Zimbabwe was heading towards its presidential and parliamentary polls at the time of the study, and respondents were afraid of victimisation after giving interviews. However, the situation was eased when the researcher's national identity document

and student cards were shown, which confirmed that the researcher was a local person and a postgraduate student, collecting data for the purposes of writing a dissertation.

Besides the politics of the environment, the use of an SSQ has drawbacks in terms of time and money needed to collect and analyse large amounts of data (Dickman, 2008:108). Generally, interviews for assessing losses and conflicts due to wildlife are subject to biases, due to the following:

- Exaggeration of depredation
- Lack of accuracy in relation to place, age of the killed animal and type of predator, due to the poor memory of adults
- Overestimation of the losses incurred
- Respondents unable to separate losses of depredation and diseases or theft (Oli, Taylor & Rogers, 1994:66), thinking that they might be compensated. Moreover, respondents were reluctant to give information about their involvement in the killing of wildlife, as they knew it to be an offence (Scholte, Adam, Kari & Mbouche, 1999:4). In Zimbabwe, harvesting, collection and selling of crocodile products is controlled by wildlife statutory law.
- Access to certain areas was difficult with a car, as the roads were poor due to lack of maintenance.

To counteract the above errors, large samples were collected from each property, to corroborate information, and, immediately before the interview, respondents were told that “I do not know” was an acceptable answer, as reliability of information is a major concern in biological surveys based on interviews (Gros, 1998:143). To account for no wrong or doubtful information, the researcher independently rated the respondents for reliability, on a 1-4 scale. Respondents received 0, 0.5 or 1 point for five aspects of their contribution: (1) precision of answer, (2) consistency, (3) no wrong or doubtful information, and (4) co-operative attitude. After the interview, the respondent was given a reliability score, and questionnaires with a score below 2 were discarded.

3.8 Ethical Considerations

The researcher was guided by principles normally followed by research in social sciences and the UNISA research ethics. The research participants were treated respectfully, as well as their culture and leadership, as such consultations were made with the ward councillor and village heads before any interview. The research findings were only used in this study, and will be destroyed after three months from the date of data capture.

Following the principles of good research ethics, village heads and councillors were consulted before interviewing the respondents. This was made easier, as the researcher had a consent letter signed by the district administrators of both BRDC and GRDC. To reduce exaggeration of answers, it was explained to respondents that participation in research work did not have any monetary benefits either to the interviewee or the immediate community. Participation in the research was voluntary, though effort was made to collect data from the sampled households or individuals, and participants were told that they were free not to continue with the interview at any time that they might feel uncomfortable.

After the successful data collection using the good principles of field research, the respondent's information was analysed and presented in the following chapter. The results are a true reflection of the gathered data, as it is an offence to misrepresent ideas of people.

Chapter 4: Results

The results shown below were computed from 95 interviews: 79 males and 16 females, who had been living in the area for at least five years to quantify data on HCC and the information has helped answers if the crocodile is actually a problem. Most of the interviewees were living close to the dam, had knowledge of crocodiles in the area, and managed to give reliable information – which was less doubtful information, due to their co-operative attitudes consistence answers during interviews. The interviewees were drawn from different age groups (Figure 4.1):

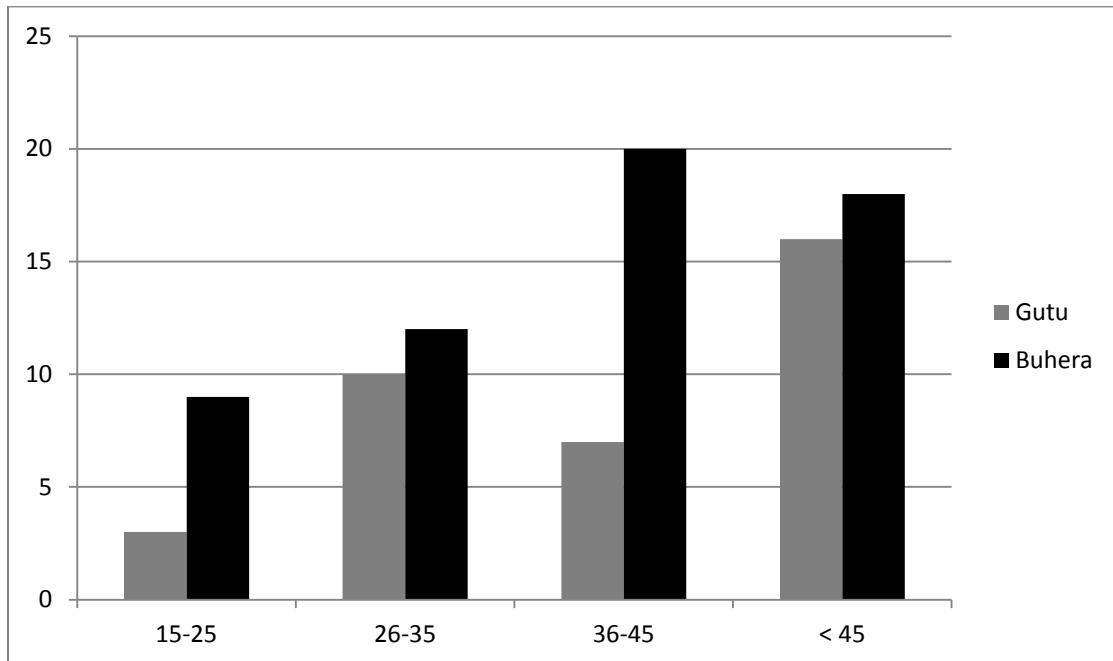


Figure 4.1: Age groups of research participants. (Source: Own source).

Ward 13 in GRDC had 36 interviews, compared to Ward 19 in BRDC with 59 interviews, due to its layout and position on the dam; it stretches away from the dam, while its counterpart spreads, following the margins of the dam. Besides the HCCs, other HWCs were also noted – especially for the brown hyena (*Hyena brunnea*) and the black-backed jackal (*Canis mesomelas*), both in GRDC and BRDC, due to developments taking place in the area that frighten and chase them towards

homesteads. This prompted the researcher to also survey livestock management techniques used to guard against these wild animals.

4.1 Totems of Respondents

Totems were long used as a conservation tool by the ancestors. Different family groups were attached to different animals. Totemic animals were respected, and killing or eating of the animal was avoiding due to myths associated with them. The totems were *shumba* (lion), *mbizi* (zebra), *nyathi* (buffalo), *shava* (eland), *shiri* (Zimbabwean bird), *mukanya* (baboon), *dziva* (water resources), *mbeva* (rats and mice), *ngara* (porcupine), *beta* (crickets) and *moyo* (heart), and were divided among the tribes (Figure 4.2):

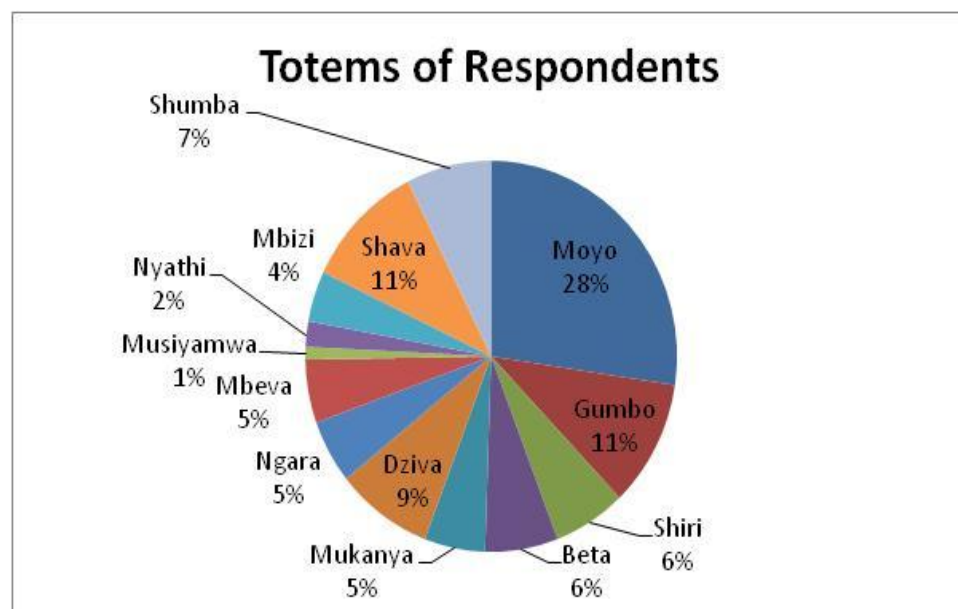


Figure 4.2: Totems in the area. (Source: Own source).

The *Dziva* family protected the water resources (fish and crocodiles) and they did not eat fish. Fishing and disturbing of the crocodile in the water was a taboo, some citing beliefs that their children won't have their own families. The neighbours of the family group were also following the issue of conservation, to strengthen relationships. If a

fish was cooked in a pot, no person associated with that totemic animal would ever use it again to prepare food.

4.2 Livestock Possession

Livestock production was the main source of income in most households in this drought-prone area. Wealth differed among individuals, and in this regard the number and type of livestock differed. Chickens were a common feature among villagers, as they are cheaper to buy, fast to mature and easy to sell (Table 4.1). Herds of cattle were found among selected individuals and their numbers were few as they are expensive to buy and take long to mature. The majority had between four and six animals. Wealth in the area was measured according to the number of livestock an individual possessed. This further impacted on field harvests, as organic manure and reliable draught power were a prerequisite for a fair harvest in the soils. This promoted soil fertility and early cultivation. As such, livestock was valued, and any loss would bring economic hardship on the family. Sheep owners were few (22.1%), as there was a belief associated with keeping this form of livestock. Sheep were regarded as a protective measure against lightning, for cattle and humans. Depending on religious beliefs, this hindered other farmers from keeping them. Donkeys had no monetary value attached to them, so farmers kept them for draught power (9.5%). Donkeys were disliked, due to their foraging behaviour.

Table 4.1: Average livestock possession per household in the livestock per ward.

		Gutu	Buhera	Study area	Study area
Livestock	Range	n	n	n	% possession
Cattle	1 - 3	8	9	17	71.6
	4 - 6	13	24	37	
	>6	7	7	14	
Goats	1 - 3	3	13	16	73.7
	4 – 6	17	21	38	
	>6	5	11	16	
Sheep	1 – 3	1	9	10	22.1
	4 – 6	1	6	7	
	>6	3	1	4	
Donkeys	1 – 3	2	5	7	9.5
	4 – 6	1	1	2	
	>6	0	0	0	
Pigs	1 – 3	0	0	0	2.1
	4 – 6	0	1	1	
	>6	1	0	1	
Chicken	1 – 3	1	3	4	72.6
	4 – 6	7	10	17	
	>6	16	32	48	
	1 – 3	0	2	2	

Guinea Fowl	4 – 6	0	0	0	3.2
	>6	1	0	1	

(Source: Own source).

Due to predator depredation, the use of preventive measures was found to be common, and a combination of different methods proved to achieve best results on crocodiles. As predation was a continuous problem, livestock farmers who had not been using any management methods, developed new methods such as releasing animals from the kraals during mid-day, and the use of stones and thorns in water (Figure 4.3). As predators could not easily cope with the new methods, farmers have found them to be highly effective.

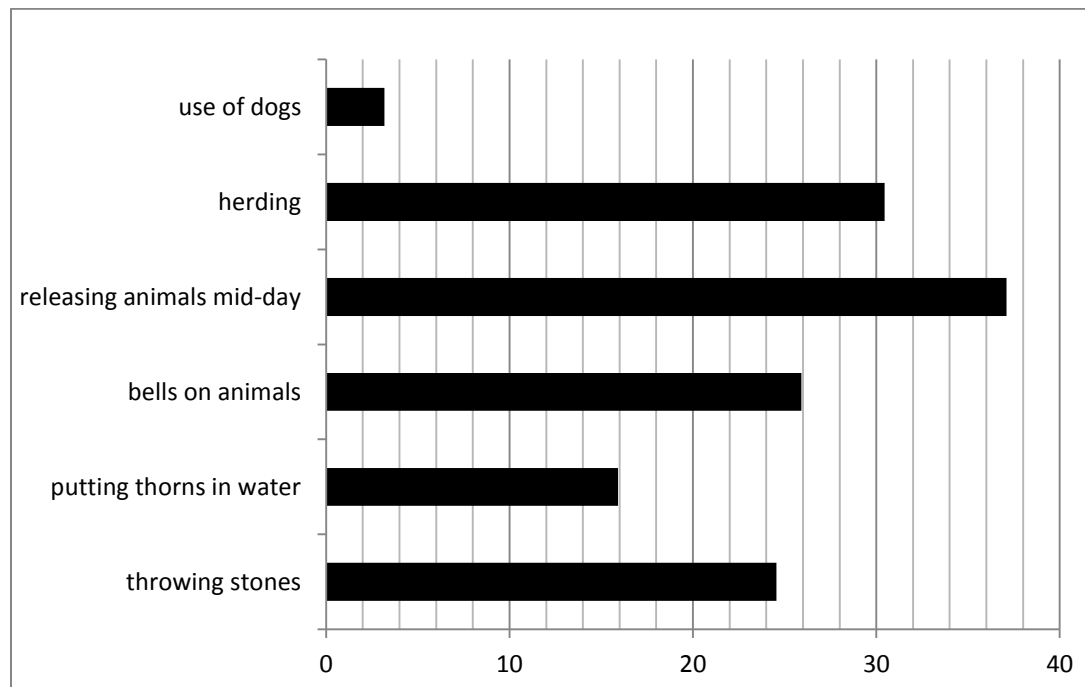


Figure 4.3: Livestock management techniques on crocodiles. (Source: Own source).

The feral dogs were not used to guard against crocodile depredation, as they were the target, due to their smelly body after exposure to water. Taking a dog to the dam was a

high risk, as it alerted the crocodiles to the presence of prey. The thorns were used (15.9%), but the technique was becoming less common, due to quick decomposition. There were complaints about the method, as it demanded more time and labour. Throwing stones (24.5%) was largely used, but respondents were afraid of dam siltation, although some supported the method as it reduced the formation of mud, where animals sank during water drinking. Release of livestock late during the day was mainly used with goats, sheep and chickens, and it prevented attacks from predators other than the crocodile. The bells fitted on the animals frightened the crocodiles, and also alerted the cattle herder during capture of the animal, as the bell continuously rang (Figure 4.3).

4.3 Water Uses

BRDC and GRDC are generally dry areas, where water is a scarce commodity and very few rivers are perennial, hence water is conserved – some going to the extent of water harvesting during the rainy seasons. People had to collect rain water falling from roofs, and store it for future use. This prevented people from walking long distances, and also collecting water from crocodile habitats.

4.3.1 Cooking and Drinking Water

Generally, boreholes are mostly used in both districts, with 47.4% (n = 45) (Figure 4.4). However, GRDC has more people who use borehole water for cooking and drinking (55.6%) (n = 20), than in BRDC (42.4%) (n = 25). In GRDC there are more water supply projects that sank boreholes, than in BRDC. Due to the unavailability of boreholes, people in BRDC have resorted to digging their own wells, which are relatively cheaper than boreholes and provide clean water (42.4%) (n = 25), compared to 33.3% (n = 12) in GRDC.

The above is regardless of these communities having irrigation taps, provided by Oxfam and used to water crops. Respondents in the area might have had prior knowledge of the dangers of using unclean water. River water is not really used for

drinking water, as there are no sandy areas where people make scoop holes to collect. The limited use of water from the river is as a result of the Environmental Management Agency (EMA) law-enforcing agents, who have stopped gardening activities along the rivers, in a bid to prevent siltation, by endorsing high penalty charges on those caught, in order to deter others. Only 5.1% (n = 3) in BRDC compared to 11.1% (n = 4) in GRDC, used water from the river. However dam water is largely used more in BRDC (6.3%) (n = 6) than in GRDC, where no respondents use it domestically.

