CHAPTER 6

CONSERVATION AND MANAGEMENT PLAN FOR THE WILD NILE CROCODILE POPULATION IN THE OLIFANTS RIVER, MPUMALANGA PROVINCE

This chapter represents an abbreviated version of the suggested conservation and management plan for the wild Nile crocodile population in the Olifants River in the Mpumalanga province while the detailed version is included as appendix I to this thesis. The document follows the format, layout and terminology used in most of the following existing crocodile conservation and management plans:

- Nature Conservation (estuarine crocodile) conservation plan 2007 and management plan 2007 - 2017 (Queensland Environmental Protection Agency2007).
- Management plan for *Crocodylus porosus* in the Northern Territory 2005 - 2010 (Parks and Wildlife Service of the Northern Territory, 2005a).
- Management program for *Crocodylus porosus* and *Crocodylus johnstoni* in the Northern Territory of Australia (Parks and Wildlife Service of the Northern Territory, 2005b).
- Saltwater crocodile (*Crocodylus porosus*) and freshwater crocodile (*Crocodylus johnstoni*) management plan for Western Australia 2004 - 2008 (Department of Conservation and Land Management, 2003).

- Management plan for *Crocodylus porosus* in Sabah, Malaysia (Sabah Wildlife Department, 2002).
- Policy and management plan for the Nile crocodile, (Tanzania Department of Wildlife, 1993).
- Management plan for crocodiles in Zimbabwe (Department of National Parks and Wildlife,1992)
- Conservation plan: *Crocodylus niloticus* (Jacobsen, 1992)
- Status survey and conservation action plan for crocodiles, (Ross, 1998).
- A management plan for the conservation of the Nile crocodile (*Crocodylus niloticus*) in the Okavango Delta, Botswana (Bourquin, 2007)
- The management of crocodiles in captivity (Bolton, 1989).
- Sustainable use of the Lake Chamo Nile crocodile population (Whitaker, 2007).

INTRODUCTION

The Nile crocodile is the only crocodilian species that occur in southern Africa. They are very large and robust animals and considered by many to be iconic animals of the African continent. Adult Nile crocodiles average between 2.8 and 3.5m in length but in southern Africa they can grow as large as 5.5m and weigh around 1000kg at that length (Alexander and Marais, 2007). Although even at 5.5m in length, Nile crocodiles are only second in size to the estuarine crocodile (*Crocodylus porosus*) which is widely regarded as the largest living

reptiles on earth (Alexander and Marais, 2007). It is however estimated that fewer than 2% of all Nile crocodiles occurring in the wild in southern Africa exceed 3.0m in length (Alexander and Marais, 2007).

Nile crocodiles favour permanent, still or slow moving water with high, sunny, sandy banks above flood levels with enough vegetation to provide shade and shelter (Hutton and Loveridge, 1999). However, this description also fits the exact locations preferred by people. These are the places where water is pumped for irrigation schemes and domestic use, where recreational areas such as fishing and camping sites are established, subsistence fishing take place, illegal commercial fishing with gill nets are practised, exclusive upmarket eco-loges and week-end homes are constructed, weirs and dams are built to supply industry, mining and agriculture with a constant water supply equal to their demand. It is clear then that there are little room left in river systems for Nile crocodiles to go about their business as they have done for millions of years.

Therefore it has become immensely important to have written conservation and management plans which must be approved and implemented by the relevant conservation authorities, provincial and national governments.

SPECIES CONCERNED

Class	:	Reptilia.
Order	:	Crocodylia.
Family	:	Crocodylidae.
Subfamily	:	Crocodylinae.
Genus and species	:	*Crocodylus niloticus* Laurenti, 1768.
Common names	:	Nile crocodile.

AGENCY RESPONSIBLE

The Olifants River falls within the boundaries of two provinces in South Africa, therefore the responsibility for the conservation of the Nile crocodile populations in the river must be shared by the two conservation organisations namely:

1. **Mpumalanga Tourism and Parks Agency**

Private Bag X11338
Nelspruit, Mpumalanga
South Africa, 1200

Telephone: +27 13 759 8300
Facsimile: +27 13 752 7012
E-mail: info@mtpa.co.za

2. **Limpopo Department of Economic Development, Environment and Tourism**

Private Bag X9484 Telephone: +27 15 8300

Polokwane, Limpopo Facsimile: +27 15 8319

South Africa, 0700 E-mail: info@ledet.gov.za

CONSERVATION STATUS AND LEGISLATIVE FRAMEWORK

Although nature conservation and the protection and management of the environment functions independently in each province of South Africa, it is also subject to national legislation and international agreements and conservation efforts ratified by the South African government.

National:

Nile crocodiles are considered to be a protected species under the *National Environmental Management: Biodiversity Act (Act 10 of 2004)*. A protected species under the NEMBA legislation is defined as "any species which is of such high conservation value or national importance that it requires national protection" (Section 56(1)(d) of Act 10 of 1998). However, the current IUCN Red List categorises the Nile crocodile as LRlc (Low Risk, Least Concern) but some experts are of the opinion that Nile crocodiles may be threatened in some parts of its range (Britton, 2009).

Due to successful crocodile farming being practised in this country, the South African population of Nile crocodiles are currently listed on Appendix II of the *Convention on the International Trade in Endangered Species of Wild Fauna and Flora* (CITES).

The current South African Red Data Book for Reptiles and Amphibians (Jacobsen, 1988) lists the Nile crocodile as vulnerable. A new assessment of all reptiles and amphibians in South Africa the South African Reptile Conservation Assessment (SARCA) is currently underway but final classification of the conservation status of reptiles according to that study is not currently available.

Provincial:

Provincial conservation legislation governing the protection of Nile crocodiles in the Olifants River are: the *Mpumalanga Nature Conservation Act* (Act 10 of 1998) and the *Limpopo Environmental Management Act* (Act 7 of 2003). In the Mpumalanga province, Nile crocodiles are considered to be protected game (Schedule 2 of Act 10 of 1998) and in the Limpopo province they are considered to be specially protected animals (Schedule 2 of Act 7 of 2003). This means that in both the Mpumalanga and Limpopo provinces, Nile crocodiles may only be hunted/killed legally under the issuance of a permit from the provincial nature conservation authority.

