AMENDMENTS TO APPENDICES I AND II OF THE CONVENTION

Proposals submitted pursuant to Resolution on Ranching

A. PROPOSAL

Maintenance of the Mozambique population of *Crocodylus niloticus* in Appendix II.

B. PROPONENT

The People's Republic of Mozambique.

C. SUPPORTING STATEMENT

1. Taxonomy

11. Class: Reptilia

12. Order: Crocodylia

13. Family: Crocodylidae

14. Species: *Crocodylus niloticus*

15. Common Names: English: Nile crocodile
French: crocodile du Nil
Spanish: Cocodrilo del Nilo

16. Code Numbers:

2. Biological Data

Considerable biological information exists on the Nile crocodile in Africa (see especially the reports of Cott, 1961; Graham, 1968 and Hutton, 1984). However, this proposal is specific for the Mozambique Nile crocodile population and information from elsewhere is excluded unless it has particular relevance.

21. Distribution: Lying on the eastern seabord of Africa and falling between latitudes 10˚ and 27˚ S and longitudes 30˚ and 41˚ E, Mozambique has a coastline of over 2,400 km and common borders with the United Republic of Tanzania, Malawi, Zambia, South Africa and Swaziland.

Over 90% of Mozambique's 799,380 km^2 surface is less than 1,000 m above the sea level and about 60% is below 500 m. Much of the North receives rainfall between 1,000 and 1,800 mm/yr and about 50% of the country, including the whole coastal portion, is considered to have a humid tropical climate (see Map I).

Geographical characteristics have combined to produce an environment with innumerable small lakes, lagoons and swamps. At this latitude and altitude temperatures are high and extremely favourable to the demographic vigour of crocodile populations giving a high potential rate of population increase (Hutton, 1984; Craig and Hutton, in litt.).

In addition to standing water, about 16 major rivers flow East to reach the sea along the Mozambique coast (see Map I). Many of the northern rivers arise within Mozambique, but most of those to the South arise in neighbouring countries.

Many rivers are famous for their crocodile populations both past and present (e.g. Shire River in Malawi, Zambezi in Zimbabwe and Zambia, Limpopo in South Africa, Zimbabwe and Botswana). The biggest river in Mozambique, the Zambezi, was Cahora Bassa, the largest lake in Africa.

211. Current Distribution: Large-scale exploitation in the 1950s and 60s greatly reduced the level of many accessible crocodile populations, but the crocodiles have recovered well. Within recent years crocodiles have been reported from virtually their entire historical range (see below) with the exception of some areas with heavy human population density.

From North to South their occurrence is reliably reported from the rivers Rovuma, Lugenda, Rueco, Messalo, Lurio, Ligonha, Munjiquai, Molocue, M'lela, Cua Cua, Malema, Licuana, Zambezi (and its tributaries and estuary), Urema, Pungue, Buzi, Gorongosa, Save, Inharrime, Limpopo, Incomate, Futi, Maputo (see 22. below for more details). There are also small populations on Basaruto Island, about 30 kms offshore (Games, 1986) and in small impoundments such as Lake Chicamba (Keay, in litt.). The largest population is probably to be found in Lake Cahora Bassa.

As noted above, in the climate typical of most of Mozambique the rate of recovery of crocodile populations after exploitation can be extremely rapid. As noted, neighbouring countries also have healthy crocodile populations, but these were also decimated in the 1950s and 1960s (Hutton et al., 1988).

The widespread distribution of the animal is doubtless due to the explosive recovery of remnant populations rather than migration.

212. Historical Distribution: While there is no systematic account of past crocodile distribution in Mozambique, there is no shortage of written evidence on their widespread occurrence and abundance. For example, Selous (1981) described de Ruenya, a tributary of the Zambezi River East of Tete, as "a river full of crocodiles". From such anecdotal report it is clear that at the end of the 19th century crocodiles occurred throughout the country wherever there was permanent water. It is generally accepted that the Zambezi River, and especially its huge estuary in the Marromeu area, had a particularly high density of crocodiles.

In the 1950s and 60s the most easily accessible crocodile populations were decimated, principally by hide hunters. Little information has survived this period but Tello (in litt.) estimated that as many as 4,000 to 5,000 skins were taken each year from the Marromeu area during the principal decade of hunting.

In 1965 large exploitation was stopped by law, (Diploma Legislativo No. 2627 of August 1965 which listed the crocodile as huntable game). For the next 10 years relatively few crocodiles were killed each year, and these principally by sport hunters. After independence, Bindernagel (1980) suggested that crocodiles be included in an integrated programme of wildlife utilization in Zambezi Delta. Whitaker (1981) examined this possibility more closely and reported that crocodiles occupied a variety of habitats in Mozambique including tidal rivers, swamps, lakes, rivers and ponds.

22. Population: The wide distribution of crocodiles throughout Mozambique makes an accurate estimate of their total number impossible. Such information would, in any case, be of limited usage in the planning of management (Hutton et al., 1988). In addition a severe impedement to crocodile surveys and population estimates in Mozambique is the incidence of wide ranging banditry which makes road, boat and light aircraft travel virtually difficult.

However, some surveys have been undertaken and Lake Cahora Bassa, where crocodiles were cropped for export under the 1987 and 1988 quotas (see below), and where operation is safer, has received special attention.

221. Results of surveys

Lake Cahora Bassa (see Map III): Chande, Games and Zolho (1988) undertook a series of estimates of crocodile numbers in the western (Zumbo and Messengwezi) basins of Lake Cahora Bassa where crocodile hunting recommenced in 1987 when Mozambique took advantage of the CITES quota for the first time (see below). Cahora Bassa is briefly described in Section 23 "Habitat" and the document prepared by Chande, Games and Zolho (1988) is presented as Annex 2.

Superficial aerial surveys of Cahora Bassa were conducted in early 1987. From there it was clear that there is little human activity either on the lake, or along its shores, and that crocodiles can be found throughout the system. They are, however, commonest in the shallow upper reaches (van der Riet, pers. comm.).

No spotlight count or population estimate could be made prior to 1987 cropping exercise, but spotlight surveys were undertaken concurrently with cropping. In addition, as much scientific information as possible was recorded from the crocodiles shot. Four morphometric measurements were taken from over 900 animals for age determination. Gonads sections were removed from over 200 animals to determine criteria of sexual maturity and reproductive status. A smimilar number of stomach contents were taken for an analysis of feeding. These data were used in an attempt to construct a population model. This is not yet complete, but will be included in the CITES Nile Crocodile Project Coordinator's report at the 1989 CITES meeting.

After the 1987 crop, but before that of 1988, a sample count was undertaken of 36 km river, and about 116 km river and lake were surveyed from the air.

All counts were underestimates and various correction factors were used to try and remove biases. Since these are untested at Cahora Bassa likely ranges are given rather than absolute estimates (see Annex I).

The results of these counts are:

i) 1987 (spotlight) 2,715 - 5,270 crocs in 153 river km
(17.7-34.4 crocs/km)

ii) 1988 (spotlight) 1,802 - 3,498 crocs in 153 river km
(11.7-22.9 crocs/km)

1988 (aerial) 1,407 - 2,728 in 153 river km
(9.2-17.8 crocs/km)

Further aerial surveys are to be undertaken at the end of the 1988 crop and this information together with the population model will be used to decide whether any cropping should be undertaken in the area as part of the 1988 quota.

Marromeu (see Map III): Extending over about 400,000 ha, the Zambezi Delta (commonly known as Marromeu though this strictly refers to a protected area of about 200,000 ha) comprises floodplains, mangrove swamps, lagoons and river outlets interspersed with areas of higher ground. In 1981 helicopter and spotlight counts were undertaken and covered about 40% of the dry season habitat of crocodiles in the 200,000 ha reserve (Whitaker, 1981, in litt.). 24 adult crocodiles were seen from the air (a mean rate of 0.26/km). During spotlight counts 15 juveniles were seen for every adult. The total crocodile population of Marromeu can therefore be calculated as 24 (crocs) x 2.5 (area) x 15 (correction) = 900 crocodiles.

From a smaller area than that surveyed (about 20% of the Marromeu protected area) 21 nests were recorded. Graham (1988) reports that the ratio between the number of nests and the total number of crocodiles in the Nile crocodile populations is between 1:5.9 and 1:12.5.

From this method the total population in Marromeu can be calculated as between 620 and 1,313 [21 (nests) x 5 (area) x 5.9 = 620; and 21 (nests) x 5 (area) x 12.5 = 1,313].

This is generally regarded as an extreme under estimate, but as Whitaker (1981) points out the impoundment of Cahora Bassa has drastically affected the hydrology of the estuary reducing dry season wetlands (see 23. Habitat, below).

By contrast Tello (1985) reported on a survey of the main rivers and lagoons in the Zambezi Estuary in 1983 in which 1,485 crocodiles were seen in about 100 km of river and

lagoons, a density of 14.85/km. By assuming the region to have about 2,400 km of such habitat the population of the area was estimated to be 35,000 crocodiles.

The crocodile population of the Zambezi Estuary is clearly substantial, but more surveys are needed and are planned for November 1988. The results will be carried to the 1989 CITES meeting to complement this report.

Massingir Lake (see Map III): Whitaker (1981, in litt.) made a brief survey of Massingir and of a small pan (5 ha) nearby.

The pan had 20 crocodiles, or about 2.2 crocs/km. On the main lake 15 crocodiles were seen, mostly where the oliphants river entered the lake. The total population was not estimated.

Chicamba Lake (see Map III): Covering an area of about 100 km^2 Chicamba has a highly dendritic shoreline. In 1986 a brief aerial survey revealed 39 adult animals in poor survey conditions. No correction factors are available, but it is also intended to resurvey this late in 1988.

Bazaruto Island (see Map III): Games (1986) carried out spotlight counts on five lakes on Bazaruto Island as part of a pre-feasibility study for a crocodile ranching scheme. Crocodiles were found in 4 of the five lakes. The largest has a shoreline of 5 km and 30 crocodiles were counted (6/km) of which 40% were adults. In July 1988 all the lakes were surveyed from the air. 73 crocodiles were seen. All were adult sizes (Van der Riel, in litt.).