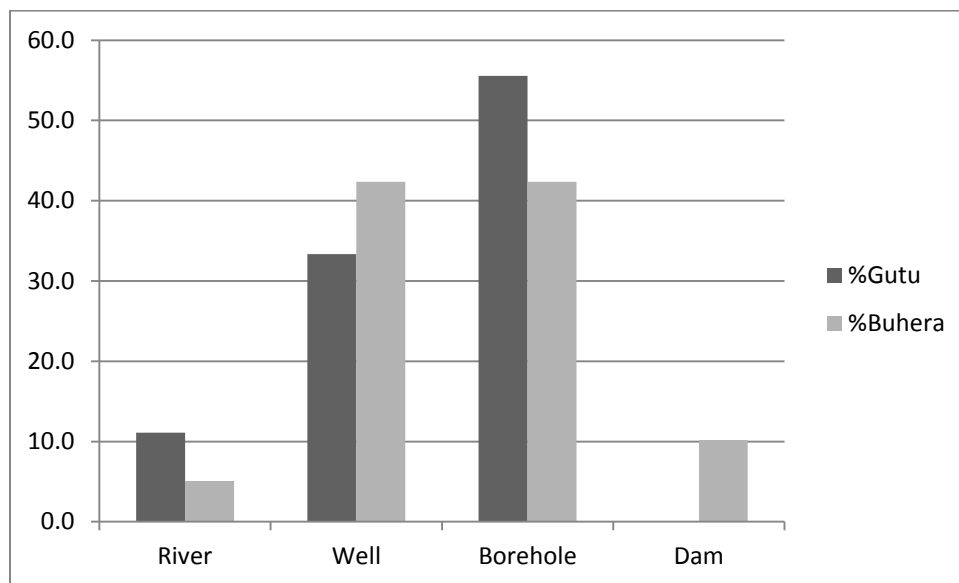


Figure 4.4: Percentages of domestic water uses. (Source: Own source).

Lower river water collections in Ward 19 might have been a result of the location of the ward, as well as the settlement pattern, unlike in Ward 13, where some homesteads are far away from the dam, with a distance of over 20 km – for example, Mukatsama village. Respondents, who collect the dam water for domestic uses, complained of the high incidence of bilharzia – which has affected most of the community members.

4.3.2 Bathing and Washing Clothes

There was a rise in the number of people who use wells for doing laundry in BRDC (27.8%) (n = 32), and a decrease in the number of people who use borehole water for laundry was noticed in both wards. Ward 13 recorded 47.2% (n = 17), while Ward 19 recorded 23.7% (n = 14) respectively. People in Ward 19 claimed that the borehole was too salty, and was not suitable for washing, as one needed to heat it first. People in Ward 13 also claimed that the boreholes were far away. Boreholes were taken as common property, and villagers had a set of rules on borehole water use.

Generally, bathing in all wards took place at home, due to the availability of toilets and bathrooms, with 76.8% (n = 73) claiming that that was the only safe way to get a proper bath. Even though people collected water from either the river or the dam, they ended up using it in the bathrooms. Only 10.5% (n = 10) were using the dam for bathing. Most of the people who were using the dam for bathing were residents of Ward 19. The use of bathrooms also reduced the number of swimmers. Very few stated that they were using either rivers close to them, or the dam itself, for swimming (31.6%) (n = 30).

Entering the dam or river for swimming was regarded as a taboo by some families, as some family members might have escaped death (68.4%) (n = 65). Children were taught the dangers associated with rivers from a tender age. No children below the age of 16 years were reported to have been either attacked or killed by a crocodile. Respondents, who were swimming, were staying away from the dam or the Nyazvidzi River. Swimming was not frequent, also due to changes in water levels (Figure 4.5):

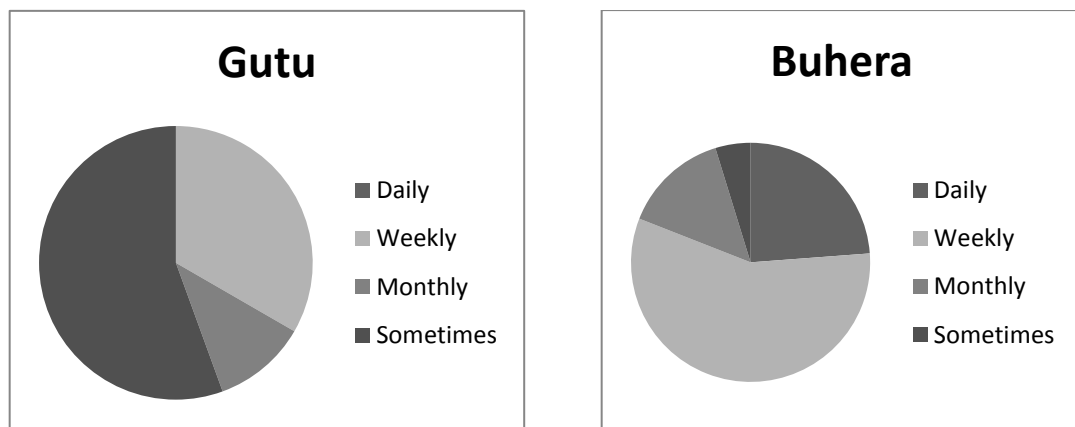


Figure 4.5: Swimming frequency in nearby rivers. (**Source:** Own source).

4.4 Fishing Activities

This section explores the different ways used to obtain fish from the Ruti Dam. Respondents were reluctant to answer questions regarding fishing activities. They knew fishing in the Ruti Dam was not allowed, and attracted a fine if found guilty. Some respondents said they were fishing (32.1%), but using different methods, depending on the fishing place and availability of resources. Most people fished in the dam (Figure 4.6), as different fish types were found there. Respondents favoured the dam over the river, as it was quicker to fulfil their requirements. Most of the respondents were dependent on fishing (66.7%) for their livelihood and fished throughout the year. The fish were sold in areas such as Murambinda Growth Point and Birchenough Bridge, where fair amounts were charged. In the villages, selling of fish was through barter trade, where fish was given in exchange for mealie-meal, sugar, soap or salt. The income from fish sales was used for buying food, clothing, and paying for school fees for the children.

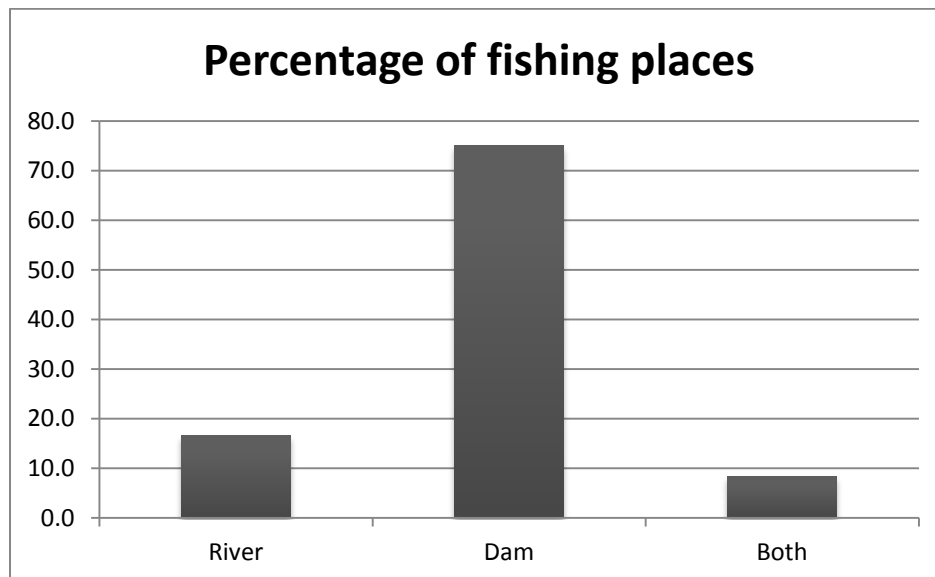


Figure 4.6: Different fishing places use. (**Source:** Own source).

The river was mostly used by people who were afraid of the dam, and fishing there was for home consumption (33.3%). Fishing dependents regarded themselves as commercial fish poachers, who used different methods to catch various type of fish as per customer requirements. Two methods of fishing were recorded throughout the study area (nets = 32% and lines = 68%).

In some instances, the nets were set using canoes made from the baobab tree (*Adansonia digitata*) and the sausage tree (*Kigelia pinnata*). Canoes were made before EMA's campaigns to protect trees. These days, big trees are only felled with written permission from the traditional leaders. The canoes protected the fishers from the Nile crocodile and hippopotamus (33.3%), and all the nets were set in the dam (100%). When setting nets, fishermen worked in groups (Figure 4.7). This ensured maximum safety from the water waves, as the canoes were lighter and could be pushed by strong winds.



Figure 4.7: Fish poachers setting nets in home-made canoes. (Source: Own source).

The nets were made from mosquito nets donated by USAID in Zimbabwe (Figure 4.8), and some were handmade from the *Aloe* species, as they were frequently destroyed by the Nile crocodile. The nets can catch anything from small fish to big fish.



Figure 4.8: Nets used in fish poaching in Ruti dam. (Source: Own source).

However, people complained that there were losses of fish catches due to the Nile crocodile (34.6%). The loss of fish catches normally resulted from the destruction of the nets, as the crocodile accessed the captured fish in the nets. The lines were used by the majority (66.7%), as the material was cheap and readily available. The lines were not favoured by the commercial fish poachers, as they were too selective and time-consuming to use. No fish catch losses to Nile crocodile were recorded for fishing lines.

4.5 Attitude towards the Nile crocodile

4.5.1 Hostility of the Community

The respondents reported that the Nile crocodile was commonplace in their lives, and the majority (89.5%) acknowledged knowing it, with 81.0% having seen it. It is a known wild animal that destroys people's wealth. As with any other predator, crocodiles are not associated with any fortunes, as they kill to sustain their lives. The

level of perceived depredation has reduced their chances of survival. Total elimination of the animal would occur, provided people had been given power to control their numbers.

Crocodiles are disliked by 83.9% of people, the reasons ranging from fear of them to their killing of people and livestock. It has become a norm that people are taught at a tender age that crocodiles are dangerous, and should never be trusted in the social life of an individual. Some argued that even if it dies, its remains can be used in witchcraft. Very few wanted the crocodile to continuously live in Ruti dam (16.1%).

Those respondents, who supported the presence of the animal, had prior knowledge of the importance of crocodiles in aquatic ecosystems, and eco-tourism. The survival of the crocodile in the area would allow that their grandchildren to get to know the animal, and there was also the chance of earning money from eco-tourism. People, who knew about the survival of the animals in the area, had ecological reasons that presence of crocodiles showed that the environment had not been altered. The hostility differed from person to person, as well with the level of education and wealth.

4.5.2 Population trends of Nile crocodile

Generally, the trend has been towards an increase in Nile crocodile numbers, either in the dam or in the Nyazvidzi River, over the past five years (95.3%) (n = 86) (Figure 4.9), but a decrease was somehow noticed in Ward 19 (1.7%) (n = 1). However, some respondents cited that they did not know if there were changes in the number of crocodiles (6.3%) (n = 6) in both the wards, with Ward 13 having 11.1% (n = 4) and Ward 19 having 3.4% (n = 2).

The increase in numbers is blamed on the lack of Nile crocodile egg collection on islands of the dam and the banks of the Nyazvidzi River, as was previously done PWMA. Marked Nile crocodiles which were introduced in Ruti dam are now outnumbered by the unmarked juveniles. As the struggle for resources continued, crocodiles migrated. This has led to one pool in Nyazvidzi River being inhabited by

more than five crocodiles, and if these crocodiles notice the shadow of any object on the water, they jump out in an effort to kill. This notion is well supported by the majority of the people, as they feel that Nile crocodiles are carnivores which are responsible for killing humans and livestock.

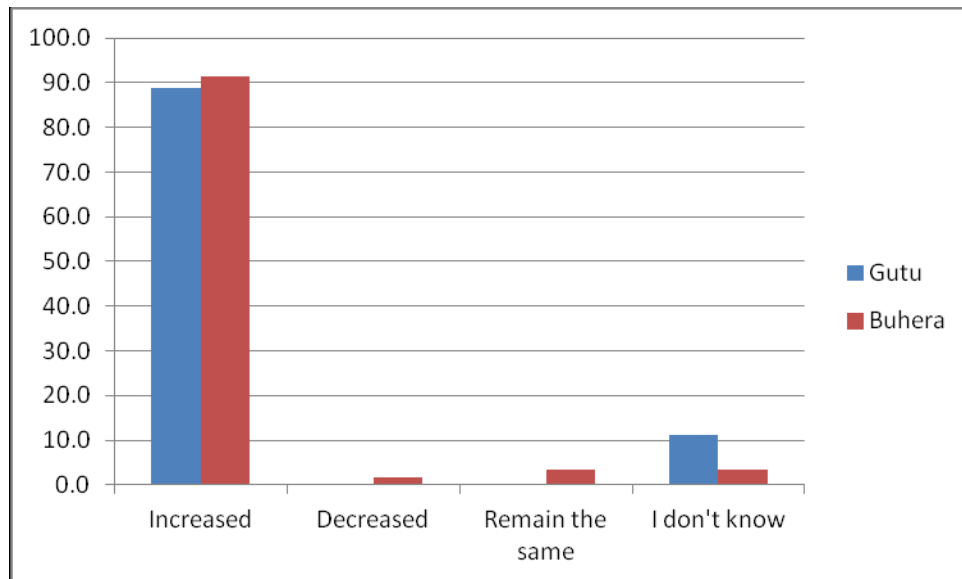


Figure 4.9: Trends in Nile crocodile populations over past 5 years. (Source: Own source).

The respondents wanted the Nile crocodile numbers to decrease, as this would increase the chances of fish catches, as people would enter the dam without fear. Respondents had a belief that the Nile crocodiles belonged to the PWMA and the government, as they were brought to scare them – as well as eat them and their belongings. This emanates from the way in which the Nile crocodile was introduced in the early 1990s.

Repondents complained that since the introduction of the Nile crocodile, their lives have deteriorated, as repondents feel bereft of help from authorities. Even if the livestock is injured or killed, they are blamed for not guarding their resources. Though the crocodile population trends have increased, no one knows the actual figure; even the PWMA has never taken a census to measure the increase in crocodile numbers since their introduction into the dam to curb fish poaching. Few people praised the

increase in numbers, as they were saying that “it shows the healthiness of the natural ecosystems”. The respondents wanted the Nile crocodile to be translocated to other places, but few cited the need to introduce ecotourism and crocodile farming to support the lives of the affected individuals. Ecotourism would increase income, as the hotel built adjacent to the dam in Ward 19 receives few to no tourists, as there is little activity around the dam such as canoeing and or surfing. Some were concerned that the removal of the Nile crocodile would affect reproductivity of fish, and their grandchildren might not be able to see a crocodile with their own eyes.

4.5.3 Interaction with Nile crocodile

This section gives a summary on human-crocodile interactions, as well as HCC. This will further show if the sightings correlate with conflicts. The crocodile-livestock preference will be determined by the killings over the past five years. A map showing areas of conflict will be provided (Fig 4.12).

4.5.3.1 Reported Sightings

The number of Nile crocodiles in the dam is debatable, as they are frequently seen on shore and on the islands, basking in the sun. Respondents who are daily fishers recorded the crocodile sightings at 100%, and this was supported when the researcher managed to see the Nile crocodiles basking in the sun during his visits in winter. The Nile crocodiles move from the dam to the river during the night on the BRDC side, but no sightings were noted for more than 100 m from the banks. They do not use the GRDC side, as it was rockier than the BDRC side. During crocodile migration, they avoided the dam walls – which were steep and rocky. The parts that support the dam wall to reduce erosion.

4.5.3.2 Reported Nile crocodile Attacks on Livestock and Humans

The Ruti crocodiles are highly regarded as non-selective killers which kill and eat anything they come across, from goats to humans. The chickens and donkeys were not attacked, as they are not found close to either the Nyazvidzi River or the dam. There were also very few people, in the area, who kept donkeys for draught power. Chickens do not drink the water in the dam, but are always at homesteads, and no reports of Nile crocodiles entering homesteads have been recorded; this might help to explain why they were not preyed upon (Figure 4.10).

Respondents report that livestock is driven for water drinking at the dam (34.7%), at the Nyazvidzi River (17.3%) and in other rivers (38.7%). Livestock farmers avoided the Nyazvidzi River and the Ruti Dam, due to the high kills experienced there. The drinking places at the Nyazvidzi River were enclosed in canopy thicket that made the view to be difficult. The density of the vegetation is indicative of a significant difference ($p < 0.001$) in kills, as few kills were noted in open areas, compared to thicket, bushy and swampy areas.

