AMENDMENTS TO APPENDICES I AND II OF THE CONVENTION

Proposals Submitted Pursuant to Resolution on Ranching

A. PROPOSAL

Maintenance in Appendix II of the Malawian population of <u>Crocodylus</u> niloticus.

B. PROPONENT

The Republic of Malawi.

- C. SUPPORTING STATEMENT
 - 1. Taxonomy
 - 11. Class: Reptilia
 - 12. Order: Crocodylia
 - 13. Family: Crocodylidae
 - 14. Species: Crocodylus niloticus

15.	Common	Names:	English:	Nile	croco	di]	le
			French:	croce	odile	du	Nil
			Spanish:	Cocod	lrilo	de	Nilo

2. Biological Data

21. <u>Background</u>: Historically, commercial crocodile hunting in Malawi has been undertaken since the first settler arrived in the country. Prior to 1948, there was no control by the Government over the hunting of the crocodile. In 1948, in a bid to manage the resource so that it remained sustainable, the Government undertook to regularize the harvest by instituting a quota system and restricted hunting in Lake Malawi and the Shire River. Since then, the species utilization has been sustainable, (Table 1).

Malawi's population of the Nile crocodile was transfered to Appendix II in 1985 subject to an annual export quota of 500 skins per year as provided for through Resolution Conf. 5.21. Increased quotas for 1988 (1,000 skins) and 1989 (1,300 skins) were approved in 1987 and provided for a consistent off-take from the wild of 700 animals per year. An increase in these quotas (to 1,700 specimens for 1988 and 2,300 specimens in 1989) was approved by the Parties by postal vote in November 1988 to allow for the export of additional skins from ranching operations. The proposal is to maintain the Malawian population of <u>Crocodylus</u> <u>niloticus</u> in Appendix II pursuant to Resolution Conf. 3.15. As Malawi's population is currently in Appendix II subject to a quota, the proposal calls for the maintenance of the country's entire population in Appendix II.

22. Distribution: Surface water resources in Malawi are abundant. To give an idea of the extent of its abundance the total annual run-off from rivers in Africa draining to the Indian Ocean is

421 x 10^9 m^3 . Of this figure, the Zambezi River with a catchment area of 1,330,000 square kilometers, has a mean annual run-off of 106 x 10^9 m^3 . Malawi with a catchment area of 94,276 square kilometers has a mean annual run-off of 19 x 10^9 m^3 , (Nsanjama, 1988).

Pike and Rimmington, (1965) consider that the drainage system of Malawi may be divided into two: the Lake Malawi/Shire River system occupying the Rift Valley trough flanked by the river systems that drain them, and the now endoreic system of Lake Chilwa lying completely outside the Rift Valley system. Lake Chilwa lies to the East of the Shire Highlands and probably at one time formed the headwaters of the Lujenda River in Mozambique, flowing North-wards to join Rovuma in the United Republic of Tanzania.

Malawi has a total geographical area of 118,484 square kilometers of which the land area is 94,276 kilometers with the lakes occupying 24,208 square kilometers. The drainage system has been divided into 17 Water Resource Areas (WRA). Each WRA lies in a specific geological and topographical feature that yields a specific run-off. A combination of available water and its accessibility, amount of annual rainfall, soil conditions and availability of essential social services, for example, hospitals and schools, have determined the human population distribution in the WRAs. From an available surface water of about 588 m^3 s⁻¹ per annum, 220.472 m³ s⁻¹ is acctually used. Out of this, 185.045 m³ s⁻¹ is non-consumptive (Nsanjama, 1988). Difficulty of access to the water and other constraints are some of the reasons for such a low level of water use. As a consequence of this, the human population of Malawi is seen to be restricted to a land area that is less than 22,000 square kilometres out of the total land area of over 94,000 square kilometers. The Malawi crocodile populations, therefore, have never been threatened and sustainable utilization has been possible since 1948. Additionally, a review of the geology of Malawi shows that Malawi is mostly underlain by impervious rocks, therefore, seepage is limited thus creating an ideal habitat for the species.

Information on the distribution of the species is obtained from annual returns of the hunters (Table I) and the survey carried out by Mphande, 1986 (Annex I).

23. Population: Near to accurate estimates of the Nile crocodile in Malawi are difficult to achieve. Access to most habitat is difficult. Mphande (1986) attempted to enumerate the species but due to problems of access and other logistics he only carried out a partial census.

Anon. (1986) estimated that the population of the Nile crocodile in 1984 was about 23,300. Mphande (1986) gives a minimum population of 4,600 with an upper limit of 15,000, (Annex I). However, due to difficulty of accessibility Mphande's working population is 8,000 crocodiles.

The World Conservation Monitoring Centre in assessing Malawi's quota for 1987 had considered Mphande's 1986 population estimate and thought it was adequately conservative. King in his review of the proposal submitted in 1988 for vote by postal procedures, had indicated that it may well be considerable under-estimate.

Mphande (1986) estimated a minimum figure of 640 animals for recruitment into the wild per annum. This is deemed inflated. Mphande based his estimates on the following assumptions:

- a standing crop of 8,000 animals;
- the existence of a 1:1 sex ratio;
- that 20 percent (800) of the 4,000 females are sexually mature adults and that they all breed annually;
- that the mean clutch size for 800 nesting females is 40 thus producing 32,000 eggs per year; and
- that 2 percent of all eggs laid produce animals that survive to maturity (i.e., 2% x 32,000 = 640).

King (in comments from IUCN on the Transfer from Appendix I to Appendix II of <u>Crocodylus niloticus</u> pursuant to Resolution Conf. 3.15 on Ranching in Malawi, 1989) stated that while the population estimate of 8,000 is appropriately conservative and the sex ratio is plausible, he feels that 20 percent of the females in the population are not likely to be sexually mature and doubts that all those that were nest every year. King believes that estimates were inflated due to failure to weight size composition for size/age class distribution. King cited Chabreck who compared the Nile crocodile and the alligattor Alligator mississippiensis that nesting adults indicate that sexually active females comprise no more that 3 percent of the population and that only 5 percent of the population were nesting adults.

Strover (Annex II) shows that the average clutch size in Malawi is about 35 even though King cites Cott (1961) that the average clutch in Zambia is 56,2 eggs. Based on the conservative population of 8,000 animals, using the 2 percent figure suggested by Mphande for the survival rate and revising the figures used in assumptions that 3 percent of the standing crop population is represented by breeding females ($3\% \times 8,000 = 240$). Assuming that the average clutch contains 35 eggs, the annual recruitment into adult wild population is:

240 nests x 35 eggs each = 8,400 eggs per year x 2% survival to maturity = 168 animals.

Until such a time when more reliable data is available, 168 animals should be the basis for establishing a quota for Malawi.

24. <u>Habitat</u>: While an increase in human population has an impact on crocodile habitat especially with regard to nesting sites, there is still a lot of suitable habitat for crocodile. Surface water resources in Malawi is abundant and has minimal use by humans due to problems of accessibility and other logistical problems. This trend may remain the same for a long time because the Government of Malawi recently is inclined more on intensive rather than extensive use of the natural resources base.

The strongholds for crocodiles in Malawi are mainly the swamps. Because of the health hazards associated with these areas, swamps are generally avoided for human settlement. For the long term survival of the species in the sild, the crocodile are protected in Liwonde and Lake Malawi National Parks and in Nkhotakota, Vwaza and Majete Game Reserves. Here the species is completely protected except in defence of human life.

- 3. Trade Data
 - 31. <u>National Utilization</u>: The Dwangwa Crocodile Ranch was authorised to collect eggs from the wild from 1984 in order to allow them to start the ranch. An annual limit of 2,000 eggs was imposed. This limit was reduced in 1986 to 1,600 eggs.

Malawi currently has 13 licensed crocodile hunters whose hunting areas cover the Lakes Malawi and Malombe, the Shire River and the adjoining Ndinde and Elephant Marsh (Fig. 1). Each hunter has a well defined area in which he is allowed to hunt.

Table I is a compilation of trade in crocodile specimens from Malawi. The projected export for 1989 are 700 from the wild and 1,600 from the Dwangwa Ranch.

32. Legal International Trade: In Malawi there is only one legal trader in crocodile skins - the Cold Storage of Malawi - a parastatal corporation. The decision to have a single dealer was designed to curtail illicit trading.

No sale of live crocodile is currently allowed in Malawi.