222. Reports of DNFFB staff: In September 1987 a meeting of Provincial Forest Officers of the DNFFB was held in Maputo. A workshop was organized to obtain first-hand information on crocodiles. Over the same period other experienced staff were interviewed.

The following is a summary of this information, catalogued from North to South.

Rovuma River	Crocodiles numerous and breeding
Lugenda River	Crocodiles numerous and breeding
Messalo River	Moderate to high human population but crocodiles numerous. Problem crocodiles are reported around Nungo
Lurio River	Crocodiles numerous and a problem in the lower reaches
Ligonha River	Crocodile problems commonly reported

Malocue River	12 human deaths from crocodiles were reported between January 1983 and August 1984 including the father of a Department Game Scout
Malema River and Malela River	Protected within the Gile Game Reserve, and crocodiles abundant
Licuana River	Crocodiles numerous
Cua Cua River	High human fishing pressure. Crocodiles are scarce
Lualua River	Crocodiles numerous
Zambezi River	Crocodiles abundant. At least 5 people are killed around Tete each year
Urema River and Lake Urema	Within Gorongosa National Park and described as "teaming" with crocodiles. One member of staff estimated 3,000 animals
Pungue River	Crocodiles present
Buzi River	Crocodiles numerous in sections
Save River	Crocodiles numbers limited by dry season permanent water
Inharrime River	Human deaths reported each year due to crocodiles
Limpopo River	Crocodiles numerous and cause human deaths every year
Incomati River	Crocodiles present
Futi River and Maputo River	Rivers in Maputo Game Reserve. Crocodiles present but in low numbers

Synthesis: The following is presented as an attempt to estimate the total crocodile population in Mozambique. We consider this to be of dubious value as it is certainly a large underestimate. The major part of the crocodile population is to be found along 20 major rivers within 3 broad regions. (see map I).

Region 1. Northern region with over 3,000 km river.

Region 2. Central region with over 1,500 km river.

Region 3. Southern region with over 1,150 km river.

Region 1 is sparsely populated (0.13 people/km^2). Crocodile densities are believed to be high (see Cahora Bassa Survey). At 10 crocodiles/km the North is estimated to support 30,000 crocodiles.

Region 2 has about 0.22 people/km^2. This area contains the Gorongosa National Park. At 8 crocodiles/km the central region is estimated to have 12,000 crocodiles.

Region 3 has high human density. In addition most of the rivers are not perennial. At 0.5 crocs/km the South is estimated to have about 600 crocodiles.

Thus a conservative estimate for the crocodile population of Mozambique is 43,000 animals. Previous estimates have been as high as 202,000 (Tello, 1985).

23. Habitat: Mozambique is a particularly sparsely populated country with an estimated 14.5 million people in about 799,380 km^2 a density of 18.0 person/km. A disproportionate number of people live in the South and along the coast (see Map II). Large parts of the interior have virtually no human populations and since Independence there have been marked efforts to resettle haphazard waterside dwellers to planned agricultural villages. On top of this, bandit activity has forced many people from the land altogether and into towns. Because of these factors human pressure on water resources is probably the lowest in Africa. Nowhere is this more clearly seen than on Lake Cahora Bassa which, though rich in fish, is barely utilized and sparsely populated.

Rivers which arise in Mozambique, which include most of those in North, are not subject to siltation. However, several in the South, notably the Save and Limpopo Rivers have become drier in recent years as a result of the expansion of subsistence agricultural and siltation in neighbouring Zimbabwe. The recent drought in southern Africa has compounded this problem. However, as detailed above, the bulk of Mozambique's crocodile population is to be found in the perennial rivers of the North.

The impoundment of the Zambezi River to form Lakes Kariba and Cahora Bassa has had a drastic effect on the hydrology of the lower Zambezi and notably the ecology of the Zambezi Delta. The closing of the Cahora Bassa Barrage in 1974 ended the natural flood regime of this huge floodplan. Since then there have been many reports of changes in the delta. Whitaker (1981) notes that "the reduced flow of water has drastically affected all of the small rivers in Marromeu, some of which have converted to grass and papyrus swamp in a matter of a few years. This has reduced crocodile habitat to a series of pools and some small stretches of open water and limits the increase of the wild population".

However, to balance this habitat loss, the formation of Lake Cahora Bassa has created, in its upper 25%, an extremely favourable crocodile habitat with a population which exceeded 5,000 animals in 1986 (see above). The total for the whole lake is unknown, but obviously much higher.

3. Trade Data

31. National Utilization: Prior to 1985 national utilization of the resource was restricted to sport hunting. However, since the introduction of CITES quotas in 1985 and Mozambique ranching

project in 1987, crocodiles have been hunted for their skins (this is reported fully in section 32.) and eggs have been removed for incubation on a licensed ranch.

311. Ranching: Crocodile ranching was proposed as a viable utilization option in Mozambique by Bundernagel (1980). Subsequently a FAO consultant examined the detailed possibilities of such a scheme (Whitaker, 1981). A small farm was started in Marromeu region,utilizing waste meat and offal from large mammal culling operations in the Zambezi Wildlife Utilization Area by the EMOFAUNA, a parastatal organization. By 1984 all attempts at ranching had ceased, solely due to security problems in the area.

In 1987, a ranching licence was granted to a private investor in association with EMOFAUNA and 1,800 eggs were collected from Cahora Bassa. Again security problems intervened and the proposed incubation site at Chicoa had to be abandoned. The Government of Mozambique therefore asked the Government of Zimbabwe for assitance and, after consultation with the CITES Secretariat, permits were issued under Article VII, paragraph 6, of the Convention for up to 5,000 eggs to be temporarily exported to Zimbabwe where they would be hatched. The hatching and unhatched eggs had to be returned to Mozambique by 31 August 1988 when rearing facilities were due to be ready at the alternative site on Bazaruto Island.

Unhappily, administrative delays resulted in the death of these 1,800 eggs. A second collection exercise was then mounted in the area and 1,050 eggs subsequently arrived in Zimbabwe. Of these 1,040 were successfully hatched. In August 1988, 1,007 live hatchings and all unhatched eggs were returned to Mozambique which therefore has a fully operational crocodile ranch on Bazaruto Island. This ranch now has its own incubator and associated facilities and it is expected that 5,000 eggs will be collected for incubation from Cahora Bassa in 1988. Thereafter egg quotas will be set on the basis of the CITES Nile Crocodile Project together with DNFFB biologists.

312. Sport hunting: At it has been pointed out, there is no sport hunting taking place in the country since 1984 to date.

During 1985 and 1986 only two skins have been exported and both obtained from exercise in defense of human life and property.

32. Legal International Trade: On acceding to CITES in 1981 Mozambique did not hold a reservation with regard to the Nile crocodile. Subsequently very limited trade was allowed under Article III, paragraph 2.

In 1985 Mozambique was assigned a quota of 1,000 Nile crocodile specimens for the years 1985, 86 and 87 (the latter to be reviewed at the sixth meeting) in terms of Resolution Conf. 5.21. The 1985 quota was given too late to use, and security problems prevented hunting and resulted in only two skins exported in 1986.

In 1987, however, a private investor, together with EMOFAUNA, put together a cropping operation on Lake Cahora Bassa. From this a total of 1,000 skins were legally exported in terms of the 1987 quota. This cropping exercise was supervised by DNFFB biologists and in conjunction with the CITES Nile Crocodile Project extensive biological data were collected. This will be presented in the coordinator's report (see above).

The export closely followed the procedures required under Resolution Conf. 5.21.

At the sixth CITES meeting in 1987 a further quota of 1,000 specimens per annum was given to Mozambique for the years 1988, 89 and 90 (the latter to be reviewed at the seventh meeting). It is expected that 1,000 specimens will be exported in 1988 and the terms of Resolutions Conf. 5.21 and 6.17 will be strictly adhered to.

Once ranching operations bear fruit all resultant specimens will be tagged and exported, and reporting made in full compliance with Resolutions Conf. 3.15 and 6.22.

33. Illegal Trade: There is no evidence of any illegal trade in crocodiles or their products in Mozambique.

34. Potential Trade Threats: All crocodiles skins produced within Mozambique are to be exported. No domestic trade is envisaged. Since skins can only be exported with approved tags, issued by the Management Authority of Mozambique, it is unlikely that there will be any pressure for illegal hunting.

Current cropping of wild animals is due to end in 1990, but in 1989 it is intended to review cropping and to encourage live capture and export. In any case, given the estimated size of the crocodile population in Mozambique it is not considered that this crop will have been any threat to the wild population. In future, egg harvesting is envisaged as the major form of utilization. There will also be a limited amount of sport hunting, estimated in 20 crocodiles and possibly small wild harvest of wild animals estimated in 1,000 individual in prestudied areas.

Eggs quotas will be set in accordance with recommendations made by the Scientific Authority of Mozambique. The population model currently being constructed (see above) should be of considerable assistance in this. It is not considered possible that exploitation under this ranching proposal will result in a threat to the wild population.

4. Protection Status

41. National: Under the Hunting Regulation (Decreto 7/78 and Portaria 117/78 of March 1978) crocodile can only be destroyed or molested in direct defence of human life and property or under condition of a hunting licence issued centrally by the DNFFB.

In the four National Parks which cover about 1.6% of the total land surface the species enjoy a full protection.

Penalties in contraventions of the Hunting and National Park's Regulation range from an equivalent to US$ 50 to 74 with an aggravating of loosing all equipments used in the offence in favour of the State.

The National Crocodile Management and Conservation Policy approved in 1987 establishes a return of 3% of the egg collected in females of 1.2 m total length (see Annex I).