BIOLOGY OF THE NILE CROCODILE

The most striking characteristic about crocodilians are their size. Nile crocodiles are large reptiles that can grow to more than 5.0m in total length and reportedly reaching 6.0m (TL) in rare instances (Britton, 2009; Alexander and Marais, 2007). Reports of animals over 7.0m (TL) that have been seen in the wild such as the infamous Gustave in Lake Tanganyika exist but these reports are hard to verify and in fact experts estimate that less than 2% of wild crocodiles in southern Africa exceed 3.0m TL (Alexander and Marais, 2007).

According to Britton (2009) some evidence seem to indicate that Nile crocodiles in cooler areas on the southern edge of their distribution range such as the South African population may reach slightly smaller adult sizes of around 4.0m TL.

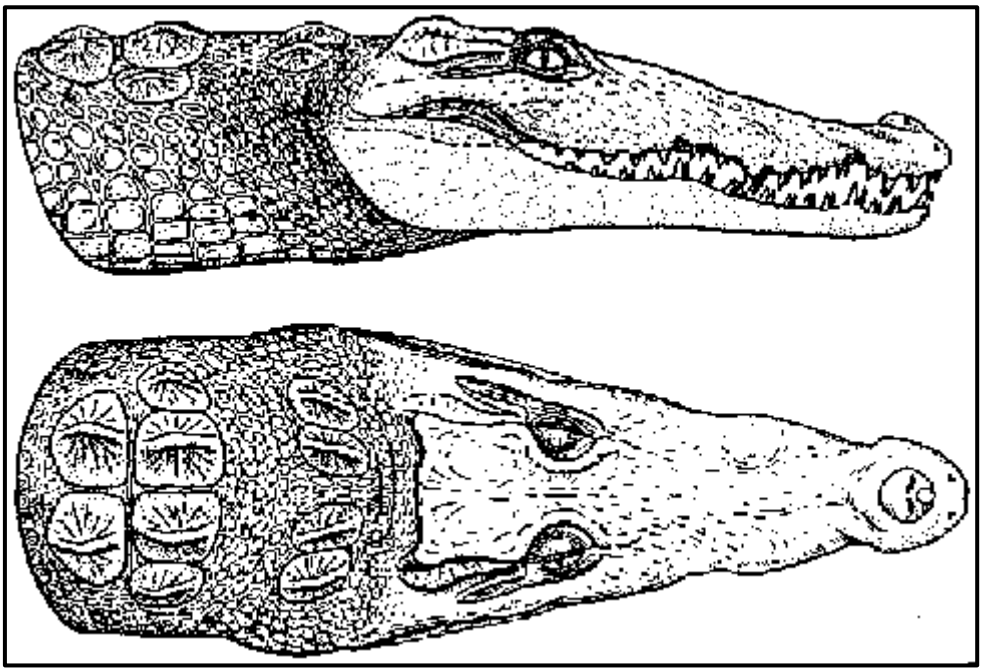

Figure 52: Head shape of the Nile crocodile (Wermuth and Fuchs, 1978).

Nile crocodiles have long snouts with large teeth that are visible even when the jaws are closed (Figure 51). Crocodilian jaws are designed for grabbing and holding prey. The teeth are conical and designed to penetrate and hold, rather than cut and chew. The upper jaw of "true" crocodiles is not as broad as that of alligators and caimans and it is sharply constricted or notched at the snout. In contrast to alligators and caimans, when "true" crocodiles close their jaws the enlarged 4th tooth on the lower jaw rests in that notch, and its tip is clearly visible. This is a major distinction between "true" crocodiles and alligators and caimans (Crocodile Specialist Group, 2009). A total of 64 - 68 teeth (5 pre-maxillary; 13 - 14 maxillary; 14 - 15 mandibular) (Britton, 2009) are set in the jaws. The eyes, nostrils and slit-like ear openings are set high on the head so they protrude from the water when the crocodile floats just beneath the surface of the water in a "minimum exposure" posture giving little indication to potential prey, of the real size of the predator's body (Crocodile Specialist Group, 2009).

Nile crocodiles show wide habitat preferences indicative of their success and distribution - e.g. lakes, rivers, freshwater swamps, and brackish water and is regarded as the top aquatic predator in freshwater ecosystems throughout large parts of Africa (Hutton and Loveridge, 1999). They are strictly carnivorous and relentless predators throughout their entire lives. Sub-adults disperse into different habitats, away from breeding areas, when they reach a length of approximately 1.2m (Hutton and Loveridge, 1999). The absence of Nile crocodiles from moist forests and extensive swamps is strongly linked to the morphological

characteristics of rivers and lakes which have a direct influence on nesting behaviour (Hutton and Loveridge, 1999). Crocodiles are active during both day and night spending most of the day basking to thermoregulate and nights in the water to prevent body temperature from dropping to low. Most of their hunting activities take place during night time.

Crocodilians are efficient and fast swimmers and Nile crocodiles are no exception to this rule. While the hind feet are webbed, the legs play little part in swimming with the muscular, laterally compressed tail (which accounts for 40% of an adult crocodile's length) being used to propel their bodies through the water (Pooley and Gans, 1976). Despite their short limbs, crocodiles are capable of reaching surprising speed over short distances on land. Crocodilians are excellent divers and can remain submerged for up to four hours (Richardson, Webb and Manolis, 2002; Britton, 2009) without needing to breathe. The ability to remain submerged for prolonged periods of time is due to several unique adaptations such as: flexibility and control over blood flow enabling the crocodile to slow down its heart rate and direct oxygenated blood only to organs which cannot function without oxygen (e.g. brain and heart); ear and nostril openings which can be closed with valves; nasal passages that are separated from the mouth by a secondary palate facilitating opening of the mouth underwater; adult crocodiles keep stones in their stomachs to increase specific gravity for easier diving thereby allowing the diving crocodile to take up to 12% more air in its lungs during dives (Alexander and Marais, 2007).