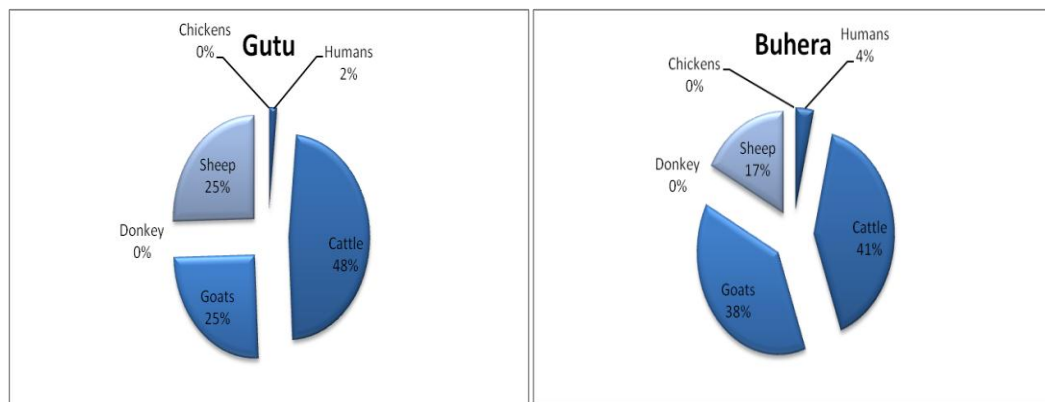


Figure 4.10: Reports of Nile crocodile favourite kills from 2007 to 2013. (Source: Own source).

The number of livestock killed by crocodiles was not significantly different ($p = 0.469$) between Gutu and Buhera. However, sheep, goats and cattle were mostly killed during the day when the cattle herders took them for water drinking. However, the mean livestock killed by crocodile was $0.642 \pm \text{S.E } 0.167$. Most livestock drink water

during the afternoon (84.8%), rather than during the morning (5.1%). The cattle herder needs to remain vigilant during this process, some saying that they have to hold the tails, in case they can help to pull the animals away from attacking crocodiles. However, before the animals drink water, the cattle herder throws stones to frighten and chase the Nile crocodile from the proximity of livestock.

Cattle are mostly attacked, as they need to enter the water before they drink and therefore become an easy target for the Nile crocodile. The edges of the dam have sticky mud during summer, which hampers animal movement along these edges. While the animal is stuck, the Nile crocodile kills with minimum effort. This mostly happens during the dry season (Figure 4.11). Humans were killed while fishing, bathing and crossing the river.

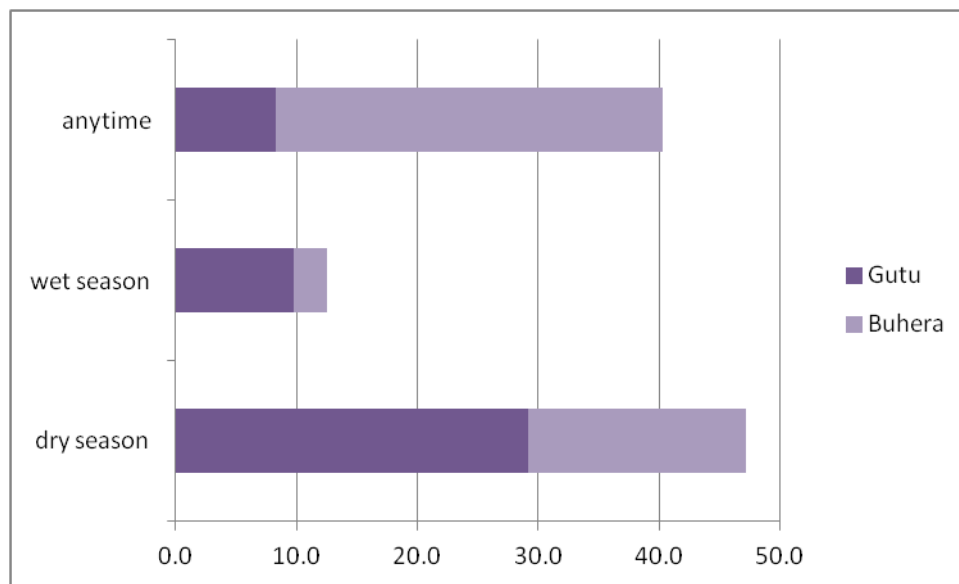


Figure 4.11: Times of Nile crocodile attacks. (Source: Own source).

Though the killing was during the dry season, most argued that kills were more after the first rains when the water is dark, as the movement of the crocodile is difficult to notice. Humans were mostly attacked during the early hours ($p = 0.004$), around 03:00 and 04:00, when they were fishing. The age group of 15 to 25 years was mostly attacked during the day ($p = 0.045$), due to their active participation in water collection

and fishing activities, although older and more experienced fishermen argued that fishing during the night increased the fish catches, as fish don't see their shadows. No reports of death from capsized canoes were recorded, as fishermen avoid the use of canoes when it is windy. Women are killed when they cross the river coming home from shops or grinding mills (Figure 4.12). This is supported by reports from Ward 13, as it lies more adjacent to the river.

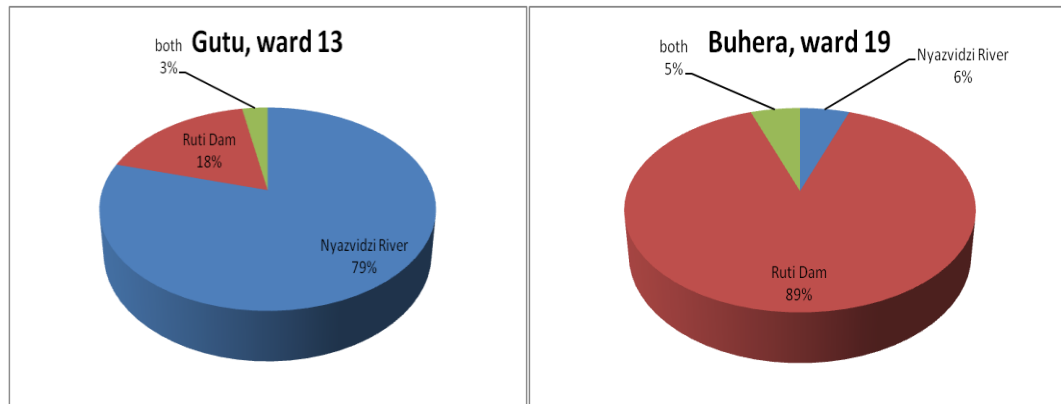


Figure 4.12: Area of Nile crocodile kills. (Source: Own source).

The attacks on people in the dam in BRDC might be greater than in GRDC, as the people lack other sources of livelihood, and hence mostly depend on fishing. The people in Ward 13 mostly do not fish in the dam. They concentrate on agricultural plots, as they have irrigation pumps, supplied by Oxfam Zimbabwe, which run throughout the year. The activity on the river did not have an influence on crocodile attacks, but proximity to the water showed an effect ($p = 0.715$).

4.5.3.3 Economic Impacts of Crocodile on Human Attacks

Evidence from collected data showed that humans are being injured and killed. The loss of one family member was cited as being of extreme economic and social significance, which would affect the family in many ways. The loss of the father, as the breadwinner, meant that children would drop out from school, due to the lack of school fees. The children would be forced to engage into other activities – for example, cattle herding for boys and prostitution for girls, to earn a living.

The loss of the mother, however, burdened the girl child, as she would assume the home duties of the mother. Furthermore, girls would be forced into premature marriages, as they try to alleviate poverty in their homes.

In cases of injuries were sustained, a reduced workforce at home resulted, and this has implications in the allocation of duties. Should the injured be taken to hospital, respondents complained that crocodile issues were diverting the hard-earned income to nurse a family member, rather than improving the status, hence increasing the HCC.

4.5.3.4 Range of Nile crocodile Attacks

Villages close to the dam and river are mostly affected by Nile crocodile attacks. Their animals drink water from the dam and the river. Moreover, the region is generally dry, with green vegetation only occurring in the wet seasons. Animals graze on river banks in search of green pasture during the dry season. The intensity of Nile crocodile attacks is greater on villagers staying in Conflict range 1a (Figure 4.13), as animals and people move shorter distances to the dam. People close to the dam might depend on the dam for water supplies. The continuous interaction with the shared resource means continuous exposure to danger.

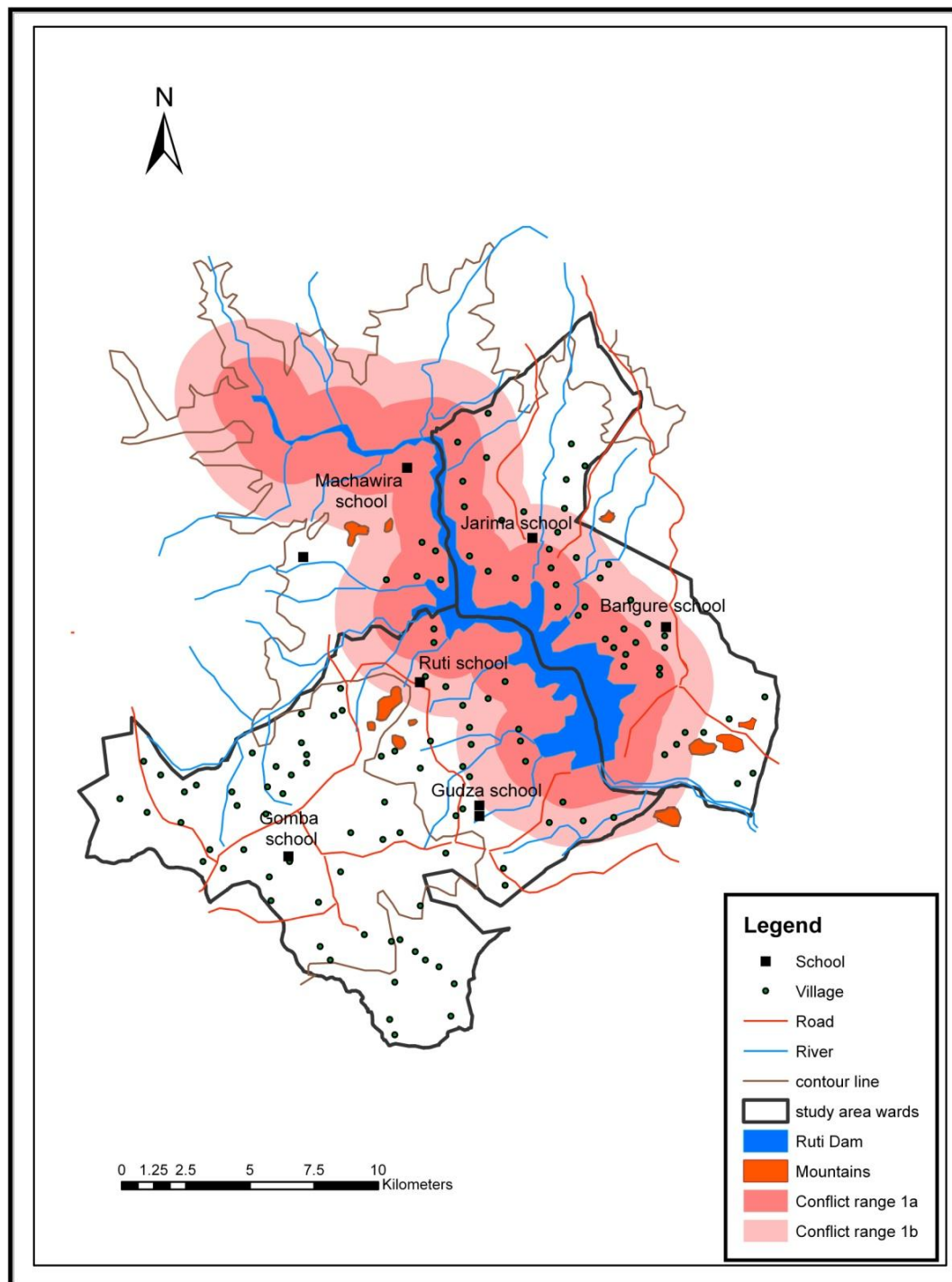


Figure 4.13: Intensity of Nile crocodile conflicts on villagers. (Source: Own source).

The intensity of HCC decreases as distances increase from the dam, as Conflict range 1b is less intense than in 1a. People still move to the dam from these areas, for fishing activities, though the numbers are smaller. The intensity of conflict varies with time, being greater mostly during the dry season than in the wet season. During the wet season, farmers spend most of their time in the fields, and accordingly are too tired to continue with fishing activities as well. Livestock are also guarded from the fields; hence cattle are always with the herders. During the dry season, most rivers dry up, increasing the chance of conflict, since most animals will be drinking water from the dam and the Nyazvidzi River – which are perennial.

4.6 Other Carnivore Attacks On Livestock

Villagers who do not live close to the Nyazvidzi River and the Ruti Dam also faced other HWCs. These conflicts were mainly due to predation by the brown hyena (*Hyaena brunnea*) and the black-backed jackal (*Canis mesomelas*). The brown hyena preyed mostly on goats and cattle heifers (Table 4.1), though there was no significant difference ($p = 0.855$) between Gutu and Buhera districts in the number of livestock killed by hyenas. The black-backed jackal preyed on chickens and lambs.

The affected villagers were those staying close to the mountains and hills, as these predators lived in those areas (Figure 4.14). In Ward 19, there were reports of one person having been eaten by a brown hyena when he was coming from a beer drinking session. The killing is opportunistic, as they kill whatever they come across. There was an increase in brown hyena threats which were blamed on the installation in mountains such as Ruti (Figure 4.14). The previously sacred places have now become invaded and modernised. The lights shown by the booster, and the noise from their generators, are a threat to these animals, as they assume these pose a danger to their lives. Respondents complained that these animals are now found everywhere, and that their home ranges have changed, posing a greater danger to people's lives and livelihood. The black-backed jackals are a threat to respondents who stay close to bushes, and reports show that they start to move as early as 18:00. The jackals hunt in

the periphery of the bush, and are not prepared to travel greater distances as they are afraid of attacks. As a result of the above, and to minimise the predation rates, farmers have resorted to new management techniques, such as opening the goat and chicken pens late (Figure 4.3). Some say that the killing of these animals is a result of retaliation by ancestral spirits for developments in the historic sacred sites.

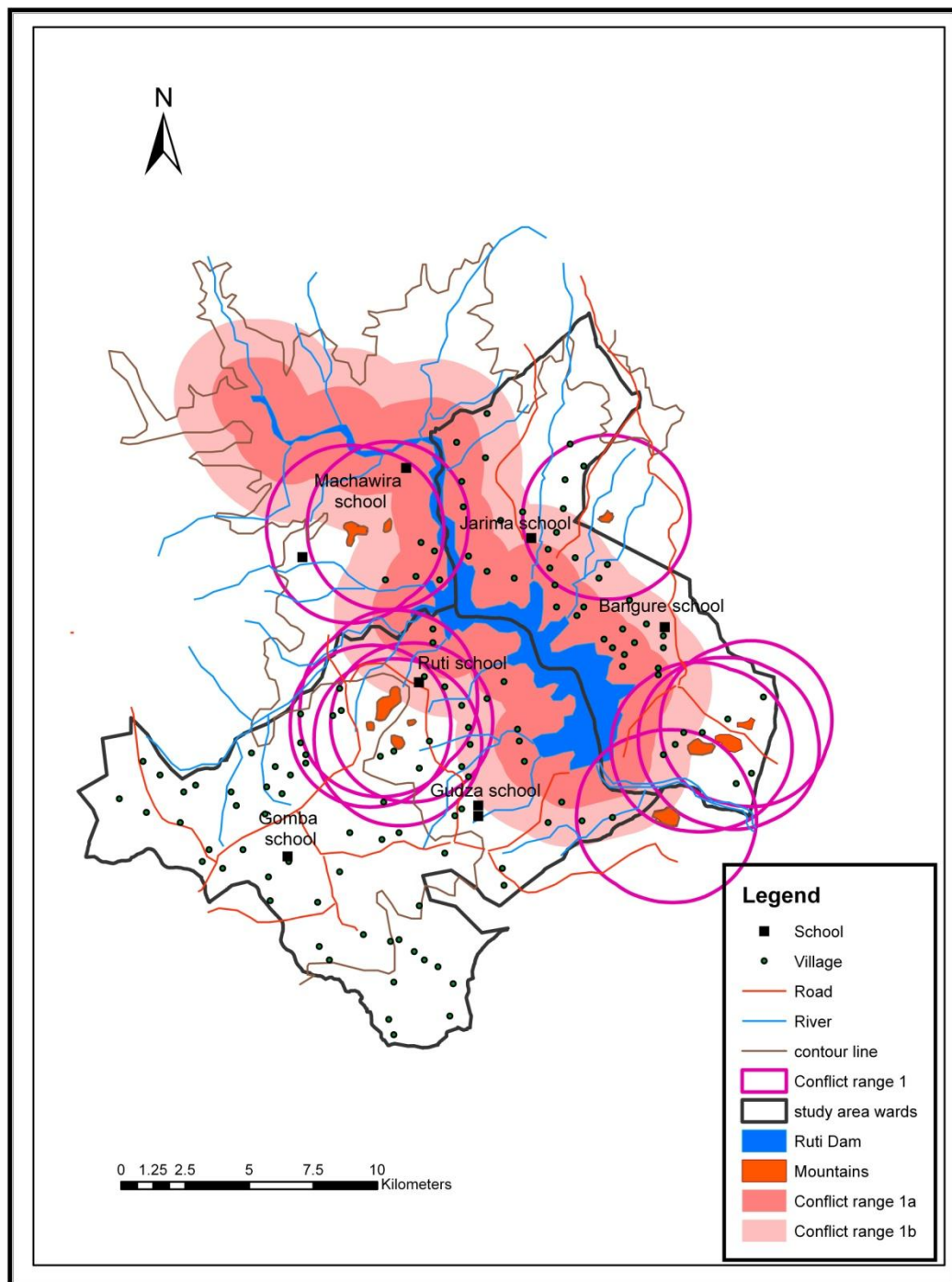


Figure 4.14: Hyena and jackal conflicts. (Source: Own source).