42. International: The Nile crocodile is listed in Appendix I of CITES for all countries except Zimbabwe (Appendix II under Resolution Conf. 3.15), and Botswana, Cameroon, the Congo, Kenya, Madagascar, Malawi, Mozambique, the Sudan, the United republic of Tanzania and Zambia (Appendix II with quotas). There are numerous farms under Resolution Conf. 2.12. The African Convention on the Conservation of Natural Resources includes this species in class B, and hunting is allowed provided a licence is granted.

43. Additional Protection Needs: Providing CITES remains intact and all neighbouring countries remain Parties, there are none for the Mozambique population which is considered secure.

5. Information on Similar Species

Not applicable since proposal is made in terms of Resolution Conf. 3.15 and there is no other crocodile species in Mozambique.

6. Comments from Countries of Origin

Not directly applicable since this proposal is made under Resolution Conf. 3.15. However, attention should be paid to the following extract from "Management and Utilization of Crocodiles in the SADCC Region" (Hutton et al., 1988).

Largely on an anecdotal basis, the Nile crocodile was placed in Appendix I at the first meeting in Washington in 1973. Although 27 African countries attended the meeting most were represented at an ambassadorial level only.

On joining the Convention in the early 1980's Botswana, the Sudan, Zambia and Zimbabwe each held a reservation with regard to the Nile crocodile.

Despite the animal's Appendix I status this allowed them to trade in the species, but only with the few consumer Parties which held a similar reservation. These African countries were indicating that they did not consider the crocodile to be endangered within their borders.

Zimbabwe's reservation was particularly important as that country had a well-developed crocodile ranching industry to protect. Although Zimbabwe's skins could continue to enter trade as result of the reservation many principal markets were barred to them.

There are different perceptions as to the function of Appendix I, but SADCC believes that a species should not be on this appendix unless, as implied in the requirement of Article II, paragraph 1, of the Convention, it is "currently threatened with extinction" otherwise the

appendix is devalued. As with leopard, the fact that the Nile crocodile (with a captive population in Zimbabwe alone of over 30,000 animals) has the same status as the black rhino (total) population less than 3,000) highlights the ludicrous state to which Appendix I has been reduced.

SADCC BELIEVES THAT SINCE THE NILE CROCODILE IS NOT CURRENTLY THREATENED WITH EXTINCTION IT SHOULD BE MOVED OFF APPENDIX I.

In 1976 the "Berne Criteria" were drawn up for the transfer of species between appendices. These require "positive scientific evidence that the plant or animal can withstand the exploitation resulting from the removal of protection. This evidence must transcend informal of lay evidence of changing biological status and any evidence of commercial trade which may have been sufficient to require the animal or plant to be placed on an appendix initially. Such evidence should include at least a well documented population survey, an indication of the population trend of the species, showing recovery sufficient to justify deletion, and an analysis of the potential for commercial trade in the species or population" (CITES Resolution Conf. 1.2). These criteria are obviously impossible to fulfil where species were included in Appendix I when their true biological status was unknown.

CITES Resolution Conf. 3.15, adopted at the third meeting of the Conference of the Parties (1981), established criteria by which a population may be transferred from Appendix I to Appendix II under a ranching proposal. Ranching is required to be beneficial to the wild population.

In 1983 at the fourth meeting of the Parties the Zimbabwe Nile crocodile population was transferred to Appendix II under a ranching proposal pursuant to Resolution Conf. 3.15. The data for this proposal took over three years to collect a total estimated of US$ 30,000. As a result of secure utilization the wild crocodile in Zimbabwe immediately became an asset, annually earning US$ 600,000 by 1985. Without the resources to follow Zimbabwe's lead neighbouring SADCC states continued to regard the Nile crocodile as a nuisance animal because of its conflict with legitimate human interests, including extensive depredations on human and livestock. Thus, despite CITES, the potential conservation status of the species in these countries was poor.

In 1984, at a workshop on CITES implementation in Africa, 25 African countries agreed that the Nile crocodile was not endangered and did not merit being in Appendix I.

In CITES Resolution Conf. 5.21 (1985) the Parties to the Convention acknowledged that the Berne Criteria are difficult to fulfil - because, amongst other things, they require positive evidence of recovery from a level which was not determined - to allow species INCORRECTLY listed in Appendix I to be transferred to Appendix II. This mechanism requires that the Scientific Authority of the involved Parties monitor permits and exports [Article IV, paragraphs 2(b) and (3), of the Convention] and continue to meet their annual reporting requirements (under Article VIII, paragraph 7) in a timely fashion. These have to include complete data on trade in the species in question.

On 23 November 1984, 150 days before the opening of the fifth meeting of the Conference of the Parties, Malawi communicated to the CITES Secretariat a proposal that the populations of nine African countries, including four SADCC countries (Malawi, Mozambique, The United Republic of Tanzania and Zambia), be transferred to Appendix II to allow legal trade under set quotas as outlined in Resolution Conf. 5.21. After the submission of additional information (Doc. 5.45.1) annual quotas for 1985, 1986 and 1987 were agreed.

7. The Ranching Proposal

71. Background: The National Crocodile Conservations and Management Policy, 1987 (P.C.M.C.) considers the species not only as an important ecological factor in the environment where it coexists with other species, but also as a potential source of foreign income to the country.

Population and habitat protection measures have been established and reenforced in the last 3 years. The ban of massive harvest since 1965 (Diploma Legislativo 2427) and reenforced by the Hunting Regulation (Decreto 7/78 of 18 April and Portaria 117/78 of 16 May 1978) and the Resettlement Programme of rural population are some of the important measures taken to protect the species.

No significant trade have been recorded in the past 15 years or so, and recent surveys undertaken in selected areas (Cahora Bassa, Buzi, Marromeu) showed the population to be healthy. In some areas, the species have become a "problem" causing fatal damage to human lives and their properties.

The available laws and the P.C.M.C. encourage full protection of the species where it is compatible and allows some utilization where it is viable.

72. Proposal Outline: As opposed to "farming", "ranching" is herein understood as the operation based on the egg collected from the wild.

The ranch operation is guided through the National Legislation and in compliance with Resolution Conf. 3.15.

721. Egg Harvest:

a) An annual quota of up to 7,000 eggs will be set for the ranch operations and this is subject to review in 3 years.

b) Eggs will be harvested in October to November, the peak of the nesting season. The harvest will be from rivers Zambezi, Pungue, Buzi, Limpopo and Maputo under supervision of the DNFFB.

c) Each clutch will be marked and put in cold boxes for transportation.

d) Harvest areas will be monitored annually by spotlight counts and aerial surveys.

e) According to P.C.M.C. and the Hunting Regulation, the permit to collect eggs will be granted to registered ranchs.

722. Egg Incubation:

a) Eggs will be transported in cold boxes by aircraft from the collection area to the ranch.

b) As the eggs are marked on collection that makes easy to see the hatching success for each clutch.

c) The incubation room is fitted with temperature control devices (heater and air conditioner) to ensure stable temperature throughout the incubation.

d) The hatchlings will be maintained in the pens in the incubation room for at least one week for acclimatization before are transferred to the rearing pens.

723. Breeding Stock:

a) Capture of 40 crocodiles for breeding purpose in the ranchs will be set, and this has in view that ranchs soon or later must be self-sufficient in eggs production.

b) The established quota (40) is due to review in 3 years.

c) Emphasis is given to capture whenever possible the "problem" animals, but where this is impractible they will be destroyed.

724. Restocking:

a) As it is mentioned in the P.C.M.C., permit to collect eggs will be granted to the registered ranchs under a condition that 3% of the eggs collected be returned to the wild in female crocodiles not less than 1.2 m total length.

b) The restocking exercise will be surveyed by the DNFFB and the return percentage will be reviewed in 3 years.

725. Monitoring of Industry:

7251. Regulatory Control of Ranchs:

a) Application to ranch crocodiles must satisfy both the foreign/National Investment Law and the Management Authority that they possess suitable experience and financial capability.

Sources of water, food and storing facilities must be stated in the proposal.

b) The Management Authority can inspect the ranch without previous notice.

7252. Stock and Skin Identification:

a) Stock of breeding animals will be marked differently from ranch to ranch and constitute matter of regular inspection.

b) Animals raised from eggs collected from the wild will be kept in class sizes and marking scheme will be developed.

c) The skins will be marked with CITES ranch tags which contains the country code number, initials of the ranch's name and year of export. The packing list must show the belly width, sex, date and ranch origin.

7253. Records: The DNFFB will maintain records of ranch stocks through quarterly reports from the ranchers and inspection will be conducted whenever necessary by Management and Scientific Authorities.

7254. Research and Monitoring: Crocodile ranching in Mozambique is apparently new subject, thus both ranches will constitute a valuable source of scientific information.

73. Criteria under Resolution Conf. 3.15:

731. Para (b) (i): The operation is designed to benefit the conservation of the local population and contribute to its increase in the wild. The return of 3% of the eggs collected to the wild will certainly contribute to the increase of the local population.

732. Para (b) (ii): The skins to be exported will be tagged in a way to deferentiate from those from the wild.

Other identification methods include the documentary checks.

733. Para (c) (i): Ranching crocodiles in Africa and elsewhere in the world has shown no significant detrimental impact on the wild population.

Egg collection areas will be monitored by spotlight and aerial surveys and the return percentage will restock the area.

734. Para (c) (ii): Research will be encouraged on biological and husbandry aspects of the operation. The economics of the operation will be assessed.

735. Para (c) (iii): All aspects of the ranch operation including egg collection, incubation, feeding and slaughtering will be undertaken to minimize stress to the animals.

736. Para (c) (iv): As outlined in the section 72., the operation is beneficial to the wild population and both Management and Scientific Authorities will continue to monitor the operation.

737. Para (c) (v): The methods to be used to identify the products will include tagging and documentary checks.

738. Para (c) (vi): Assurance is given that the operation will be closely monitored by the Scientific and Management Authorities to ensure that the criteria continue to be met, and annual reports will include details of the status of the wild population and the performance of the operations.