Hatchling Nile crocodiles feed on smaller prey items such as insects, tadpoles, frogs and fish (Allexander and Marais, 2007; Pooley and Gans, 1976). As they grow into juvenile crocodiles their diet changes to include terrapins, water birds and small mammals but by the time they reach adulthood, Nile crocodiles prey mainly on fish, large mammals and birds. Adult crocodiles have the ability to routinely kill large prey such as wildebeest, zebra and even buffaloes but do not lose the ability to feed opportunistically on lesser prey such as frogs, crabs and small fish (Pooley and Gans, 1976). The weight gain of juvenile Nile crocodiles as they grow to adulthood is between 2400 and 4000 fold while the size of their prey increase accordingly (Pooley and Gans, 1976). Crocodiles cannot bite large chunks of meat off their prey like mammalian predators can. Therefore crocodiles have adapted to this inability by grabbing onto their prey and rolling their bodies or simply shaking the prey vigorously until it breaks apart.

Nile crocodiles are capable of cooperative feeding behaviour for example, a number of individuals will hold onto a carcass with their powerful jaws providing anchorage while allowing others to tear of large chunks of prey for easier swallowing (Pooley and Gans, 1976). Another example of cooperative feeding behaviour which has been reported is the action of several animals to cordon off an area of shallow water to concentrate fish in order to entrap them (Pooley and Gans, 1976). Pooley once observed two Nile crocodiles walking overland side by side while carrying the carcass of a Nyala well off the ground between them (Pooley and Gans, 1976).

Female Nile crocodiles reach sexual maturity when they are approximately 2.5m in length which converts to an age group of about 12 - 15 years old. Large territorial males fight for the right to mate with the females who indicates willingness to mate by lifting of the head out of the water and exposing the throat. Mating occurs several times per day over many days at the end of winter/beginning of spring between July and September (Pooley and Gans, 1976). Egg laying takes place about three months later at the start of the rainy season during October to December (Alexander and Marais, 2007; Pooley and Gans, 1976).

Female Nile crocodiles select a nesting site based on a number of environmental parameters which includes, soil type, location on the slope of the shore, incline of the shore, direct sunlight, height above the flood line, vegetation providing shade and the proximity of deep pools of water (Alexander and Marais, 2007; Pooley and Gans, 1976; Swanepoel, 1999). A hole about 300 - 450mm deep is excavated and a number of eggs (anywhere between about 30 to 75 or 80 eggs) are laid in the hole and covered up again with sand excavated from the nest hole. The nesting female protects the nest from predators such as baboons and monitor lizards (*Varanus* sp.) but despite her efforts as many as 50% to 90% of nests are destroyed by predators before hatching (Alexander and Marais 2007). Eggs are white with hard shells and hatch after an incubation period of approximately 90 to 95 days (Pooley and Gans, 1976). Incubation temperature and other factors such as humidity determine the gender of the hatchlings. Eggs incubated at 31°C to 34°C generally develop into males while eggs incubated above or below this temperature range generally

develop into females. During the incubation period, the nesting female evidently does not feed at all and can loos up to 30% of their bodyweight (Pooley and Gans, 1976).

At the end of the incubation period the females open the nest and carry the hatchlings to the water. Both males and females have been reported to assist hatching by gently cracking open eggs between their tongue and upper palate. Hatchlings measure about 250 - 300mm TL when newly hatched and they remain close to the juveniles for up to two years after hatching, often forming a crèche with other females. As with many other crocodilian species, older juveniles tend to stay away from older, more territorial animals.

Nile crocodile used to occur as far south as around East London in the Eastern Cape province but today their southern African range only extend as far south as the Tugela River in the KwaZulu-Natal province and northwards into northern Zululand, Mpumalanga province, North West province, Limpopo province, Mozambique, Zimbabwe, eastern and northern Botswana and Namibia (Alexander and Marais, 2007; Jacobsen, 1988; McLachlan, 1978).

Nile crocodiles are especially dangerous animals to humans and a 3.0m (TL) animal can easily overpower an adult human while smaller crocodiles are known to have caused extensive injuries during attacks on humans. Nile crocodiles have a reputation as being man-eaters much like *Crocodylus porosus,* but according to Britton (2009) Nile crocodiles

are probably responsible for more fatalities of people than all other crocodilian species combined.

THREATS TO THE NILE CROCODILE POPULATION IN THE OLIFANTS RIVER

1. The indirect destruction of habitat caused by the construction of dams and weirs in the upper reaches and catchment areas of the river reducing the amount of water available to the river lower down. This is closely associated with authorities not even allowing the minimum ecological reserve flow through the river especially during the dry season. It is clear from figures in table 1 (Chapter 2) that the water resource of the Olifants River is already heavily over utilised and the situation is only getting worse with more demands for water from the platinum mining industry. The Flag Boshielo Dam was raised intentionally to provide water for mining and the Blue Ridge Platinum Mine near Groblersdal is already demanding more water from Loskop Dam. Providing water for paying customers or providing water for the environment without showing a profit too often becomes the choice. The river system provide some of the most important habitat for crocodiles and monitoring has shown that breeding and nesting do not take place in the main water body of dams but rather in the river itself. During the dry season the lack of water due to dams and weir impeding natural flow may reach critical proportions. The Olifants River in the Kruger National Park is one such example, where the river stops flowing for some months during the dry season.

2. Abstraction of water from the river is a direct threat to the survival of Nile crocodiles in the Olifants River. Pumping water from the river including permanent dry season pools reduces the level of water available to the crocodiles that needs deep pools to thermoregulate and also reduces the food source available to crocodiles in the river and pools.

