AMENDMENTS TO APPENDICES I AND II OF THE CONVENTION

Proposals Submitted Pursuant to Resolution on Ranching

A. PROPOSAL

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

B. PROпонент

The Republic of Botswana.

C. SUPPORTING STATEMENT

1. Taxonomy

11. Class: Reptilia

12. Order: Crocodylia

13. Family: Crocodylidae

14. Species: *Crocodylus niloticus* Laurenti, 1768

15. Common Names: English: Nile crocodile

French: crocodile du Nil

Spanish: Crocodrilo del Nilo

16. Code Numbers: -

2. Biological Data

Since this proposal is made solely for Resolution Conf. 3.15 on "Ranching", information relating to populations extralimital to Botswana is excluded from this proposal.

21. Distribution: Both historically and at present the Nile crocodile's distribution is confined to the few perennial rivers of the country. These rivers are the Okavango River with its many tributaries and swamps, Kwando, Linyanti/Chobe River, Boteti River, Savuti Channel and the Limpopo River. A small section of the Zambezi (5 km) is also known to support a crocodile population.

The Okavango Swamps fall wholly within Botswana and have a mean area of 10,000 km² while the Kwando, Linyanti/Chobe River extends for about 300 km before joining the Zambezi on the border with Namibia, Zambia and Zimbabwe. Currently crocodiles are distributed throughout the country where suitable habitats prevail. They become localized, and isolated populations exist in permanent pools and main river channels during the dry season but being migratory animals, during the rainy season and the onset of seasonal floods on the Okavango, they quickly re-establish themselves in the lower stretches of the rivers and the delta. (Simbotwe, 1988a).
22. **Population**: The distribution of the population of crocodiles in mostly dense relatively inaccessible papyrus/phragmites swamps make accurate estimates of the population impracticable. The main crocodile population occurs in the Kwando, Linyanti/Chobe which extends 300 km. The Okavango River (100 km) and the Okavango Delta (15,540 sq. km) are the other major crocodile localities. A substantial population is also known to occur in the Limpopo River, a 319 km stretch of seasonal river.

The main crocodile localities can be divided as follows:

1. Linyanti/Chobe 166 km
2. Zambezi 5 km
3. Kwando 56 km
4. Limpopo 319 km
5. Savuti 65 km
6. Okavango 100 km
   i. Boro 175 km
   ii. Thoage 105 km
   iii. Boteti 290 km
   iv. Moanachira 70 km
   v. Santantadibe 100.5 km
   vi. Khwai 98 km

In our attempts to estimate the population of crocodiles in the aforementioned rivers, aerial surveys and night counts (by boat) have been undertaken over a period of five years by Graham and Blomberg and the last one year to date by the Department of Wildlife and National Parks team. Data on the crocodile population on the Okavango "Panhandle" (a stretch of river from Mohembo to Seronga; see maps 1 and 2) is available (Graham and Simbotwe, 1988; in prep.). The Okavango River consists of what is commonly known as the main channel, the eastern channel and numerous off-channels including the Keola Thogo (50 km length) all of which account for a minimum of 200 kilometres of suitable habitat. Our present data from both aerial counts by fixed wing plane and night counts by boat for a 100 km of the main channel revealed an estimation of 2.1 ± 1.5 crocodile per river km. This indicates a conservative estimate of not less than 400 adult crocodile population on the panhandle alone. But there are many papyrus choked off-channels not accessible by boat and hence not included in the night counts. This low estimate is compounded by terrain that is difficult to work through. Our estimate based on recruitment on the panhandle show that there are thirteen times as many crocodiles recruited yearly i.e. at least there is a minimum thriving population of not less than 5,000 hatchlings at the end of each breeding season. Not less than 100 nests are made per annum on the Okavango Panhandle and with a mean clutch size of 50 eggs, this gives a potential recruitment figure of 5,000 hatchlings per annum for this area alone. Percent hatchability and survivorship of young has not been accounted for but it is being worked out, from in coming field research data. Its effect however, on the estimated population is expected to be minor.

The Okavango Delta is made of 5 main river channels that when added together with the Savuti Channel give a mean river length 134 km. This excludes much of the inaccessible permanent swamp which is very suitable crocodile habitat. Taking a nominal
population of 2 crocodiles per kilometre, we have $6 \times 134 \times 2 = 1608$ crocodiles. This is likely again to be an underestimate because the Okavango Delta covers 15,540 sq. km and is mostly dense relatively inaccessible papyrus swamp.

In the North and North-West hydrological system are the rivers Kwando, Linyanti/Chobe and Zambesi whereas flowing in the eastern direction is the Limpopo River which has been surveyed during the day only due to security reasons. Part of the 100 km of river that fall within the Chobe National Park and 8 km of Limpopo River front was at Sherwood surveyed. Data on number of crocodiles seen per kilometre of river showed a population of 5 crocodiles per kilometre. For the 3 rivers and total length of 556 km the estimated population would be approximately 2,780 crocodiles. The Linyanti/Chobe and Kwando Rivers have swampy conditions much similar to the Okavango, hence most places are inaccessible to the study team.

The Okavango Panhandle has an estimated population of 5,000 crocodiles along the main channel, whereas the channels in the delta have an estimated population of 1,608 crocodiles. The 3 rivers in the North and eastern Botswana are estimated to support a crocodile population of 2,780. We can safely say that the crocodile population in accessible water ways for the whole country is in excess of 9,380 crocodiles. However the frequency by which crocodiles are seen by the Departmental research team may indicate an increase in population of crocodiles in the rivers in the North. Local safari operators and local fishermen have pointed out that the crocodile population on the Okavango River has shown an upward trend since the late 1970s and years following the ban on hunting.

The only reliable way to estimate shifts in population numbers and biological status in swampy crocodile habitats is by counting crocodile nests. A detailed monitoring programme on the crocodile nesting population in Botswana is in operation and yields more reliable data than aerial counts of crocodiles in these swampy conditions. Detailed information on breeding characteristics of the Okavango crocodiles is given by Graham and Simbotwe (1988; in prep.). It is essential to say that we have not only identified gaps in knowledge concerning crocodiles in Botswana but have also identified areas important as habitats for crocodiles and to their nesting activity.

There are substantial isolated crocodile populations in Lake Liambezi, and Savuti Channel (Slogrove, pers. comm.) yet to be counted. It can be safely assumed that the crocodile population in Botswana is in the region of 9,000 to 10,000 crocodiles and is on the increase. Our current management and conservation plans will certainly help promote increase in crocodile numbers. Reports on problem animals by stock owners and fishermen in areas where crocodiles are not protected could indicate an increase in crocodile populations rather than just greater human/crocodile contact.

23. **Habitat**: Apart from drought which has caused some of the smaller rivers and streams which were once perennial, to be ephemeral, the crocodile habitat is secure. A Veterinary Disease Control Cordon fence partly surrounds the Okavango Swamps and this
separates the cattle and arable farming from the swamps. There is also a firm proposal to declare most of the swamps as Wildlife Management Areas, where wildlife will be the primary land use, and therefore this should ensure more protection for the swamps and their crocodile population. In addition, some 3,880 km of the Okavango Delta comprises the Moremi Game Reserve where no hunting or capture of the crocodile is allowed. At least 100 km of the Linyanti/Chobe system falls within the Chobe National Park (see maps 1 and 2). We have identified the Okavango Panhandle (area between Mohembo and Seronga), Kwando, Chobe/Linyanti and Limpopo rivers as important area for the Nile crocodile in Botswana which need the necessary protection. Hence our zoning programme which is supposed to operate on staggered utilization of range per given time will be effected in these areas. The Kwando/Linyanti and Lake Liambezi mostly fall on the Namibian side and hence protected (Slogrove, pers. comm.). No capture of crocodiles is allowed on the Namibia side of the river. Botswana has had such good rains this year (1988) that the crocodile habitat is likely to show dramatic improvement and the animals should be widely distributed compared to years of drought. Human encroachment on the delta does not present a problem at the present moment and future protection to wildlife is assured through present landuse, zoning exercise underway. We have identified factors important to nesting and threats likely to have negative impact have been documented (Simbotwe, 1988b).