8. REFERENCES

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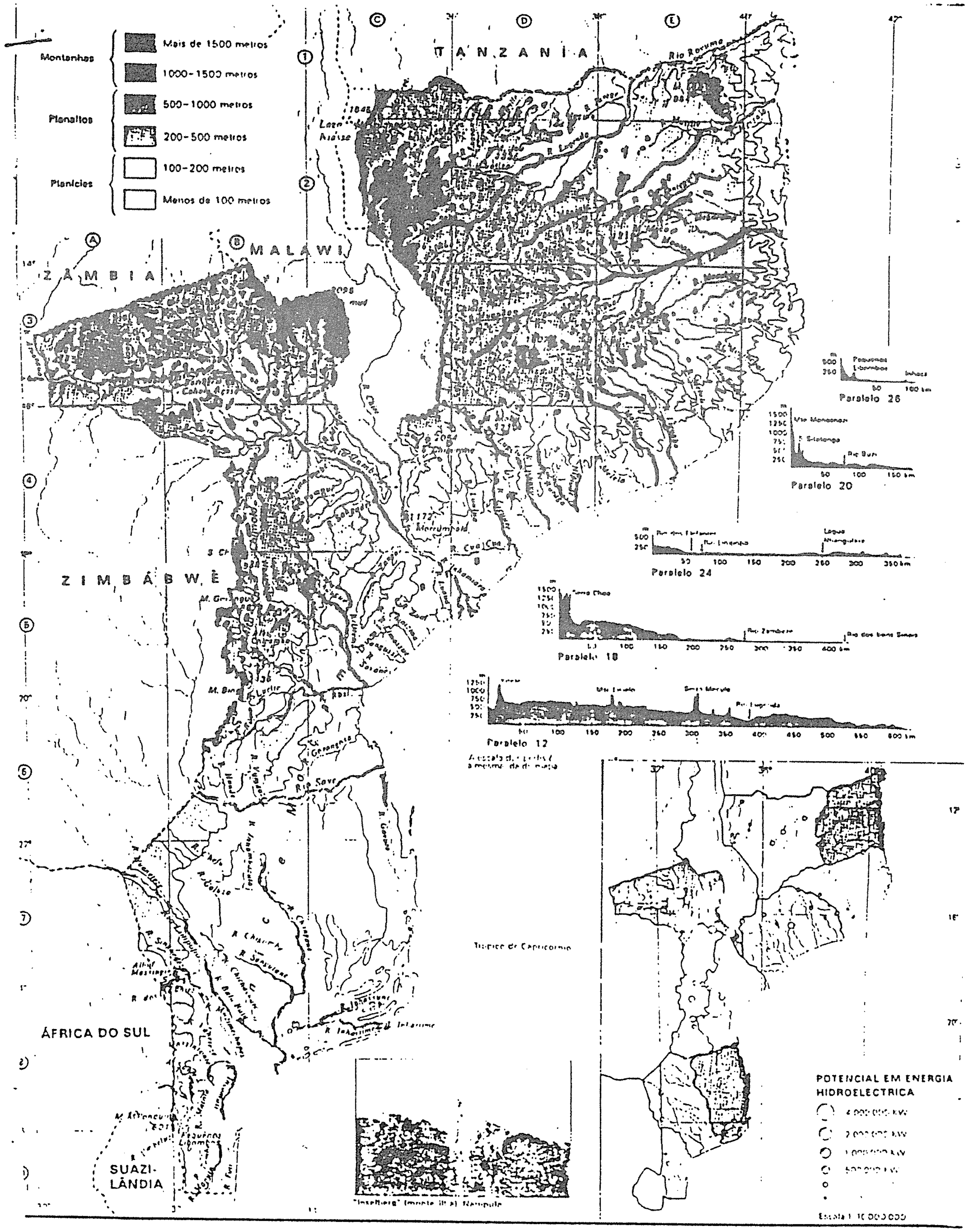
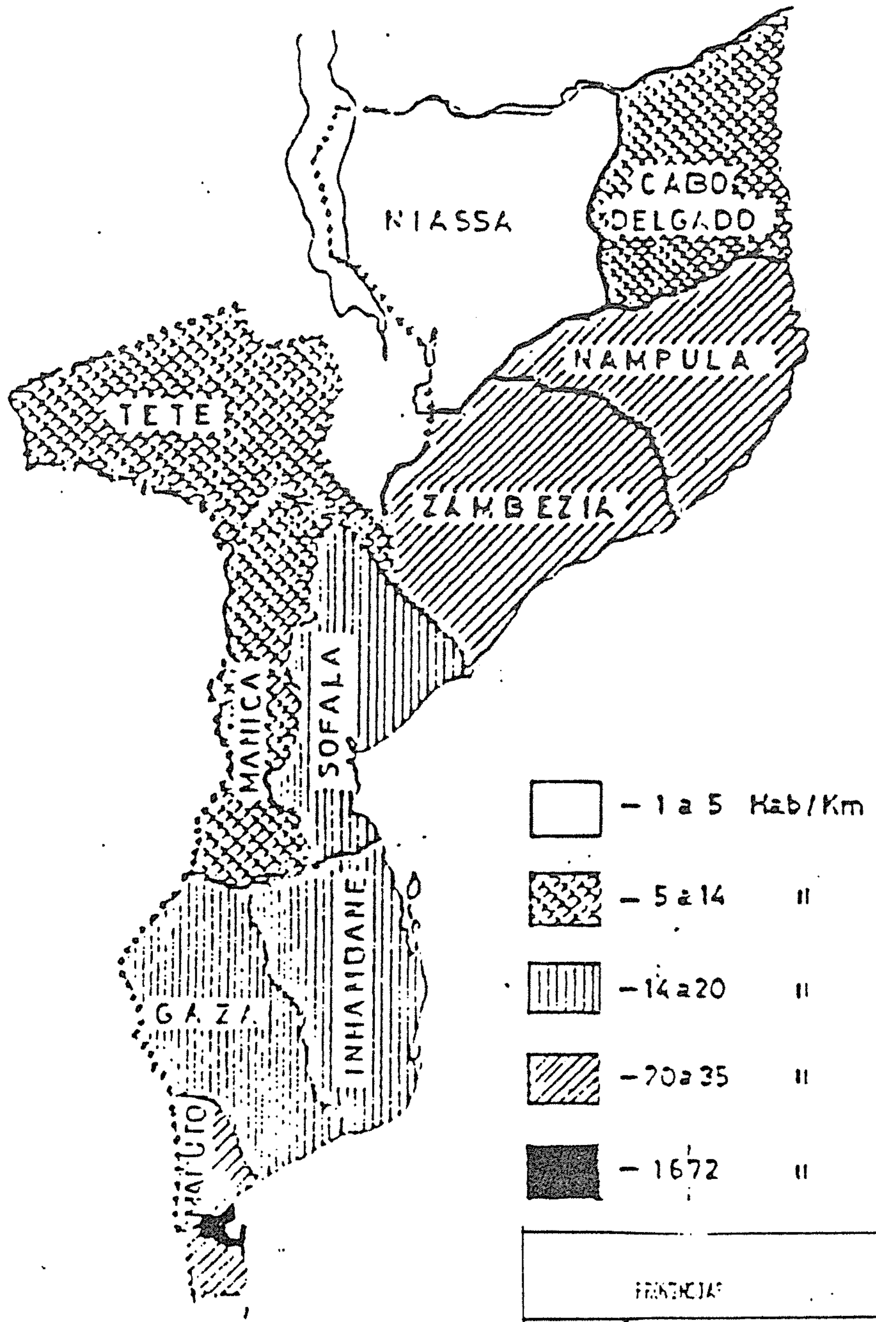
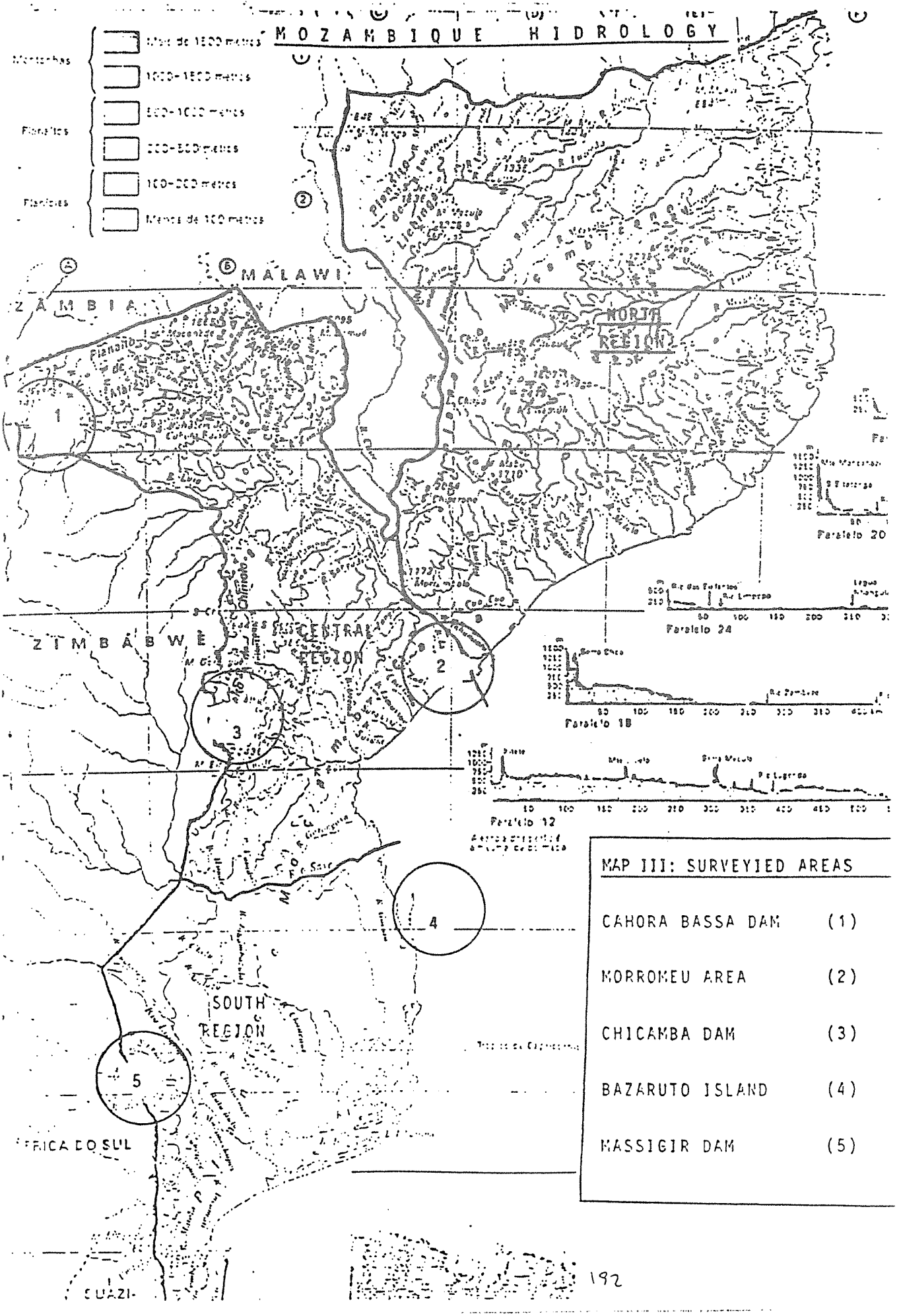