3. Incompatibility between human activities and Nile crocodiles directly threatens the well being of crocodiles in the Olifants River. On occasion crocodiles take livestock drinking at the river and more frequently take fish from illegal gill nets. Due to the social interaction within the crocodile population many sub-adult animals in the 1.4 - 2.1m (TL) size class leave the river and take up residence in irrigation ponds constructed by commercial farmers thus representing a danger to farm workers. The impact that these crocodiles have on the economic activities (irrespective of the legality of the person's activities at the time) lead directly to a high level of animosity towards all crocodiles which inevitably results in the removal of the crocodile from the system either by killing or capture (both of which are illegal). Dr Niels Jacobsen reported seven crocodiles, all of reproductive age and size, being killed by unknown persons in the Flag Boshielo Dam during the early 1990's (Jacobsen, 1992). Disturbingly, my own studies revealed a total of five male crocodiles most of which were of reproductive age and size (3.10m TL; 4.10m TL; 4.60m TL; 1.50m TL and 3.96m TL) being killed by unknown persons in the

Flag Boshielo Dam during 2002/2003 illustrating human intolerance for these magnificent beasts.

4. The destruction of nests by unknown persons. The height of the nesting season in South Africa coincides with the summer school holidays which are a time when families traditionally spend much time outdoors. Public angling is allowed on private property and in public waters like the large dams in the Olifants River. People typically spend the whole day at one spot next to the water and it often happens that they then spot a Nile crocodile lying in the same place all day, which is of course a female guarding her nest. Whether from boredom, bravery or stupidity the decision to chase the crocodile away is soon reached and the nest discovered and destroyed to "make the angling spot safe for future use"

5. Construction of fishing camps, caravan parks, camping sites, eco lodges and weekend homes. This is mostly done without considering or even studying the ecological impact of the construction and operating phase. These recreational facilities are poorly planned in most cases and based purely on bringing as many people as possible to unspoiled areas at a price. With the exponential increase in people angling at these areas, Nile crocodiles are forced to compete for the food source in terms of fish and this competition is not appreciated by the owners of such places since visitors will only return if the fishing is good. Construction sites are chosen in most cases for easy access

to the river and scenic setting on sandbanks overlooking pools in the river which is exactly where crocodiles go to nest. A returning female looking for a good nesting site and finding a huge building or compacted camping ground in its place is forced to search for and use suboptimal nesting areas with a correspondingly lower chance on hatching success.

6. Boating and recreational activities near nesting areas have a detrimental effect on nesting in those areas. It has been shown that indirect disturbance even by human activities such as camping, fishing and boating are expected to increasingly affect crocodiles (United States Fish and Wildlife Service, 1999; Beacham, Castronova and Sessine, 2000). Observations suggest that repeated close human presence may cause female crocodiles to abandon or relocate their nest sites (Beacham, Castronova and Sessine, 2000). In the Flag Boshielo Dam specific nests located on sandbanks in the dam were used for the first time in nine years when all recreational activities on the dam were banned during construction of the raised dam wall.

7. Raising of dams by the Department of Water Affairs and Forestry impacts severely on Nile crocodile populations in the Olifants River. The incidence of loss of habitat, loss of basking sites, loss of nesting areas and change in prey composition after a dam wall is increased in height is devastating to resident Nile crocodile populations. Three dams in the Olifants River were raised in height and at each site the crocodile population suffered. The Loskop Dam was raised in 1977 which changed the character of the dam

from a winding river-like appearance to flat open water with huge fluctuations in level, all basking and nesting sites in the dam were flooded and crocodiles retreated into the inlets and numbers began to decline seriously. The Flag Boshielo Dam was raised recently (2005) and again all basking and nesting sites where flooded and crocodiles retreated away from the vast expanse of water. Massingire Dam in Moçambique was repaired and increased to full supply level flooding the Olifants River Gorge changing the flowing river into standing slow moving water with increased siltation and a change in prey species composition. This contributed to a massive decline in crocodile numbers from what was once a crocodile haven.

8. Pollution in the upper catchment of the Olifants River has a direct influence on the survival of Nile crocodiles in the river. It has been shown that Nile crocodiles in Loskop Dam died in large numbers due to pansteatis, a disease contracted by predators feeding on rancid fish. It is also know that large fish die-offs occurred at the same time as crocodile die-offs possibly due to the effects of sewage and acid mine drainage into the river. The large scale die-off of crocodiles in the Olifants River Gorge during August and September 2008 was also positively linked to the pansteatitis disease. Blood biochemistry results indicate clearly that crocodiles in these populations suffer from poor health (Chapter 5).

9. Illegal hunting of Nile crocodiles for traditional medicine and to a lesser extent for their skins contributes to the loss of animals in the reproductive size class. Loss of these animals have a profound influence on the recovery of depleted populations making it almost impossible for such populations to recover as can clearly be seen in the Loskop Dam population (Chapter 4)

GOALS AND OBJECTIVES

Goals and underlying principles:

The goal of this conservation and management programme is to provide clear guidelines to ensure the long-term survival and conservation of viable Nile crocodile populations along the entire length of the Olifants River in South Africa while providing for public safety and ecologically sustainable utilisation.

This conservation and management programme is underpinned by the principle that abundant and viable populations of Nile crocodiles should be maintained in the Olifants River for their ecological and economic value whilst at the same time ensuring that crocodiles do not threaten human safety or people's enjoyment of the environment. This conservation and management plan for Nile crocodiles in the Olifants River system embraces the national environmental management principles as set out in the National Environmental Management Act (Act no 107 of 1998).

This conservation and management plan recognises the precautionary principle to ensure that scientific uncertainty will not be used as a reason to postpone management measures aimed at protecting Nile crocodile populations in the Olifants River or their environment.