4.6.1 Reported Killings of Livestock

The Nile crocodile is mainly associated with the killing of large stock, which is of high value. The predation is high on cattle, followed by goats. These killings by the Nile crocodile on livestock occur mostly during the day. Brown hyenas recorded the highest killings on livestock ($p = 0.004$), comparable to the Nile crocodile, with the mean number killed at $0.9 \pm \text{S.E } 0.031$. The killings by hyenas were mainly performed inside the livestock pens.

The way the livestock pens were built contributed much to this loss, as greater losses were in kraals made of wood (57%), compared to kraals made of wood but surrounded with thorns (20.6%). Furthermore, livestock pens which were built close to homes experienced fewer depredations. This was also lessened by the use of dogs, at homesteads, which act as alarm triggers. More goats succumbed to brown hyenas, perhaps due to their feeble defence (Table 4.2). All brown hyena killings occurred at night, due to their nocturnal behavioural characteristics. From data gathered, jackals preyed mostly on small stock, due to their own small body size, but there was only one incident where they killed a calf.

Table 4.2: Percentage livestock killings by predators.

	Crocodile	Hyena	Baboon	Leopard	Jackal
Type of livestock	N (%)	N (%)	N (%)	N (%)	N (%)
Cattle	12 (26.7)	32 (71.1)	0 (0.0)	0 (0.0)	1 (2.2)
Goats	34 (11.0)	208 (67.3)	30 (9.7)	25 (8.1)	12 (3.9)
Sheep	7 (7.8)	69 (76.7)	0 (0.0)	8 (8.9)	6 (6.7)
Donkey	0 (0.0)	18 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)
Chicken	0 (0.0)	13 (11.9)	11 (10.1)	5 (4.6)	80 (73.4)
Pigs	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)

Guinea Fowl	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	2(100.0)
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(Source: Own source).

Interviews showed that the livestock was not well protected from the predators. Very few farmers were in a position to improve their livestock management techniques, such as the use of dogs at night; 44.2% of the interviewees had dogs at their homes, and 47.6% of these had one dog, while 38.1% had two dogs. The respondents noted that the dogs protected livestock against predators as well as against stock theft.

The respondents from the Johanne Masowe Church and Marange Apostolic Church were not allowed to have dogs, according to church principles. The people without dogs experienced high brown hyena depredation in bomas (56.5%), compared to those with dogs (44.5%). Female-headed households with dogs had more predation (61.3%), as dogs only acted as alarms for alertness, and females were afraid to defend their livestock and fight predators outside the safety of their homes. Besides losses from the homesteads, there were livestock losses in grazing fields at night – if they were not kraaled. These losses were mainly experienced during the winter season.

4.7 Human Impacts on Nile crocodile

No harm to crocodiles by either humans or other animals has been recorded. Competition for shared resources is affecting the crocodile, though the extent of the effect is not known, as fishermen avoid barbel fish (*Clarius sp.*), due to religious and cultural issues (Figure 4.2). The small-scale livestock farmers and the fishermen are afraid of both crocodiles and the law. The respondents reported knowing the risk of killing wildlife. The harsh penalties posed by the Zimbabwean government on poachers of wildlife might be the major reason for failing to attack the crocodiles; 84.2% acknowledged that no one was able to kill the crocodile, and the reasons for failing to attack the animal differed among individuals. The strength of crocodiles in water (72.1%), the unavailability of weapons (60.7%), and the PWMA conservation

laws (80.0%), were among the reasons given by the respondents why they avoided trying to kill crocodiles. The use of bait to eliminate the animal was never implemented (75.4%), as the community was afraid to pollute the water and kill fish. Fish and water are the common resources drawn from the Nyazvidzi River and the Ruti Dam, whether rich or poor, as most livestock drink water from the dam during the dry season. From the sample population, only 2.1% said that some people killed crocodiles, but had no evidence of any crocodiles killed in the past five years. The disappearance of numbered crocodiles was linked to animal killing. This might not be a true representation, as the animals might have relocated, due to shortages of food in their previous areas.

4.8 Prey Species Abundance

There were no wild terrestrial prey species preferred by the crocodiles in their diet. From the road transect walked, there were faecal and spoor sightings for the common duiker (*Sylvicapra grimmia*) and hare (*Lepus sp*). No animal sightings were recorded along the transect or at different watering points at the dam. Wild prey is rarely seen in the area; even the waterbuck (*Kobus ellipsiprymnus*) and the buffalo (*Syncerus caffer*) were not seen along the flood plain. The most common and widespread in the area is the brown hyena. The hyenas are less accounted for in the crocodile diet, as they rarely drink water, but if it comes to close proximity it might be killed and eaten – as is happening to the baboons (*Papio ursinus*).

4.9 Summary of Chapter

The data from the study has been compiled and there is evidence that Nile crocodile is affecting respondents' lives through killing and or damaging their property and sometimes the killing of the humans. There is evidence that crocodile numbers are also increasing and the presence of juvenile crocodiles and increasing of the conflicts which collaborate with frequency of encounter help to comprehends the information.

The fishermen in Ruti dam have developed fishing canoes to help them increase their fish catches, due to competition on the edges of the dam, and this has also led to safe fishing practice, as no fishermen have been killed from a canoe. There are also other predators which rely on livestock, as evidenced by the unavailability of wild prey in the study area. The farmers have developed techniques to reduce the predation levels. However, the next chapter will discuss the results of the study, and analyse why the results of the study are significant, compared to other studies. It will further show recommendations that might help to reduce the human-crocodile conflict. Lastly, conclusions will be drawn, giving a summary of the formulated hypotheses.

Chapter 5: Discussion

This chapter gives a review of the results, and explains why the results are significant. It further gives recommendations on how Nile crocodile predation can best be minimised, to help decrease the HCC and the HWC at large, in the area. There has been a remarkable increase in HWC worldwide (Woodroffe *et al.*, 2007:1251), including the areas surrounding Ruti Dam. The increase is linked to the risk factors associated with predator attacks on humans and livestock that range from fatal injuries to death (Ogada *et al.*, 2003:1524). Amelioration of these problems needs a deep understanding of the local situation. An understanding of the anthropogenic factors and ecological aspects of the area will have a positive impact on conflict resolution. This will reduce negative attitudes towards the predators, and will serve to further maintain viable populations, even creating good breeding sites for the populations, to boost other areas. This will further the chances for the Nile crocodile to retain its status in natural waters.

5.1 Population Trends of Nile crocodile

According to various reports crocodile numbers have tended to be on the increase over the past five years, in both the Ruti Dam and the Nyazvidzi River. Most respondents noted the general increase in the frequency of juvenile crocodile sightings, compared to the marked adults. The juvenile and adult crocodiles that were born after successful translocation, were not marked. The translocated crocodiles were marked, probably as a way to trace their movement and presence. The lower numbers of marked crocodiles might be due to their mobile ability and social behaviour. To avoid competing for a shared resource, some moved downstream, and others upstream, to form new social groups, depending on the availability of food (Campbell *et al.*, 2010:5).

The presence of more juveniles could be as a result of good nesting areas and food sources, as well as suitable temperatures that promote hatching and growth of the hatchlings (Hutton & Child, 1989:63). The crocodile have been seen basking in the sun on small islands in the middle of the dam. The islands might be used for mating

and nesting, as there are no human and/or animal disturbances (ZPWMA, 2006:10; Mattee & Shem, 2006:16). The location of the islands, free from human and livestock disturbance, might have influenced an increase. Absence of the above factors resulted in good social activity and zero nest damage.

The presence of the Christian group, *Mwazha mutumwa weAfrica*, is an advantage to the crocodile. The group spreads the Holy Gospel, and has strong doctrines which are respected by the majority of followers. The fishermen do not harvest the barbel fish, due to lack of buyers, as according to church doctrine it is not eaten, and this ensures a continuous food supply in the absence of wild ungulates for adult crocodiles to survive on (Blomberg, 1977:5). A good food source is a requirement for reproduction and production (Bayman, Linde-Sapire & Raphala, 2010:108).

5.2 Nile crocodile Conflict

In this baseline survey, there were indications that the Ruti Dam and the Nyazvidzi River are still home to the Nile crocodile. Its presence cannot be separated from conflict in the area. Evidence from the results of the study has shown that its predation levels are high, either on livestock or humans. The Nile crocodile has been recorded as the major killer of humans among the noted predators. The presence of the dam lured many people for various reasons, varying from reed collection to fishing activities, and it has been noted as ideal habitat for survival of the juvenile crocodiles, due to the presence of fish. The diet of juveniles consists mainly of insects and fish – unlike adult crocodiles, with 33% fish in their meal (Wallace & Leslie, 2008:365; Blomberg, 1977:5).

Results indicated that the dam use frequency was linked to predation. Evidence of animal encounters explains that the Nile crocodile still utilises the area freely, despite human presence, as they have learnt that humans pose no threat (Fijn, 2013:6). However, Nile crocodiles in the Ruti Dam suffer stiff competition for food. Competition from fish poachers, coupled with the lack of natural prey, leaves the crocodile with no option but to prey on livestock (Anderson & Pariela, 2005:26). As to

whether or not these animals seen are actually the culprits in livestock and human killing, or whether they just benefit from the kills, is not known.

5.2.1 Nile crocodile Predation on Livestock

Nile crocodiles are big bodied, and eat big herbivores to cater for long periods which they spend without eating (Walsh, 1989:68). Nile crocodiles attacked mainly cattle, humans and goats, due to the absence of natural prey, and this was also noticed in Venezuela (Polisar, Maxit, Scognamillo, Farrell, Sunquist & Eisenberg, 2003:301). Similarly, Dikobe in his study in Botswana (1997:81) noted this preference in the absence of natural prey, though the numbers differed from season to season.

Moreover, other researchers noted that the adult Nile crocodile favours large vertebrates due to the size of their bodies (Aust, 2009:43; Revol, 1995:303). In GRDC and BRDC, there was a limited prey base, which caused the Nile crocodile to prey on livestock. The killing of livestock might have been due to the dryness of the area and the unavailability of natural prey, and also easy capture (Mishra *et al.*, 2003:1515; Wegge, Shrestha & Flagstad, 2012:138). Recorded killings were mainly of cattle and goats – which closely supports the Namibian and Kariba studies, respectively (Aust *et al.*, 2009:62; McGregor, 2005:361). The killings were on shore, as the animals were drinking water or grazing, and this might be the reason why donkeys were not killed. It is the crocodiles' common strategy to lie and wait for the prey that comes for water (Richter *et al.*, 2010:24; Shacks, 2006:4). Goats and cattle are water-loving, and drink water every day, given the chance – unlike donkeys, which do not like water and do not graze near water.

Animals grazed on the floodplains along the dam and the river, in search of green grazing – which frequently brought them closer to the Nile crocodile. A similar trend has been recorded in India in tigers (*Panthera tigris*), which killed cattle and goats that were in close proximity to the Sariska Tiger reserve (Sekhar, 1998:166). The competition for resources might have made livestock easy prey (Butler, Du Toit & Bingham, 2004:373). This further supported the reason why more attacks were

recorded in the dry season and, mostly, at the beginning of the rainy season when the dam and river water was dark. Attacks increase during this time, due to the colour of the water, which allows them to lie unnoticed (Huchzermeyer, 2003:53). The water becomes dark, due to extensive erosion in the area – which has resulted in the formation of dongas, as soil is excessively washed away.

In Aust's Namibian study (2009:63), the trends in attacks were similar to those of Ruti Dam, as more attacks took place between September and December. The rate of consumption is higher then, than in winter, when they spend most of their time basking. The Nile crocodiles are involved in different activities which need high energy requirements (Kofron, 1993:467; Hutton, 1987:34). Fewer attacks were in the cold season, between May and July, as the crocodiles spent most of the time basking to raise their body temperature (Kofron, 1993:467).

Crocodiles, like any other reptiles, are poikilothermic (Seebacher *et al.*, 1999:84). Juveniles mostly spend their energy moving from one pool to another, as the pools dry out, and establish new territories – which prevents conflict with older members. "The crocodiles in Ruti Dam move to Nyazvidzi River in summer – the movement being mostly at night" (Chisema, 2013). This similar trend in movement had been noticed in crocodiles in GNP (Kofron, 1993:466; Hutton, 1989:1040). However, the metabolic rate is low during winter; hence the rate of feeding is low. The animals spend more time outside the water, in direct sunlight, as they are exothermic (Downs *et al.*, 2008:188). Few or no crocodile kills were recorded during this period.

Cattle and goats were most valued, as the majority of people were not employed (76.8%). These people survived on subsistence farming, where crop farming has proved to be a failure after seven years of continuous drought. The 23.2% that are employed receive meagre wages, as the majority operate as shopkeepers, and only one teacher was sampled during the survey.

Cattle are the most valuable livestock in these areas, with cows costing an average of US\$700, and bulls costing an average of US\$1000. This amount is much higher for dwellers who have no other source of income. The result of goat and cattle values

comes from their multi-purpose uses. In most African countries – for example, Namibia and Zimbabwe, they are used for meat, milk, barter trade and cultural activities such as rituals and paying bride price (Masaka, 2009:141; Mishra *et al.*, 2003:1515; Mandudzo & Hawkes, 1996:10). A loss of one head of cattle means loss of socio-economic value, as the peasant farmer cannot replace the animal (Kissui, 2008:422), as the animals lost to predation are not replaced. In some other regions such as Kenya and parts of India, compensation was small compared to the loss suffered – and slowly processed, due to the bureaucratic system (Madhusudan, 2003:469).

Livestock in any arid region is most likely to be the main source of livelihood, where correct disposal through selling of the animal or its products, brings income (Bettencourt, Tilman, Henriques, Narciso & Carvalho, 2013:9; Pica-Ciamarra, Tasciotti, Otte & Zezza, 2011:11; Covarrubias, Nsiima & Zezza, 2012:18). The loss of an animal is aligned with conflict, and is the main source of conflict to subsistence farmers in an arid land with few animal herds. In this study, the majority of farmers possessed between four and six of the highly valued animals, which are cattle and goats. In cases of drought, livestock is used in exchange for grain crops (finger-millet, maize and sorghum), as families have to move long distances to areas with reliable rains, in search of food. The less-valued chickens were used for family consumption during holidays, and for visitors. However, cattle and goats were rarely slaughtered for family consumption – only the recovered meat, after being killed by a crocodile, was eaten, and killing of cattle was only performed when an adult member in the family died. This was closely linked to a study in the Mbeya district of Tanzania, which found that cattle and goats were much prized and protected, due to their contribution towards paying lobola and cultural ceremonies (Lupindu, 2007:18).

5.2.2 Nile crocodile attacks on humans

Humans are normally killed when they conduct their activities at the edge of the water, or in the water. Males were inclined to be vigilant, and able to escape or survive the

crocodile attack, with one male surviving five attacks but vowing not to stop fishing. Similarly, De Silva (2008:14) showed that 80% of males survived the minor attacks.

The human activities during these attacks might be looking for worms, or bathing, or as they try to board a canoe. In the mid-Zambezi valley, crocodiles attacked canoe fishermen, 57.1% and 29.6% were attacks on people collecting water (Wallace *et al.*, 2011: 65). Contrary to this, no reports were recorded of attacks of fishermen in canoes, and kills were only recorded of humans who entered the dam without canoes, setting nets or line fishing. Crossing Nyazvidzi River is dangerous, regardless of the water level. A woman was killed while crossing the river, and another, while fishing. Both incidents occurred when the water was below knee level. In water, humans are slower and powerless compared to any animal of their own size. The use of canoes was regarded as the safest method of fishing in Ruti Dam.