3. Trade Data

31. National Utilization: This scheme can be divided into two main categories:

i. recreational hunting

ii. crocodile farming.

Under sport hunting a total of 50 crocodiles per annum are allocated to non-resident safari hunters.

Under current farming operations, ("farm" is used to denote both ranches and captive-breeding operations). The two farmers in Botswana were allowed a combined quota of 1,600 crocodiles and 12,000 eggs over a three year period up until 1989 for the purpose of developing their farms into self contained and economically viable farms by 1989. The Okavango Swamps Farm has so far captured 795 crocodiles and collected 5,930 eggs. The farmer has only this year as his last to collect from the wild. The Wildlife Services Botswana, Kazungula crocodile farm started later and the farmer has so far captured only 258 crocodiles and collected 3,013 eggs. He thus has an outstanding balance of 342 crocodiles and 2,987 eggs. The farmer will fulfill the outstanding capture quota in the 1988/1989 season.

The need to apply for ranching status is in support of development of ranches and a co-operative based on ranching (see table 3).

The Fauna Conservation Act requires possession of an export permit in order to export skins or any crocodile by-product. Similar restrictions are imposed by the Veterinary Authorities.
for live specimens. Customs officials at the border gates also check export permit documents to ensure that they are proper.

32. **Legal International Trade:** Since the licensing of the first crocodile farm in 1983, as shown in 31 above, the national hunting quota has been progressively reduced to its present level of 50 animals and this is only for non resident safari hunters. This reduction was made to facilitate the setting up of crocodile farms and to accommodate their capture and export quotas. So far the Okavango Swamps Farm based at Maun has, since its inception in 1983, exported 3,443 live crocodiles, composed of wild captured adult animals and hatchlings from wild collected eggs and eggs produced on the farm. The Wildlife Services, Kazungula based farm has since 1984, exported 1,044 live animals, also composed of wild eggs and eggs produced on the farm. All these live crocodiles have been exported to crocodile farms. A restriction has been effected on capturing of wild crocodiles on the Okavango Panhandle, an area locally and internationally known to be the prime breeding area of the Botswana crocodile hence critical to the survival of this animal. No dead specimens have yet been exported by the two farmers so far. But as present farms enter full farm status next year (1989) they will start to slaughter for skins and meat. Commercial exports are permitted only when skins originate from a registrated breeding/ranching station. All such commercial exports, will be covered by CITES export permits, issued by the Department and skins will have the appropriate tags attached.

Each permit bears a security stamp. Officers from the Department maintain strict controls and farmers are expected to submit quarterly accurate records of stock and regular inspections of the farms by the Departmental staff is a strict requirement.

33. **Illegal Trade:** Since no market exists locally for crocodile skins, illegal collection of crocodiles or sale of crocodile products is very minimal and under control. Killing of crocodiles, apart from licensed killing, is due to predation control in cases where crocodiles attack people and/or livestock and where they are caught in fishing nets. The killing of an animal in such cases is however legal according to the national fauna legislation.

34. **Potential Trade Threats**

341. **Live Specimens:** As already stated live specimens have so far only been in trade since 1983 and exports have been from Government licensed crocodile farms to crocodile farms in South Africa. Trade in live specimens is also under strict control from veterinary side. And even within the country there are disease control zones and one requires a permit to take an animal from one veterinary zone to another. Finally the Customs Department at the point of exit also requires to see valid export permits. A restriction on collecting of wild specimens from the Okavango Panhandle is now on. Hence there is little chance of trade in live specimens proving a threat to the species. Over collection of wild eggs can not occur because there are set collecting quotas monitored by the Department and farms are expected to return to the wild 5% of the ranch stock.
342. **Parts and Derivatives:** Botswana is just now starting selling skins from ranched/farmed animals. Locally, limited marketable crocodile derived items are sold. Apart from skins to be sold by licensed farmers, only trophy skins for licensed foreign hunters will enter the foreign market. We shall adhere to CITES requirements of tagging all skins and use of CITES forms.

4. **Protection Status**

41. **National:** The Fauna Conservation Act (chapter 38.01 of the Laws of Botswana) has its preamble: "An Act to make further and better provision for the conservation and control of the wild animal life of Botswana..." A crocodile is a game animal and can only be hunted or captured on the strength of a permit issued in terms of the Fauna Conservation Act. As for any other animal, crocodiles may not be hunted or collected in a Game Reserve or National Park. A crocodile or its parts and derivatives may only be exported on the strength of an export permit issued in terms of the Fauna Conservation Act. As stated elsewhere the annual hunting quota for resident hunters has been done away with altogether. In the past, crocodile hunting quota for residents was given but this was hardly utilized and even when it was, residents found themselves losing money on buying crocodile licences only to end up with skins which had no buyers.

Zoning of crocodile habitats has been undertaken (Simbotwe and Matlhare, 1988) and should further lead to strict control on both utilization of eggs and adult crocodiles per given period. Protection ranges from total protection in National Parks and Game Reserves to strictly controlled hunting and harvesting of eggs outside protected areas.

42. **International:** Botswana depends a lot on its own internal laws for protecting its wildlife resources and any wild animal specimen, whether live or dead, has to have a permit which may be either an import, export or re-export permit. Crocodiles fall under the category of animals for which export permits are required. The strength of this domestic legislation made it only natural that Botswana should become a Party to CITES. Botswana endorses the decision to place crocodile populations in Appendix II on the basis of a set wild export quota. This should ensure adequate international protection of this species since both Botswana and CITES have now agreed on a common status for the species.

43. **Additional Protection Needs:** None considered necessary.

5. **Information on Similar Species**

Only the Nile crocodile occurs in Botswana.

6. **Comments from Countries of Origin**

Not applicable since this ranching proposal concerns only the Botswana population. But it is relevant to say that like many other SADCC member states, Botswana is carrying out a long term project to establish the size of the crocodile population. The crocodile researcher has also worked out and recommended to the Department
management options and monitoring programmes for the country. African and SADCC countries support the keeping of Botswana's crocodile on Appendix II (see reference section for relevant documents). Attempts are being made through SARCUS to discuss populations of crocodile in rivers bordering South Africa and Namibia.

7. Additional Remarks

71. Legal Protection and Population Trends: Crocodiles in Botswana are not totally protected as it is envisaged that current wild stocks are out of danger. This followed a reservation that Botswana entered but does not anymore technically observe. However, crocodiles in Botswana are regarded as game animals hunted only on licence. The species was seldom hunted either for its skin or meat, but it was occasionally destroyed as a problem animal as it conflicted with man. Such attitudes persist but they are now slowly dying out with the growing awareness of the commercial value of the animals. In the past, crocodiles were admittedly over-exploited and Graham (1976) states that between 1957 and about 1969 the Okavango crocodiles were hunted intensively for skins and the number taken was probably 10,000 animals which may have reduced the population to a very low level. According to Blomberg (1976) the figure cropped between 1957 and 1974 was 7,600 while other sources say that some 40,000 crocodile skins were marketed between 1959 and 1969 (Medem, 1981).

Crocodiles are now on the increase in the rivers of northern Botswana; Chobe/Linyanti, Kwando and the North-West; Okavango and the Delta. A recent preliminary aerial survey show that there are 9,000 to about 10,000 adult crocodiles inhabiting the aforementioned aquatic systems. The Limpopo River has a healthy population of crocodiles and attempts to determine population size continue. Problem animals, and those facing drying outs are captured and given to the farmers. Conflicts however, arise in the Okavango an area that support substantial livestock and fisheries activities. It is indeed the current commercial value of the crocodiles that has helped the crocodile population in Botswana to reach the size it has at the present moment and without which the crocodile could be viewed in the negative by the public.