Objectives:

In the Olifants River in the Mpumalanga and Limpopo provinces the specific objectives of this conservation and management plan are to:

1. Maintain viable wild populations of Nile crocodiles in the Olifants River, in the Mpumalanga and Limpopo provinces at least at current population levels.
2. Maintain, manage and protect Nile crocodile habitat (especially nesting sites) in the Olifants River, Mpumalanga.
3. Promote scientific research and long term monitoring of Nile crocodile populations in the Olifants River, Mpumalanga.
4. Increase public awareness regarding the ecological significance of Nile crocodiles in the Olifants River, Mpumalanga and the need for their conservation.
5. Manage human interaction and contact with Nile crocodiles in the Olifants River, Mpumalanga in order to ensure public safety.
6. Establish co-operative governance with other government departments, conservation organisations, academic institutions and non-government organisations who may have a direct or indirect influence on the Nile crocodile population in the Olifants River,

Mpumalanga (e.g. DWAF, Olifants River Forum, Veterinary Faculty of the University of Pretoria).

MANAGEMENT

Maintain viable wild populations of Nile crocodiles in the Olifants River, in the Mpumalanga and Limpopo provinces at least at current population levels:

1. The maintenance of the Olifants River Nile crocodile population at current levels or above must be a priority for conservation authorities in both provinces.
2. The destruction of habitat is arguably one of the most important factors in the decline of total numbers of crocodile populations in the Olifants River.
3. In terms of the above strategies to replace destroyed habitat by clearing encroached river banks from alien and invasive plants to establish basking sites must be funded and implemented.
4. The construction of artificial nesting areas in locations such as the Flag Boshielo Dam, and the Loskop Dam must be implemented. It should be relatively easy to construct a type of berm near the river bank in areas where crocodiles are frequently seen.
5. Re-introduction of crocodiles to depleted populations must also be considered. Although some experts argue that it will be pointless to re-introduce crocodiles to dams and rivers which are clearly polluted since the odds are against the introduced crocodile

to survive. However, problem crocodiles are in any case doomed and re-introducing them to depleted populations may serve a better cause.

6. The cost of maintaining viable populations and implementing strategies to achieve this should be borne by industries and mining that utilise the water produced by destroying natural habitat and who release pollutant matter into river systems. The "polluter pays" and to coin a new phrase "mega water-user pays" principle should be enforced in this instance
7. Egg harvesting and capture of wild crocodiles for crocodile ranching, although not currently allowed, must be banned until scientific research and long-term monitoring has proved that enough eggs are produced annually in the wild to sustain any sort of harvest and that population numbers are high enough to allow sustainable take off for crocodile ranching.
8. A strategy must be implemented by the two provincial conservation authorities to locate and map all/most nests annually through aerial surveys. These nests must then be tracked and their success/failure noted. If circumstance change to the effect that any nest is threatened (e.g. by development, flooding, dam construction etc) the eggs should be rescued and hatched elsewhere and the young returned to the nest site upon hatching.

Maintain, manage and protect Nile crocodile habitat (especially nesting sites) in the Olifants River, Mpumalanga:

1. The area of the middle Olifants River from Witbank Dam to the international border with Moçambique including the banks of the river for a distance of at least 300m to 500m on each side, must be declared a Protected Environment in terms section 28 (2)(c)(d)(e) of the National Environmental Management: Protected Areas Act (No 57 of 2003) to give some degree of official protection to the area and a basis from which to ensure that development is not done in an unplanned manner.
2. Sandbanks, riverbanks and the riverbed particularly in the critical habitat must be protected from destruction by declining permission for development in these areas especially for the mining of sand.
3. Nile crocodile populations occurring in provincial nature reserves must be protected by ensuring that sensitive areas such as basking, nesting and nursery areas are designated as areas not accessible for public recreation. All declared conservation areas where Nile crocodiles occur should be zoned according to the following principles:

   3.1. The area where crocodiles are most active should be zoned as an **Environmental Reserve Zone.** These areas are critically important to crocodiles because most social interactions such as mating, nesting, establishment of dominance, home range maintenance, hunting etc take place here. Detailed conditions for public access to this area are given in Appendix II.

3.2. The second area (where crocodiles are less active) should be zoned as a **Wilderness Zone** where public access will be strictly controlled. This area is important to crocodiles because most of the secondary important nesting areas and also primary important basking areas occur here. The area could also be joined with the first (Filter/Environmental Reserve Zone) area to form one continuous wilderness area. Public access to this area must be strictly controlled to ensure compliance with both conservation and public safety regulations. Detailed conditions for public access to this area are given in Appendix II.

3.3. The third area (where crocodiles are occasionally active) should be zoned as a **Conservation Zone** because important basking areas will occur here. Detailed conditions for public access to this area are given in Appendix II.

3.4. All other areas which are visited by crocodiles from time to time but which are of minor importance to crocodiles must be zoned as a **Public Access Zone**. Detailed conditions for public access to this area are given in Appendix II.

Promote scientific research and long term monitoring of Nile crocodile populations in the Olifants River, Mpumalanga:

1. A co-ordinating committee must be established between the Mpumalanga Tourism and Parks Agency, Limpopo Department of Economic Development, Environment and Tourism, South African National Parks (as lead agencies), and other departments and

tertiary education institutions who are interested in researching aspects of Nile crocodiles.

2. The functions of this committee will include the coordination and distribution of research results, ensuring that research projects are not duplicated and that therefore funding is appropriately allocated and that monitoring data are shared by all departments who deal with issues impacting on the environment.
3. Any future development projects (industrial, residential, golf estates, mining etc) that make use of the Olifants River in any way or is situated on the banks of the Olifants River must pay a percentage of the total cost of the development into a trust account to fund further research and monitoring of the Olifants River Nile crocodile population.
4. Research and monitoring programmes that must be implemented as a matter of urgency are:
    4.1. Confirmation of occurrence of Nile crocodiles in all waters (river and dams) of Mpumalanga and Limpopo.
    4.2. Crocodile numbers, populations structure and distribution in dams where they occur (spotlight and aerial surveys at least twice a year in January and August, the frequency of surveys can be adjusted after five years if the reliability of data permits changes to the survey frequency).
    4.3. Aerial surveys of rivers in the Mpumalanga and Limpopo provinces to determine numbers, population structure and distribution (possibly number of nests depending on the timing of the survey).