In Australia, crocodiles are known to attack fishermen in canoes (Gruen, 2009:1561). In Niassa National Reserve, 19% were attacked during net fishing, 19% while bathing, 14% while crossing the river, 4% while line fishing, 2% when falling out of the canoe, and the other 2% while fetching water (Begg *et al.*, 2007:20). While in Lake Kariba in Zimbabwe, fishermen were predated while collecting water and digging for worms (McGregor, 2005:363). Canoe fishermen only used their canoes when there was no wind that could upset them. Canoes were designed to carry one person, though the people were fishing in groups. Before boarding the canoe on the shores of the dam, they had to throw stones into the water and make a noise to frighten the crocodiles (Le Bel *et al.*, 2010:297), or check for crocodiles basking in the sun.

The crocodile attacks animals that do not pose a threat to it and which are solitary, and have entered their territory. Nile crocodiles mark their home area (home range); if the crocodiles were out basking in the sun, people regarded the water as safe, and to board the canoe was also safe. The respondents, who set their nets without canoes, only entered the water when there were no crocodiles outside of the water, as they did not want the crocodiles to see them.

The crocodile attacks in Ruti and Nyazvidzi occurred in the morning around 11:00 am, for females, and in males, during net fishing, it occurred around 03:00 am. This similar trend in attacks was found in Nilwala river (De Silva, 2008:14), Hut Bay (Whittaker, 2007:3) and India (Whittaker, 2007:4). All the attacks were recorded in water, where there are no CEEs (De Silva, De Silva & Dawundasakara, 2013:230). The CEEs need to be continuously monitored, and damages repaired (Whittaker, 2007:6). In the Ruti Dam and the Nyazvidzi River, where locals fetch water and bath, tree branches have been put in the water to deter and to recognise crocodile movement. Fencing of watering points was seen as the most effective method (Le Bel *et al.*, 2010:297), and in India, bathing gates are also used (Whittaker, 2007:4).

5.2.3 Nile crocodile impacts on fishing

Fishing in crocodile-infested waters is associated with conflict. The prolonged droughts and economic hardships have seen an increase in fishing activities and human-crocodile contact. The nets are most often destroyed, and less fish are collected. More time was spent on repairing fishing gear than fish harvesting. Damaging nets means reducing the fishing equipment. Most of the nets in the Ruti dam were damaged by the crocodiles (Figure 4.8). Due to their intelligence, crocodiles might have learnt to catch easy prey from the nets by following plastic markers attached to the net floating on water (Figure 4.7) (Ogamba & Abowei, 2012:11). Sometimes, the nets were checked every few hours, to reduce fish catch loss to crocodiles. There were no reports of canoe damage by crocodiles.

5.3 Nile crocodile versus hyena predation

Although crocodiles kill livestock, the results show that brown hyena killings are higher than those by crocodiles, and the farmers do not normally complain, because they usually collect the remains of the killed animal. This differs from Butler's study (2000:26), where crocodiles were responsible for more kills. The high hyena killings

might have resulted from the many mountains that surround the area, which provide shelter to the hyenas. These brown hyenas might have escaped the boundaries of Save Conservancy when the relocated farmers cut off the wire to prepare snares for hunting game. In fact, people were of the view that hyenas could be managed by means of correct livestock management techniques (Le Bel *et al.*, 2010:313), and also noted that the absence of a water source in the area was the main cause of crocodile attacks on livestock, as they go to the dam to drink water.

There was a seasonal variation in hyena attacks: they were frequent during the winter season, when animals were free-ranging, and this only happened to farmers who failed to return their livestock to the kraals. This also differs from Butler's study (2000:26), which showed hyena attacks only occurring in the dry season. The respondents mainly used dogs, at night, to sound the alarm of an attack.

5.4 Attitudes towards Nile crocodile

Predators are generally feared, worldwide, though environmental education is helping to induce a sense of inter-relationships, where they focus their importance on the normal functioning of the ecosystem. The negative attitudes that exist are mainly due to perceived depredation. Crocodiles like any other predator, are also associated with this depredation (Le Bel *et al.*, 2010:297; Van Vuuren, 2011:14; Ogada *et al.*, 2003:1523). Unlike with other carnivores which leave carcasses and footprints, it is difficult to say a death is definitely associated with a crocodile. The disappearance of livestock or human beings was attributed to crocodile predation, though no kills were linked to hippopotami, although they were also found in the dam.

The crocodile is disliked by people who own livestock, and by fishermen (Holmern *et al.*, 2007:539; Woodroffe, 2000:165). Fishermen suffer tough competition with the crocodile for the natural feed, which is fish, and risky activities are involved during fish poaching (Anderson & Pariela, 2005:26). With little knowledge concerning the importance of aquatic conservation, crocodiles are considered as killers and competitors in the fishing industry. Their environmental and economic importance is

not known by many people living in close proximity with the animal. The introduction of crocodiles by PWMA, who brought them in to guard against fish poaching, was not communicated to the local communities. Local people are stealing from themselves, as fish resources are governed by the community (FAO, 2013: 7). The absence of natural prey, due to the lack of large areas with vegetation, might have caused the crocodile to prey on livestock.

Some people have built their homes as close as 500 m from the dam. The close proximity of people to wildlife, as in Impalila and Kasika in Namibia, might be the reason why Ward 19 recorded more crocodile attacks than did Ward 13 (Aust *et al.*, 2009:62). People kept feral dogs for defence, not knowing that they might scavenge on wild prey and carcasses of animals, due to food shortages in the homes (Silva-Rodriguez & Sieving, 2011:811; Butler *et al.*, 2004:32). The feral dogs were also killed by crocodiles, which clearly shows that it's useless to use them as guards for livestock.

The introduction of the crocodile has increased the conflict between the PWMA and the residents, which has been exacerbated by zero compensation on injury or death due to crocodile attack (FAO, 2010:87). Villagers have questioned why such animals are kept at such great cost of loss of human life and property. The situation is mostly in developing countries, where loss is poorly or not compensated, and has led to the creation of the CBNRM (Torquebiau & Taylor, 2009:2540).

In Zimbabwe, the community-based programmes on wildlife have been affected by the country's land reform programmes. The CBNRM promoted conservation with an incentive: more conflict, more benefits, and local resources should support local people living with them. (Chigwenya & Muparamoto, 2009:392). The livestock kills are reported neither to the police nor to traditional leaders, as the reports need to be fully detailed, explaining why the livestock were at the dam. Human killings are reported, in order to access reports for notices of death – which are needed at the registrar-general's office when processing a death certificate.

Few respondents acknowledged the importance of the crocodiles in the wetlands. Some knew that the presence of crocodiles revealed that water is not polluted (Sergio *et al.*, 2008:11; Glen *et al.*, 2007:492). Unlike other communities where they only see the crocodile in pictures, the *dziva* totem people felt powerful to be culturally associated with the animal which was of importance to their ancestral spirits (Masaka, 2009:143; Shirley *et al.*, 2009:143). They were not allowed to eat anything from the water, and by so doing, ensured the continued survival of the animal.

Crocodiles are highly valued on the international market, through selling the skin and tail meat. With the increase in the crocodile numbers, some held the view of introducing crocodile farming – which might be in association with ecotourism. This would maintain viable populations in the wild, as crocodile farming is mainly dependent on egg collection to boost farm populations. However, employing locals to collect eggs has since failed to change their attitudes in early 2000, but it has increased hatred among individuals, as crocodiles are connected with witchcraft (McGregor, 2005:363).

The collection of eggs ensured that crocodilian populations would remain constant, as there will be no expansion of home ranges with newly-weaned juveniles. This stopped, however; perhaps uneducated rural egg collectors might have affected the hatching ability adversely (Hutton & Child, 1989:66).

5.5 Livestock Management Tools

Livestock was managed, to reduce the predation levels. Livestock farmers had to use a combination of different cheap methods to achieve maximum protection of their animals (Woodroffe *et al.*, 2007:1256). The use of a single method for monitoring livestock resulted in predation either by crocodiles or common terrestrial predators (hyena and jackal), as a single method is set to have a weakness, which makes the predators easily understand, and attack the animals.

Releasing the animals in the afternoon was of great importance, as schoolchildren could follow them and protect them from predators which normally kill in the morning and evening. This differs from Kenyan studies along reserves where predators killed between 11:00 and 16:00 (Kolowski & Holekamp, 2006:533). Predators are generally active in the mornings and evenings; however, in the evening the animals will be enclosed. No kills for crocodile were recorded at homesteads or in an enclosure. Enclosures and herding during the day, by a vigilant herder, ensured maximum protection from the crocodiles.

During the day, the herder would divert the animals from crocodile-infested areas, preventing them from being attacked. The bells were not frightening the crocodiles, as they were not ringing when the animals were submerged in water, but seemingly, they indicated the position of the animals to the crocodiles. Few respondents had dogs which they used to guard the homesteads, and which sounded the alarm on the arrival of a predator (Woodroffe *et al.*, 2007:1254; Koloskwi & Holekamp, 2006:536). The dogs were more effective in male-headed families, who could risk their life to fight the predator. In other families, predation occurred in the presence of dogs, where the hyena would attack goats in an enclosure; similar trends in attacks have been recorded in different African communities (Woodroffe *et al.*, 2007:1255). The goat enclosures were surrounded with wire, or they were put inside a cattle kraal or in the middle of the homestead, as they were understood to be weak and liable to predation. However, jackal attacked free-ranging chickens during the day. In guarding from crocodile attacks, dogs proved to be incompetent, as they themselves were frequently attacked.

5.6 Totems in Resource Harvesting

Totems still play a role in wildlife conservation (Mushuku, 2014:29). The abundance of the same clan of people in an area, affects the existence of any wildlife species. The effect will be either over-utilisation or over-protection of the resource. In the study, *Moyo*, *Shava* and *Gumbo* were more abundant than the other clans – especially the *Dziva*. *Shava* and *Moyo* dominated the Buhera area, while *Gumbo* dominated the Gutu

area. The *Dziva* clan were less common, but their presence promoted the survival of the fish resource and crocodile, though to a lesser extent.

The *Dziva* respected the crocodile, calling it mambo wemumvura “*chief of the waters*”. As also noted in both the Ghanaian and Australian studies, there were residents who prayed to and praised the crocodile (Fijn, 2013:3; Negi, 2010:194). The *Dziva* clan did not eat fish or kill crocodile, as it was considered sacred. Disobedience towards the rules would result in a curse by the ancestors, which might bring misfortune in the family and this follows a trend in studies in east Africa (Westerman & Gardner, 2013:5; Kideghesho, 2008:1869). The *Dziva* clan did not fish, and only used water and reeds from the river.

However, poverty forced the non-*Dziva* clan women to fish with their husbands, to avoid sharing the small catches arising from the non-usage of canoes, and this resulted in neighbours not respecting their neighbours. Fish poaching was high, due to the abundance of the *Moyo* clan, who ate everything from the river, except the heart of the animal. Moreover, Ruti dam and Nyazvidzi River were considered non-sacred, and every area was free of exploitation. This difference was shown in other studies (Kideghosho, 2008:1869), which noted that other areas were sacred, and humans avoided fishing and grazing of their animals. Encroaching on sacred areas, especially wetlands, where mermaids are believed to be present, resulted in the disappearance of an individual or continuous drought (Mushuku, 2014:32; Mujere, 2007:2). This was also the case at Ruti Dam, where some areas of the dam were preserved from fishing, due to traditional beliefs. The chiefs and village headmen were involved in the punishing of offenders, before the ancestors punished the community.

5.7 Impacts of Humans on Nile crocodile

The researcher noted that there were no significant human impacts on crocodile activity that might affect its social behaviour and its reproductive efficiency. This was supported by a continuous increase in its numbers. The fishing activities in the dam might have an effect on the diet of sub-adult crocodiles, as they greatly depend on fish

(Wallace & Leslie, 2008:365). The implications in the diet might result in death, or changes in the social behaviour of crocodilians, as they can form hunting groups to attack large prey (Huchzermeyer, 2003:55).

The abundance of fishing nets in the dam is of no harm, since no death of a crocodile has been recorded in a net, but it may have helped crocodilians to obtain easy feed. The use of engine-free canoes in fishing just helps fishermen to reach deep places, but cannot affect crocodile movement, as noticed in Lake Nasser in Egypt (Hussein & Salem, 2013:27). The waves generated by engines normally affect the movement of juvenile crocodiles, and sometimes disturb females in the breeding sites; furthermore, the oil leaks from the engine adversely impact the fish and crocodile population (Hussein & Salem, 2013:27).

5.8 Availability of Prey Species

The transect walks conducted in the study area did not show any presence of wild crocodile prey. The antelope species favoured by adult crocodile were not encountered along the transect and/or in the faecal droppings. Presence of feral dogs in the area might have had an impact in the disappearance, though respondents were not willing to admit it. The study area had encountered many prolonged droughts, which might have caused the dog owners to fail to feed the animals. The feral dog can play a role in intra-guild competition (competition among carnivores), as was shown in Gokwe communal lands where they were killing impala and domestic animals (Butler *et al.*, 2004:372). The size of the dogs was too small to attack even the baboons; hence they were used to hunt hares. The height and mass of the dogs were also shown to be influential when they failed to kill kudu and duikers (Butler *et al.*, 2004:372). However, dogs were found to be preyed on by crocodile and hyena, though no attacks on dogs by baboons were recorded (Butler *et al.*, 2004:373). The feral dogs are domestic, to the extent that they are always with humans who might fight back when they are attacked; this might also help to explain why they were not killed.

Chapter 6: Conclusion and Recommendations

6.1 Conclusion

This section recaps the objectives of the study and how they were met. This is coupled with the major conclusions of the findings and how the research satisfied its aim and objectives:

Objective 1: Investigating the crocodile impacts on humans and livestock.

The research managed to establish the different types of impacts that arise in the area, due to the presence of crocodiles. Both human beings and their animal possessions are lost, due to crocodile predation. The humans were mostly killed during the crossing of the Nyazvidzi river and when fishing in Ruti Dam. The people who come close to the edge of the dam, for water, were most likely to be attacked, as the killings and damage around the dam is significantly high. The losses incurred due to crocodile, were less likely to be restored, as the government cannot compensate due to poor funding. The respondents were poor and their livelihood highly depends on fishing and livestock keeping, due to the dry nature of the area. Crocodiles were causing permanent damage to property and also human beings – who might have escaped death – which might have implications in the survival of the family. The data obtained clearly show that crocodiles are affecting people's lives, with zero benefits.

Objective 2: Assessing of trends and seasonality of crocodile predation.

From the data collected, it showed an increase in the crocodile population in the area. The heat of the area, as it is found in Ecological Region 3 or 4, might have promoted the survival of the hatchlings and therefore the population growth of the crocodiles. This also showed an increased occurrence of juveniles, compared with adults. No dead crocodiles due to natural causes were recorded in the area; this might well support the healthiness of the wetland, as diseases do play a significant role in crocodile deaths. There was also an increase in attacks, which supported the fact that crocodiles had

increased – which demanded more food. The attacks were mostly during the dry season when animals were drinking water from the few sources sheltering the crocodiles. However, humans were mostly attacked in November and December, after the first rains, when the water was still dark and murky. The number of attacks might have been high during this period, due to the high temperature that made the increased crocodile numbers active, and, therefore, a demand for more food. The females might have been the major culprits, as they guard their nests.

Objective 3: To identify other predators that affect people's lives in the area.

The Nile crocodile was not found to be the only predator affecting the residents. Hyena, jackal, baboon and leopard were also found to be affecting farmers' lives, as they strongly depended on farmers' livestock for food. The hyenas were found to be killing goats, donkeys and cattle, all of which were of economic importance. The hyenas often attacked the humans when they failed to get a kill; the attacks were widespread among all age groups and gender, and most of the people were hospitalised after surviving an attack. The baboons were reportedly killing goats and chickens. Jackals were killing chickens. However, the most affected farmers were those who lived close to the mountains, which provide shelter to these animals. The hyena recorded the highest total killings of livestock, second only to the crocodiles.

6.2 Hypotheses

H₀: There is no association between population age and conflict level

The age of the population showed that it did have an influence on crocodile attacks. People in the age group of 15 – 25 years were more often attacked, compared to all age groups. The age group is of youth, who are energetic and spend most of their time close to the dam, as fishermen or cattle herders. Analysis between genders of the age group was not done, due to lack of adequate data.

H₀: There is no significant difference between crocodile attack and human activities

Activities of the respondents had no influence on human attacks by the crocodile, but the distance from the water showed an influence. The closer the humans were to the dam, the more the incidences of attacks. The Ruti crocodiles only attacked assumed prey inside the water, and no attacks outside the water were recorded for this study. The distance from the dam also had an influence on the level of conflict, as the residents were frequently interacting with the crocodiles. People far away from the dam had little or no knowledge on the impact of the crocodiles, as they rarely witnessed its impacts. These were the people who liked the crocodile to continue surviving in its natural environment.