72. Commercial Exploitation of Crocodiles: Crocodiles were hunted intensely especially in the Delta in the mid-fifties. The concessionaires closed business in 1969 by virtue of over-exploitation that lead to economic inviability at that time. Hunting was however, re-opened in 1974/75 but only for a short time. Recent CITES statistics indicate the export of 1,164 skins from 1979 to 1982 and Caldwell (1984) shows that most of these (1,158) were being imported into the Federal Republic of Germany in 1979. In 1983 the Okavango Swamps Crocodile Farm (Pty) Ltd opened business and this was followed by the Wildlife Services Botswana (Pty) Ltd in 1984. The present farms in Botswana harvest eggs from the wild for captive breeding purposes. Based on past experiences, capture of wild crocodiles is now discouraged and strictly regulated and is under restriction in the Panhandle area of the Okavango.
Research: In order to support crocodile commercialization, we have instituted a crocodile country-wide census. Numbers of crocodiles are estimated by aerial surveys and on the ground by boat at night using a spot light. We also work out population size structure. It is important to work out a body size structure of crocodile populations especially in rivers where capturing has continued. Our preliminary results has shown that young animals below 2.6 m are always in the majority of animals counted in the Okavango and the Delta.

This is a healthy sign and could mean that recruitment and survival of young is good and that the population is likely to grow with the likely positive contribution from the young recruits. Formal Departmental documents and publications on crocodile management by members of the Department and their associates are listed under Annex B. Current investigations are listed under Annex C. Relevant documents are appended and meanwhile studies continue.

Restocking: A return of well grown crocodiles equivalent to 5% of the eggs taken by the farms each year is one of the conditions which operators have to fulfill. The river systems that fall within managed and protected areas, i.e. National Parks and Game Reserves have been identified as suitable crocodile habitats where re-stocking can genuinely be done to justify sustainable conservation efforts. The size of female crocodiles to be released is 1.2 to 1.5 m. long. The first release operation should take place in early September 1989.

International Assistance and Co-operation: The present crocodile researcher in Botswana is a member of the Crocodile Specialists Group (CSG) of the IUCN. Botswana recently hosted the 13th Wildlife Sector meeting for SADCC countries. Botswana was asked to provide its expertise on crocodiles when the SADCC sponsored crocodile survey and monitoring programme gets off-ground. This shows much confidence the international community has on Botswana's current crocodile projects and management plans.

Conservation and Management: Botswana has a wildlife conservation policy. This document which was approved by the National Assembly in July, 1986 discusses in addition to the potential economic significance of wildlife the development of commercial wildlife utilization. This philosophical support for game utilization schemes is of great value to crocodile utilization operations in Botswana. However, this document is general and not specific to any taxa. There is to date strict legislation that protects crocodiles in Botswana, and this would hamper the repetition of over-exploitation of the Botswana crocodile that occurred in the 1950's that nearly sent the animal to extinction. Current management policy of strict control of numbers of crocodiles and eggs to be used in farms has currently helped wild populations to recover and there is positive evidence that populations are increasing outside protected areas.

Trade: Botswana has allowed sales of a small number of live crocodiles to enable crocodile farm operators to generate some income. This has been for a period of three years only and permission to do so expires in 1988/1989 period. Botswana has discouraged selling of its adult crocodiles outside the country. The question of selling hatchlings outside Botswana is also being looked into. It is a general consensus among countries of the
Persons who will be issued with permits to operate crocodile farms will have strict pre-conditions to satisfy and these are discussed in detail in the document entitled "Crocodile ranching and farming in Botswana" by Simbotwe and Matlhare (1987).

a) The Department must be satisfied that the wild stock can support the annual harvest of eggs. Information from our annual nesting monitoring programme helps the Department make appropriate decisions. One third of the total nests recorded yearly from respective habitats will be given to needy farmers.

b) The applicant must have the expertise to run the scheme and must produce convincing evidence that his capital resources are adequate to maintain his operation until such a time he expects to start getting a financial return.

c) The operators pledge to provide the Department with well grown crocodiles of the ranched stock amounting to 5% of the number of eggs originally collected. These hatchlings are now being stocked in the Moremi Game Reserve, the gateway to the Okavango River.

d) The operators also agree to have a staff of the Department accompany them on egg harvesting and crocodile capturing operations. They make quarterly reports concerning the operations and stock on the farm and their facilities are open to regular inspection by the Department.

Collecting quotas originally for the two farms were set to run for a period of three years, (see tables 1 and 2) and expire during the 1988/1989 period. Local quotas under the ranching proposal will be arrived at using information from crocodile census and nest count monitoring programmes. Tables 1 and 2 show the stocks held by each farm up to February, 1988. Both farms have progressed well and hope to start exporting skins by 1989/1990 period. The Okavango Swamps crocodile operation hopes to export up to maximum of 2,000 skins whereas Wildlife Services Botswana wishes to export 1,000 skins annually.

Wildlife Services Botswana Pty Ltd, has a breeding unit made up of 13 males and 60 females. This is the first year (1988) that there has been notable breeding activity on this farm and 626 eggs were harvested on the farm last year. This number should increase as animals mature. The Okavango Swamps crocodile operation has a breeding unit comprising of 6 pens with single breeding system and 1 pen maintained on a multiple breeding system. Each of the 6 pens has 1 male and 7 females giving a total of 6 males and 42 females, i.e. 48 animals maintained on this system. The multiple breeding pond has 42 animals. In total this farm has a breeding unit composed of 90 animals. This farm has produced 1,874 eggs from it captive breeding unit, i.e. more than 50% of its annual requirements. This is a welcome trend since it reduces pressure on the wild population and should allow the Department to expand it's crocodile commercial venture through a ranching programme using eggs harvested from the wild. This should enhance the commercial value of crocodiles as an acceptable form of wildlife utilization scheme.
SADCC region not to export live crocodiles but only skins from the SADCC region in order to encourage local industries. For detailed quota exports, refer to the Botswana CITES Report of 1986.

78. **Criteria to Be Met under Resolution Conf. 3.15**

781. **Paragraph b) i/ of Conf. 3.15:** The crocodile operators are subject to strict control and this has obvious conservation values and benefits. Strict controls on utilization have been responsible for current increase of the Botswana population of crocodiles in the wild.

782. **Paragraph b) ii) of Conf. 3.15:** Products from Botswana will all be documented according to the requirements of CITES; will bear CITES stamps and skins will be tagged to ensure adequate identification of products exported from Botswana. This should help to distinguish such products from those originating elsewhere (see section 787 below);

783. **Paragraph c) i) of Conf. 3.15:** Discussions on sections 22 and 72 provide clear evidence that taking from the wild populations has not had significant detrimental impact. The operations have been going for the past 5 years now has strict controls on exploitation has benefitted the wild population in view of recorded increase in nesting and population numbers (Simbotwe, 1988).

784. **Paragraph c) ii) of Conf. 3.15:** The biological and economic success of the farming operations is already likely to be realized as operations start to produce products for export next year (1989).

785. **Paragraph c) iii) of Conf. 3.15:** All crocodiles in captivity are treated humanely and quickest method of killing is advocated. Finishing the animal quickly ensures minimum disturbance to other animals in the pen. Animals are kept under proper facilities ensuring proper hygienic conditions and are well fed. Both farms have started or are in planning stage of starting fish/duck farming and are encouraged to farm chickens. This should provide a permanent food supply for crocodiles and provide immediate income.

786. **Paragraph c) iv) of Conf. 3.15:** Botswana has made it a condition for operators to make available to the Department 5% of ranched stock for re-introduction to wild. Continued monitoring and populations census by the Department has resulted into management plans that are beneficial to wild population and increase in wild population provides evidence that such measures are working.

787. **Paragraph c) v) of Conf. 3.15:** In Botswana operators have just started dealing in wet salted skins. They hope to start exporting by next year 1989. When they do, they will follow the usual requirements of CITES already discussed under section 782. No manufactured items derivatives of crocodiles products will enter the market as yet and when
they do they will bear the usual security stamps having approved CITES serial numbers. This is already in practice
in Zimbabwe and is expected to work satisfactorily.

788. Paragraph c) vi) of Conf. 3.15: Botswana certifies that the
operations will be monitored very closely by the Department
to ensure that this criteria continues to be met with and
that Botswana's annual report will include a statement on
trends in the wild population and performance of the
operations.