4.4. Identify and map areas of high crocodile population density in the Olifants River

4.5. Determine and map the number of nests per season in the Olifants River.

4.6. Determine and map priority areas of high conservation value for crocodiles in the Olifants River in order to develop specific strategies to conserve the animals and their habitat.

4.7. Identify, quantify and monitor the processes threatening the survival of Nile crocodiles in the Olifants River.

4.8. Determine the movement patterns and spatial requirements of crocodiles over 2.1m (TL) in the Olifants River using satellite, GPS/GSM and radio telemetry.

4.9. Maintain a GIS database for records of Nile crocodiles, their habitat in the Olifants River and all human-crocodile interactions.

4.10. River health surveys (especially in the Olifants River).

Increase public awareness regarding the ecological significance of Nile crocodiles in the Olifants River, Mpumalanga and the need for their conservation:

1. Provincial Nature Conservation Authorities (Mpumalanga and Limpopo provinces) must promote the conservation and management of crocodile populations. The importance of crocodiles and the need to protect their habitat should be widely explained to the general public.

2. Research and long-term monitoring of crocodile populations and river health must be published and promoted in layman's terms to the general public in printed and electronic media.

Manage human interaction and contact with Nile crocodiles in the Olifants River, Mpumalanga in order to ensure public safety:

A need exists and the provincial conservation authorities have an obligation in terms of the South African Constitution (No 108 of 1996) as amended and the National Environmental Management Act (No 107 of 1998) as amended to protect the public from threatening and/or dangerous crocodiles.

Due to the depleted status of most of the Nile crocodile populations in the Olifants River, there is a requirement to release wild crocodiles back into wild populations in support of critical research programmes.

Continual removal of crocodiles from the wild, with no considerations of relocation options is considered to be a negative management strategy which should be abandoned in favour of a more positive approach towards restocking dwindling crocodile populations while the cause of the reduction in numbers are addressed on another level through research and monitoring.

Problem crocodiles:

A crocodile is considered to be a "problem crocodile" if:

- It displays aggressive behaviour towards humans;
- It displays aggressive behaviour towards stock or pets (where adequate control measures are in place e.g. alternative water points, fences and barriers etc)
- It is sighted within 200m of a legally developed public facility and it is over 2.0m in total length;
- It is captured in a trap specifically set for crocodiles with the permission of the provincial nature conservation authority and it is over 2.0m in total length;
- The provincial nature conservation authority through its Chief Executive Officer or Head of Department (or his appointed delegate) considers the crocodile a threat for any other reason.

Removal of problem crocodiles:

Nature Conservation Officers should only remove problem crocodiles from any premises which have been developed or altered from its natural state in any way after the owners/developers have produced a legal document proving that the development was authorised by the competent and relevant provincial and national government departments. If such an authorisation cannot be shown by the owners/developers then the nature

conservation authority must decline to remove the crocodile except where the nature conservation officer on the scene is satisfied that human lives are in eminent danger. Any nature conservation officer who removes a crocodile from any premises where the owners/developers cannot produce a legal document proving that the development was authorised by the competent and relevant provincial and national government departments, must on his return to his office immediately submit a full written motivation explaining his actions to the Chief Executive Officer or Head of Department and the relevant Herpetologist or Specialist Herpetologist in his department.

Problem crocodiles will be captured in a humane way using standard capture techniques (e.g. box trap, Pitman trap, floating trap, netting, noose and rope, fishing pole with braided line and barbless hook), removed from the wild and either relocated or sold to a crocodile farmer or other suitable facility. Crocodiles less than 2.0m (TL) are not considered to be problem crocodiles and must be returned to the wild without delay. Information regarding the species and population must be collected from each crocodile captured to help understand crocodile behaviour and their environmental needs.

The following data must be recorded from each captured crocodile and forwarded to the Herpetologist or Specialist Herpetologist of the relevant nature conservation authority:

- Description of environmental conditions at the capture site;
- Size and gender of the crocodile(s) captured;

- Number and sizes of other crocodiles spotted in the same general area;
- Photographs (preferably digital photographs) of the animal and the site;
- GPS coordinates of the capture site and release site (if released back into the wild);
- A copy of the legal document authorising the development where the crocodile presents a problem;
- If possible, blood or tissue samples taken from the captured animal to monitor pollutant levels and general health of the population.

Problem crocodiles will be disposed of by selling them to licensed crocodile farmers or relocating them to wild populations.

When crocodiles are sold to crocodile farmers the following guidelines should be followed:

- The crocodile farmer must have licensed facilities approved by the relevant nature conservation authority and comply with the South African National Standard (SANS 631) for keeping and transporting Nile crocodiles and with the code of practise of the Crocodile Farmers Association;
- The crocodile farmer receiving the crocodile must pay a predetermined amount the cover the conservation value of the animal lost from the wild population. This amount must be determined by applicable structures in each provincial nature conservation authority (i.e. Financial Manager or Treasury Department in conjunction with the relevant Herpetologist or Specialist Herpetologist);

- The crocodile farmer receiving the crocodile and his/her staff must have proven abilities and experience in the safe handling and managing of crocodiles in captivity, particularly large crocodiles;
- The crocodile farmer receiving the crocodile must agree to hold the crocodile received off display from visitors to the farm for a sufficient time to allow it to be habitualised to captivity and have adequate holding facilities, off display, to hold the animal in isolation while it adapts to captivity
- All relevant information regarding the captured crocodile must be forwarded as described above in the section dealing with data required by the herpetologist or specialist herpetologist of the relevant nature conservation authority.