H₀: There is no relationship between appearance of water drinking place and crocodile damage

The respondents cleared vegetation around the water drinking places, so that the crocodile presence could easily be noticed. The appearance of the drinking place had an influence on the crocodile damage to property. The attacks were both recorded on bush, thicket and open places, but respondents cited that open places were easier to help attacked individuals.

6.3 Recommendation

In many African authorities, the interests of human beings are regarded as paramount, wildlife is better dead than alive, and wherever human beings are in conflict with the wildlife, it is the wildlife that must go (Musambachime, 1987:197). This attitude was seen in Zimbabwe during the unplanned, politically-related, fast-track land reform programme that forced most of the White farmers off their properties. The wildlife on

the properties was abused, and killed for meat and cash after sales, and the telephones cables were turned into snares.

To avoid the loss and to protect the Nile crocodile populations in their current status and range, conservation needs to be reconciled with the needs of the people at grassroots – livestock farmers, fishermen and the community at large. The motives for conservation should be planned in such a way as to avoid misconceptions as to who owns, who loses, who compensates and who benefits:

- I. Educational campaigns on appropriate management measures need to be implemented, to minimise conflict between the Nile crocodile and the community. Also, information about the role of the Nile crocodile in the freshwater ecosystem should be distributed to all ages and levels of communities, including the decision-makers. The information will help people to the sustainability of understanding the importance of crocodiles in wetlands. Information about the loss of a keystone species in this environment should be well distributed, such that people will appreciate its presence and safeguard its existence. The lack of information at grassroots level causes fear and lack of trust in the government, as the local communities' suspect that crocodiles were brought to punish them through loss of either livestock or family members.
- II. Direct incentives for any losses related to the Nile crocodile should be devised to reduce the level of conflict (Mishra *et al.*, 2003:1517). The incentives might be in the form of money, or replacement of the killed animal. The issue of incentives is difficult to conduct, though, as people will exaggerate their losses, and serious problems normally arise when a human being has been lost. Money cannot buy life, and the loss of a family member affects the social and economic value of a family. However, food parcels and paying of school fees for disadvantaged families who have lost a breadwinner should be carried out in communities surrounding Ruti Dam. This will encourage the communities to even protect the crocodile, as they will

be deriving benefits arising from projects at Ruti Dam, either crocodile or fish farming.

- III. Crocodile counting should be done, to find the actual number using utilising Ruti Dam and the Nyazvidzvi River as a territory. The research should be carried out using various methods that include mark-recapture, spotlight counting, aerial survey and also radio telemetry. The radio telemetry will give results on the home ranges and the general movement of the crocodile. The latter will indicate results on areas of preference and on feeding sites. Once the preference sites have been noted, in strategic crocodile management, will be assisted through fencing and signs of deterrents about the frequency of crocodile in the area. This will have a positive impact on minimising loss or damage, as people and in particular cattle herders would be inclined to shy away from the demarcated areas.
- IV. Crocodile farming should be implemented, to include egg collection and the selling of problem animals. This would generate the money needed to compensate the affected families. Local persons would also be able to seek employment on crocodile farms and this would boost local economies. The employment would also be for people who keep the crocodiles, and collect eggs from the wild, and skin culled crocodiles. Furthermore, programmes such as incentives for location and identification of crocodile nests, as is being done in the lower Zambezi valley, should also be implemented in Ruti dam and Nyazvidzi River. This will promote ownership, as the community will preserve the breeding facilities, a problem will be regarded as a financial resource.
- V. A footbridge should be built to link the upper areas of BRDC and GRDC, as families frequently visit relatives and shops, as has been done in the lower areas of Nyadi. Every time a female or child is attacked by a crocodile, they are either coming from shops or from school. The women and children go to the nearest facilities by crossing the river. When the people are in the water, they are easily attacked and killed by the crocodile. The issue of crossing the river is caused by the

absence of the required facilities – a problem which cannot be solved at community level.

- VI. A commercial fishing company, which will be monitored by the PWMA's scientific and research services, needs to be appointed and start operations. The identification of a reputable company will reduce attacks by either crocodiles or hippopotami, as their company will be using motorised boats. This will reduce overharvesting of the fish species in Ruti Dam, as monitoring will take place. The community will also benefit from the fish trade, as their sound infrastructure, communication lines and monetary rewards will be retained by the community organisations, for example trust for development.
- VII. Furthermore, research on the composition of the Ruti Dam needs to be carried out, to determine the different fish species and other organisms that constitute the diet of the Nile crocodile. This will inform whether the current crocodile population can survive without interfering with people's property. Comparing the feed quantity and quality with the predator numbers, can lead to an estimation of the carrying capacity. If the carrying capacity has been exceeded, then the option will be planned translocation, to reduce injury and death when the animal is moved to an area occupied by other crocodiles.

REFERENCES

- Abensperg-Traun, M. 2009. CITES, sustainable use of wild species and incentives driven conservation in developing countries, with an emphasis on Southern Africa. *Biological conservation* 142(5):948-963.
- Adams, M., Sibanda, S. & Turner, S. 1999. Land tenure reform and rural livelihoods in Southern Africa. *Natural resource perspectives*, 39:1-15.
- Anderson, J.L. & Pariela, F. 2005. *Strategies to mitigate human-wildlife conflicts in Mozambique*. Rome: FAO. (Wildlife management working paper No-8).
- Ashton, P.J. 2010. The demise of the Nile crocodile (*Crocodylus niloticus*) as a keystone species for aquatic ecosystem conservation in South Africa: the case of the Olifants River. *Aquatic conservation: Marine and freshwater ecosystem*, 20:489-493.
- Aswani S. & Lauer M. 2006. Incorporating Fishermen's local knowledge and behaviour into geographical information Systems (GIS) for Designing marine Protected areas in Oceania. *Human Organization* 65(1):81-102.
- Atickem, A., Williams, S., Bekele, A. & Thirgood, S. 2010. Livestock predation in the Bale Mountains, Ethiopia. *African journal of ecology*, 48:1076-1080.
- Aust, P.W. 2009. *The ecology, conservation and management of Nile crocodiles (Crocodylus niloticus) in a human dominated landscape*. PhD Thesis. Imperial College, London.
- Aust, P.W., Boyle, B., Fergusson, R. & Coulson, T. 2009. The impact of Nile crocodiles on rural livelihoods in north-eastern Namibia. *South African journal of wildlife research*, 39(1):57.
- Balazs, C. 2006. *Rural livelihoods and access to resources in relation to small reservoirs: a study in Brazil's Preto River Basin*. MSc thesis, University of California, Berkeley, CA.

Barkin, D. 2013. Ecotourism: a tool for sustainable development in an era of international integration? *Yale forestry & environmental studies bulletin*, 99:263-272.

Barnes, R.F.W. 1996. The conflict between humans and elephants in the central African forests. *Mammal Society*, 26(2/3):67-87.

Bauer, H. & De Iongh, H.H. 2005. Lion (*Panthera leo*) home ranges and livestock conflicts in Waza National Park, Cameroon. *Africa journal of ecology*, 43(3):208-214.

Bayman, H., Linde-Sapire, H. & Raphala, B.S. 2010. *Viva agricultural sciences*. Florida, Roodepoort: Vivlia Publishers.

Beacham, W. 2000. *Beachman's guide to international endangered species: non-mammals listed prior to 2000*. Washington, DC: Beacham Publishers.

Bebbington, A. 1999. Capitals and capabilities: a framework for analyzing peasant viability rural livelihoods and poverty. *World development*, 27(12):2021-2044.

Begg, C.M., Hahn, R. & Madatta, N. 2007. *Ecological and socio-ecological survey of the Ruvuma River contained within Selous Niassa Wildlife Corridor, Tanzania and Niassa Nature Reserve, Mozambique*. Unpublished Report for Ministry of Natural Resources and Tourism: Wildlife Division, Tanzania.

Bernhard, A. 2012. The nitrogen cycle: processes, players and human impact. *Nature education knowledge*, 2(12)1-9.

Bettencourt, M.V.E., Tilman, M., Henriques, P.D.S., Narciso, V. & Carvalho, M.L.S. 2013. *The economic and sociocultural role of livestock in the wellbeing of rural communities of Timor-Lestes*. Evora, Portugal: Center for Advanced Studies in Management and Economics. (CEFAGE-UE Working Paper 2013/01).

Bishop, J.M., Leslie, A.J., Bourquin, S.L. & O'Ryan, C. 2009. Reduced effective population size in an overexploited population of the Nile crocodile (*Crocodylus niloticus*). *Biological conservation*, 142(10):2335-2341.

Blomberg, G.E.D. 1977. Feeding ecology, nesting ecology and habitat preference of the Okavango crocodiles. In: Shacks V. 2006. *Habitat vulnerability for the Nile crocodile (Crocodylus niloticus) in the Okavango Delta, Botswana*. MA Thesis. Stellenbosch University.

Botha, H., Van Hoven, W. & Guillette L.J. 2011. The decline of the Nile crocodile population in Loskop Dam, Olifants River South Africa. *Water SA*, 37(1):103-108.

Botha, P.J. 2010. *The distribution, conservation status and blood biochemistry of Nile crocodile in the Olifants River system in Mpumalanga, South Africa*. PhD Thesis. University of Pretoria.

Bouare, O. 2006. A policy tool for establishing a balance between wildlife habitat preservation and the use of natural resources by the rural people in South Africa. *African journal of ecology*, 44:95-101.

Boudreaux, K. & Nelson, F. 2011. Community conservation in Namibia: empowering the poor with property rights. *Economic affairs*, 31(2):17-24.

Bourquin, S.L. & Leslie, A.J. 2011. Estimating demographics of the Nile crocodile (*Crocodylus niloticus Laurenti*) in the panhandle region of the Okavango Delta Botswana. *African journal of ecology*, 50(1):1-8.

Buckland, S.T., Anderson, D.A., Burnham, K.P. & Laake, J.L. 2006. Distance sampling: estimating abundance of biological populations. In: *Encyclopedia of Environmetrics*. 2012. 2nd edition. London: Wiley.

Butler, J.R.A. 2000. The economic costs of wildlife predation on livestock in Gokwe communal land, Zimbabwe. *African journal of ecology*, 38:23-30.

Butler, J.R.A., Du Toit, J.T. & Bingham, J. 2004. Free-ranging domestic dogs (*Canis familiaris*) as predators and prey in rural Zimbabwe: threats of competition and diseases to large wild carnivores. *Biological conservation*, 115:369-378.

Caldwell, J. 2010. *World trade in crocodilian skins, 2006-2008*. Cambridge: United Nations Environment Programme, World Conservation Monitoring Centre.

Campell, H.A., Watts, M.E., Sullivan, S., Read, M.A., Choukroun, S., Irwin, S.R. & Franklin, C.E. 2010. Estuarine crocodiles ride surface currents to facilitate long-distance travel. *Journal of ecology*, 79(5):955-964.

Chihona, S. 2006. *A field assessment of cheetah (Acinonyx jubatus) status and conflict situation in resettlement areas surrounding the Bubiya Conservancy in Gwanda District (Matabeleland South province)*. BSc (Hons) dissertation. Bindura University of Science Education. Bindura, Zimbabwe. (Unpublished).

Chimbuya, S. 1993. Traditional fishing gear in Zimbabwe. *ALCOM News*, 12:1-7.

Chimedza, P. 2011. *Access to clean, portable water: Buhera Integrated Community Water Project Ward 4 (Nerutanga), Buhera District*. Harare: Africare.

Chingwenya, A. & Chirisa, I. 2007. Structure without processes: an analysis of the institutional deficiencies in community based forest resource management in Seke Resettlement Scheme. *Journal of sustainable development in Africa*, 9(4):16-47.

Chingwenya, A. & Muparamoto, N. 2009. Diversifying livelihoods through utilisation of wetlands: the case of Ward 14: Buhera. *Journal of sustainable development in Africa*, 10:388-404.

Chisema, J., Deputy District Administrator, Gutu District, Masvingo Province. 2013. Statement to author, 10 June. Gutu.

Chiutsi, S., Mukoroverwa, M., Karigambe, P. & Mudzengi, B.K. 2011. The theory and practise of ecotourism in Southern Africa. *Journal of hospitality management & tourism*, 2(2):14-21.

Cinner, J.E., Aswani, S. 2007. Integrating customary management into marine conservation. *Biological conservation*, 140:201-216.

CITES. 2012. Appendices I, II and III. From: <http://www.CITES.org/eng/app/appendices.shtml> (accessed 20 April 2013).

Collett, H., Khumalo, F., Madiba, J., Sisitka L., De Fontaine, J., Asafo-Adjei R.T., Smuts, A., Strydom, L., Gcwensa, S.M. & Tshabang T.A. 2011. *Agricultural sciences*. Cape Town: Maskew Miller Longman.

Collins, L. 1995. Crocodilian skin production 1992-1993: Crocodile Specialist Group Newsletter, 14: In: IUCN/SCC Crocodile Specialist Group: *crocodiles status, survey and conservation action plan*. 2nd edition. Cambridge: The Group.

Combrink, X., Korrubel, J.L., Kyle, R., Taylor, R. & Ross, P. 2011. Evidence of declining Nile crocodile (*Crocodylus niloticus*) population at Lake Sibaya, South Africa. *South African journal of wildlife research*, 41(2):145-157.

Conforti, V.A & De Azevedo, F.C.C. 2003. Local perceptions of jaguars (*Panthera onca*) and pumas (*Puma concolor*) in the Iguacu National Park area, South Brazil. *Biological conservation*, 3:1-7.

Conover, M.R. 2002. *Resolving human-wildlife conflicts: the science of wildlife damage management*. Boca Raton, FL: Lewis Publishers.

Conyer, D. 2002. *Whose elephants are they? Decentralization of control over wildlife management through the CAMPFIRE program in Binga District, Zimbabwe*. Washington, DC: The Institute. (Working Paper).

Covarrubias, K., Nsiima, L. & Zezza, A. 2012. *Livestock and livelihoods in rural Tanzania: a descriptive analysis of the 2009 National Panel Survey*. (Joint paper of the World Bank, FAO, AU-IBAR and the Tanzania Ministry of Livestock and Fisheries Development). Washington, DC: World Bank.

Crocodile Specialist Group (CSG). 2011. *January 2011 – March 2011 Newsletter*, Volume 30(1). Karama, Australia: IUCN, World Conservation Union, Species Survival Commission.

De Silva, A. 2008. *The status of the saltwater crocodile (Crocodylus porosus) inhabiting the Nilwala River, Matara District and its impact on the community*. Karama, Australia: IUCN, World Conservation Union, SSC.

De Silva, A., De Silva, P. & Dawundasakara, P.M.N.K. 2013. *Crocodile attacks in Sri Lanka*. (22nd Working Meeting of the IUCN SSC Crocodile Specialist Group, Colombo, Sri Lanka, 20-23 May, p.227-233).

Dickman, A.J. 2008. *Key determinants of conflict between people and wildlife, particularly large carnivores, around Ruaha National Park, Tanzania*. PhD Thesis. University College, London.

Dickman, A.J. 2010. Complexities of conflict: the importance of considering social factors for effectively resolving human-wildlife conflict. *Animal conservation*, 13:458-466.

Dickman, A.J., Macdonald, D.W. & Marker, L. 2005. *Survivorship and causes of mortality for livestock-guarding dogs on Namibian rangeland*. Otjiwarongo, Namibia: Cheetah Conservation Fund.

Dikobe, M.L. 1997. *Patterns and economic impacts of livestock predation in rural communities bordering Makgadikgadi Pans National Park in Botswana*. MSc dissertation. University of Natal, Durban.

Downs, C., Greaver, C. & Taylor, R. 2008. Body temperature and basking behaviour of Nile crocodiles (*Crocodylus niloticus*) during winter. *Journal of thermal biology*, 33:185-192.

Ehrlich, P.R. 2009. Cultural evolution and the human predicament. *TREE*, 24:409-412.

Eyong, C.T. & Foy, I.I. 2006. Towards alternative strategies for sustainable development in Africa. *International journal for sustainable development*, 1(2):133-156.

FAO see Food and Agricultural Organization of the United Nations

Fergusson, R.A. 2010. Nile crocodile, *Crocodylus niloticus*. In: *IUCN/SCC Crocodile Specialist Group: crocodiles status, survey and conservation action plan*. 3rd edition. Cambridge: The Group, p.84-89.