79. Conclusions: Botswana fully supports removal of the Nile
crocodile from Appendix I and its inclusion Appendix II. With
current crocodile country-wide census project and nest count and
nest site monitoring programme, a proper evaluation of wild
population is possible, management options currently in force are
instrumental to improvement in conservation of the Nile crocodile
in Botswana and the wild population that has now increased
considerably. Crocodile farming operations have helped in
educating the public on the ecological and economic value of
crocodiles. Now the public is able to tolerate crocodiles which
would not have been the case some years ago. The strict
management laws and control concerning utilization of crocodiles
in Botswana has led populations of crocodiles to be included in
Appendix II which is also the case with neighbouring countries.
The inclusion of the Nile crocodile in Botswana in Appendix II
was supported by SADCC member countries at the SADCC workshop on
management and utilization of crocodiles (Kariba 2-6 July 1987).
A positive statement was made on Botswana population in support
of the amendment of Appendices I and II of the Convention and
asserted that "there are large areas of very suitable crocodile
habitat of which a considerable portion is protected.....the
crocodile population is in no danger of extinction".

8. References

Medem, F. 1981. Assistance to crocodile management in rural areas.
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crocodile in Botswana. - Terms of reference. Paper presented
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meeting of the Conference of the Parties, Ottawa (Canada), 12th
to 24th July 1987.

presented to the 9th meeting of the Crocodile Specialist Group,

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niloticus Laurent) in Botswana. Paper presented to the sixth
meeting of the Conference of the Parties, Ottawa (Canada), 12th
to 24th July 1987.

POLICY STATEMENTS ON - CONSERVATION AND MANAGEMENT OF CROCODILES

1. Background: The Government of Botswana is committed to the fact that crocodiles should be commercially utilized but only on a sustainable conservation basis; applying sound ecological principles and appropriate ecological and technological knowledge.

Detailed programme of action that outline the objectives, management and conservation options is contained in the document entitled - Crocodile Management in Botswana. The following salient policy statements are outlined in order to match up with current perspectives.

2. Policy

2.1 The industry is being developed commercially in order to create economic opportunities and help to promote conservation awareness through utilization.

2.2 Because we realize the problems brought about by drought; such as general reduction in surface water in crocodile habitats, the Department has designed present operations to be compatible with the present needs to increase the numbers of crocodiles in the wild through re-stocking programme in areas we feel crocodiles have been depleted and where re-stocking is likely to be successful.

2.3 The Department's policy and aim is to increase crocodile numbers in areas where crocodile populations seem to be depleted and where they are acceptable.

2.4 The farming operations once established will be based on a regulated system that is being developed with aid of data from both crocodile country-wide surveys and monitoring of reproduction in various isolated crocodile sub-populations throughout the country.

2.5 The Department will exploit crocodiles under regulated control through zoning of crocodile habitat to ensure appropriate utilization, and sustainable conservation.

2.6 Under valid permit, controlled hunting of crocodiles and removal of eggs outside national parks and game reserves will continue to be undertaken.

2.7 Where conflict with man occurs frequently, it is legitimate to have to reduce or maintain crocodile numbers at low and safe levels.

2.8 Farmers will be allowed to harvest eggs only after a team of biologists from the Department has finished the annual population census, nest count and nesting site monitoring programme. Whereas a comprehensive population census may be done every 2 years once a long term dossier has been established on the populations in various habitats, the annual monitoring programme will continue to enable us to study the production base and estimate the nature and magnitude of recruitment into the population.
2.9 Farmers will understand that the farm and all production records should be available for inspection by an official of the Department. Quarterly reports should be submitted to the Director, including egg collecting records. Egg collecting teams will continue to be at all time accompanied by staff members of the Department of Wildlife and National Parks.

3.0 Farmers are expected to conform with CITES regulations; such as use of tags, and CITES stamps bearing serial numbers. These conditions are clearly spelt out in contract papers on terms of operation.


CURRENT PROJECTS
PROYECTOS EN CURSO
PROJETS EN COURS

1.0 Aerial counts of crocodiles in the Chobe/Linyanti and Kwando Rivers, Limpopo and Okavango River and Delta.

2.0 Monitoring of nesting and nest sites of crocodiles in the Limpopo and the Okavango Rivers.

DWNP 3.0 Fidelity of breeding female crocodiles to nest sites.

DWNP 4.0 Reproductive characteristics of the crocodiles in the Limpopo and Okavango rivers.
TABLE/CUADRO/TABLEAU 1

OKAVANGO SWAMPS FARM PTY LTD

Operations of the farm during the 1983 to 1988 period of growth.

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<tbody>
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<td>1.</td>
<td>Capture quota - live crocodiles (over a 3 year period only)</td>
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<td>2.</td>
<td>Collection quota - eggs (over a 3 year period only)</td>
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<td>3.</td>
<td>Crocodile captured until 1.2.88</td>
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<td>4.</td>
<td>Eggs collected so far until 1.2.88</td>
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<td>5.</td>
<td>Eggs produced by farm animals</td>
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<td>6.</td>
<td>Hatchlings from wild collected eggs</td>
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<tr>
<td>7.</td>
<td>Percent hatching success over past year 68%</td>
</tr>
<tr>
<td>8.</td>
<td>Hatchlings from farm animals</td>
</tr>
<tr>
<td>9.</td>
<td>Percent hatching success</td>
</tr>
<tr>
<td>10.</td>
<td>Total crocodiles (3+6+8)</td>
</tr>
<tr>
<td>11.</td>
<td>Total crocodiles exported</td>
</tr>
<tr>
<td>12.</td>
<td>Stock on farm 1.2.88</td>
</tr>
<tr>
<td>13.</td>
<td>When likely to export skins Number per annum approximately</td>
</tr>
</tbody>
</table>

* BALANCE

* where applicable

Statement of intent on current operations: Item 11 shows the number of crocodiles that have since been exported. Note that these numbers are mostly of old post-reproductive males and problem animals including hatchlings raised from eggs laid on the farm. Farmers will move into production of skins, meat, mounted specimens, osteological specimens, decorative egg shells, and gastroliths (stomach stones) in 1989 and these will always remain as the major commercial products.
Operations of the farm during the 1983 to 1988 period of growth.

<table>
<thead>
<tr>
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<th>BALANCE</th>
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<tr>
<td>1. Capture quota - live crocodiles  (over a 3 year period only)</td>
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<td>2. Collection quota - eggs  (over a 3 year period only)</td>
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<td>3. Crocodile captured</td>
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<td>4. Eggs collected up to February 1988</td>
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<td>5. Eggs produced by farm animals</td>
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<td>6. Hatchlings from wild collected eggs</td>
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<td>7. Percent hatching success</td>
<td>82%</td>
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<td>8. Hatchlings from eggs by farm animals</td>
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<td>9. Percent hatching success</td>
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<td>10. Total crocodiles (3+6+8)</td>
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<td>11. Total crocodiles exported</td>
<td>1044</td>
</tr>
<tr>
<td>12. Stock on farm</td>
<td>1962</td>
</tr>
<tr>
<td>13. (a) When likely to export skins</td>
<td>1989</td>
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<tr>
<td>(b) Number per annum</td>
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### LIST OF CROCODILE FARMS

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<tr>
<th>NAME</th>
<th>AREA</th>
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<tr>
<td>Okavango Swamps Farm (Pty) Ltd</td>
<td>Maun</td>
<td>1983</td>
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<tr>
<td>Wildlife Services Botswana (Pty) Ltd</td>
<td>Kazungula</td>
<td>1984</td>
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<tr>
<td>Ngarangi Crocodile Farm</td>
<td>Shakawe</td>
<td>being registered (1988-89)</td>
</tr>
<tr>
<td>Limpopo Crocodile Farm</td>
<td>Sherwood Ranch</td>
<td>being registered (1988-89)</td>
</tr>
<tr>
<td>Ngamiland Crocodile Co-operative</td>
<td>Maun</td>
<td>Under consideration</td>
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### STOCKS OF CROCODILES HELD TO DATE

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<tr>
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<th>SLAUGHTER STOCK</th>
<th>BREEDING STOCK</th>
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<tr>
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<td>1000</td>
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<tr>
<td>Ngarangi Crocodile Farm</td>
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<td>-</td>
<td>-</td>
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<tr>
<td>Limpopo Crocodile Farm</td>
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<td>2000*</td>
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* stock requested
REPUBLIC OF BOTSWANA

DEPARTMENTAL PAPER NO.1 1988
MINISTRY OF COMMERCE AND INDUSTRY
GABORONE, BOTSWANA.