- 33. Illegal Trade: The fact that there is only one dealer in crocodile skins has resulted in no illegal traders in the product. The Government has not picked up any signs of illegal trade since 1967 when the decision to have a single trader was adopted.
- 34. <u>Ranching</u>: Malawi has one very active ranch operated by the Dwangwa Sugar Corporation in Nkhotakota. Another ranch is being established in Mangochi. Malawi has potential for more ranches.

The Dwangwa Ranch started as a pilot scheme in crocodile ranching in Malawi to encourage ranching so as relieve pressure on the wild population. However, the welfare of the animals has to be taken into consideration. This is why the ranch started as a pilot project on which basis future government policies on ranching would be based. So far the Dwangwa Ranch has done extremely well (communication from Hutton, 1988). The ranch aims at a production rate of 1,600 hatchings per year.

A similar number will be disposed annually. In 1988 the ranch exported 700 skins to Italy. In 1989 they expect to export 1,600 skins.

The hatching on the ranch is over 80 per cent. Once hatched, the mortality rate of the hatchlings is 5 per cent. The ranch therefore, is very successful, (Appendix II).

Initially the ranch depended on the wild population for egg production. To meet production of 1,600 hatchlings a year, they would need to collect about 1920 eggs with a hatching success of 80 per cent. The impact of this level of egg collection on the

wild population would be detrimental. About 55 nests with an average clutch of 35 eggs would be excavated. Having realized this conservation hazard, the ranch has established its own breeding stock of 8 females. The balance is still being supplemented from the wild. The ranch is however, endeavouring to be self-sufficient in egg production.

Where the ranch has used eggs from the wild, it is a requirement that 5 per cent are returned to the wild as a means for contributing to the stability of the wild population. Only 15 crocodiles have been returned to the wild. In future this mandate will be enforced.

4. Export Quota

Malawi's crocodile population is very stable with a minimum recruitment of 168 per annum which is on extremely lower side. The figure is on the lower side because the data used is believed to be an under-estimate due to a sample error which might have been introduced because the census was only partial. In 1988 Malawi was allowed to export 700 crocodile skins harvested from the wild while another 700 skins were collected from the ranch. In 1989 another 700 skins were allowed to be harvested from the wild and the quota from the ranch was raised from 700 to 1,600 skins.

The current proposal requests that the Malawi population of the Nile crocodile <u>Crocodylus niloticus</u> be maintained in Appendix II subject to the following quotas: 250 skins harvested from the wild subject to revision in the light of adequate and reliable census undertaken in the future. And quota of 1,600 from Dwangwa Ranch also subject to revision in the light of another ranch being developed and fulfilling the conditions under Resolution Conf. 5.15 on ranching.

While it is realized that in accordance with the available data, the recruitment rate is calculated at 168 per annum, cognance is taken that the estimate of 8,000 is extremely conservative therefore, an allowance of 32 skins is given and 25 skins have been allowed for marauding crocodiles that might not be captured by ranching operations.

Malawi's major market for crocodile skins has been France, Italy, Federal Republic of Germany through agents in Zimbabwe. Currently, the export of wild skins is carried out by a Government parastatal organization - the Cold Storage. This has enable strict control which has included the physical tagging of skins by a member of the Department and the centralization of export documentation at the Department's headquarters.

5. Potential Trade Threats

- 51. <u>Live Specimens</u>: No trade in live specimens is allowed and therefore there is no threat.
- 52. Parts and Derivatives: The Crocodile Act of the Laws of Malawi Cap. 66:06 which came into effect in 1968 states that no person may hunt, rear, or be in possession of any crocodile or crocodile products unless he is the holder of a valid licence or permit issued by the Minister responsible for the administration of the Act. The number of crocodiles shot in the wild is controlled by a CITES quota system.

Except for the ranch, all skins are exported and monitored by a centralized system, and no evidence that illegal trading in parts and derivatives of the crocodile exists. The situation in Malawi, therefore, signifies a continued propagation of the wild and ranched crocodiles for a continued sustained utilization.

6. Protection Status

61. <u>National:</u> The Nile crocodile in Malawi is protected by the Crocodile Act of the Laws of Malawi.

Collection for export of the ranched and wild stocks is by a CITES quota system and therefore, skins collected outside the quota may not enter the international market. Utilization of parts and derivatives inside Malawi is virtually non-existent and, therefore, poaching on crocodile has not been detected during the last 10 years.

In national parks, game and forest reserves crocodiles are completely protected from hunting and collection of eggs except by authority of the responsible Minister. Such authority is only granted where it is established that the objective of the hunting or egg collection is in conformity with the primary conservation goals of the species.

- 62. International: Malawi is a Party to CITES and therefore requires that all crocodile skins be accompanied by the appropriate CITES documentation and each skin be individually marked by a special CITES tag.
- 63. Additional Protection Needs: Once the ranches are fully fledged, all marauding crocodiles will be captured and taken to ranches for breeding purposes. Otherwise currently additional protection not necessarly.
- 7. Information on Similar Species

Only the Nile crocodile occurs in Malawi.

8. Comments from Countries of Origin

In 1983 the Zimbabwe's crocodile population was downgraded to Appendix II. Principally, in the SADCC states (except Lesotho and Swaziland) there is a concensus that the Nile crocodile be downgraded to Appendix II. Malawi, Mozambique and Zambia previously submitted ranching proposals for their populations of the species.

This is a dependable indication that the crocodile population in this region is health and, therefore, calls for the listing down to Appendix II.

9. Additional Remarks

The ranching of crocodile in Malawi which started in 1984 as a pilot project at Dwangwa Sugar Corporation has been a success and therefore more ranches must be encouraged. Even though returning to the wild of the successfully hatched animals has not been observed in the past, this undertaking is useful for the continued propagation of the wild stock since it is stated elsewhere that of the eggs hatched in the wild only 2 percent reach maturity. Return to the wild is between 5 and 10 percent.

Presently, the crocodiles in Malawi are protected under the Crocodile Act which is administered by the Departement of Fisheries. This anomally has for a long time been a matter of concern by the Government. The new National Parks and Wildlife Legislation (presently being vetted by the Officer of the Attorney General and Secretary for Justice before it is sent to Parliament), incorporates the crocodile.

10. Government Policy on Crocodile

The provisions of the Crocodile Act have been translated into a national policy. The official government policy with regard to crocodile is as follows:

- a) To so manage the exploitation of crocodiles in Malawi that;
 - i) human life is not put at undue hazard;
 - ii) the development of its fisheries is not hampered;
 - iii) the maximum sustainable return in forms of value of skins exported, compatible to (i) and (ii) above, is achieved and;
 - iv) the crocodile is preserved from extinction (Anon., 1973).

The Department of Fisheries in its statement of Development Policy for 1986 - 1995 has committed itself to expand and develop the supply of crocodile skins for export. The goal of the policy is to assess and achieve the maximum sustainable return from export of crocodile products, (Anon., 1986).

11. Tagging System

Under the CITES quota system, Malawi has enjoyed the cropping from the wild and ranch of crocodiles for export to the international markets. An officer from the Departement has physically put the tags on the skins and documentation has been centralized from the Departement headquarters. This tagging system has proved to be effective and it is the whish of Malawi that the system be continued if the Parties to the Convention will support Malawi's proposal.

12. Rationale for Proposal

In the recent times there has been pressure from national governments for the need for justification for the conservation of wildlife resources not only in terms of social, cultural and ethics but also in economic terms. It is also the belief of most conservation government departments that this move is the only long term rationale that will ensure the long term survival of most wildlife species, particularly in Africa.

In Malawi, this role can adequately be fulfilled by the crocodile according to the available data and findings. Particularly, the ranching aspects of the species not only bring into Malawi an economic aspect but also continued propagation of the species in the wild.

13. References

Anonymous. Various correspondences from the CITES Secretariat.

Hutton, J., 1987/89. Various personal communications and letter/correspondences.

IUCN, 1989. Transfer from Appendix I to Appendix II of Crocodylus niloticus pursuant to Resolution Conf. 3.16 on Ranching in Malawi - Comments on 1st proposal.

Mphande, J.N.B., 1987. Status of the Nile Crocodile in Malawi.

Nsanjama, H., 1988. An Overview of Surface Water Resources and Potential for Development in Malawi.

Strover, P.M., 1987/89. Various communications and letters/correspondences.