MAP I: MAJOR RIVERS



	PROVINCIAS	AREA (KM2)	POPULAÇÃO (1/1/1983)	DENSIDADE POPULACIONAL
NORTH REGION	NIASSA	129056	607670	4.7
	CABO DELGADO	82625	1109921	13.4
	NAMPULA	81606	[illegible]	[illegible]
	ZAMBEZIA	105000	[illegible]	[illegible]
CENTRAL REGION	TETE	100724	[illegible]	9.7
	MANICA	[illegible]	[illegible]	[illegible]
	SOFALA	[illegible]	1257710	[illegible]
SOUTH REGION	INHAMBANE	[illegible]	[illegible]	[illegible]
	GAZA	75709	[illegible]	[illegible]
	PROVINCIA DE MAPUTO	25756	544692	21.1
	CIDADE DE MAPUTO	602	[illegible]	[illegible]
	TOTAL DO PAIS	[illegible]	[illegible]	[illegible]

MAP II: DEMOGRAPHY



MAP III: SURVEYIED AREAS

CAHORA BASSA DAM	(1)
MORROMEU AREA	(2)
CHICAMBA DAM	(3)
BAZARUTO ISLAND	(4)
MASSIGIR DAM	(5)

ESTIMATION OF CROCODILE NUMBERS ON LAKE CAHORA BASSA

ZUMBO/MESSENGUEZI BASINS

1987/1988

*Chande, B., **Games, I., *Zolho, R.

INTRODUCTION

This survey was undertaken as a joint project between Mozambique and the CITES Nile crocodile project, with assistance from the private sector in Zimbabwe. The aim was to derive a population estimate for crocodiles in the Zumbo/ Messenguezi basins of Cahora Bassa Dam where 1000 crocodiles were cropped in 1987. The following questions were asked:

1) What was the population before the 1987 cull?

2) What was the population after the 1987 cull?

3) Can the population withstand the removal of another 1000 animals in 1988.

The objective of the study is to enable the wildlife authorities in Mozambique to make management decisions regarding optimal utilization of the crocodile resource.

STUDY AREA DESCRIPTION

The following is a brief description of the Cahora Bassa Dam and the Zumbo/Messenguezi area.

Cahora Bassa Dam

This section is largely a summary of the data presented in the FAO report "Moçambique". Investigations into the fishery and limnology of Cahora Bassa reservoir seven years after dam closure" (Bernacsek and Lopes, 1984).

Cahora Bassa is the fifth largest reservoir in Africa and was completed in December 1974. It has a length of 246 km, a shoreline of approximately 1,200 km and a surface area of 2,005 km^2. It is very shallow in the upper reaches - maximum depth 18 metres in the Zumbo basin - but becomes very deep in the Cahora Bassa Gorge (156 metres). The two major feeder rivers are the Zambezi, which is regulated by the Kariba Dam, and the Luangwa. There are 50 minor rivers draining into the lake - the largest being the Hunyani and the Messenguezi, both of which originate in Zimbabwe.

The maximum lake level is 330.5 metres above sea level and the minimum is 295 metres above sea level. The present low lake levels mean that approximately 20-40 km of the original lake can be reclassified as river. The actual distance is directly related to the water level (i.e., when the lake levels are high more of the river section is submerged. Conversely, lower lake levels mean extended river).

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The lake is divided into 7 basins: Zumbo - Messenguezi - Carinde - Mucanha - Mague - Chicoa and Garganta (Inset - Map 1).

The water residence time is short - 0.61 years as opposed to 4 years in Kariba. Water temperatures ranged from 18 - 30°C in the river, prior to impoundement. Air temperatures vary from 14 - 39°C. Winds are predominantly South-East and South with peaks in March.

Water in the dam is an olive green colour due to clay particles which are of uncertain origin. This substantially reduces light penetration. Secchi disc readings are from less than 1 metre with short peaks of 3 metres. Kariba, in comparison, has readings of between 4 and 5 metres in the Sanyati basin, throughout the year. It is estimated that water visibility in the river at Zumbo is between 10 and 20 cm owing to high suspension loads. The average ph is 7.8.

Four species of aquatic macrophytes are listed as occuring. These are Eichornia crassipes (water hyacinth), Salvinia molesta (Kariba weed), Pista stratiotes (water lettuce) and Azolla nilotica (water fern). It appears that Eichornia is the only one that has made any substantial headway as a problem plant and this is most evident where the river flow diminishes as it enters the lake. It is speculated that drawdown has a large part to play in limiting the spread. Salvinia was never well established.

The lake itself is bordered, for the most part, with rocky shores. Dead trees are abundant on shallow shelving shores. There are three narrow passes (+/- 1 km in width). Two of these are in the Carinde basin and the third is the boundary between the Chicoa and Mague basins.

Fisheries exist at New Chicoa and Songo where there are some boats and buildings. It is not known what the present fishing effort is, but there are plans to build a refrigeration unit at New Chicoa All other fishing effort on the lake is from local inhabitants using gill nets and dugout canoes. There is no utilization of the sardine stocks.

The lake is thinly populated along its length. Fishing effort is only relatively intense in the Garganta and Zumbo basins. Owing to recent civil strife many small villages in the Mague and Mucanha basins were uninhabited in 1987.

Zumbo/Messenguezi

The Messenguezi basin is characterised by rocky shores. There are very few sandbanks. When the water level is high large areas become inundated with shallow water and this is ideal habitat for crocodiles. Water hyacinth (E. crassipes) starts to become noticeable in the Carinde basin and dense mats are to be seen close to the shore in the Messenguezi basin. Some of these are extensive. There is no evidence of consolidated mats of Kariba weed (S. molesta) as is the case on Lake Kariba.

Between 20-40 kilometres from the Zimbabwe/Zambian border the lake ends and the river begins. The distance is determined by the water level and the areas most affected by the rise and fall is the Zumbo basin. There is also a secondary weekly fluctuation of ± 20 cm which corresponds to the discharge from Kariba Dam.

This basin is characterized ny numerous channels which vary from 15 - 200 metres in width. There are large sandbank islands dominated by reeds (Phragmites sp.) and the channel fringes are often obscured by a narrow band

of Phragmites. There are occasional stands of rooted aquatic grasses (Eichinochloa/Vossia sp.) in the calmer waters. The vertical banks of the sand islands can be up to 4 metres in height and crocodile trails and hippo paths are common feature. The islands/sandbanks generally have a limited lifespan and the course of the channels changes with each new flood.

UTILIZATION OF THE CROCODILE RESOURCE

In 1987 1,000 crocodiles were shot in the Zumbo basin and their skins exported as Mozambique quota under CITES. It is estimated that approximately 25% of crocodiles shot were not recovered which means that at least 1250 animals were removed from the population.

Three periods were needed to shoot the crocodiles, each being of about 3 weeks duration. During the first period 228 animals were shot, during the second 301 animals and 471 during the third. The encounter rate during the third period was far greater than during the first period. (One of the authors was present as a hunter during both of these periods). This is contrary to what one would expect i.e., as crocodiles are being removed it should become more difficult to shoot them. We believe that the apparent increase was due to falling water levels and shrinking habitats.

In addition 2,850 eggs were removed. These eggs were to form the nucleus of a crocodile farm on Bazaruto Island, off the Mozambique coast.

Egg collection can be summarised as follows. In October 1987, 1,800 eggs were taken from 96 nests. Owing to administrative problems these eggs were impounded in Tete until they became inviable. None of these eggs hatched (Hutton, pers. comm.).

In December a further 1,050 eggs were taken. The majority of these eggs hatched as they came out of the ground or during transportation to camp. As a consequence it was decided to immediately move the hatchlings to temporary holding pens in Zimbabwe, with the approval of the Zimbabwe Government and the CITES Co-ordinator. Any delays would have resulted in the death of these animals. In total, 1,040 hatchlings were introduced into the pens in Zimbabwe. While the hatchlings are in Zimbabwe their progress is being monitored by the CITES Nile crocodile project Co-ordinator. He has undertaken to ensure that the crocodiles return to Mozambique as soon as suitable pens are constructed. (The projected date is August 1988). To date 1,007 hatchlings remain, 33 having died from disease, stress or undetermined causes.

As much scientific information as possible was recorded from the crocodiles shot in 1987. Four morphometric measurements were taken from almost all carcasses and the animals sex was recorded when possible.

Leg bones were taken from 500 animals for age determination and the contents of 200 stomachs were taken for diet analysis. Gonad sections were taken from a number of animals to determine the criteria of sexual maturity and reproductive status. This data is currently under analysis by I. Games, R. Zolho and J. Hutton and a report and population model is being constructed.