CROCODILE MANAGEMENT IN BOTSWANA

September, 1988
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<td>6. General knowledge on crocodile operations</td>
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<td>33</td>
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Document prepared for the Director by

Dr. M.P. Simbotwe, Senior Wildlife Biologist (HQ)

Assisted by

Mr. J.M. Matlhare, Wildlife Biologist
1. INTRODUCTION

The Botswana Nile Crocodile is a game animal hunted on licence under the Fauna Conservation Act. (chapter 38.01 of the Laws of Botswana). This species was recently downlisted under an export quota system from a CITES appendix I to appendix II category. The latter category allows for controlled trade. Hence it is an intention of the Botswana Government through its Wildlife Conservation Policy 1986 that the biological resources of the country—crocodile included—be developed commercially for the benefit of the people of Botswana. The crocodile is a property of the people of Botswana and the Botswana Government is committed to the fact that this animal will be commercially utilized only on a sustainable basis; applying sound ecological principles and appropriate ecological and technological knowledge. These measures should be implemented to avoid wastage of resources and over-exploitation. The Department of Wildlife and National Parks is determined to see that the future of the crocodile in the wild in Botswana is not unnecessarily prejudiced and/or threatened. It is also important to note that as a result of recent drought, crocodiles no longer occur in some habitats such as Lake Ngami, which has dried up and only a small population still occurs in the Boteti, Savuti channel and Thamalakane river. This has, largely confined the crocodile to only few perennial wetlands, mainly in the northern part of the country. This suffice to say, constitute an important change in the geographical distribution of the Botswana Nile crocodile. The Department recognizes these chances and is now naturally careful and will only approve methods of exploitation that are compatible with the conservation and resource utilization laws and policies in Botswana, including SADCC principles outlined in the document titled Management and Utilization of Crocodiles in the SADCC Region. (1988 in press). Should climatic conditions improve, areas that were once habitats of crocodiles could become potential re-stocking areas.

2. MANAGEMENT AIMS AND OPTIONS

The major reasons given to justify the development of the crocodile industry in Botswana are compatible with the objectives outlined in the Wildlife Conservation Policy Government Paper Number 1 of 1986. The industry needs to be promoted and developed commercially in order to create economic opportunities and jobs, especially for the rural masses, to enable them to earn
hard cash and enter into a modern wage economy. A tourism component would help to promote conservation awareness. An education programme should also assist prospective farmers to understand the mechanics of crocodile farming and trade. Our motto is that to utilize is to conserve.

Because of the present need to maintain high crocodile numbers in all habitats in Botswana, the Department of Wildlife and National Parks has no other option but to promote a crocodile ranching industry. Such a scheme is likely to help increase the numbers of crocodiles in the wild through a re-stocking programme in areas where crocodile numbers are low. Botswana has opted to be a ranch state with effect from 1989. Hatching rate under artificial incubation of 90% is far superior to that of the wild that is normally put at 50%. Hence eggs collected from the wild would certainly be better utilized under a ranching system.

The following management aims and options are adopted by the department;

(1) The Department's aim is to increase crocodile numbers in areas where crocodile populations seem to be depleted and where they are accordingly accepted. This is being done under a re-stocking programme.

(2) The Department only allows ranching based on an established local quota system that is being developed with aid of data from both crocodile surveys and nesting monitoring programmes (see Appendix). If applied correctly, this operation should enable populations to oscillate at some appropriate level to allow natural balance and recovery.

(3) The Department exploits the crocodile only under regulated control through zoning of crocodile habitats. From time to time and depending on crocodile surveys and monitoring data, crocodile habitats will be classified accordingly as safe, vulnerable and threatened. Simultaneously, regulated exploitation of eggs, hatchlings, subadults, adult males and adult females is being implemented.
3. ZONING AND UTILIZATION OF CROCODILE HABITATS

There are three wetland systems in Botswana that still remain crocodile strongholds and important crocodile habitats. These wetlands are, the Okavango River and Delta and the Kwando/Linyanti/Chobe drainage system. Sections of the Limpopo River that retain water permanently are also known to support numbers of crocodiles (Figs 1 and 2). A small section of the Zambezi (5km) is also known to support a crocodile population.

Several factors must be considered before the status of crocodile populations and crocodile habitats can be determined and appropriate management measures implemented. The persistent drought has greatly reduced permanent wetlands in Botswana. Degradation of crocodile habitats and microhabitats - important for example in nesting and general breeding - by livestock, fire, cutting of vegetation etc is on the increase. Consequently the Department has decided to zone crocodile habitats in Botswana in response to these and other various problems.

This zoning exercise however does not ignore the importance of existing national land use programmes in the districts under which crocodile habitats fall. This linkage raises important questions of conflicts between various land use schemes and indeed the need to consult and co-ordinate. If care is not exercised a campaign to increase the numbers of crocodiles on the Okavango, for example, could run into conflict with livestock and fisheries industries, whereas an attempt to eliminate or reduce the number of crocodiles in this ecological system would equally run into problems with the aspirations of the tourism industry i.e. aesthetics including scientific values.

The zoning exercise adopted here is subject to review and amendment depending on fresh knowledge coming from crocodile surveys and monitoring activities. Crocodile populations in National Parks and Game Reserves enjoy full protection as stipulated by the National Parks and Fauna Conservation Acts.

The Okavango River which is commonly referred to as the "pan-handle" is increasingly being exploited to levels beyond its natural carrying capacity. Clearing for human settlements, poaching, livestock watering and grazing, agriculture, tourism, ravaging fires and reed bed cutting by locals are on the increase and suffice to say these activities leave behind irreparable
damage. It is on the Panhandle that the crocodile has been over-exploited in the recent past and it is also important to note that, this is the same locality that is the prime breeding area of the Nile Crocodile in Botswana. The Department has until further notice designated both the crocodile population in this area and the habitat as threatened. Hence a crocodile population and habitat monitoring programme is currently undertaken on a regular basis. Except under a special permit from the Department, no hunting or capturing of crocodiles is to be allowed on the Okavango Pan Handle (area between Mohembo and Seronga).

This zone is strictly open only to egg harvesting activities to support a ranching industry (see nest maps in appendix section). A re-stocking exercise is being implemented.

The Okavango Delta can be divided into three main ecologically distinct zones; the permanent swamp, the seasonal swamp and the dryland masses (Fig 2). Part of the permanent swamp and seasonal swamp falls under the Moremi Game Reserve where no hunting or capture of crocodiles is allowed. Results from aerial surveys show that both the Moremi Game Reserve (3,880 sq km) and the permanent swamp portion of the delta, support a healthy population of crocodiles. This zone is relatively inaccessible and does not render itself to easy navigation. Hence this zone is designated as a safe habitat. Here our management aim is to maintain crocodile numbers and utilize them under a set local quota system.

The dryland masses of the Delta present a different picture. Cattle grazing, fires, tree felling and cutting of reedbod and molapo farming is common in this area. This activity and its effects is however not confined to this zone only, and in no time it is expected to move progressively towards the upper reaches of the Delta, hence threatening the future of the whole Delta. The dryland masses zone is consequently hereby regarded as a threatened habitat. Studies on habitat degradation are ongoing and solutions to rehabilitate should be arrived at soon. However, the Delta Nile Crocodile including that of the Thamalakane and Boteti Rivers and the Savuti channel (134km) is regarded to be safe, and should be hunted under permit and eggs harvested under a local quota system. This management option should help protect crocodile populations in this area.
The Kwando/Linyanti/Chobe/Zambezi river wetland system has broad floodplains with vast stands of *Cyperus papyrus* and *Phragmites* spp. hence showing the characteristics of a permanent swamp. About 100km of the Linyanti/Chobe river falls under the Chobe National Park and supports a crocodile population that is totally protected. The terrain here does not render itself easily to free navigation and this impenetrable habitat provides the much needed safety to the Nile Crocodile. The area is also a restricted military zone which again provides an added advantage. The area is hence classified as a **safe habitat**. Removal of eggs **outside** the National Park should be encouraged under permit. Here crocodiles will be maintained and utilized under a quota system.