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TABLE 1: TRADE STATISTICS FOR CROCODILE SKINS : 1976 TO 1985 K = MALAVI - KWACHA : +INCLUDES 211 PIECES

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STATUS OF THE NILE CROCODILE IN MALAWI

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ABSTRACT

The status of the Nile crococile (<u>Crocodylus niloticus</u>, in Malawi is summarized. Legal protection, nabitat, government policy and utilization patterns are discussed. The population of corcodiles is estimated at a minimum of 4,600 with an upper limit of 15,000. Due to the unreliability of the estimate method arising from different biases, a working population of 8,000 is used to determine the sustainable offtake from the wild population. An analysis of the hunting the past reveals that the population bas been stable conservation and management of ensure survival of the species are discussed and six recommendations are made.

INTRODUCTION

(a) Background Information

(i) Legal Protection

The Nile crocodile (<u>Crocodylus niloticus</u>) is protected under the Crocodile Act (Laws of Malawi Chapter 66:06) which came into effect in 1988. The act replaced the Crocodile Ordinance of 1951. Under the Crocodile Act no person may hunt, rear, or be in possession of any crocodile or crocodile product, or import, or export any crocodile product unless he is the holder of a valid permit issued by the Minister of Forestry and Natural Resources. The day-to-day administration of the Act is under the charge the Chief Fisheries Officer.

The Crocodile Act does not provide for the setting aside for the protection of crocodile habitat. This aspect is taken care of by the other Acts such as the Game Act, National Parks Act and Forestry Act which provide for setting aside game reserves, national parks, and forest reserves respectively. In such areas the Nile crocodile is completely protected and any habitat contained is also protected.

(ii) Government Policy on Crocodiles

The provisions of the Crocodile Act have been translated into a national policy. The official Government policy with regard to crocodiles is as follows:

(a) to so manage the exploitation of crocodiles in Malawi that:

1. human life is not put at undue hazard,

2. the development of its fisheries is not hampered,

3. the maximum sustainable return in forms of value of askins exported, compatible to (1) and (2) above, is achieved, and

4. The crocodile is preserved from extinction in (Anon. 1973).

The Department of Fisheries in its statement of Development Policy for 1986-1995 has committed itself to expand and develop the supply of proceedile skins for export. The policy goal is to assess and then achieve the maximum sustainable return from export of proceedile products (Anon. 1986).

' .b. Current Trends

(i) Habitat

As aforementioned, the Crocodile Act does not provide for habitat protection hence the only places where crocodile habitat is protected is in national parks, game and forest reserves. However, the Nile crocodile is widely distributed throughout the country. In most cases crocodile conservation is direct competition with other forms of land use such as agriculture and fisheries. Crocodile need sand banks as nesting sites but the same sites are required as bota yards by fishermen. In marshy areas crocodiles need the islands as nestsing sites but these are required for "Dimaba" cultivation (dry season cropping). For example in Lower Shire Valley dimba land supplies a considerable proportion of total food production and it appears that dimba production is increasing in importance (Freeman, 1974). The importance of dimba land lies in the fact that it enables the food supply to be spread over a greater part of the year. This form of cultivation is definitely vital and with increasing human population the demand of islands in the marsh is also increasing. 1

(ii) Crocodile Utilization

The primary concern in crocodile utilization is that the exploitation of crocodiles is managed so that human life is not put at undue hazard. In comformity to this concern crocodile utilization in Malawi has moved from an open hunting policy in the early 1970's to controlled hunting in the late 1970's. In 1971 following a major concern in tourist development on Lake Malawi particularly with respect to water sports, it was decided to exterminate crocodiles from all tourist areas on Lake Malawi (Anon. 1971). The size limit on crocodiles to be taken was lifted in these areas consequently a large number of hornbacks were sold in the early 1970's. Having reduced the crocodile population significantly in the tourist areas controlled utilization was reinstituted and the size limit of 5 ft (152 cm) was reinforced. Currently the number of hunters and areas in which they hunt is defined. The number of crocodiles taken by each hunter is also limited in conformity with the hunting quota established under CITES. However, where human life is at stake the hunting quota may be evershot.

This Paper's Objecive

This paper aims at summarising the current state of affairs of the Nile crocodile in Malawi with recommendations for its better management. The facts presented here are from a field survey conducted between September and October, 1985 and inspection of records held at the Fisheries Department Headquarters and the Headquarters of National Parks and Wildlife Department.

CROCODILE POPULATIONS

Two types of crocodile populations are recognised viz. Wild populations and ranched populations. These two types of populations are dealt with separately.

(a) Wild Population

(i) **Estimates**

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The survey area was divided into different segments based on the habitat type, settlement patterns, and utilization level. There are two basic components: the Lake and the rivers. The lake was divided into rocky shoreline and clear or marshy shoreline. The two subdivisions were further subdivided on basis of settlement. The rivers were further divided into clear shoreline and marshy shoreline. Further subdivisions were patterns and utilization level.

Crocodiles were counted from a boat at night using a spotlight. All crocodiles spotted (crocodile eyes gives a deep red shine in the light) on a stretch of shoreline were recorded and a sighting rate determined. The stretches surveyed were stratified so that as many habitat types as possible were surveyed during the study. The choice of survey areas was done from 1:250,000 topographic maps. Determination of similar habitat gypes and settlement patterns was also done from the topographic maps. Distance used in the sighting rate determination are map distances.

RESULTS

The results of the survey are given separately for each of the three regions of the country.

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1. Southern Region

(a) The Lake

Only the rocky shoreline between Golden Sands Camp Site to the mouth of Lisangadzi river was surveyed. No crocodiles were seen on this stretch.

It was planned to survey the area between Matewele (where the Shire leaves the lake, to Club 's all's is all segment was not sampled due to bad weather. The segment would have represented clear shoreline with heavy settlement.

On the western arm of the lake the plan was to go as far down as Malombe to cover shoreline with light settlement. This segment was not fully covered due to the distance involved.

A survey was carried out on the Shire between Matewele and Mangochi Bridge covering one shoreline at a time. On the eastern shoreline 15 crocodiles were counted giving a sighting rate of 1.5 crocodiles/km.

On the west shoreline the sighting rate was 1 crocodile(km. The eastern shoreline is lightly settled while the west is heavily settled. The shorelines are generally marshy. In the absence of figures for the lake the river sighting rates have been used to estimate the population on the lake shore.

From Boundary Pillar 17 to the mouth of river Shire the eastern sighting rate was used i.e. 1.5 crocodiles/km since the area is lightly settled. The population estimate for the area is 225. For the shoreline from Matewele to Monkey-Bay which is heavily settled, the sighting of 1 crocodile/km has been used. Total distance is 64 km with 8 km of rocky shoreline giving an effective distance of clear and marshy shoreline of 56 km. The population estimate for this area is 56 crocodiles.

From Lisangadzi river mouth to Namkelukelu river mouth the shoreline is clear and marshy but lightly settled. Sighting rate of 1.5 crocodiles/km has been applied giving a population estimate of 36 crocodiles.

The total population estimate for the lake shore in the southern region is 317.

to Shire and Lake Malombe

A survey was done in Liwonde National Park. A sighting rate of 4.25 crocodiles per length of shoreline was found. This sighting rate was ued to estimate population of crocodiles in the park. A population of 319 crocodiles was found.

Another survey was done from Nchalo Sugar Estate to the confluence of Mwanza river. A sighting rate of 2.9 crocodiles/ km was found. Following the Shire downwards from Nchalo Sugar Estate another sighting rate of 1.07 crocodiles/km was found. The overall sighting rate for Shire River in the Elephant Marsh area is 1.9 crocodiles/km. This sighting was used for the main Shire from below Kapichila Falls to the Mozambique border giving a population estimate of 453 crocodiles. A survey on the side channels of elephant marsh yielded a sighting rate of 2.7 crocodiles/km. Applying this figure to the Elephant Marsh and Ndindi Marsh reveals population estimates of 1,345 and 235 crocodiles respectively.

For Lake Malombe the sighting rate of 1.5 crocodiles/km was used as this area is lightly settled and generally marshy. The population estimate for the area is 108. From Likwenu to Matope bridge the sighting rate of 2 crocodiles/km of river was used as the area is generally moderately settled. The population estimate for this segment of the river is 140. The sighting rates used for Lake Malombe and the river Shire outside Liwonde National Park are those derived from the Mangochi Bridge to Matekwele survey.