METHODS

Knowledge of the population size is important for management of the crocodile resource. There are a number of problems peculiar to counting crocodiles and it should be pointed out that the nature of the animal and its habitat make it impossible to arrive at a true total. All counts provide estimates which have qualities of precision and accuracy. Furthermore, it is often completely

impractical to attempt a total count of an area, especially one as large as the Zumbo/Messenguezi basins. Therefore a sample count is made of a section of the area and then the results are extrapolated to the whole region. Counts are usually underestimates owing to factors such as concealement, diving behaviour and observer bias (Graham, 1988).

The three common census methods for crocodiles are:

1) Spotlight counts at night
2) Aerial counts during specific times of day
3) Aerial counts/Ground counts of nests.

All three methods have their advantages and limitations. In order to allow for these biases, correction factors are built in to any estimate of numbers.

The proportion of a crocodile population seen during spotlight counts from boats is affected by the extent of shoreline vegetation, water levels, wind and waves, temperature and diving behaviour of the crocodiles. Hutton (1984), in a study done in Zimbabwe, showed that, on occasions, as few as 30% of the total number of crocodiles were seen. Bayliss et al. (1986) recorded similar figures for the saltwater crocodile in Australia. These factors need to be taken into account when computing the final estimate.

Aerial surveys rely on the fact that crocodiles emerge to bask in the warm sunlight during the day. The proportion of animals on the bank varies with air and water temperature. Generally more crocodiles are to be found basking during early to mid-morning and in the late afternoon than at midday. Sightings of crocodiles are also affected by the observer, water visibility, vegetation and time of the year.

The correction factor for the complicated channel system in the Zumbo area is calculated to be 5.1. This figure was derived from careful analysis of aerial photographs (1: 80,000). The total length of the channels, in two sample units, was measured directly of the photographs by two observers. This was then divided by the straight line distance for the river.

In September 1987, six spotlight counts were carried out at the beginning of the cull, on different nights and on different sections of the river (Map 1). No attempt was made to differentiate between size classes. Counts were done during actual culling exercises and the driver recorded all crocodiles seen by the spotlighter, whether they were shot or not.

In July 1988, in the same area that counts were undertaken in 1987, a single spotlight count was done over 34.2 kilometres of river. The river was, however, divided into 11 subsections in order to reflect numbers in high and low density areas (Map 1). The team consisted of a driver, spotlighter and two recorders. Again, no attempt was made at size class differentiation.

An aerial survey was also carried out along the southern shoreline from Zumbo to the Messenguezi River. The aircraft flew in a circular pattern in an attempt to cover the extensive floodplain areas. The recorder sat behind the pilot and recorded three data sets.

1) The number of crocodiles seen by the pilot or other observers, depending on the side of the aeroplane, but not by him.

2) The number of crocodiles seen by the recorder but not by any other observers.

3) The number of crocodiles seen by both the recorder and the observer.

RESULTS

Table 1 shows the results of the 1987 pre-cull spotlight count.

Table 1 - Spotlight Count - September 1987

Date	Approximate Distance	Numbers	Density (d)	d
16	2	21	10.5	110.25
18	2	26	13.0	169.00
20	10	83	8.3	68.89
21	6	68	11.3	127.69
22	3	42	14.0	196.00
24	2	21	10.5	110.25
Totals	25	261	67.6	782.08

SE N = 126.32 CV = 7.9 (See Appendix 1)

Estimated channel length = 30 x 5.1 = 153

Estimated No. crocodiles = 10.44 x 153 = 1597.32

1597 corrected by 3.3 = 5270 (30% seen during the count)

1597 corrected by 1.7 = 2715 (60% seen during the count)

Using the spotlight correction factor (Hutton, 1984; Graham, 1986 and Taylor, 1988) and the channel correction factor, a population estimate can be proposed for the area in September 1987. This ranges from 2,715 to 5,270 crocodiles. The true figure is somewhere between the upper and lower limit. We feel that it is closer to the upper limit owing to the amount of cover available to the crocodiles along the channel fringes. Also giving weight to a higher figure is the fact that aggregations of crocodiles were not well counted, owing to cropping happening at the same time.

Table 2 shows the results of the spotlight count done in July 1988.

Again we tend to believe that the true figure is towards the upper limit for the reasons already outlined. If we use the upper limit of the pre-cull count and subtract the number of crocodiles shot during 1987 we get a figure remarkably close to the upper limit of the post-cull count.

5270 - 1250 = 4020

We feel that this is a reasonably accurate picture of what actually occurred.

Table 3 shows the results of the aerial survey undertaken in June 1988. It can be divided into two sections which are separated on the basis of water level and shoreline habitat. Sections 1 - 3 come under one stratum while section 4 can be considered separately. Sections 1 - 3 cover the area where culling took place in 1987.

Table 2 - Spotlight Count - July 1988

	Distance	Numbers	Density (d)	d
Subsection 1	5.4	34	6.3	39.69
Subsection 2	2.5	23	9.2	84.64
Subsection 3	1.1	22	20.0	400.00
Subsection 4	1.0	30	30.0	900.00
Subsection 5	1.1	11	10.0	100.00
Subsection 6	1.9	7	3.7	13.69
Subsection 7	3.4	23	6.8	46.24
Subsection 8	4.6	8	1.7	2.89
Subsection 9	4.7	6	1.3	1.69
Subsection 10	2.5	35	14.1	196.28
Subsection 11	6.6	38	5.8	33.64
Total	34.2	237	108.9	1818.76

S = 74.24 var N = 157987.47 SE = 397.47 CV = 37.5
(See Appendix 1)

Estimated No. crocodiles = 6.93 x 153 = 1060.26

1060 corrected by 3.3 = 3498 (30% seen during count)

1060 corrected by 1.7 = 1802 (60% seen during count)

Table 3 - Aerial Survey July 1988

	Length km	S1	S2	B	N	V	Density km
SECTION 1	17	15	5	33	54	3.45	3.17
SECTION 2	7	14	7	58	81	2.26	11.50
SECTION 3	36	28	12	28	80	31.20	2.20
SECTION 4	56	22	11	74	110	4.70	1.90
TOTAL	116	79	35	193	321	23.50	2.76

S1 = No. seen by pilot only

S2 = No. seen by observer only

S3 = No. seen by both

N = Numbers V = Variance

$$\text{Total No.} = N = \frac{((S1 + B + 1)(S2 + B + 1)}{(B + 1) - 1)}$$

$$\text{Variance} = V = \frac{S1\ S2\ (S1 + B + 1)(S2 + B + 1)}{(B + 1)^2\ (B + 2)}$$

The total computed count of crocodiles on the aerial survey is 321. Only the southern shore was counted which means that the northern shore and much of the central areas were not included. It would not be unreasonable to correct this count by a factor of three for the unsurveyed areas. This would put the figure at 963 animals visible from the air. It should be borne in mind that crocodiles less that 2 metres total length are significantly undercounted during aerial survey (Parker and Watson, 1970).

We feel that this is a gross underestimate and the following factors must be taken into account. The day that the aerial survey was done was overcast and cool. The water and air temperatures were both 22˚C at takeoff time. This means that a large proportion of the crocodiles would remain in the water. The overcast conditions coupled with the very light colouration of crocodiles in this area also made spotting more difficult.

As ground counts are a better reflection of population numbers they can be applied to aerial counts to provide an estimate of bias to adjust the aerial count, (Taylor, 1988). Appendix 2 shows the calculations used for the estimation of bias and the adjusted number of animals. This was possible as we had both aerial and spotlight counts for section two (Map 2).

This gives a range between 6,207 and 3,197 crocodiles adjusted for the spotlight counts. These figures are higher than the spotlight count estimates but this is expected as they cover a far larger area.

EGG COLLECTION

A good method of monitoring a crocodile population is to collect data on the production base or the number of eggs produced. In Zimbabwe this is being done by allowing the crocodile ranchers to collect all the eggs that they are able to locate. This is a cheap and effective method of monitoring the producion base and the information can be used to set realistic quotas in the future.

If there are fears about population decline through this practice, it should be remembered that the authorities can recall the agreed 3% for restocking purposes once they have reached a size where it is likely that they will survive in the wild. It would be advantageous to ensure that all released animals are females.

CONCLUSIONS AND RECOMMENDATIONS

The two spotlight counts give figures which we feel represent a true picture of events in the Zumbo basin during the past 11 months. We also feel that they compare favourably with the aerial survey and that the population could withstand the removal of another 1,000 animals this year.

We therefore recommend:

1) That the cull be allowed to take place during 1988

2) That a size limit be placed on crocodiles shot in order to protect breeding stocks (see Appendix 3)

3) That surveys are carried out at the conclusion of each culling period

4) That the operator be allowed to collect all the eggs that he is able to locate.

ACKNOWLEDGEMENTS

We would like to thank Mr. R. Van der Riet and Crocodilos de Moçambique for making this study possible. We also extend our thanks to Dr. J. Hutton for his advice.

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APPENDIX 1

Calculation of Standard Error and Coefficient of Variation

The standard error is calculated using the mean square of the sampling densities and the variances.

Mean Square of Sampling Densities (S) is derived from this equation

$S = \frac{(\Sigma d^2 - ((\Sigma d)^2/n)}{(n-1)}$ where n = number of samples

The variance (N) = and is derived from this equation

var $N_2 = S(L_2^2/n)$ where L = total length of shoreline

The standard error of N is the square root of the variance and is calculated by SE n_2 var N_2

The standard error is then expressed as a percentage of the estimate for the coefficient of variation (CV).