Flowing in the eastern direction is the Limpopo River. This is one of Africa's major rivers and forms a national boundary between Botswana and South Africa. However, because of persistent drought the Limpopo River is no more as mighty as it used to be and is now only perennial in its upper reaches. However, where water occurs permanently (in pools), the river still supports a good population of crocodiles. It's long stretches of sandy banks provide suitable nesting sites. In this zone, the crocodile population is relatively isolated and the river is subjected to considerable disturbances by human activities. The zone is designated as **vulnerable**. A small quota to enable cropping of crocodile eggs for the ranching industry must be allowed. The area should be re-stocked with a ranched crop of hatchlings. But this should be done in a way that it does not conflict with other forms of landuse in the Tuli-Block. Our management aim in the Limpopo is that crocodiles will be tolerated and utilized under ranching.

Generally an appropriate action on the various management aims in various areas will be to seek for popular public support at district level. Total acceptance of the management aims by landuse planners in the districts is key to the success of these plans.

4. **GUIDELINES TO BE FOLLOWED IN WRITING AN APPLICATION TO THE DEPARTMENT OF WILDLIFE AND NATIONAL PARKS FOR PERMISSION TO UNDERTAKE A CROCODILE OPERATION.**

Below is set out the requirements for proposals submitted by individuals and companies to ensure efficient and systematic processing of such applications by the Department.
LIST OF REQUIREMENTS

A proposal containing a full account of the project is required. It should be submitted to the Director, DWNP and it should contain information on the following items.

A - Background

Outline the background to the project. The physical environment and the social setting need to be outlined, e.g. whose land is involved, how will it be acquired, background and residential status of the project proponents and the operators, etc.

B - Project Objectives

The objectives of the project, e.g. commercial, educational, developmental, conservational, etc.

C - Technical Plan

C1 - Start up - Proposals for acquisition and build up of stock. Acquisition of land, labour and capital items, etc.

C2 - Production Process - Production system(s) to be employed in the project. Ways in which feeding requirements are to be met, herd/flock management, water provision, disease control, etc. The various products to be produced.

C3 - Processing - Details of any plans for product processing, e.g. tanning, crafts production, packaging, etc.

D - Marketing

Outline of plans for the marketing of the various products to be produced. Preferably this should contain available information on the size, stability and growth potential, if any, of the markets.

E - Financial Plan

Financial estimates indicating project viability if this is an objective. This should preferably contain annual cash flow projections.
F - Employment: Job Creation

Outline of staff requirements and employment of full time and casual labour.

G - Localisation

Plans, if any, for localisation of managerial posts. Plans and statements, if any, for making use of joint venture opportunities with local people should be given.

H - Other Information

Any other relevant information on the project. Of particular relevance would be plans for the involvement of rural people in the project or the value of the project from the point of view of training or conservation, etc.

CONCLUSION

Adoption of the guidelines above should help reduce delays and frustrations on the part of the interested parties. It will also, hopefully, prevent wastage of wildlife resource.

5. REQUIREMENTS FOR RUNNING A CROCODILE RANCH

The Departmental policy is such that we shall openly support crocodile ranching operations in Botswana while assisting breeding operations. We shall harvest eggs under ranching as long as 5% of annual crop of hatchlings is returned to the wild to re-stock natural habitats. One of the basic justifications for harvesting eggs to stock hatcheries is that most eggs are wasted and never hatch in nature, whereas artificial incubation provides an 80% or more hatching success rate. The re-stocking component will be of great help to our crocodile management programme in Botswana. Hence a crocodile ranching proposal has been presented to the CITES Secretariat and a decision is awaited.

Before any person(s), company or authorized representative(s) of accompany can be granted a permit for a crocodile business, necessary pre-qualification must be met. These are as follows:

(1) Before granting a permit for private enterprise to establish a ranch the
Department will investigate the applicant's land tenure and financial resources, particularly since it takes 3 to 4 years before a farm starts to produce crocodiles suitable for culling.

(2) The applicant's ability and experience of rearing crocodiles will be determined. Where this does not exist applicants will be requested to seek it elsewhere through a consultancy.

(3) A plan of the proposed ranch including details of water, food supply, veterinary help as well as proposed methods of harvesting food will be examined. Financial projections on investment and employment opportunities must be indicated.

(4) A valid permit will state name of holder and/or his authorized representative, the annual total number of eggs and crocodiles allocated for harvesting and area where collection is permitted. Permit to capture crocodiles for breeding must categorically specify how many adult males and adult females will be collected. No permit to harvest eggs and to collect crocodiles will be issued until adequate rearing facilities have been prepared.

(5) Permits will include leases from the Land Boards. Ranching permits of 5 years renewable and capture and collecting permits with lifespans of 1 year renewable after the necessary fees have been paid. Ranches are expected to mature and realize profits after a 5 year period of operation. The renew or issue further permits if the ranch is not managed satisfactorily or if permit conditions have not been observed.

(6) Ranchers should understand that the ranch and all production records should be available for inspection by an official of the department.

(7) Operators of crocodile schemes are required to submit quarterly reports detailing total number of nests (from wild and farm separately) raid, eggs harvested, egg-mortality and number hatched. Quarterly reports should also have details on numbers
of crocodiles held in captivity, mortality, its causes if known, and animals sold or culled.

(8) The Department encourages egg harvesting, incubation, hatching and rearing of young crocodiles for commercial purposes and for release of some ranched stock to the wild at a later stage. This should protect the breeding stock. Hence owners of crocodile operations are expected to conform to this.

(9) In zones where eggs are harvested annually, nesting sites will be raided in rotation. Collecting from given nest sites one year, then leaving it undisturbed the next year. Continuous raiding of the same nest sites year after year leads to abandonment by the nesting female. Nest maps have been useful in fulfilling this task.

(10) Collecting eggs must be staggered throughout a breeding colony and this can be achieved by using nest locality maps. Care must be exercised not to disturb a nesting colony because this seems to be the best deterrent against predators.

(11) All ranchers are required to release 5% (1.2m females) of their annual crop of hatchlings in order to re-stock the natural habitat.

(12) Ranchers will be required to carry and complete the egg record forms during each egg harvesting trip. Forms are available from the Department of Wildlife and National Parks, Gaborone. These forms together with nest maps should be submitted to the Director.

(13) Farmers are expected to conform with all regulations and trade laws, e.g. use of tags by CITES, including additional regulations on the permit, failure of which a permit to operate a farm may be denied or revoked and the operation consequently closed. A section of law quoted on the permit will operate in case of violation leading to closure of a ranch.
6. GENERAL KNOWLEDGE ON CROCODILE OPERATIONS

1. It is necessary to acquire sufficient land (10-25ha) on which to develop a ranch. Choice of a place to establish a ranch is important and the place should be near the resources to be exploited (crocodiles and their eggs).

2. The operation should be in a place with plenty of cheap water that does not run-out. Otherwise it is advisable to put up well points and boreholes.

3. Food is another important consideration. Food should be readily available. The diet of a wild crocodiles changes with age and size of the animals; from predominantly insectivorous diet as hatchlings to feeding on mainly red meat in adulthood.

4. Food for hatchlings and adults should be prepared separately. Hatchlings need food rich in calcium to promote growth of bones and protein for growth and repair of worn out tissues. Adults can be maintained on fish and red meat diet.

5. How much food and how many times one should feed hatchlings, young animals and adults is something that needs sorting out. Over fed crocodiles develop gout and feeding excessively on high protein diet could result in excess built up of urates manifesting into renal failure.

6. Food estimates per 1000 slaughter animals per annum are as follows:
   a. hatchlings would need 4.5 metric tons of fresh meat,
   b. 1 to 2 years juveniles, 9 tons,
   c. 2 to 3 years juveniles, 17.2 tons, and
   d. breeding adults would need 230 tons.

A cold room must be built in which to store food.

THE FOLLOWING MOBILE AND FIXED ASSETS ARE ESSENTIAL

1. Breeding and holding earth ponds with overgrown aquatic vegetation to simulate natural conditions. These ponds should be biologically living systems, and hygienically clean. Salmonella bacteria cause clinical manifestations and damage to skins renders them of little value.
2. Egg incubation and hatching house. This facility should be well insulated to ensure desirable conditions of humidity and temperature. This is necessary to maintain high levels of hatching successes.