When releasing crocodiles back into the wild, the following guidelines must be followed:

- Captured crocodiles may only be handled by nature conservation officers;
- The nature conservation officer releasing the animal must confer with the Herpetologist/Specialist Herpetologist of the relevant nature conservation authority regarding the most acceptable site for release;
- Any crocodile handled after capture must have its jaws restrained by using duct tape or electricians tape;
- The crocodile must ideally be taken directly to the release site and not be transported to holding pens or isolation ponds before release;

- At the release site the animals must be placed a maximum of a couple of paces from the water's edge and must be released facing the water;
- The release is the most dangerous time when handling a crocodile and as such crocodiles may only be released by nature conservation officers with proven experience in the capture and release of crocodiles;
- Nature conservation officers experienced in handling large crocodiles must make sure that all restraints are removed from the jaws of the animal prior to release;
- The release site must be at a location with water deep enough for the released animal to submerge immediately after release (this will assist with calming the animal down and to avoid further capture stress);
- The number of persons involved in the capture and release process must be strictly limited to ensure safety and to restrict noise during the release.
- All relevant information regarding the captured crocodile must be forwarded as described above in the section dealing with data required by the herpetologist/specialist herpetologist of the relevant nature conservation authority.

Icon crocodiles:

An "icon crocodile" is defined as a problem crocodile that is four metres or more in total length or if less than four metres in total length has unusual characteristics such as albinism for example.

Icon crocodiles can represent a significant commercial benefit to a crocodile farm, crocodile centre or zoo. However, icon crocodiles also present an exceptional opportunity to achieve educational, public awareness, scientific and conservation outcomes for crocodiles and crocodile habitat. Therefore, the decision as to how and where to dispose of such an exceptionally large crocodile must be based on scientific input. The herpetologist/specialist herpetologist of the applicable nature conservation authority will be required to motivate the disposal of such an animal and will be required to decide on returning the crocodile to the wild to supplement dwindling populations/size classes in populations or to sell the crocodile to a crocodile farm, crocodile centre or zoo. Any such motivation or decision must receive final approval from the Chief Executive Officer or Head of Department of the relevant nature conservation authority before implementation.

In the event that a decision is reached to sell the icon crocodile, the nature conservation authority will request written offers from selected licensed crocodile farms, crocodile centres and/or zoos chosen to buy the crocodile. The crocodile farms, crocodile centres and/or zoos chosen approached in this instance will be identified on the basis of the following guidelines:

- The crocodile farmer must have licensed facilities approved by the relevant nature conservation authority and comply with the South African National Standard (SANS

631) for keeping and transporting Nile crocodiles and with the code of practise of the Crocodile Farmers Association;

- The crocodile farmer receiving the crocodile must pay a predetermined amount the cover the conservation value of the animal lost to the wild population. This amount must be determined by applicable structures in each provincial nature conservation authority (i.e. Financial Manager or Treasury Department);
- The crocodile farmer receiving the crocodile and his/her staff must have proven abilities and experience in the safe handling and managing of crocodiles in captivity, particularly large crocodiles;
- The crocodile farmer receiving the crocodile must agree to hold the crocodile received off display from visitors to the farm for a sufficient time to allow it to be habitualised to captivity and have adequate holding facilities off display to hold the animal in isolation while it adapts to captivity
- All relevant information regarding the captured crocodile must be forwarded as described above in the section above dealing with data required by the herpetologist/specialist herpetologist of the relevant nature conservation authority.

Once an offer from a crocodile farm, crocodile centre or zoo to buy the icon crocodile is accepted by the nature conservation authority the buyer will be informed and required to collect the animal within 48 hours or the transaction will be cancelled and the animal forfeited.

The nature conservation authority will retain the right to release the icon crocodile back into the wild at the most appropriate location if none of the offers received are regarded as fair.

High risk crocodile nests:

Nile crocodile nests in the Olifants River that are threatened by imminent danger must be considered as high risk nests and should be rescued. The "high risk status" of nests must be measured against a number of criteria but only one of these criteria need to be present for the nest to be considered under high risk of destruction. Nests must be assessed for their risk of destruction no later than November/December each year. However, if conditions at the nest have improved at the time of the planned egg collection to such an extent that the high risk category does not apply any longer, egg collection should not proceed. Rescued eggs must be taken to a reputable crocodile farm or crocodile centre to hatch and hatchlings must be returned to the river upon hatching.

Previous policies suggested that hatchlings be reared by the crocodile farm until they reach a total length of 1.0m before they are released back into the wild. However, since we do not know how many crocodiles from nests will survive to 1.0m length, the impact of releasing a large number of 1.0m long crocodiles from rescued eggs than would normally not have survived could potentially be ecologically disrupting. It is therefore recommended

that hatchling crocodiles are released back into the wild as close to the nesting site as possible as soon as they hatch.

Criteria for crocodile nests to be considered in high risk of being destroyed:

- The nest has no protection (vegetation or inlet etc) against wave action from the river or dam within 25m where it is located.
- The nest is located so low that it will be flooded by a 10cm rise in groundwater level. The average nest depth is 40cm and therefore if the water level is within 50cm of the surface the nest must be regarded as high risk. Groundwater levels can be checked by digging a hole within 0.5m of the nest.
- The nest is situated on a site where there is an 80% probability that it may be flooded by a sudden rise in water levels for example due to imminent flooding or heavy rain falls.
- The nest is situated in an area where there is constant daily threat by people or stock animals in a manner that cannot be controlled by the relevant nature conservation authority.
- The nest is situated in soil that is so impervious that the eggs will be saturated by heavy rain falls.
- The nest is situated in an area where legal authorisation has been given by the relevant competent environmental authorities for development (lodge, sand mining camping area etc) to take place and construction is about to commence.

Establish co-operative governance with other government departments, conservation organisations, academic institutions and non-government organisations who may have a direct or indirect influence on the Nile crocodile population in the Olifants River, Mpumalanga (e.g. DWAF, Olifants River Forum, Veterinary Faculty of the University of Pretoria).