The section of the river from Matope Bridge to Kapichila Falls has fast running water with rapids and falls hence the habitat is not ideal for crocodiles except at confluences with other rivers and streams. Although this segmentit was not surveyed the sighting rate should be lower than the upper Shire and lower Shire even though this segment is generally not settled. A sighting rate of 1 crocodile/km of river has been used giving a population estimate of 70 crocodiles.

(c) Ruo River

Crocodiles have been reported on the Ruo in areas below the rapids down stsream from Sankhulani. The sighting rate for the main Shire river channell has been used i.e. 1.9 crocodiles/km. The population estimate derived is 34 crocodiles.

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SUMMARY OF POPULATION ESTIMATE IN SOUTHERN REGION

SECTION	LENGTH	SIGHTING RATE	POPULATION
Boundary Pillar 17 to Matewele	150 km	1.5/kom	225
Matewele to Monkey-Bay	56 kom	1.0/icm	56
Lisangadzi to Nankolukolu	24 km	1.5/km	36
Matewele to Lake Malembo	16 koza	2.5/km	4 0
Lake Malembo	72 km	1.5/km	108
Liwonde National Park	75 km	4.25/km	319
Likwenu to Matope	70 kana	2.0/km +	140
Matope to Kapichila Falls	70 kom	1.0/km +	70
Kapichila Falls to Chiromo	105 km	1.9/km +	20 0
Chiromo to Nkupila	87 kan	1.9/km	165
Blephant Narsh	498 km	2.7/km	1,345
Ndindi Marsh	87 km	2.7/km	235
Ruo from Rapids Below Sakhulani to Confluence with Shire	18 km	1.9/km	34

sighting rate per kilometre of river as opposed to shoreline.

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2. CENTRAL REGION

ia The Lake

Surveys were carried out in the following sections:

(1) Fish Eagle into mouth of Linthipe (Salima District) representing clear to marsh shoreline and heavily settled. A sighting rate of 0.75 crocodile/km was obtained.

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(ii) Kuluunda to Mpherere (Salima) representing marshy shoreline and light settlement. A sighting rate of 1.6/km was obtained.

(b) Rivers and Lagoons

Surveys were done at Kaombe River mouth, Chia Lagoon, and the Bua River in Nkhotakota Game Reserve (Nkhotakota). The sighting rate obtained were 9 crocodiles/km, and 3 crocodiles/km respectively. The Bua sighting rate is from a foot patrol carried out during the day.

The sighting rates obtained in these areas were applied to similar habitats within the central region. The results are summarized below.

SUMMARY OF CROCODILE POPULATION ESTIMATES IN CENTRAL REGION

	Length	Sighting Rate	Population
Nankolukolu to Nadzipula	30 km	1.5/km	45
Nadzipula to Namikombe Point	55 km	0.75/km	41
Namikombe point to Makanjira	43 kom	1.6/km	69
Makanjira to Mkumbaleza Swamp	27 km	0.75/km	28
Mkumbaleza Swamp	6 km	1.6/km	10
Mkumbaleza Swamp to Nkhotakota Boma	50 km	0.75/km	38
Nkhotakota Boma to Bua point	20 km	0.75/km	15
Dzaza Swamp	10 km	1.6/km	16
Dzaza Swamp to Nkana Swamp	12 km	0.75/km	9
Nkana and Bana Swamp	45 km	1.6/km	7 2
Bana Swamp to Kalali Swamp	10 km	0.75/km	8
Kalali Swamp	8 km	1.6/km	13
Chia Lagoon	20 km	0.25/km	5
TOTAL	336 km	14.25/km	369

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NKHOTAKOTA GAME RESERVE

	Length	Sighting Rate	Population
Bua	40 km	3.0/km	120
Kaombe	35 km	1.0/km	35
Dwangwa	30 km	1.0/km	30
TATOT	105 km	5.0/km	185
River Channels			
Nankolukolu	3 kun	9/km	27
Bwanje	3 km	9/km	27
Mpatsanjoka	3 kan	9/km	27
Kaombe	3 km	9/102	27
Dzaza Swamp	10 km	9/km	9 0
Bana Swamp and Nkana Swamp	30 km.	9/kma	270
Kalali Swamp	6 km	9/km	54
Chia Lagoon	6 km	9/km	54
	64 km	72/koz	576
OVER ALL TOTAL POPULATION		. =	1,130

1,130

3. NORTHERN REGION

No lsurvey was done in the Northern Region. Sighting rates obtained in the Southern Region and Central Region surveys were applied to similar habitat with similar settlement pattern in the Northern Region. The estimates are summarized below:

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Dwambadzi to Ndawambe	25 km	0.75/km	19
Ndawambe to Nkhata-Bay Boma	60 km	0.75/km	45
Nkhata-Bay Boma to Chandagha	15 km	0.75/km	11
Chandagha to Bweteka	20 km	0.75/km	15
Rukulu point to Songwe	145 km	0.75/km	109
Songwe River (Karonga side)	50 koz	1.0/km	50
South Rukulu (5 km from the			
lake Mlowe Area).	5 kma	1.5/km	8
North Rukulu (from mouth)	10 km	1.0/km	10
Laeàa	15 kma	1.5/km	23
Limpasa	40 km	1.5/km	60
Chidzumulo Island	10 km	1.5/km	15
TOTAL	39 5 km	11.75/km	3 65

SUMMARY OF CROCODILE POPULATION ESTIMATES IN NORTHERN REGION

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The total population estimate for the country is summarized below:

Region	Population Estimate
South	2,973
Central	1,130
North	365
Total	4,468

In addition to the populations in the areas aforementioned, are scattered pockets of crocodile population in pools of some rivers in the country. For example there are some 15 to 20 crocodiles in the Lingadzi River within the Lilongwe Nature Sanctuary in the Capital City. It is likely that there are more populations of a similar nature elsewhere in the country. I put the estimate of such populations at a minimum of 100 crocodiles.

DISCUSSION AND CONCLUSION

The total minimum crocodile population is put at about 4,600. This estimate is on the low side for several reasons:

(i) Counting Bias

Motor boats were used during this survey. Placement and size of engines was variable. Out-board engines were used insome cases and in-board engines in other cases. Crocodiles are normally close to the shore as opposed to the open waters in the lake or river. How close to shore a boat can nagivate is dependent on the size of the boat and the type of engine being used. With out-board engines you easily hit solid ground and stall but generally small. With big in-board engine boats, you cannot get very close to shore. The depth of water both in lakes and rivers is also variable hence making it impossible to maintain the same distance from the shore in all survey areas.

Chances of spotting crocodile eyes decrease as you go further from the shore. Some crocodiles were spotted from a main method for a main and for a main and the spotted for a main were obviously missed when navigating further in shore. In alot of cases, especially on the lake, where big boats had to be used navigating was further in shore hence sighting rates obtained are underestimates. At river mouths the situation was even worse due to the large sand deposits from the rivers making the lake particularly shallow. Where we managed to get into the river mouth e.g. at Kaombe the sighting rates were very high, i.e. 9 crocodiles/km.

In the rivers, navigating was again difficult due to shallowness particularly at confluences. Another complication were the weeds which would choke the out-board engines making alot of side channels within the river to be in-accessible. The sighting rates in those areas are again underestimates in almost all cases. Where back water were sampled, the sighting rates were at least double those of the main channel. The crocodiles use the back waters as their refuge since the main channels are subjected to a lot of traffic.

TABLE 2 : TRADE STATISTICS FOR CROCODILE SKINS : 1976 TO 1985 $\mathbf{K} = \text{FOLLANT KWACHA} : +$ INCLUDES 211 PIECESS

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	JUB/B/E		W."GERIMNIT S		SWITZE	SWITZERLAND		FRANCE		I	TOTAL		
	No. of Skins,	Value R	No. of Skins	Value K	No. of Skins	Value K	No, of Skins	Value K	llo. of Skins	Value K	No. of Skins	Value K	Av. Price Per Skin K
1976	432	a,709.25	-		-	-	-	-	-	-	432	4,709.25	10.90
1977	-	5,053,45	-	-	115	5,702-00	_	-	29	351.45	-	12,106.90	-
1973	170 ·'	9,702,00	-	-	80	4,470.00	69 ·	3,538.00	14	103.00	333 .	17,818.00	53.50
1979	-	14,529,00		-	234	14,629,00	-		5			-	-
1980	155	3,531.00	-	-	_	-			-	-	135	8.531.00	62.73
1931	777	45,413.09		-	-	-		-	-	-	777	46,413.09	59.73
1932	718	63,562.00	-	-	-	_		-	-	-	718	68,662.00	95.63
1983	935	20,895.00	-	-	-	-		-	-	-	935	80,896.00	86.52
198-			-	-	-		-	-	-	-	-	-	-
1985	1533	-	-	-	-		298 ·	-	_		298	-	

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(ii) Crocodile Behaviour

The crocodile's sight is very sharp both to the sides and to the front. It also has a superior sound perception in the range from about 100 to 4,000 hertz - cycle per sound - (Pooley and Gans 1976). With these devices it is possible that some crocodiles went under water soon after picking the sound and seeing the search light. Light seems to be a more critical factor than sound particularly where hunting intensity is high. The effect of sound seems to be rather minimal as crocodiles have been approached to within 5 metres with a boat properlied by a 12 horse power in-board diesel engine. Some crocodiles must have been missed out due to their behaviour of submerging themselves in time of danger hence resulting in an underestimated sighting rate.