3. A rearing environmental house. This facility should have a partition for holding hatchlings during yolk absorption period. Young having absorbed yolk must be sorted out according to sizes and kept under constant temperature of 31 to 32°C through a system of heated circulating water. Preferably grown in total darkness, hatchlings should be allowed a period of exposure to light to acquire Vitamin D from ultraviolet light.

4. Slaughter house, food preparation and cold room area including skin preparation and storage area must be accommodated among fixed assets expenses.

5. General equipment should include:
   a. tractors/front-loader equipment to use in clearing and excavation work.
   b. landcruisers, motor boats and water pumps
   c. capture equipment (nooses and gaft)
   d. chemicals (Flaxedil). Used with Veterinary Department permit.
   e. heavy duty masking tapes and ropes.

HUSBANDRY TECHNIQUES

1. In Botswana enough eggs are laid by crocodiles to sustain a ranching industry. But this can only accommodate a limited number of operations. For long term purposes ranching operations are encouraged to also establish small breeding units to offset heavy dependence on the wild population. Limited use of eggs from the wild by well established enterprises should give a chance for new operations to get established.

2. It is necessary to operate breeding pens on both single and multiple breeding styles. Using both systems will cancel disadvantages of each set up and optimize advantages. A single breeding system should operate on 1 male 6 females basis and multiple breeding type on ideally 4 males and 8 females.

3. A 2.6–2.7m crocodile in Botswana is considered mature and ready to breed. Hatchlings are not readily sexed.
MANPOWER

1. It is necessary to have reasonable labour force. This team should compose of casual labourers, well trained capture team equipped with knowledge of rivers, motor boat driving and repair, shooting in case of danger and have reliable communication skills and equipment (walky talkies), spot lights, spare motor batteries, a lighter, a knife, float jackets, first aid box and snakebite kits etc.

A crocodile hunting and egg harvesting team should have a person or persons trained in handling and transporting crocodiles or crocodile eggs to home base. Extreme caution must be exercised for the success of operations and accident free work.

2. Schemes must be run by two Senior Managers in the establishment. These staff members must at all times supervise both field operations and farm work. Feeding, cleaning and monitoring conditions in the rearing room must always be done by a very senior and knowledgeable person. Capture, egg harvesting and transporting operations demand similar attention.

3. It is necessary to send a good number of people for training in skinning. Badly prepared skins get low grade and are almost worthless.

MARKETING

1. It is necessary to budget for trips to Gaborone to sort out various financial matters with financial institutions, operation matters with the Department of Wildlife and National Parks. From time to time owners of game utilization schemes will need to consult customs officials as well as veterinary personnel on various matters related to their operations.

2. It is necessary to attend exotic leather fairs in France, US, Italy etc to familiarize oneself with needs of the overseas markets. Visiting enterprises in neighbouring countries is useful in improving technology and marketing ideas.

3. However, the basic aims of establishing ranches in the country is that they will produce skins which local processing industries, once established, will utilize to manufacture finished goods. The re-stocking component of ranching will ensure increased numbers of crocodiles in the wild hence sustainable conservation.
APPENDIX—

A CROCODILE MONITORING PROGRAM—

A PROGRAM TO ESTIMATE CROCODILE POPULATIONS AND TO MONITOR NEST SITES AND NESTING IN NILE CROCODILE POPULATIONS IN BOTSWANA.
CONTENTS

I. Introduction
II. Objectives
III. Methods
IV. Data Compilation and Analysis
V. Annexure—
   Data Sheets and maps
I. INTRODUCTION.

Monitoring of nests and nesting sites including counts of the Nile Crocodile covers all major wetlands in Botswana which support substantial crocodile populations. There are three important wetland areas in Botswana and these are; the Okavango River and Delta, the Kwando/Linyanti/Chobe/Zambezi drainage system, and the Limpopo River.

The Okavango River and Delta is an expanse of wetland that covers approximately 15,000 sq km and can be divided basically into four main, ecologically distinct, zones; the Okavango River commonly known as the "Panhandle", the permanent swamp, the seasonal swamps, and the dryland masses. The water that enters the Okavango originates from Angola hence the flood cycle on the Delta is out of phase with local rains. Flood waters take approximately five months (January to July) before discharging about 2% of the original input into the Boteti River.

The Kwando River also has its source in Angola, whereas the Chobe and Linyanti receive major water recharge mostly from the Zambezi. Hence the hydrologic regime of both river systems depends much on the good rains from Angola and Zambia. But these rivers also form an international boundary with Namibia hence most of this wetland region falls outside Botswana. The rivers have broad floodplains and generally show the characteristics of the permanent swamp zone of the Okavango.

The Limpopo River flows in the eastern direction and forms an international boundary with the Republic of South Africa. Here in isolated pools also thrive a good population of crocodiles.

Following a period of intensified hunting of the Nile Crocodile in 1950s, the then Department of Wildlife, National Parks and Tourism (DWNPT) began a programme to study crocodile and monitor populations (see Blomberg, 1976; Graham, 1976). These studies however were limited to the Okavango River. The current population study and monitoring programme covers the whole country. The monitoring programme is also an integral part of a management policy whose details are found in the first part of this document and compliments the country-wide crocodile census project.

The paper outlines a staged monitoring very similar to that proposed by Graham (1979). This is in keeping with the need to standardize methodology and procedure so that work done here after will be compared to that done before. Graham (1979) writes that it is necessary to keep procedures straightforward, so that results may be transferable from team to team to allow valid comparisons between years. This, suffice to say, is the only valid way by which the status of the Nile crocodile may be determined. The breeding biology characteristics dealt with in
detail are those that are most relevant to the management programme.

Operational Procedures

This staged monitoring programme is meant to devote equal searching time to all wetlands known to support crocodiles in Botswana. However, a priori we know that the Panhandle and the floodplain between Chief's Island and the Moremi Game Reserve support very high densities of crocodiles, more than any other wetland in Botswana. It should also be understood that nest counts from aerial viewing represent only an estimate, and that an absolute total number of nests in the whole system cannot be arrived at. Hence systematic measurements of all the parameters reflecting population status is not possible. It is also impossible to count all the crocodiles.

Biological Criteria

During the egg nesting season (September to early November) the otherwise cryptic animal apparently becomes highly conspicuous. During nesting season, the entire breeding female subpopulation segregates itself from the rest of the population. At any other time it is impossible to tell a male from a female visually except by cloacal inspection. This segregation and attendant exposure permits both visual and photographic records to be made. This study employs visual counts and logging of exact sites (grid fixing). This data leads to the development of crocodile nest maps that are of great use to the management programme just instituted.

The features of a breeding subpopulation that can be monitored resemble those suggested first by Graham (1979) as follows:

1. By visual observation
   - location and number of nest sites
   - pattern of use of nest sites
   - clutch size (by ground inspection)

2. By photographic observation
   - size frequency of nesting females, and hence age frequency
   - individual female growth rates
   - individual pattern of nesting activity via dossiers of individuals recognizable by distinct color, shape or abnormalities.

The second technique will be utilized only if its cost is less than the returns from management. Graham (1979) however employed this technique with reasonable amount of success.
II. OBJECTIVES - A stage approach

Because of the need to standardize methods, ways of analyzing data and manner of interpretation of results, a stage approach of Graham (1979) is adopted in its entirety as follows:

Stage 1. Visual aerial observations

Visual aerial observations will be carried out regularly. The idea being to maintain a log of nesting activity consisting of an annual record of:

- the number of nests made
- the location of all known nests, hence a determination of the overall pattern of nesting activity.

This data collecting technique is best for swampy areas because the often extremely difficult crocodiles to find on the ground get nearly always exposed to an airborne observer. However nests nearest to each other may be missed and counted as one nest only. Also some nests may be identified with much doubt hence as "possible nests" only.