1. Provincial Nature Conservation Authorities (Mpumalanga and Limpopo provinces) must be included in decision making process of the Department of Water Affairs and Forestry regarding the allocation and abstraction of water from the Olifants River (and other rivers) as well as future plans to construct dams in the Olifants and other rivers. This process is not designed to put nature conservation in a regulating position over other departments but is important to ensure the viability of the Olifants River for future generations since different departments have different views on the meaning of sustainability and viability of rivers. Because this co-operation is so important and could easily be misinterpreted, it must be agreed upon at top management level for all departments involved (i.e. Director General of Department of Water Affairs and Forestry; Chief Executive Officer of Mpumalanga Tourism and Parks Agency; Head of Department of Limpopo Department of Economic Development, Environment and Tourism).
2. Provincial Nature Conservation Authorities (Mpumalanga and Limpopo provinces) must be involved with the National and Provincial Agriculture Departments to promote soil

and water conservation especially in cases where the control of irrigation and clearing of land for agriculture is involved

3. Provincial Nature Conservation Authorities (Mpumalanga and Limpopo provinces) must be involved with the Department of Minerals and Energy particularly on the Regional Mining Development Committee (RMDEC) to promote better understanding when evaluating applications for sand mining in riverbeds, sandbanks and riverbanks.

REFERENCES

ALEXANDER, G. and MARAIS, J. 2007. *A guide to the reptiles of southern Africa*. Struik Publishers, Cape Town.

BEACHAM, W., CASTRONOVA, F.V. and SESSINE, S. 2000. American crocodile. In: *Beacham's guide to the endangered species of North America.* Thomson Gale, Farmington Hills, Michigan.

BOLTON, M. 1989. The management of crocodiles in captivity. *FAO Conservation Guide 22*. Food and Agriculture Organization of the United Nations, Rome.

BOURQUIN, S.L. 2007. *The population ecology of the Nile crocodile (Crocodylus niloticus) in the Panhandle Region of the Okavango Delta, Botswana.* PhD Thesis. University of Stellenbosch.

BRITTON, A. 2009. *Crocodilian species list,* viewed 07 April 2009, http://www.flmnh.ufl.edu/cnhc/csp_cnil.htm/

BRITTON, A. 2009. *Crocodilian biology database,* viewed 07 April 2009, http://www.flmnh.ufl.edu/cnhc/csp_cnil.htm/

CROCODILE SPECIALIST GROUP. 2009. *Crocodilian biology,* viewed 08 April 2009, http://www.iucncsg.org/ph1/modules/crocodilians/

DEPARTMENT OF CONSERVATION AND LAND MANAGEMENT. 2003. Saltwater crocodile (*Crocodylus porosus*) and freshwater crocodile (*Crocodylus johnstoni*) management plan for Western Australia 2004 - 2008. Unpubl Report, Department of Conservation and Land Management, Perth.

DEPARTMENT OF NATIONAL PARKS AND WILDLIFE. 1992. Management plan for crocodiles in Zimbabwe. Unpubl. Report, Department of National Parks and Wildlife, Harare.

DEPARTMENT OF WILDLIFE. 1993. Policy and management plan for the Nile crocodile. Unpubl. Report, Department of Wildlife, Dar es Salaam.

HUTON, J.M. and LOVERIDGE, J. 1999. *Resolving conflicts between Nile crocodiles and man in Africa.* Resource Africa, Cambridge, UK, viewed 07 April 2009, http://www.resourceafrica.org/documents/1999/1999_nile_crocodiles.pdf

JACOBSEN, N.H.G. 1988. The Nile crocodile. In: *South African red data book – reptiles and amphibians. South African National Scientific Report No 151*. Edited by W.R. Branch. CSIR, Pretoria.

JACOBSEN, N.H.G. 1992. Conservation plan: *Crocodylus niloticus.* Unpubl. Report, Chief Directorate of Nature and Environmental Conservation, Pretoria.

McLACHLAN, G.R. 1978. *South African red data book – reptiles and amphibians. South African National Scientific Report No 23*. CSIR, Pretoria.

NORTHERN TERRITORY GOVERNMENT. 2005. Management plan for *Crocodylus porosus* in the Northern Territory 2005-2010. Unpubl. Report, Department of Natural Resources, Environment and the Arts, Palmerston.

PARKS AND WILDLIFE COMMISSION OF THE NORHERN TERRITORY. 2005. A management program for *Crocodylus porosus* and *Crocodylus johnstoni* in the Northern Territory of Australia. Unpubl. Report, Parks and Wildlife Commission of the Norhern Territory, Palmerston.

POOLEY, A.C and GANS, C. 1976. The Nile crocodile. *Scientific American,* 234: 114-124.

QUEENSLAND ENVIRONMENTAL PROTECTION AGENCY. 2007. Nature Conservation (estuarine crocodile) conservation plan 2007 and management plan 2007 - 2017. Unpubl Report, Queensland Government, Brisbane.

RICHARDSON, K.C., WEBB, G.J.W and MANOLIS, S.C. 2002. *Crocodiles: Inside out a guide to the crocodilians and their functional morphology.* Surrey Beatty and Sons, Chipping Norton.

ROSS, J.P. (ed.) 1998. *Crocodiles. Status survey and conservation action plan.* 2nd edition. IUCN/SSC Crocodile Specialist Group. IUCN, Gland, Switzerland.

SABAH WILDLIFE DEPARTMENT. 2002. Management plan for *Crocodylus porosus* in Sabah, Malaysia. Unpubl Report, Sabah Wildlife Department, Kota Kinabalu, Sabah (Malaysia).

SWANEPOEL, D.G.J. 1999. *Movements, nesting and the effects of pollution on the Nile crocodile Crocodylus niloticus in the Olifants River, Kruger National Park.* M.Sc. thesis. University of Natal.

UNITED STATES FISH AND WILDLIFE SERVICE, 1999. American crocodile. In: *Multi species recovery plan for South Florida.* U.S. Fish and Wildlife Service, Atlanta, Georgia.

WERMUTH, H. and FUCHS, K. 1978. *Bestimmen von krokodilen unter ihrer haute.* Gustave Fsicher Verlag, Stuttgart.

WHITAKER, R. 2007. Sustainable use of the Lake Chamo Nile crocodile population. Unpubl. Report, African Parks, Addis Ababa.