(iii) Sampling Intensity

The total stretch of both rivers and lake shores sampled is very small. A total of 125 km were covered on rivers and 84 km on lakes and lagoons and these are only 9.5% and 9.4% respectively of the total suitable crocodile habitat identified. This sampling bias can go either way i.e. over estimating or underestimating. The greater the number of smaples in different habitat types the more accurate the estimated sighting rate would be. For example, the Kaombe river mouth estimate of 9 crocodiles/km may not be representative of other river mouths. There was need sample more river mouths to come up with a more to representative estimate. Financial constraints and the practical difficulties of getting into some river mouths made it impossible to obtain more than one sample. This estimated sighting rate is likely to be a little high hence the overall population estimate in areas where this sighting rate has been used is also high. On the other hand the sighting rates determined on the lake were from a small segment of the lake. The sighting rates might be high or low but have been applied to similar habitat over a wide area. The effects of the low sampling intensity are likely to cancel each other out hence this factor is not important in pushing the estimate either way.

From the foregoing discussion of problems with the current estimates I conclude that the population estimate of 4,600 should be considered to be minimum. I put the up limit of the population at 15,000 crocodiles and working population for planning purpose at 8,000 crocodiles.

TABLE I

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PERCENTAGE OF SKINS IN DIFFERENT LENGTH CLASSES FOR THE YEARS 1977 TO 1986 (NOVEMBER). IN 1984 THERE WAS NO TRADE IN CROCODILE SKINS

YEAR		22242240000000000000000000000000000000	¢ a		S	ICIN LEI	чдтн (г	t.)		ante la companya da subserva a gan			T C S	OFAL HUCODILE KINS	TOTAL %
	4	5	6	7	8	9	10	71	12	13	1/ <u>i</u>	15	16		
1977	0	9,5	14,2	22°5	18,8	11.9	11.4	6.2	2 ,8	2.3	0	0.5	0	176	100%
1,973	0	12.0	14.3	24.0	24.0	16.6	⁶ .2	2.8	0,9	0.4	C.4	0.4	0	217	100%
1973	5.8 ¹	14.4	15.5	20.0	15.9	9.4	8.1	5.6	<u>}</u> .0	1.2	0.6	0.5	Ο	160	100%
1920	0	6.0	19.5	20,8	20,8	12_0	10.7	3.1	1.3	1.9.	1,2	1.2	0	159	100%
≰0 <u>,</u> 51	С	8.9	14,5	24.3	27.7	13.4	5.8	2.1	∂. 7	0.7	0.5	0.4	0	560	100%
1922	0.3	14.2	16,8	13,4	22,5	14.5	7.7	3.2	1.0	0.6.	0.5	0.1	0	691	100%
1933,	1.0	18.6	17.5	17.5	55°5	18.6	6.6	3.0	1.3	1.1	0.5	0	0.0	1019	100%
1954	-	-			100/2002/00/2000/2000/2000			_		-	-		-	-	-
1985	0	12.5	25.2	14.1	14.7	13.6	7.8	2.6	4.2	0.5	1.0	1.0	1.7	191 -	100%
1955	.0	15.2	15_8	21.9	18,2	13.3	6.3	5.9	2.0	1.2	0.8	0.4	•0	511	100%
CC/L	5.1	113.4.	155.4	193.2	185.9	115.3	69.6	51.5	13,6	9.9	5.6	4.7	1.31	3684	
م م م م م م م م م م م م م م م م م م م م	0.5	12.6	17.3	20.4	20.6	12.8	7.7	3.5	2.1	1.1	0.6	0.5	0.2	409	100%
3.7.	1.2	3.5	3.6	3.0	3.7	2.0	2.1	1.3	1.2	0.6	0.3	0.4	0.5	2883	

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(b) Previous Estimates

In 1984 the population of crocodiles in Malawi was estimated at 28,300 (Annon. 1986). This estimate was arrived at using a sighting rate of 10 crocodiles per kilometre of shore line. The crocodile habitat was put at 2,090 river shoreline and 740 lake shoreline. This estimate was an overestimate because of the high sighting rate which was applied to the whole area. The only places where a sighting rate of 10 crocodiles can be obtained are Liwonde National Park and river mouth where there is little or no settlement such as Kaombe river. In the latter case the sighting rate will apply to only short segments of the river, i.e. 3 km or less. The length of suitable habitat is also 607 km longer than the one identified during this survey. The difference in length of suitable habitat has minimal impact compared to the sighting rate. The average sighting rate obtained during this survey is 2.7 crocodiles/km. The sighting rate in 1984 is expected to have been a little higher as there was no hunting in that year but not much higher as there was no hunting in that year but not much higher than the present. The overall sighting rate might have been around 3 crocodiles/km hence the population estimate should have been around 8,500 crocodiles. I therefore conclude that there has been little change in the crocodile population following the introduction of hunting in August, 1985. A total of 697 crocodiles have been shot between August 1985 to date.

(2) Recruitment Rate

METHODS

It was the intention of the survey to come up with a recruitment rate for the crocodile population for two reasons:

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- (a) to know the vigour of the population; and
- (b) to determine the offtake that the population can stand.

The method decided on was a photographic method. A photographic of a crocodile or group of crocodiles would be taken and after the crocodiles left, a stick marked 10 cm segments would be placed wehre the crocodile(s) lay and a photograph taken from the same angle and position. By comparing the two photographs the length of the crocodiles would be determined. For this method to be workable the relationship between length of crocodile and age was necessary. It was hoped that a large enough sample would be obtained to build up an age structure from clusters of different lenghts. Using known age animals in captivity some indication of approximate age for different clusters would be obtained. This method did not work due to the different of photographing on shore. Crocodiles quickly take to the water after picking up the sound or sighting approaching humans. Another problem is the under-representation of young crocodiles which are vital in such study. The crocodiles found on sand banks are normally nesting females. Young crocodiles found on

Young crocodiles tend to nide in the reeds and bask in isclated areas which are not easily accessible. I therefore had to resort to ligerature on recruitment rate to come up with an estimate of annual recruitments in the Malawi population. To supplement this information regarding vigour of the population I analysed the hunting returns to see if there has been any change in the distribution of skin length over the years. The null hypothesis being tested is that there is no change in distribution of skin lengths over the years which is indicative of a stable population in the face of hunting pressure. The alternative hypothesis is that there is a change in the distribution of skin lengths which is indicative of a changing population in the face The assumption made is that hunters' of hunting pressure. tastes thave remained the same over the years and that the hunting methods used are none selective apart from conforming with the legal limit that crocodiles of less than 5 ft. (15 cm.) should not be hunted.

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PESULTS AND DISCUSSION

Pocley (1982) report that of all eggs laid only 25% grow into adult crocodiles. The average number of eggs laid per female per year is put at 60 by Ross (1962). In Malawi the average nest size is 40 eggs (P.M. Strover, personal communicating). With a base population of 8,000 crocodiles the annual recruitment is 640 crocodiles if a sex ratio 1.1 and a percentage of breeding females of 20% are assumed. It is normal in most populations to have more females than males. Also the percentage of breeding females is likely to be on low side. Hence the recruitment rate of 640 crocodile should be considered as minimum.

On the vigour of the population an analysis of distribution of skin lengths was made for the years 1977 to 1985. The results are summarized in Table 1.