Fijn, N. 2013. Living with crocodiles: engagement with a powerful reptilian being. *Animal studies journal*, 2(2):1-27.

Flamand, J.R., Rogers, P.S. & Blake, D.K. 1992. Immobilization in crocodiles. In: Ebedes H (eds.). *The use of tranquilisers in wildlife: Proceedings of the Wildlife Tranquilisers Symposium*. Pretoria: Department of Agricultural Development, p.61-65.

Food and Agricultural Organization of the United Nations. 2009. *Human-wildlife conflict in Africa: causes, consequences and management strategies*. Rome: The Organization.

Food and Agricultural Organization of the United Nations. 2010. *Managing the conflicts between people and lion*. Rome: The Organization. (Wildlife Management Working Paper, 13).

Food and Agricultural Organization of the United Nations. 2013. *Implementing improved tenure governance in fisheries*. From: <http://www.fao.org> (accessed 6 February 2014).

Frank, L. & Woodroffe, R. 2002. Managing predators and livestock on an East African rangeland. Lion Conservation Research Workshop 2: "Modelling Conflict". Oxford, Wildlife Conservation Research. In: FAO. 2010. *Managing the conflicts between people and lion*. (Wildlife Management Working Paper 13).

Frost, P.G.H. & Bond, I. 2008. The CAMPFIRE programme in Zimbabwe: payments for wildlife services. *Ecological economics*, 65:776-778.

Gandiwa, P., Matsvayi, W., Ngwenya, M.M. & Gandiwa, E. 2011. Assessment of livestock and human settlement encroachment into the northern Gonarezhou National Park, Zimbabwe. *Journal of sustainable development in Africa*, 13(5):19-33.

Gans, C. & Pooley, A.C. 1976. Research on crocodiles. *Ecology*, 57(5):839-840.

Ganswidt, S.B. 2012. *Non-invasive assessment of adrenocortical function in captive Nile crocodiles (Crocodylus niloticus) and its relation to housing conditions*. Pretoria: University of Pretoria. (Unpublished report).

Garba, M.H. & Di Silvestre, I. 2008. Conflicts between large carnivores and domestic livestock in the peripheral zone of the Regional Park 'W' in Niger. In: Croes, B., Buij,

R., De Iongh, H.H. & Bauer, H. (eds.) *Proceedings of an international seminar on management and conservation of large carnivores in West and Central Africa*. Leiden, The Netherlands, p.133-144.

Gehring, T.M., VerCauteren, K.C. & Landry, J.-M. 2010. Livestock protection dogs in the 21st century: is an ancient tool relevant to modern conservation challenges? *BioScience*, 60(4):299-308.

Giampiccoli, A. & Kalis, J.H. 2012. Tourism, food and culture: community-based tourism, local food and community development in Mpondoland. *Journal of culture & agriculture*, 34(2):101-123.

Glen, A.S., Dickman, C.R., Soule, M.E. & Mackey, B.G. 2007. Evaluating the role of the dingo as a trophic regulator in Australian ecosystems. *Australian ecology*, 32:492-501.

Gonzales, M., Manalo, R.I., Alibo, V.L.B., Mercado, V.P., Belo, W.T. & Barlis, D.C. 2013. *Manobo-crocodile co-existence in Agusan Marsh, Philippines: a cultural legacy of mutual benefit*. (22nd Working Meeting of the IUCN SSC Crocodile Specialist Group). Gland: IUCN-SSC, p.83-89.

Griffiths, B., Scott, M.J., Carpenter, J.W. & Reed, C. 1989. Translocation as a species conservation tool: status and strategy. *Science*, 245:477-480.

Gros, P.M. 1998. Status of the cheetah in Kenya: a field-interview based assessment. *Biological conservation*, 85:137-149.

Gruen, R.L. 2009. Crocodile attacks in Australia: challenges for injury prevention and trauma care. *World journal of surgery*, 33(8):1554-1561.

Grzimek, B. & Grzimek, M. 1961. *Serengeti shall not die*. New York: E.P. Dutton & Co.

Hekkala, E., Amato, G., DeSalle, R. & Blum, M. 2010. Molecular assessment of population differentiation and individual assignment potential of Nile crocodile (*Crocodylus niloticus*) populations. *Conservation genetics*, 11(4):1435-1443.

Hekkala, E., Shirley, M.H., Amato, G., Austin, J.D., Charter, S., Thorbjarnarson, J., Vliet, K.A., Houck, M.L., Desalle, R. & Blum, M.J. 2011. An ancient icon reveals new mysteries: mummy DNA resurrects a cryptic species within the Nile crocodile. *Molecular ecology*, 20:1499-4215.

Henderson, R.F. & Spaeth, C.W. 1980. *Managing predator problems: practices and procedures for preventing and reducing livestock losses*. Manhattan: Kansas State University.

Hersteinsson, P. & MacDonald, D.W. 1996. Diet of arctic foxes (*Alopex lagopus*) in Iceland. *Journal of zoology*, 240 (3):457-474.

Holmern, T., Nyahongo, J. & Røskft, E. 2007. Livestock loss caused by predators outside the Serengeti National Park, Tanzania. *Biological conservation*, 135:518-526.

Huchzermeyer, F. 2003. *Crocodiles: biology, husbandry, diseases*. Boston, MA: CABI International Publishing.

Hussein, A. & Salem, I. 2013. Habitat vulnerability for the Nile crocodile (*Crocodylus niloticus*) in Nasser Lake (Egypt). *Transylvanian review of systematical and ecological research*, 15(1):19-32.

Hutton, J.M. 1987. Growth and feeding ecology of the Nile crocodile *Crocodylus niloticus* at Ngezi, Zimbabwe. *Journal of animal ecology*, 56(1):25-38.

Hutton, J.M. & Child, G.F.T. 1989. Crocodile management in Zimbabwe. In: *Crocodiles, their ecology, management and conservation*. Geneva: IUCN.

Hutton, J.M. 1989. Movements, home range, dispersal and the separation of size classes in Nile crocodiles. *American zoologist*, 29:1033-1049.

Inoni, O.E., Chukwuji, C.O., Ogisi, O.D. & Oyaide, W.J. 2007. Alleviating rural poverty: what role for small-holder livestock production in Delta State, Nigeria? *Agricultura tropica ET subtropica*, (40)2:39-43.

Johannesen, A.B. & Skonhøft, A. 2005. Tourism, poaching and wildlife conservation: What can integrated conservation development projects accomplish? *Resource and energy economics*, 27:208-226.

Jones, B.T.B. & Weaver, C. 2008. CBNRM in Namibia: growth trends, lessons and constraints. In: Suich, H & Child, B. (eds.) *Evolution and Innovation in wildlife conservation: parks and game ranchers to transfrontier conservation areas*. Herndon, VA: Earthscan.

Jones, B.T.B., Davies, A., Diez, L. & Diggle, R.W. 2012. Community-based natural resources management (CBNRM) and reducing poverty in Namibia. In: Roe, D. (ed.) *Biodiversity conservation and poverty alleviation*. 2012. London: Wiley, p.191-205.

Kellert, S.R. 1997. *The value of life: biological diversity and human society*. Washington, DC: Island Press.

Kideghesho, J.R. 2008. Co-existence between traditional societies and wildlife in Western Serengeti, Tanzania: its relevancy in contemporary wildlife conservation efforts. *Biodiversity conservation*, 17:1861-1881.

Kissui, B.M. 2008. Livestock predation by lions, leopards, spotted hyena and their vulnerability to retaliatory killing in the Maasai steppe, Tanzania. *Animal conservation*, 11:422-432.

Koerth, B.H., Webb, M.W., Bryant, F.C. & Guthery, F.S. 1983. Cattle trampling of simulated ground nest under short duration and continuous grazing. *Journal of range management*, 36(3):385-386.

Kofron, C.P. 1993. Behaviour of Nile crocodiles in a seasonal river in Zimbabwe. *Copeia*, (2):463-469.

Kolowski, M.J. & Holekamp, K.E. 2006. Spatial, temporal, and physical characteristics of livestock depredations by large carnivores along Kenyan reserve border. *Biological conservation*, 128(4):529-541.

Kushlan, J.A. & Mazzotti, F.J. 1989. Population biology of the American crocodile. *Journal of herpetology*, 23(1):7-21.

Lang, J.W. 1975. The Florida crocodile: will it survive? *Field Museum of Natural History Bulletin*, 46(8):4-9.

Lang, J.W. & Andrews, H.V. 1994. Temperature-dependent sex determination in crocodilians. *Journal of experimental zoology*, 270:28-44.

Le Bel, S., Murwira, A., Mukamuri, B., Czudek, R., Taylor, R. & La Grange, M. 2010. Human wildlife conflicts in Southern Africa: riding the whirl wind in Mozambique and in Zimbabwe. In: Pujol, J.L. (ed.) *The importance of biological interactions in the study of biodiversity*. 2011. **Chapter 15**. Rijeka, Croatia: Intech.

Lindsey, P.A., Roulet, P.A. & Romanach, S.S. 2007. Economic and conservation significance of the trophy hunting industry in sub-Saharan Africa. *Biological conservation*, 134(1):455-469.

Lipton, M. 2012. *Approaches to rural poverty alleviation in developing Asia: role of water resources*. Brighton: Sussex University, Poverty Research Unit.

Lord, K., Feinstein, M. & Coppinger, R. 2009. Barking and mobbing. *Behavioural processes*, 81:358-368.

Lupindu, M.A. 2007. *Pastoralists in Mbeya District of Tanzania and their perception of the national livestock policy*. MSc Thesis. Wageningen University, Netherlands:Animal Production Systems Group.

Maddox, T. 2003. *The ecology of cheetahs and other large carnivores in a pastoralist-dominated buffer zone*. PhD Thesis. University of London, Department of Anthropology..

Madhusudan, M.D. 2003. Living amidst large wildlife: livestock and crop depredation by large mammals in the interior villages of Bhadra Tiger Reserve, South India. *Environmental management*, 31(4):97-102.

Madope, A. 1999. Community participation in wildlife management. In: Ferraz B. & Munslow, B. (eds.) *Sustainable development in Mozambique*. Currey, Oxford, p.217-222.

Mandudzo, E. & Hawkes, R. 1996. *Grazing and cattle as challenges in community-based natural resources management in Bulilimamangwe District of Zimbabwe*. Harare: University of Zimbabwe, Centre for Applied Social Sciences.

Manzungu, E. 2001. A lost opportunity: the case of the water reform debate in the fourth parliament of Zimbabwe. *Zambezia*, 28(1):97-120.

Mapedza, E. (2007). *Keeping CAMPFIRE going: Political uncertainty and Natural Resource Management in Zimbabwe*. London: International Institute for Environment and Development.

Marker, L.L., Dickman, A.J., Mills, M.G.L. & Macdonald, D.W. 2003. Aspects of the management of cheetah, *Acinonxy jubatus jubatus*, trapped on Namibian farmlands. *Biological conservation*, 114:401-412.

Marker, L.L., Mills, M.G.L. & Macdonald, D.W. 2003. Factors influencing perceptions and tolerance toward cheetahs (*Acinonxy jubatus*) on Namibian farmlands. *Conservation biology*, 17(5):1290-1298.

Masaka, D. 2009. Abuse of non-human animal rights in the context of Zimbabwe's agrarian reforms (2000-2006): an ethical perspective. *Journal of ecology & the natural environment*, 1(6):137-146.

Mashinya, J. 2007. *Participation and devolution in Zimbabwe's CAMPFIRE program: findings from local projects in Mahenye and Nyaminyami*. PhD Thesis. College Park: University of Maryland.

Mattee, A.Z. & Shem, M. 2006. *Ambivalence and contradiction: a review of the policy environment in Tanzania in relation to pastoralism*. London: International Institute for Environment and Development. (Drylands Issue Paper No. 140).

McClanahan, T.R., Marnane, M.J., Cinner, J.E. & Kiene, W.E. 2006. A comparison of marine protected areas and alternative approaches to coral reef conservation. *Current biology*, 16:1408-1413.

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

Michalski, F., Boulhosa, R.L.P., Faria, A. & Peres, A. 2005. Human-wildlife conflicts in a fragmented Amazonian forest landscape: determinants of large felid depredation on livestock. *Animal conservation*, 9:179-188.

Mishra, C., Allen, P., McCarthy, T., Madhusudan, M., Bayarjargal, A. & Prins, H. 2003. The role of incentive programs in conserving the snow leopard. *Conservation biology*, 17(6):1512-1520.

Modha, M. 1967. The ecology of the Nile crocodile (*Crocodylus niloticus laurentii*) on Central Island, Lake Rudolf. *East African wildlife journal*, 5:74-95.

Mokgope, K. & Butterworth, J.A. 2001. *Rural water supply and productive uses: a rapid survey in the Sand River Catchment*. Chatham: Natural Resources Institute. (WHIRL project working paper 4).

Molenaar, D. 1987. *The Challenge of Rainier. A record of the explorations and ascents, triumphs and tragedies, on the Northwest's greatest mountain*. The Mountain Books. Cordee Publishers.

Mtisi, S. 2011. *Water reforms during the crisis and beyond: understanding policy and political challenges of reforming the water sector in Zimbabwe*. London: Overseas Development Institute. (Working Paper 333).

Mtisi, S. & Nicol, A. 2003. *Caught in the act: new stakeholders, decentralization and water management processes in Zimbabwe*. Brighton: Institute of Development Studies. (Sustainable livelihoods in Southern Africa: Research Paper 1).

Mujere, J. 2007. The Marumbi rain cult: gender and the interface between rainmaking and politics of water in Gutu. *The power of water: landscape, water and the state in Southern Eastern Africa Conference*, University of Edinburgh, Scotland, 28-29 March 2007.

Munthali, S.M. 2007. Transfrontier conservation areas: integrating biodiversity and poverty alleviation in Southern Africa. *Natural resources forum*, 31:51-60.

Murphree, M.W. 2005. *Community conservation research in Africa: principles and comparative practice*. Harare: University of Zimbabwe, Centre for Applied Social Sciences. (Paper No. 2).

Musambachime, M.C. 1987. The fate of the Nile crocodile in African waterways. *African affairs*, 343(88):197-207.

Mushuku, A. 2014. Revisiting indigenous knowledge systems for sustainable management of natural resources in fast track resettlement schemes: a comparative analysis of indigenous knowledge systems use in A1 resettlement schemes and communal areas in Chiredzi and Zaka district, Zimbabwe. *Greener journal of social sciences*, 4(1):24-36.

Mutshinyalo, T.T. & Siebert, S.J. 2010. Myth as a biodiversity conservation strategy for the Vhavenda, South Africa. *Indilinga –African journal of indigenous knowledge*, 9(2):151-171.

Muyambo, A., Lacroix, S. & Euvrard, D. 2003. Innovative technology contributes to the sustainable development of Ruti dam, Zimbabwe. *International journal on hydropower and dams*, 10(6):54-57.

NASCO. 2010. *Namibia's communal conservancies: a review of progress and challenges in 2009*. Windhoek: NASCO.

Naughton-Treves, L. & Treves, A. 2005. Socio-ecological factors shaping local support for wildlife: crop-raiding by elephants and other wildlife in Africa. In:

Woodroffe, R., Thirgood, S. & Rabinowitz, A. *People and wildlife: conflict or coexistence?* London: Cambridge University Press, p.252-277.

Ncube, G.T. 2011. Crisis of communal leadership: post-colonial local government reform and administrative conflict with traditional authorities in the communal areas of Zimbabwe, 1980-2008. *African journal of history and culture*, 3(6):89-95.

Negi, C.S. 2010. The institution of taboo and the local resource management and conservation surrounding sacred natural sites in Uttarakhand, Central Himalaya. *International journal of biodiversity & conservation*, 2(8):186-195.

Nelson, F. & Agrawal, A. 2008. Patronage or participation: community-based natural resources management reform in sub-Saharan Africa. *Development & change*, 39(4):557-585.

Newmark, W. & Hough, J. 2000. Conserving wildlife in Africa: integrated conservation and development projects and beyond. *Bioscience*, 50(7):585-592.

Ngwerume, E.T. & Muchemwa, C. 2011. Community-based natural resources management (CBNRM): a vehicle towards sustainable rural development. The case of CAMPFIRE in Zimbabwe's Mashonaland West Hurungwe District. *Journal of emerging trends in economics and management sciences*, 2(3):75-82.

Niaskanen, L. 2005. Development of a standardised monitoring and information system. In: *Human-wildlife conflict management (HWCM) in Namibia*. Windhoek, Namibia: Ministry of Environment and Tourism, p.52-56.