APPENDIX 2

Adjusted estimates for aerial counts using bias estimated from spotlight counts

Bias (R) can be estimated by:

$$(R) = \Sigma y / \Sigma x = \bar{y} / \bar{x}$$

x = the spotlight count of crocodiles in subsample units
y = the aerial count in subsample units

Substituting our figures in the above equation gives

$$R = 79/165 = 0.478$$

The adjusted number of crocodiles can be calculated by:

$$\hat{x} = N \bar{y}' / \hat{R}$$

N = the total number of sample units in the survey area
y' = the observed number of animals in the main sample units
n = the number of units in the subsample used for the bias estimate
n' = the number of units in the main sample
$\bar{y}' = y' / n'$

Once again substitution gives us:

$$x = 4 \times 76.75/0.49 = 627$$

Using the upper and lower limits correction factors for spotlight counts, i.e., 3.3 an 1.7 (30% and 60% respectively) we can calculate the range.

Upper limit = 627 x 3.3 = 2067 x 3 (area) = 6207

Lower limit = 627 x 1.7 = 1066 x 3 (area) = 3197

APPENDIX 3

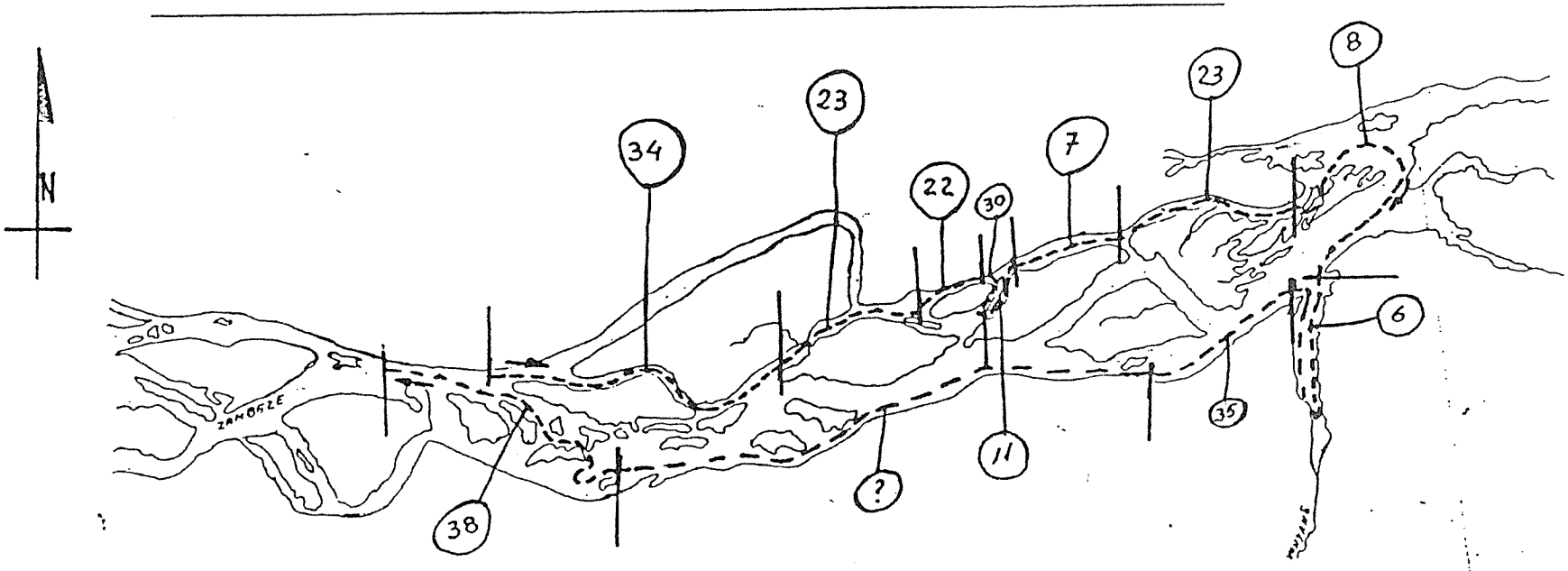
Size limits during culling

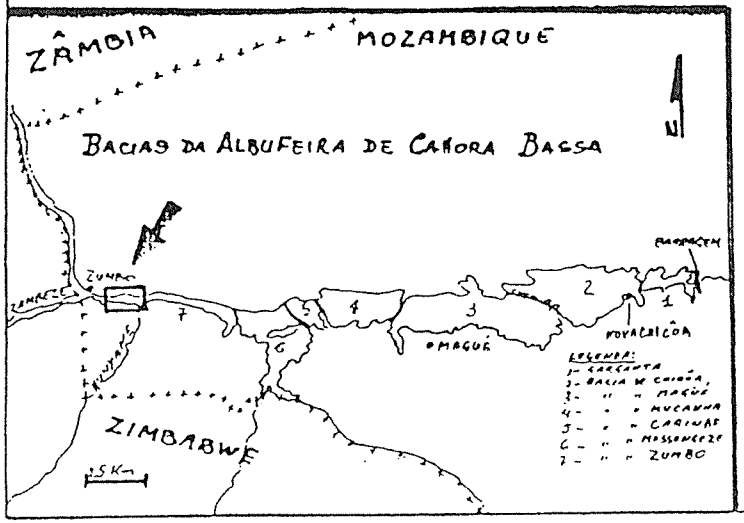
The imposition of a maximum size limit will help to protect the breeding females.

Data from Zimbabwe (Hutton, 1984) and the 1987 Zumbo cull suggests that females become sexually mature at around 2.5 - 2.7 metres total length. It is therefore recommended that a maximum allowable size be set at 2.5 metres with a 10% leeway for mistakes in size estimation. (It is often difficult to accurately estimate the size of an animal).

This can be checked both in the field by actually measuring the carcasses as they are brought in and by measuring the belly width when the skins are exported. The second method is not as accurate and shrinkage must be taken into account. Measuring in the field will also allow the sex to be determined which is valuable information.

CONTAGEM COM FAROLIN - BACIA DE ZUMBO, 11 JULHO 1988





LEGENDA

AGUA.....

CANAIS DE RECONHECIMENTO...

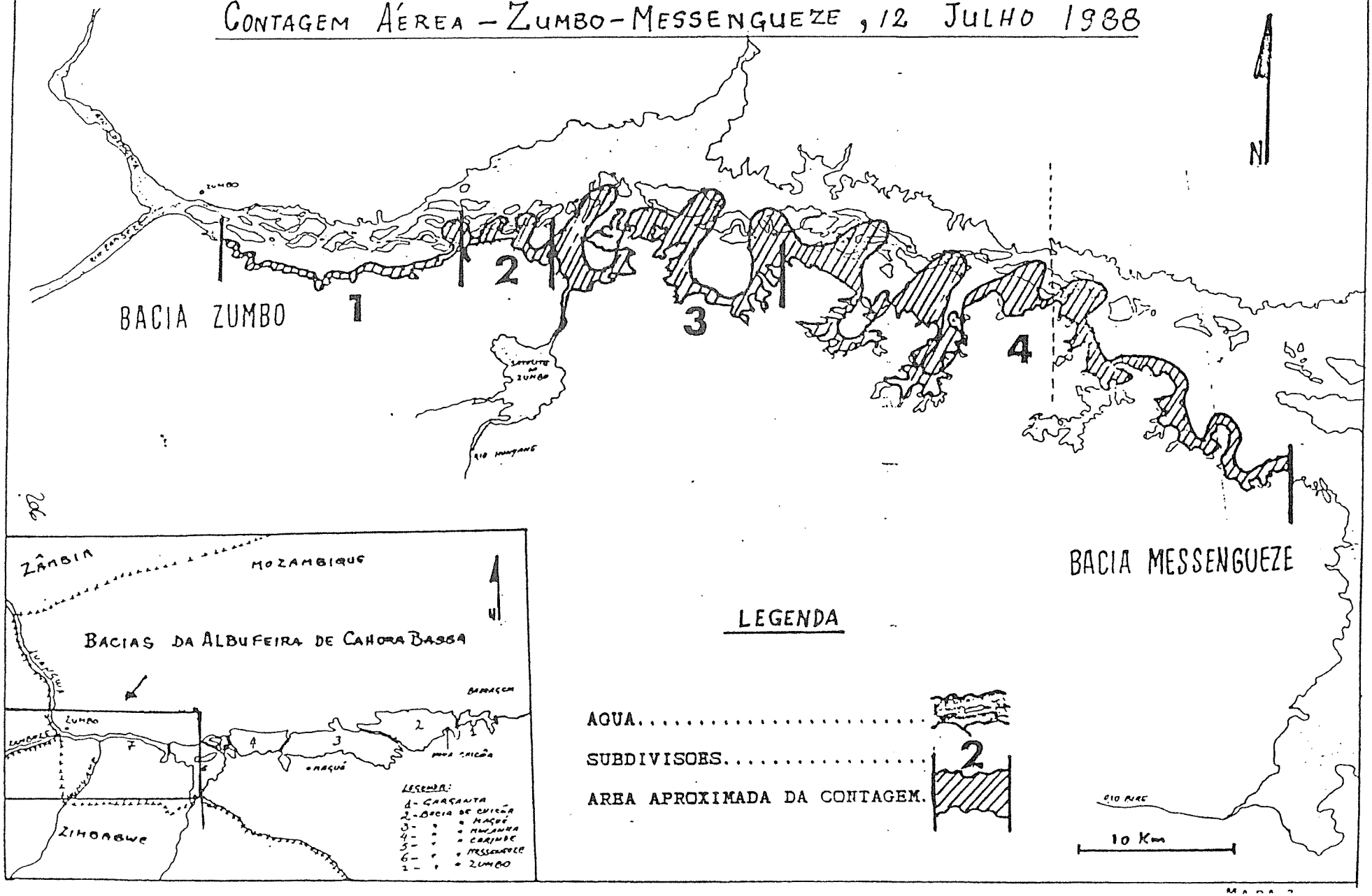
SUDIVISOES.....