Pooley and Gans (1976) put the sexual maturity of crocodiles in Southern Africa at 12 to 15 years at which the crocodiles are between about 7 ft and 10 ft (2 to 3). Graham (1975), who has worked with crocodiles in Lake Rudolf and Okavango, put sexual maturity for crocodiles in Okavango at body length of 9 ft (2.74 m). Considering that female crocodiles rarely exceed a maximum length of 3.75 metres (about 12 ft) (Pooley, 1982), the crocodile population is Malawi can be said to be stable with a large enough breeding stock. This conclusion only holds if assumption that the proportion of crocodiles of a certain length in the shot sample is similar to that in the living population is true. Crocodiles of 7 ft to 12 ft length comprise over 50% of the shot sample (Table 1). Crocodile hunters are known to have the notion the bigger the better hence they will go for large crocodiles if the same are available. In addition to the feeling of greater achievement there is an economic incentive. Crocodile skins are sold per inch or cm of the belly width. The bigger the crocodile the wider the belly width hence the higher the price (fig. 1).

with the foregoing argument on the hunters mentality it can be concluded that the small proportion of crocodiles of more than (12 ft (3.75 m) is a concequence of greater availability in the population although the actual percentage may not be the same. Crocodiles of 7 ft (2 metres) and lower are in lower proportion due to the fact that they are selected against but not necessary due to lower numbers in the population. Four foot (1.2 m) crocodiles have been shot by mistake on a few occassions (0.6% of the shot sample on average - Table 1). I therefore conclude that there is a substantial percentage of crocodiles in the breeding age. The majority of breeding females must be in the 9 ft (2.74 m) length class or slightly lower since the average clutch size in Malawi is 40 eggs which is the number of eggs that a 9 ft (2.74 m) female will lay on average. Clutch size increases with age and hence length of the crocodile (Graham, 1975). A 9 ft (2.74 m), 11 ft (3.4 m) and 12 ft (3.75 m) crocodile will lay 40, 55, 70, and 90 eggs respectively.

The conclusion that the population is table is further substantiated by the fact that distribution of skin lengths has not changed over the 10 years analysed. Although there are minor fluctuations from year to year the modal class has been 7 ft (2 m) to 8 ft (2.4 m) in all the years and the percentage of skins of length 5 ft (1.5 m) to 10 ft (3 m) has always been 80% or more through the years (Table 1). If hunting had a substantial effect on the population, one would anticipate a shift in the modal class and a change in the percentage of skins of certain classes.

CONCLUSION

The crocodile population in Malawi is stable with an estimated minimum annual recruitment of 640 crocodiles.

3. HABITAT

Available habitat for crocodiles was assessed from observations during the survey. Areas of similar settlement pattern were then from a 1:25,000 map. Across of the same physiography and similar settlement pattern were deemed to be the same in terms of suitability for crocodiles. The main objective of the survey with respect to habitat was to record suitable habitat for crocodiles and identify activities that are incompatible with crocodiles conservation. In general an assessment of the trend in crocodile habitat was envisaged.

RESULTS, DISCUSSION, AND CONCLUSIONS

Crocodile prefer marshy areas or reed banks or beaches in addition to open water. Rocky shoreline are not ideal for crocodiles as these will not offer suitable nesting sites. Crocodiles will also burrow into mud banks during cold weather to conserve energy. Prey species, both aquatic and terrential, have to be present in the area for the site to be preferred.

Unfortunately, the crocodile's choice of habitat coincides with the numan choice leading to direct conflicts. Sandy beaches are boat yards for fisnerman. They are also used as recreation areas at tourist resorts. The result is that crocodiles have retreated into remote areas with respect to numan settlement. It is in these areas that crocodiles breed and survive. With increasing human population even these areas might in time become unsafe foe crocodile habitation.

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On the Lakeshore starting from the south west of the lake in the south to the north at the mouth of Songwe River, there is dense settlement with tourist areas dotted all over the Lakeshore. In this segment, crocodiles only survive in marshy areas with small islands. These marshy areas or swamp are normally associated with river mouths. However, in swamps where islands of substantial size are available, the islands are used for rice growing or multiple maize crops (dimba cultivation) hence infringing on crocodile habitat. The population of crocodiles in this area, i.e. south west arm of Lake Malawi, Central and Southern Regions, is less than half the population of the south east arm and the Shire River system (about 32% of the total population in the country).

A consequence of the low population density is the relatively low frequency of crocodile damage to human life and proerty in the area. Loss of human life was not reported from any of the areas in question. Injuries and threats to human life have been reported from Nkhata-Bay in 1986 in areas of local concentrations of crocodiles such as Limpasa, Lweya, and the islands of Chizumulo and Likoma. Damage to fishing nets were reported from Kasanga-Bay in Mangochi District, Kuluunda area in Salima, Chia Lagoon and Bana Swamp in Nkhotakota and Dwambadzi in Nkhata-Bay. Livestock infuries and losses are not normally reported as these tend to be rare occurances.

In the South-east arm of the lake and the Shire River system density of settlement is relatively low. Even with high human settlement, crocodiles still have a chance to survive as a consequence of the pattern of swamps and islands in the Shire River. The back waters in the Shire are generally woody hence detracting fishermen from setting nets in the areas. The size of the islands are generally small hence not conducive to rice growing or dimba cultivation. It is in these areas that the crocodiles survice is and acculat has none-the-less been reduced by human settlement in river banks adjacent to open water. The strong hold for crocodiles in the Lower Shire Valley particularly the Elephant Marsh. At least 30% of the total crocodile population in the country is in the Elephant Marsh. Although dimba cultivation is a threat to the survival of the crocodile in the area, the Nile crocodile so structured that some parts are in accessible. The Nile crocodile will continue to survive in this habitat.

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Conflicts between man and crocodiles in the Lower Shire Valley are rampant. From January 1985 to August, 1986, a total of 14 people have been killed by crocodiles in the Shire River between Kapichila Falls and Chiromo bridge. Livestock losses and injuries to both humans and livestock are a common occurance in the area. A similar situation is expected to exist in the Nsanje District (no reports were obtained from Nsanje during the survey).

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In up or middle Shire no human deaths were reported but injuries were reported in the Liwonde area. Damage to fishing nets was common in the Makanjila area and lake Malombe.

Although crocodile habitat might be under a general threat from human settlement there is adequate habitat preserved in conservation areas. In these areas, crocodiles are completely protected. They can only be shot in defence of human life. Liwonde National Park, Majete Game Reserve, and Nkhotakota Game Reserve observe viable populations of crocodiles. A total of between 620 and 1,100 crocodiles is currently preserved in these areas. The population is likely to increase. The only threats to these populations are collection of eggs for the ranching project and the effects of closing of the barrage on the nesting crocodiles in Liwonde National Park.

Collection of eggs is strictly controlled by the Department of National Parks and Wildlife and is limited to a very small proportion of the nests. Collection was allowed in 1986 on the understanding that 10% of the hatchlings will be given to the Department for introduction in areas where the species has been extripated. The ranch has to be encouraged to obtain its own breeding stocks. The barrage is opened and closed to regulate the flow of water in the middle Shire for purpose of hydro-electric power generation. The closures of the barrage causes a rise in the water level in the Liwonde National Park. The barrage is normally closed after the crocodiles have laid their eggs (i.e. October) hence submerging the eggs. The barrage in such years is a major mortality factor. Ways and means have to be found to alleviate this problem. A compromise solution between the Ministry of Forestry and Natural Resources and Escom has to be worked out. If possible the barrage should be closed before crocodiles start nesting i.e. August.

(a) Trade Statistics

The trade statistics for crocodile skins are summarized in Table 2.

Table 2 : (see next page)

In Malawi only the Cold Storage Company Limited, (a parastatal organization) is licenced to buy crocodile skins originating from the wild population and it is the sole exporting agency. The company sends monthly returns of its sales and purchases to the Chief Fisheries Officer. It is these records that have been summarized in Table 2. Some records are in complete in that they do not snow the value or the number of skins sold. None-the-less an insight can be gained into the volume of the trade in crocodile skins. The points that emerge from Table 2 are that:

(a) The bulk of our skins are exported to Zimbabwe.

(b) The price of skins has generally increased through the years.

On the local market, the prices were reviewed in 1982 but wind of an increase in price was around in 1981 hence leading to a high hunting return from 1981 to 1983 (Table 1). The international prices have a bearing on the hunting pressure if the sole buyer in Malawi increases the prices accordingly. Fortunately the buying price is controlled by the Government through its Ministry of Trade, Industry and Tourism hence increases in international prices have no direct bearing on the local price hence the hunting pressure. Reduced local prices can act as a disincentive to active hunting hence protecting the species from overexploitation.