Ogada, M.O., Woodroffe, R., Ouge, N.O. & Frank, L.G. 2003. Limiting depredation by African carnivores: the role of livestock husbandry. *Conservation biology*, 17:1521-1530.

Ogamba, E.N. & Abowei, J.F.N. 2012. Some aquatic reptiles in culture fisheries management. *International journal of fishes and aquatic sciences*, 1(1):5-15.

Okech, R.N. 2010. Wildlife-community conflicts in conservation areas in Kenya. *African journal of conflict resolution*, 10(2):65-80.

Okello, M.M., Ole Seno, S.K. & Nthiga, R.W. 2009. Reconciling people's livelihoods and environmental conservation in the rural landscapes in Kenya: opportunities and challenges in the Amboseli landscapes. *Natural resources forum*, 33:123-133.

Oki, T. & Kanae, S. 2006. Global hydrological cycles and world water resources. *Science*, 313:1068-1072.

Oli, M.K., Taylor, I.R. & Rogers, M.E. 1994. Snow leopard *Panthera uncia* predation of livestock: an assessment of local perceptions in Annapurna Conservation Area, Nepal. *Biological conservation*, 68:63-68.

Onuoha, F.C. 2009. Environmental degradation, livelihood & conflicts: a focus on the implications of the diminishing water resources of Lake Chad for north-eastern Nigeria. *African journal on conflict resolution*, 8(2):35-62.

Opoku, K.A. 1982. Communalism and community in the African heritage. *International review of mission*, 79(316):487-492, Oct. [1990 reprint of original document].

O'Riordan, T. & Voisey, H. (eds.) 1997. *Sustainable development in western Europe: coming to terms with Agenda 21*. London: Wiley.

Oxfam. 2012. *Honde Valley learning visit report, 05 March 2012*. The Hague: SNV

Parks and Wildlife Service of the Northern Territory (PWSNT). 2012. *Management programme for the saltwater crocodile in the Northern Territory of Australia 2012-2014*. Palmerston, NT: NT Department of Natural Resources, Environment and the Arts.

Pica-Ciamarra, U., Tasciotti, L., Otte, J. & Zezza, A. 2011. *Livestock assets, livestock income and rural households: cross-country evidence from household surveys*. Rome: FAO.

Polisar, J., Maxit, I., Scognamillo, D., Farrell, L., Sunquist, M.E. & Eisenberg, J.F. 2003. Jaguars, pumas, their prey base and cattle ranching: ecological interpretations of a management problem. *Biological conservation*, 119(4):507- 516.

Purchase, G.K. & Vhurumuku, G. 2005. *Evaluation of a wild-wild translocation of cheetah (Acinonyx jubatus) from private land to Matusadonha National Park, Zimbabwe (1994-2005)*. Harare, Zimbabwe: Zambezi Society.

Ratner, B.D. 2011. *Common-pool resources, livelihoods and resilience:critical challenges for governance in Cambodia*. Washington, DC: International Food Policy Research Institute. (IFPRI Discussion Paper 01149).

Republic of Zimbabwe. 1998. Water Act No. 14 of 1998. Harare: Government Printer.

Republic of Zimbabwe. 2001. Traditional Leaders Act No. 22 of 2001. Harare: Government Printer.

Republic of Zimbabwe. 2002. Environmental Management Act, No. 13 of 2002. Harare: Government Printer.

Republic of Zimbabwe. 2005. Environmental Management Act No. 6 of 2005. Harare: Zimbabwe Government Printer.

Republic of Zimbabwe. 2011. *Parliamentary report: Buhera South constituency profile*. Harare: Government Printer.

Republic of Zimbabwe. 2012. *Zimbabwe population census 2012*. Causeway, Harare: Government Printer.

Revol, B. 1995. Crocodile farming and conservation, the example of Zimbabwe. *Biodiversity and conservation*, 4:299-305.

Richter, R.D., Postel, S., Revenga, C., Scudder, T., Lehner, B., Churchill, A. & Chow, M. 2010. Lost in development shadow: the downstream human consequences of dams. *Water alternatives*, 3(2):14-42.

Rodda, G.H. 1984. Movement of juvenile American crocodiles in Gatun Lake, Panam. *Herpetologica*, 40(4):441-451.

Ross, J.P. 1998. *Crocodiles: status survey and conservation action plan*. 2nd edition. Cambridge, UK: IUCN/SSC Crocodile Specialist Group.

Rusinga, O., Murwendo, T. & Zinhiva, H. 2012. Political implications of building small dams in communal areas of Zimbabwe: the case of Mhakwe Dam in Chimanimani district. *Journal of sustainable development in Africa*, 14(4):147-157.

Scheiess-Meier, M., Ramsauer, S., Gabanapelo, T. & Kong, B. 2007. Livestock predation-insight from problem animal control registers in Botswana. *Journal of wildlife management*, 71(4):1267-1274.

Scholte, P., Adam, S., Kari, S. & Mbouche, J.H. 1999. Walking a tightrope: using PRA in a conflict situation around Waza National Park. *Conservation PLA notes*, 35:1-6.

Seebacher, F., Grigg, G. & Beard, L. 1999. Crocodiles as dinosaurs: behavioural thermoregulation in very large ectotherms leads to high and stable body temperatures. *Journal of experimental biology*, 202(1):77-86.

Sekhar, N.U. 1998. Crop and livestock depredation caused by wild animals in protected areas: the case of Sariska Tiger Reserve, Rajasthan, India. *Environmental conservation*, 2:160-171.

Sergio, F., Caro, T., Brown, D., Clucas, B., Hunter, J., Ketchum, J., McHugh, K. & Hiraldo, F. 2008. Top predators as conservation tools: ecological rational assumptions and efficacy. *JSTOR journal*, 39:1-19.

Shacks, V. 2006. *Habitat vulnerability for the Nile crocodile (Crocodylus niloticus) in the Okavango Delta, Botswana*. MA dissertation. University of Stellenbosch, Cape.

Shirley, M.H., Oduro, W. & Beibro, H.Y. 2009. Conservation status of crocodiles in Ghana and Cote-d'Ivoire, West Africa. *Fauna and flora international, Oryx*, 43(1):136-145.

- Silva-Rodriguez, E.A. & Sieving, K.E. 2011. Influence of care of domestic carnivores on their predation on vertebrates. *Conservation biology*, 25(4):808-815.
- Smith, M.H. 2014. *Sheep – from the animal's point of view, 1: What does it mean to be a sheep?* Davis, CA: University of California. (Publication no. 8474).
- Stander, P.E. 1992. Foraging dynamics of lions in a semi-arid environment. *Canadian journal of zoology*, 70:8-12.
- Stankowich, T. 2008. Ungulate flight responses to human disturbance: a review and meta-analysis. *Biological conservation*, 141:2159-2173.
- Sterling, E.J., Gomez, A. & Porzecanski, A.L. 2010. A systematic view of biodiversity and its conservation : processes, interrelationships and human culture. *Problems and paradigms bioessays*, 32:1090-1098.
- Thorbjarnarson, J.B. 1992. *Crocodiles: an action plan for their conservation*. Gland, Switzerland: IUCN – The World Conservation Union
- Thorbjarnarson, J.B. 1996. Reproductive characteristics of the Order Crocodylia. *Herpetologica*, 52(1):8-24.
- Thorp, H.J. 1986. Two distinct roles of predators in freshwater assemblages. *JSTOR journal*, 47:75-82.
- Tiner, R.W. 2003. Geographically isolated wetlands of the United States. *Wetlands*, 23(3):494-516.
- Torquebiau, E. & Taylor, R.D. 2009. Natural resource management by rural citizens in developing countries: innovations still required. *Biodiversity conservation*, 18:2537-2550.
- Treves, A. & Karanth, K.U. 2003. Human-carnivore conflict and perspectives on carnivore management worldwide. *Conservation biology*, 17:1491-1499.
- Treves, A., Wallace, R.B. & White, S. 2009. Participatory planning of interventions to mitigate human-wildlife conflicts. *Conservation biology*, 23(6):1577-1587.

Trim, J.G. 2008. *Materialistic values and depressive symptoms among Mexican-American adults*. PhD Dissertation. Phoenix: Arizona State University.

Urry, J. 2011. *Climate change and society*. New York: Polity Press.

Van Oel, P.R., Karol, M.S. & Hoekstra, A.Y. 2009. A river basin as a common-pool resource: a case study for Jaguaribe basin in the semi-arid Northeast Brazil. *International journal of river basin management*, 7(4):345-353.

Van Vuuren, L. 2011. KwaZulu-Natal: it's man versus croc. *Water Wheel*, 10(4):13-18, Jul-Aug.

Vanak, A.T. & Gompper, M.E. 2009. Dogs (*Canis familiaris*) as carnivores: their role and function in intra-guild competition. *Mammal review*, 39:265-283.

Vergne, A.L., Pritz, M.B. & Mathevon, N. 2009. Acoustic communication in crocodilians: from behaviour to brain. *Biological reviews*, 84:391-411.

Virtanen, P. 2005. Community based natural resources management in Mozambique: a critical review of the concept's applicability at local level. *Sustainable development*, 13:1-12.

Wallace, K.M. & Leslie, A. 2008. The diet of the Nile crocodile (*Crocodylus niloticus*) in the Okavango Delta, Botswana. *Journal of herpetology*, 42(2):361-368.

Wallace, K.M., Leslie, A.J. & Coulson, T. 2011. Living with predators: a focus on the issues of human-crocodile conflict within the Lower Zambezi valley. *Wildlife research*, 38(8):747-755.

Walsh, B. 1989. Aestivation in the freshwater Australian crocodile. *Australian zoologist*, 25(3):68-70.

Watson, R.M., Graham, A.D. & Bell, R.H.V. 1971. A comparison of four East African crocodile (*Crocodylus niloticus Laurenti*) populations. *East African wildlife journal*, 9:25-34.

Weaver, D. 2008. *Ecotourism*. 2nd edition. New York: Wiley.

Wegge, P., Shrestha, R. & Flagstad, Ø. 2012. Snow leopard *Panthera uncia* predation on livestock and wild prey in a mountain valley in northern Nepal: implications for conservation management. *Wildlife biology*, 18:131-141.

Westerman, K. & Gardner, C.J. 2013. Adoption of socio-cultural norms to increase community compliance in permanent marine reserves Southwest Madagascar. *Conservation evidence*, 10:4-9.

Whitaker, N. 2007. *Survey of human/crocodile conflict in India, Maharashtra State*. Madras: Madras Crocodile Trust.

Whiting, M.J., Williams, V.L. & Hibbitts, T.J. 2011. Animals traded for traditional medicine at the Faraday market in South Africa: species diversity and conservation implication. *Journal of zoology*, 284:84-96.

Whitlow, R. 1990. Conservation status of wetlands in Zimbabwe: past and present. *GeoJournal*, 20.3:191-202.

Williams, V.L., Balkwill, K. & Witkowski, E.T.F. 2007. Size-class prevalence of bulbous and perennial herbs sold in the Johannesburg medicinal plant markets between 1995 and 2001. *South African journal of botany*, 73:144-155.

Woodroffe, R. 2000. Predators and people: using human densities to interpret declines of large carnivores. *Animal conservation*, 3(2):165-173.

Woodroffe, R., Frank, L.G., Lindsey, P.A., Ole Ranah, S.M.K. & Romanach, S. 2007. Livestock husbandry as a tool for carnivore conservation in Africa's community rangelands: a case control study. *Biodiversity conservation*, 16:1245-1260.

World Wildlife Fund. 2013. *Who we are*. WWF Zimbabwe Offices. From: <http://www.wwf.panda.org> (accessed 17 November 2013).

Wright, M.R. 1995. Alleviating poverty and conserving wildlife in Africa: an "imperfect" model from Zambia. *Napa bulletin*, 15:19-31.

Zimbabwe Parks & Wildlife Management Authority (ZPWMA). 2006. Status of wild crocodile population in Zimbabwe. Harare: ZPWMA.

ZPWMA **see** Zimbabwe Parks & Wildlife Management Authority.

Appendix 1

UNIVERSITY OF SOUTH AFRICA 2013 HUMAN-CROCODILE CONFLICTS QUESTIONNAIRE FOR RUTI DAM CROCODILES.

Questionnaire Number:

Date:

Ranking Parameters:

*Precision.....

*Doubtful Information.....

*Co-operative attitude.....

Total Score.....out of 3.

(Score: 0; 0,5; 1)

Bio Data

Gender male ☐ male ☐

1. Age (years).....
2. Totem.....
3. Village name.....
4. How many years have you lived here?.....
5. Distance from the dam.....km
6. Name of closest river.....approx distance.....km
7. Are you employed? ☐ Yes ☐ No and where do you work
8. FAMILY LIVELIHOOD

Type	Total No	Number killed: 2007-2013					Stolen	Sold
Cattle		Crocodile	Hyena	Leopard	Baboon	Other		
	Bulls							
	Calves							
	heifers							
Goats								
Sheep								
Donkey								
Chicken								
Pigs								

9. If any killed, how did you know

-
10. Do you own dogs? Yes ☐ No ☐
 11. If **yes**, how many dogs do you own? and what do you use them for?.....
 12. Do you do fishing? Yes ☐ No ☐
 13. If **yes**, where do you do your fishing? River ☐ Dam ☐
 14. Are you dependent on fishing? Yes ☐ No ☐
and explain why.....
 -
 15. How do you do your fishing?
☐ Nets ☐ Lines ☐ Traditional baskets ☐ Other
 16. How do you set your nets.
☐ In the river ☐ in the dam ☐ the floodplain
 17. Do you use a canoe during fishing?
☐ Yes ☐ No
 18. Do you sometimes lose fish catches to crocodiles?
☐ Yes ☐ No
 19. If **yes**, how do you know it was a crocodile?.....
 -
 20. At what time do you do your fishing?
☐ Day ☐ Evening ☐ Night ☐ Anytime
 21. Where do your livestock drink water from? (give name or area).....
 22. At what time do your livestock normally drink water?
☐ Morning ☐ Afternoon ☐ Evening ☐ Any time
 23. Describe how the place looks like, where they drink their water:

WATER USE

1. Where do you get your drinking and cooking water?
☐ River ☐ Well ☐ Borehole ☐ Dam
2. Where do you do your washen?
☐ River ☐ Well ☐ Borehole ☐ Dam
3. Where do you normally bath?
☐ River ☐ Toilet/Bathroom ☐ Dam
4. Do you or your children swim in the river?
☐ Yes ☐ No
5. If **yes** how often?
☐ Daily ☐ Weekly ☐ Monthly ☐ Sometimes
6. If no, why don't you/they swim?.....

HUMAN-CROCODILE INTERACTION

1. Do you know a crocodile? ☐ Yes ☐ No
2. Do you like a crocodile?
☐ Yes ☐ No ☐ I don't know

- 2.1 If **yes**, why do you like them?
- 2.2 If **no**, why don't you like them?
3. Do people kill crocodiles? ☐ Yes ☐ No
- 3.1 If **yes**, a) Where do they kill them?.....

b) Why do they kill them?.....

3.2 If **no**, why do they not kill them?.....

4. Do you think the number of crocodile has, over the past 5 years,

☐ Increased ☐ Decreased ☐ Remained the same

4.1 Why are you saying so?.....

.....

CROCODILE ATTACKS

1. When do crocodiles mostly kill or attack?
-
2. Are rivers most dangerous, compared to dam?.....
3. Which river is most dangerous?.....
4. Are crocodile attacks more during dry season ☐ wet season ☐
5. Which animal do crocodiles like most?.....
6. Do you have a family member killed by a crocodiles Yes ☐ No ☐
- 6.1 If **yes**: a) How old was the person?.....
- 6.2 Was it a she or he.....
- 6.3 What was the person doing?.....
- 6.4 At what time was the attack?.....
7. How do you prevent the attacks
- 7.1 on livestock?.....
- 7.2 on humans?.....
8. Are you compensated for the losses? ☐ Yes ☐ No
- 8.1 If **yes**, who compensates?.....
- 8.2 How do they compensate?.....
9. Given a chance to relocate, would you move? ☐s ☐
- Explain why

Thank you for your co-operation and time in helping us to get the little-known information to complete the gap on people living with crocodiles. The privacy of your contributions is our concern.

Appendix 2

Ruti Dam Road Strip Counts Data Sheet

Wild Animal abundance determination (inclusive of carnivores)

Area Name.....

Observers:

Weather condition:.....

Transect length.....No/.....

Date / / 2013 Time.....

Dist/m	Co-ordinates	Animal type	F	S	V	Habitat type	Distance from observer	Angle of observation

Other information noted along the transect :

.....
.....

Key

F- Faecal droppings

V- Animals sighted

S- Animal spoor