NO. CROCODILOS AVISTADOS... (34)

0 1 2 3 4 5 Km

MAPA 1

CONTAGEM AÉREA – ZUMBO-MESSENGUEZE, 12 JULHO 1988



CROCODILE SURVEY

BAZARUTO ISLAND

11 - 13 OCTOBER 1986

1. ESTABLISH NUMBERS

Daylight counts were carried out on five lakes on Bazeruto Island. A one night count was done from a boat on the largest lake. Lake Lengue (Lake 4). The results are presented lake by lake (see map for numbers).

i) Lake 1
No crocodiles seen

ii) Lake 2
Two large crocodiles seen

iii) Lake 3
No crocodiles seen

iv) Lake 4 - Lake Lengue
During the daylight count eight large and medium size crocodiles were seen near the end dune side of the lake.

The night count on Lake Lengue gave a figure of 30 crocodiles (see Appendix 1). Very few of these were hatchings and juveniles (i.e, below 1 m in length). Sub-adults constituted 43% of the total and there were 11 animals that could be considered as potential breeders (+ 2.5 m in length). The high number of sub-adult crocodiles suggests an active recruitment into the population and it is felt that there are a substantial number of juveniles who reside in the Ph feedbeds. These beds were often too thick for the spotlight to penetrate, and the few eyes that were approached through reeds dived before any positive identification could be made. Burning the reedbeds may help to clarify the situation.

The day count of Lake Lengue showed only about a quarter of the animals that were seen at night. Whether this would be true of the other lakes is impossible to say.

v) Lake 5
Four crocodiles seen. This lake had fairly loose reedbeds and I feel that this number is likely to be closer to the truth.

2. SIZES

Of the 30 crocodiles seen on Lake Lengue 11 (37%) were definitely of breeding size (+ 2.5 m) assuming that this isolated population follows the pattern of Zimbabwe.

No small crocodiles (less than 1 m) were positively identified. A total of 6 eyes were not ascribed to any size class.

The remaining 43% were thought to be too small for breeding following the assumption made in paragraph one.

No crocodile larger than 3.0/3.3 m in length were seen.

All the crocodiles seen on the other lakes were at least 2.0 m or bigger.

3. NESTS

Assuming a 1:1 sex ratio (not always the case, however) there should be at least five nests on Lake Lengue. A number of "ideal" nesting sites were searched at 15 cm intervals, to a depth of one metre, with a metal probe. No nests were found. Crocodiles have been known to nest in "storage" or places such as hard earth or trees and so crocodile trails leading away from the lake were looked out for but not found. No nest sites were found at any of the other lakes.

4. The three lakes with sand dune frontage (2, 4 and 5) all had a sand bank on the far side i.e., on the Bazaruta bay side.

The lakes are discussed separately below.

i) LAKE 1

This lake was away from the large sand dune. It had a thick vegetation fringe which was a mixture of the bullrush (typha) and the reed (Phragmites sp.) - water sample No. 6.

ii) LAKE 2

Lake two had sand dune frontage and had both the bullrush and the reed but they were separated. The bullrush predominated on the southern bank and the reed on the northern bank. It is of interest to note that there were substantial stands of the wild date palm (Phoenix redinata) and the vegatable ivory palm on the banks. It has a sand bank on the Bazaruto bay side - water sample No.5.

iii) LAKE 3

This lake was very close to Lake Lengue and away from the sand dune. It had both a bullrush and reed fringe but the reeds were predominant near the bank with bullrush taking over towards the water. The lake is unusual in that it is the only one of the five displaying floating aquatic macrophytes. These are water lilies and are possibly Ny - water sample No 7.

iv) LAKE 4 - LAKE LENGUE

This lake had two major plant types - the phragmites reed and a sedge which has been tentatively identified as Cyperus sp. The details are shown on Map 2. Water sample No 3 (centre lake) and 4 (close to sand dune).

v) LAKE 5

Only one vegetation type was noted on this lake and that was the phragmites reed. It was less dense than that seen elsewhere. Water sample No 1 (near sand dune) and 2 (near sand bank).

It is likely - but unfortunately not verified - that all of the lakes, except lake 3, are devoid of any submerged or floating aquatic vegetation.

A number of Phragmites reed filled basins were seen all over the island and it is likely that these were once lakes that have been taken over by the reeds.

Water samples were collected from all the lakes for later analysis. All the lakes were slightly saline to taste. Lake Lengue was very murky with a visiblitiy of around 15 cm.

5. TYPE/COLOUR/CONFORMATION

It is very unlikely that these crocodiles are anything but the Nile crocodiles (Crocodylus niloticus). All individuals on the island appear to be very light in colour.

6. EATING HABITS

It was hoped that some juveniles could be captured and stomach pumped but this was not possible. Capture and stomach pumping of larger individuals would require more time and more equipment.

It was noted that there appeared to be some form of communal feeding. Ten crocodiles were observed in one group and on two occasions individuals were seen to swallow small fish. This communal feeding is possibly a response to fish schoaling. Another group of seven animals had stationed themselves on the sandbank at the entrance to the area on the North bank of the lake. It is of interest to note that there was a definite size segregation between the two groups. Those on the sandbank were estimated to be between 1.5 m and 2.2 m (perhaps up to 2.5 m), while the group in the deeper water were generally between 2.2 m and 3.3 m.

Several goat skulls were found in the lake and, according to the locals, the crocodiles do take their goats.

No details are available on the fish in the lakes except that barbel were caught in lake 2.

7. PLAN OF HABITATION AREAS AND NESTING PLACES

See maps.

8. LANDING STRIP/CROC FARM/WATER SOURCE

There is a possible landing strip site near the Bazaruto bay side and this has been seen by Dave Scott. Its approximate location is marked on Map 1.

Fresh water is easily available by digging less than 1 m into the ground.

9. NUMBER OF LAKES INHABITATED AND DEPTH OF WATER

See Maps 1 and 2 and section 1.

10. TRY TO CATCH FISH AND IDENTIFY

The shortage of time meant that this was not really practical but it was noted that barbel occur in lake 2. A large number of skeletons of fish approximately 15 cm in length were seen on the shores of Lake Lengue but no fresh specimens were found. It is likely that this fish is a predator.

11. MOVEMENT OF CROCODILES BETWEEN LAKES

This would be impossible to establish without a long term study.

12. TRY FEEDING CROCODILES SEA FISH

This, if it is to be of any use, should be conducted as a controlled experiment of a long term period (a minimum of several months).

13. GENERAL OBSERVATIONS

A number of paths obviously used by crocodiles were seen in a burnt phragmites reed bed. They did not appear to lead anywhere in particular. It was initially hoped that they would go to nesting sites.

The island is crisscrossed with numerous paths and is quite heavily populated with villages consisting of at least two huts in various stages of repair which can be seen every 500 or 1,000 m. There is a lot of rubbish and the island has the general impression of being untidy. It is interesting to note that some of the villages are near the lake side.

14. BEST ACCESS POINT FROM THE SEA

The boat landing spot marked on Map 1 gives easy access to the interior over gently rolling dunes.

15. DETAILS OF OTHER ANIMAL HABITATION

Goats and dogs are the only mammals of any size on the island. There are a surprising number of bird species present and it is likely that some of these may form an occasional prey item for crocodiles.

APPENDIX 1

NIGHT COUNT

LAKE LENGUE - BAZARTUTO ISLAND - MOZAMBIQUE

Date	12 October 1986	
Time Start	19h00	
Time Elapsed	2 1/2 hours	
Air Temperature	29.5°C	
Water Temperature	26.3°C	
Daytime Maximum Temperature	36°C	
Wind	Slight	
Moon	Nearly full	
Cloud	None	
Shoreline length approx	5 Km	
Total crocodiles seen	30	
Definitely adults	11	(37%)
Sub-adults	13	(43%)
Eyes only	6	(20%)
L (Possible juveniles)	(3)	[10%]
Largest crocodile seen	± 3.0 m - 3.3 m	

14 October 1986

To: J.L. Kennedy
FROM: D.M. Scott
SUBJECT: Crocodile survey - Bazaruto Island

Ian Games arrived with his equipment in a Z-WOB piloted by Buster Brown late on the evening of Friday 10.10.86.

In the morning of 11.10.86 I took him, his equipment and 4 workers in the ski-boat to Bazaruto.

The landing was on the western shore, as indicated by Mr. Games' map, close to a small fishing village, after a 55 minute journey, contact was made with the Administrators second-in-command at a village further along the shore in a northerly direction. The administrator was apparently away addressing a meeting. The 2-i/c was put in the picture reference for survey.

It was decided that the camp would remain close to the beach. The boat, motor, and battery for the spotlight etc. were then carried to the Lake Lengue where a preliminary survey was carried out. Walking time between camp and lake was approximately 20 minutes along existing paths, and no problems were encountered carrying the equipment to the lake.

I then returned to Magaruque Island, leaving Ian Games with 2 helpers.

The return journey took one hour in a strong wind from the South-West.

The chosen landing site was suitable for access to both high and low tides for vessels drawing + - metres. Well sheltered from the East, partially sheltered from the South.

Local Africans were pleasant and helpful, some of them assisting with moving equipment.

Access to the Lake Lengue area from the open sea eastern side not good due to strong wave and wind action, and steepness of large high sand dune, + - 300. Should water samples show Lake Lengue water to be suitable for use in crocodile farming then the siting of the pens being into an adjacent small valley, where a vegatable/citrus garden could be established.

There is a good site for an airstrip as indicated on the map. There is an area + - 800 metres long, clean of all obstacles apart from sweet potatoe beds. The soil is very sandy. Levelling would entail less work than was necessary on Magaruque. The only potential problem appears to be that during or after heavy rain the area may be wet. However, a cambered strip with a drain along the length and on each side should overcome any problems on that score.

The runway direction would be approximately N.N.W. - S.S.E.

Due to problems with visas for both Mr. Games and his assistant who was unable to finally come at all, a more detailed and extensive survey was not possible. This was a great pity.

However, the work carried out by Mr. Games is, I feel, a most worthwhile and interesting survey, and a great deal of valuable information has been made available to the project.

Poor weather, with wind and rain, also hampered proceedings on the night of 10.10.86. I would hope that Ian Games could carry out further similar surveys on crocodile breeding areas on the mainland in the future, assuming there are no similar delays with visas and other documents.