Crocodile trade contributes considerably to the fdoreign exchange earnings of the state. It is therefore a valuable trade.

(b) Ranched Populations

There is only one ranch in Malawi operated by the Dwangwa

Sugar Corporation (DWASCO). The ranch is a pilot one to see if crocodile ranching is a viable option in Malawi. While ranching is encouraged so as to relieve pressure on the wild population, the welfare of the animals has to be taken into consideration when licensing crocodile ranches hence the pilot scheme. The success or failure of the present ranch will affect future government policy on ranching. So far the Dwangwa crocodile ranch is doing very well in all respects. The production target is 2,000 hatchlings a year. A similar number will be disposed of annually once the target is reached. In the meantime the ranch proposes to dispose of 150 to 200 crocodiles a year, initially as skins only. In future live sales may be considered.

The hatching success on the ranch is 75% largely because sterile eggs are as far as can be determined discarded in the field. Once hatched, the mortality rate in the hatchlings is put at 5%. The ranch is therefore very successful.

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The one advantage of the ranch is that it is dependent on the wild population for egg production. To meet the production of 2,000 hatchlings a year, they would need to collect 2,667 eggs at a natching success of 75%. The impact of this level of egg collection on the wild population is substantial. Sixty-seven nests of 40 eggs each would have to excavated. The ranch should be encouraged to establish its own breeding stock to relieve pressure on the wild population. Currently they have 13 breeding adults of which only 2 are females. There is need for the ranch to capture ata least 10 females initially as a nucleus breeding stock. The production target can only be reached after 5 to 10 years of operation at which stage the ranch might have a sufficiently large breeding stock. In the meantime the ranch should be restricted in its egg collection to no more than 1,500 eggs annually.

GENERAL CONCLUSIONS AND RECOMMENDATIONS

Malawi's crocodile population is stable at a minimum of 4,600 crocodiles. The upper limit for the crocodile population is 15,000. A working population estimate of 8,000 crocodiles has been decided on. With a base population of 8,000 crocodiles on annual recruitment of 640 crocodiles is achieved at a sex rate of 1.1 and a proportion of breeding females of 20%. The assumption is that only 2% of all eggs laid grow into adult crocodiles. This annual recruitment should be considered as minimum.

In accordance with the government's policy of maximizing benefits from crocodile utilization while minimizing the negative impact of crocodiles on other forms of development and being mindful of the need to preserve the Nile crocodile from extinction in Malawi, the offtake from the wild population has to be large enough to maintain life and property is minimal and reduce the population sufficiently in areas where damage to human life and property is still rampant. I therefore recommend that Malawi applies for a quota of 900 crocodiles to CITERS. Seven hundred of those will come from the wild population and 200 from the ranched population. This is my firsts recommendation.

Licenced crocodile hunters are given equal quotas based on the fact that he fee for the licence is the same. However, the crocodile populations in the different hunting areas is different resulting in present recommendation of 700 crocodiles from the wild is taken then each of the 13 hunters licensed in 1986 (assuming all will have their licences renewed) would have a quota of 54 crocodiles. If we are to maintain the crocodile population in the northern region and central region and also the population of crocodiles in the south and of the lake including river Shire up to Kapichila Falls at the present level the number of hunters in these areas has to be reduced. My recommendation is as follows:

One hunter in northern region concentrating his efforts in the Nknata-Bay area, 3 hunters in central region, 1 hunter in the south-east and south-west arm of the lake including Shire River to Matewele Village, 1 hunter from Matewele to Matope Bridge, and the hunter from Matope Bridge to Nonalo has to be maintained. This is recommendation 2.

In view of the high losses of human life in the Lower Shire Valley particularly Chikwawa Disrict, the number of hunters in this area has to be increased in order to reduce the crocodile population sufficiently hence minimizing damage. My recommendation is that the number of hunters be increased from the present 3 to 6.At least four of these hunters should be allocated to hunt in the Elephant Marsh. Recommendation 3.

Crocodile population in protected areas should act as buffer to whatever might happen to the populations outside these areas. Therefore threats to populations in protected areas have to be minimised. The current threats are egg collections in Nkhotakota Game Reserve and flooding of nesting sites in Liwonde National Park. Egg collection from protected areas should stop and negotiations on synchronizing the closure of the barrage with the nesting period of crocodiles should be considered.

It would be the advantage of the crocodiles if the barrage was closed in August before they start nesting. In this way crocodiles would choose nesting sites on high ground unlikely to flood. This is recommendation 4.

Ranching operations have to be encouraged in the country but no further ranches should be opened until Dwangwa crocodile ranch has attained independence from the wild population. In order to assist DWASCO in achieving this independence they should be allowed to capture 10 female crocodiles of breeding age to start a breeding nucleus. Recommendation 5.

The survey conducted in 1985 aimed at estimating the crocodile population in the country and also to determine the recruitment rate for the population. What the survey has yielded is a minimum population estimate and an indication of the maximum. The actual crocodile population cannot be determined with any certainty hence a working population of 8,000 was decided on. The important things that have come out of the survey are the sighting rates determined for different These sighting rates are population indices and areas. any changes in the indices indicate similar changes in the population. It is therefore important that a commitment is made by government to finance surveys of similar nature on an annual basis initially and then at intervals that are deemed appropriate in future. The objective is to monitor changes in the population in the face of hunting pressure so that corrective measures are taken in time.

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The total cost of the 1986 survey was K3,500 in terms of fuel and subsistence. There is need for a more detailed survey to include the north and also to allow for repeated surveys in some segments to determine short term changes in sighting areas. Liwonde National Park would be an ideal place for such an exercise. A commitment of at least K5,000 is in line. Recommendation 6.

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INTRODUCTION

The Dwangwa Delta has been a natural habitat for the Nile Crocodile for meons. During the formation of the delta it is obvious that crocodiles took up resistence in the many pans, oxbow lakes and streams that were formed by the meandering river in its course to the meanes of the lake.

With the agricultural development and subsequent settlement that has taken place on the delta, the crocodiles were forced to retreat to the river mouths and swamps. However, some of the adults, remembering their traditional locations on the delta, and juveniles seeking refuge from breeding adults in the swamps, found themselves new homes in the night storage dams that are an integral part of the irrigated sugar estate.

Having noticed that crocodiles were thus still resident on the delta, appreciating the need for conserving the species and aware of the commerical potential of crocodile products, we decided to contemplate crocodile farming as a diversification. Not only were we to rear crocodiles in their natural location but the infrastructure of the estate provided storage dams and abundant water for the production of a ready source of food. Furthermore, hot, waste water from the sugar factory was readily available and would be used to warm the pans and hatchlings and thus greatly increased their production potential.

Five crocodile nests were incubated in a medium of factory ash for a feasibility study. From the first results it was obvious this medium would be quite suitable for the purpose and the prospects looked encouraging. Wooden boxes $45 \times 45 \times 40$ cm were made to hold the clutches, and a spare labour house was used for the incubating room. The temperature was maintained between 30 and 33° C with a simple bar heater and the room was opened on occasions when the temperature was too high. Trays of water were kept on the floor to keep the humidity high.

This method has been used for all the eggs incubated to date.

Post-natal care involves maintaining the hatchlings at between 30 and 34° C for 24 hours or until the umbilicus is well healed. Food is not offered until the yolks are fully resorbed. Since hot water is only available when the sugar factory is in production, the hatchling pens are initially heated with electric lights. Once the hot water comes on stream the lights are removed. Hot water is passed through the pools as well as under the floor of the pens. With this method the minimum night temeprature of the hatchling pens can be maintained at about 30° C.

For the first 10-11 months, until the hatchlings are moved to the growing out pens, the diet is eclusively whole fish, bred on the farm mainly in the sewage/oxidation ponds.

Yearlings are kept predominatly on a fish diet but are supplemented with chicken and other livestock mortalities that may occur from time to time.

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Summaries of the hatching records for the four seasons, 1984-1988 are given in the tables below:

HATCHING RECORD 1984/85

TABLE I

LOCATION	CLUTCHES	TOTAL EGGS	EGGS CLUTCH	RANGE	INCUBATED	HATCHED	×
Nyavuu Maamala	4 1	171 36	43 36	30–56 -	156 36	148 30	94.9 83.3
TOTAL	5	207	41	30-56	192	178	92.7

REMARKS

Egg collecting was confined to the Bana Swamp in the first season. The first clutch of 35 eggs was taken from Nyavuu on the 6th October, 1984. It was laid on the night of the 5th.

The last clutch (47) was collected from the Bana Swamp in the same vicinity on 20th October, 1984.

HATCHING RECORD 1985/86

TABLE II

LOCATION	CLUTCHES	TOTAL EGGS	eggs/ Clutch	RANGE	INCUBATED	HATCHED	X
Nyavuu	10	38 6	39	30-55	382	246	63,9
Manala	3	112	37	23-45	108	6 9	82,4
Lower-	7	271	39	20-59	266	215	80,8
Lureya River	1	28	28	-	27	18	6 6,7
Mazembe	1	43	43	-	41	33	30,5
Dwambaxi	1	48	48	-	47	41	87,2
TOTALS	23	88 8	39		871	642	73,7

REMARKS

Collecting started 20th September with a clutch of 41 from Mazembe River. These eggs had been removed by a fisherman, packed in a basket and then reported to us. As a result of the disturbance the embryos did not continue to develop. This clutch is not included in the table above.

The last clutch (41) was also collected from Mazembe on the 15th November, 1985.

Unfortunately, not all the eggs that were damaged or sterile on collection were recorded and the true clutch size was not determined, however the estimated clutch size compares favourably with the average size of nests in 1986 and 1987. All egg weights however were recorded.

The largest eggs came from Msamala 10/85 (45) and weighed 132 gms while the smallest eggs weighed 79 gms and were collected from the Lower Shire 18/85 (20).

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The relatively poor incubation success reflected in the table could have been the result of inefficient rejection of damanged and sterile eggs at the time of collection.

HATCHING RECORD 1986/87

TABLE III

LOCATION	CLUTCHES	TOTAL EGGS	eggs Clutch	RANGE	INCUBATED	HATCHED	x
Nyavuu	16	58 6	37	15-59	503	442	87,9
Monnals	11	364	3 3	22-56	361	317	88,8
Lower Shire	5	221	44	3460	211	187	95,4
Kaombe Riv_r	2	81	41	26-55	80	76	95,0
Dwambazi	1	52	52	-	50	36	72,0
Likuchi	1	43	43	-	41	41	100,0
Luweya River	1	32	32	-	31	29	93,5
Bua Reserve	13	619	48	33-58	554	54 5	98,4
TOTALS	50	1998	40	15-60	1871	1673	91,4

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The first clutch was collected on 17th September, 1986 from Nyavuu and the last one collected on 5th December from the Kaombe River and hatched 17 days later. Hatching started on 27th November, 1986 and was completed on 11th January, 1987.

Clutch No. 14/86 (34) was collected from Chintheche but was previously unearthed by children and repacked in the sand. These eggs did not develop.

Clutch No. 39/86 (15) was laid by one of our breeding females but was not discovered until she was found opening the nest. One hatchling had died before being exposed by the mother. This next was laid close to the water and all the remaining eggs were water-logged. Neither of these clutches have been included in the table above.

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The largest eggs recorded were from clutch No. 17/86 (55) collected from the Kaombe River and weighed 147 gms each. The smallest eggs weighed 67 gms and were taken from the breeding pond, clutch No. 39/86 (15).

HATCHING RECORD 1987/88

TABLE IV

LOCATION	CLUTCHES	TOTAL EGGS	EGGS/ CLUTCH	RANGE	INCUBATED	HATCHED	X
Nyavuu	8	329	41	35-55	315	267	84 ,8
. Msamala	8	281	35	25-51	25 5	238	93. 3
Lover Shire	27	1118	41	27-69	1044	86 0	83,1
Kaosbe River	2	57	29	33-24	57	32	56,1
Dwangwa River	1	37	37	-	36	28	77,8
Breeding Pond	5	113	23	37-11	110	76	69 ,1
Bua River	14	547	39	20-54	543	532	98,0
<u> </u>			2033				

REMARKS

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Collecting started on 1st September, 1987 when a clutch of 37 was laid by one of our females in the breeding pond. This clutch hatched 105 days later. Only 19 hatched, the rest were infertile. The last clutch was collected in the Bua Reserve on 30th October.

Two clutches, Nos. 24/87 (37) and 36/87 (24) did not hatch. 24/87 was collected from visible growth ring at the time of collection. These two clutches are included in the table above.

The largest eggs recorded were from clutch No. 30/87 (53) collected from the Lower Shire on the Nyamachimba River and weighed 132 gms. The smallest eggs recorded were from clutch No. 1/87 (37) collected from the breeding pond and weighed 72,5 gms.

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HATCHING MECORD 1988/89

TABLE V

LOCATIO	CLUTCHES	TOTAL EGGS	eggs/ Clutch	RANGE	INCUBATED	HATCHED	X
Nyavuu Macmala	11 8	375 335	34 42	18-49 24-53	362 314	344 2180	95.1 89.2
Lover Shire Kaombe River	33 2	1162 65	35 33	16-70 28-37	1083 61	911 61	84.1 100.0
Breedin Pond Dema	6 1	174 52	ନ୍ଧ ଅ	22-42 52	174 51	137 11	93.2 21.6
TOTALS	61	2163	35	16-70	2045	1744	85.3

REMARKS

The first clutch of 28 eggs was collected from the Kaombe River. Twenty seven were packed and all hatched successfully.

The last clutch of the season was also collected from the breeding pond.

The largest eggs were from clutch 33 collected in the Lower Shire. This clutch was also the largest clutch collected and comprised 70 eggs with an average weight of 145 gms per egg. The eggs were collected fresh, 69 were packed and all hatched successfully. Clutch 58/88 from Msamala also had an average weight of 145 gm.

The smallest eggs were collected from the breeding pond, clutch No. 10/88 (23) and weighed 75 gms. There were 20 successfull hatchlings, 2 sterile eggs and 1 neonatal mortality.

The Dema clutch indicated above was disturbed by local fishermen a few days before being collected and most of the embryos ceased to develop.

Table VI summarises the hatching records for the years 1984-1989

TABLE VI

SUBBIARY : 1984-1989

LOCATION	CLUTCHES	TOTAL EGGS	EGGS/ CLUTCH	INCUBATED	HATCHED	x
Nyavuu	49	1847	38	1718	1447	84.2
Maamala	31	1128	36	1074	954	88.8
Lover Shire	72	2772	39	2604	2173	83.4
Lurveya	2	60	30	58	47	81.0
Nazanbe	1	43	43	41	33	80.5
Dvambazi	2	100	50	97	77	79.4
Breeding Pond	11	287	26	284	213	75.0
Bun River	27	1166	43	1097	1077	96.2
Kaombe River	6	203	34	198	169	85.4
Likuchi	1	43	43	41	41	100.0
Dwangwa River	1	37	37	36	28	77.8
Dema	1	52	52	51	11	21.6
TOTAL	204	7738	38	7299	6270	85.9

HATCHLING HORTALITY

The summary of the total mortalities is given in Table VI.

TABLE VII

YEAR	TOTAL HATCHLINGS	TOTAL LOSSES	x	S REORATAL
1985	178	16	9.0	63
1986	642	31	4.8	6 5
1987	1673	54	3.2	80
198 8	2033	85	4.2	76
				- Andrew and the Res
TOTAL	4526	186	4.1	73

We have been fortunate in that we have been able to keep our losses to a minimum.

There have so far been no major outbreaks of diseae, save Pos virus, which infected the majority of the 1986 hatchlings. The crocodiles were not seriously affected and no mortalities resulted from the infection. Since the heating system has been completed no disease outbreak has been recorded.

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Typically, the majority of the losses have occurred during the neonatal period, i.e. during the first month of the hatchlings' life.

An interesting, but devastating condition has occurred during past two seasons in clutches collected from the Nkhotakota Game Reserve (Bua River).

The condition has affected only hatchlings from the Bua and has manifested itself as a calcium immobilization syndrome and has been reported by Dr. C. Foggin. Hatchlings afflicted with the condition are recognised early on in the neonatal period and have always succumbed to the disease. By keeping the Bua hatchlings separate we have been able to identify some of the clutches and the location from where the eggs were collected in the Bua. We believe that this disease accounted for 67% of the 1987 losses and about 45% of the 1988 losses.

Eggs were not collected from the Nkhotakota Game Reserve (Bua River) in 1988 and there have been no cases of this condition in the 1989 hatchlings.

It is therefore highly probable that their condition is hereditary and is being perpertuated by some of the Bua crocodiles.

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