Stage 2. Visual ground observations

To supplement those parameters not visible from the aerial net work, the following parameters will be dealt with from ground observation:

- structure of breeding female segment of the population
- hatching rates and other behavioral features
- nest site parameters, such as physical characteristics of the substrate and vegetation (see also data sheets)

This stage will be done on a more regular and/or rigid basis than the first.

Stage 3. Aerial photography

Graham (1979) pointed out five features which he thought were accessible to monitoring via scaled photographs. These are:

- size frequency distribution of the breeding female population
- size frequency distribution of the whole population of the approximately one metre in size upwards
Stage 4. **Returns from cropped and captured animals**

Returns on cropped or captured individuals from the wild may provide some useful indications on certain population characteristics and demographic features.

- Size of female's plus changing structure of the population
- Secondary sex ratios (frequency in population)
- Number deformed.

From among captive individuals, information on age specific growth rates, using marked individuals and age specific survival rates could be gathered.

It is possible to carry out all these stages concurrently. But this will depend much on available manpower and demands of management. How many eggs and crocodiles will be harvested demands need for more accurate information upon which to base strategies. The basic objective of this staged monitoring programme is to determine the rates of sustainable harvest of eggs and/or numbers of crocodiles in Botswana.

### III. METHODOLOGY

**FLIGHT PLANS**

- Flying time is important and will be divided into two shifts per day i.e. day break to about 9 a.m. and afternoon from 16.00 hours (4 p.m.) onwards.
- Flying will be between 80-100 k.p.h.
- Flying height of 90-150m
- Flying will be done systematically along all water courses and then across all the off channel areas with potential nest sites i.e.

1. **Okavango (100km)**  \( 21°51' E \times 18°15'S \) and \( 22°30'E \times 18°3'S \)
2. **Khwai (98km)**  \( 23°45'E \times 19°10'S \) and \( 23°45'E \times 19°11'S \)
3. **Moanachira (70km)**  \( 23°E \times 10°E \times 19°10'S \) and \( 23°38'E \times 18°0'S \)
4. **Kwando (66km)**  \( 23°45'E \times 19°10'S \) and \( 23°38'E \times 18°0'S \)
5. Linyanti/Chobe (166km) 23°38'E x 18°30'S x 25°10'E x 17°05'S

6. Savuti (65km) 23°04'E x 18°50'S and 24°05'E x 18°35'S

7. Santantadibe (100km) 23°03'E x 19°05'S and 23°40'E x 19°45'S

8. Thaoge (105km) 22°15'E x 18°55'S and 23°33'E x 20°00'S

9. Boro (175km) 22°43'E x 19°05'S and 23°28'E x 19°55'S

10. Limpopo (319km) 29°28'E x 22°21'S and 26°45'E x 24°15'S

11. Zambezi (5km) 25°10'E x 17°05'S x 25°17'E x 17°04'S

The criteria by which a nest is established from the air are as follows:

- Presence of a crocodile of the appropriate size (2.7-3.5m long) on a suitable site.
- Animals that are nesting go far from water whereas those merely lying ashore seldom do.
- Animals nesting tend to stay put even after prolonged circling by an aircraft whereas those merely lying ashore tend to return to water when circled.
- When a female is absent at the time of observations the nest can often be detected from the deep imprint left in the sand as a result of the tendency to use the same "lie" when attending the nest (see also Graham, 1979). With this observational technique, nests that are close to each other may be counted as one and some may be classified only as possible nests. Hence the necessity of conducting simultaneously ground observations.

* Area may not be overflown because the rivers are zones of military conflicts. However ground observations are possible.
A ground survey observation is being done twice yearly to count crocodiles and to estimate size, structure of the populations in all river systems where crocodiles are known to occur. A boat is used in the search for crocodiles and nests. An observation time schedule similar to that applied in the aerial survey observation is being followed. A careful visual search from the ground of nests along the banks of rivers Kwando, Linyanti, Chobe and Limpopo is carried out from a slow moving vehicle and on foot. The parameters on which data may be recorded are shown in the data format sheets appended.

IV. DATA COMPILATION AND ANALYSIS

Data compilation could be affected by the nature of the aircraft used. Good slow flying characteristics is essential. The necessary data sheets (see annexure) are carried on the aircraft and the following basic features are recorded:

- the location of all nest sites
- location of all nests
- number of crocodiles counted per kilometer of river plus an estimation of age/sizes.

Graham (1979) has regarded nest sites as more or less permanent because according to him only about half of them are used in any one given year. However the truth is that the pattern of nest location differs in detail yearly, though overall pattern of distribution seems to be consistent. It is not possible to a priori determine all possible sites, hence the crew must satisfy themselves that a thorough search has been made before proceeding to the next area. A grid reference will be given for every nest site and nest located. This nest search grid reference system, once operational, will be used to record and determine, new sites whether they are in use or not, including old ones (on the Okavango only) recorded before by Graham during five years of monitoring activities, 1974 to 1979.

Data recording is done on sheets designed for this purpose (see annexure) and nest sites and nest location data are both displayed in form of grid maps and in graphical form. This mapping method allows new sites and nests to be added on as new information is acquired over the years.

An office data sheet (see annexure) is used to summarize at the end of each season information contained in field data sheets.

Data is being analyzed to provide the necessary information needed to run the instituted crocodile management programme. Data is plotted in the form of nest and nest site distribution maps. This should reveal the nature of distribution of these features and patterns of change over time. Depending on the direction and
rate of change, i.e. positive or negative, we may have to make the necessary management decisions on how to deal with such change. Such simple analysis is all that is necessary to generate information in support of a simple management programme.

It is important that the nests and nest sites monitoring programme be continued yearly. Hence the following sequences of actions are designed to ensure that each new season's observations are added to the existing database. This data should be readily retrievable for the surveys in subsequent years. Hence:

1. Base photos, are available and kept secure at Headquarters,
2. Dyeline copies are made for field work each year,
3. Nest log data sheets are copied for each new season so the entire history of each site is on one sheet,
4. Annotated dyelines are returned to the office after each season's surveys, which together with nesting log, are used to update base photos and prepare next season's updated log. Gazetteer of nests and nest site localities has been developed and nest maps are available at the Headquarters (see e.g. map 1 of Shakawe in annexure).

The monitoring programme also involves habitat assessment in all known crocodile habitats, to pinpoint management related problems. The following activities will be monitored: reed bed cutting, indiscriminate burning of the delta, trampling on sandy banks and islands by cattle and large mammals, drying up of channels and off channels, settlements by local cattlemen, fishermen and safari operators, predation on crocodile eggs by monitor lizards, abandonment of nests by female crocodiles, mechanical and chemical damage to eggs, harvesting of eggs by farmers. Sandy banks and islands such as Maswabi on the Panhandle are important to the breeding of the Nile crocodile.

V. ANNEXURE-DATA SHEETS AND MAPS
ANNEXURE

A CROCODILE MONITORING PROGRAM

By visual observation from the air

Survey No.

<table>
<thead>
<tr>
<th>Type of Aircraft</th>
<th>Date:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>-------</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Sequential number of nests seen</th>
<th>Time seen</th>
<th>Notes: (surrounding veg., exposed to sky)</th>
<th>Access by female direct from grid ref.</th>
<th>Log in location</th>
<th>River Grid Ref.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
</tr>
</tbody>
</table>


# A CROCODILE MONITORING PROGRAM

By ground survey observation

<table>
<thead>
<tr>
<th>Survey No.</th>
<th>Date:</th>
</tr>
</thead>
<tbody>
<tr>
<td>------------</td>
<td>-------</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sequential number of nests seen</th>
<th>Locality</th>
<th>Clutch size and No. of egg layers</th>
<th>Eggs taken Clutch diameter of egg layers</th>
<th>Clutch Depth</th>
<th>Notes deepest egg</th>
</tr>
</thead>
<tbody>
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<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

52
A CROCODILE MONITORING PROGRAM
(CROCODILE EGG RECORD)

1. Egg Collection:
   Season ______ Clutch No. ______
   Date ______ Locality ______ Gridfix ______

   Number of eggs in clutch ______
   Number of eggs rejected ______
   Number of nests located and examined ______

   Further comments on nest sites and monitor lizards:

2. Incubation and hatching:

   No. incubated ______ Date ______
   No. infertile/dead hatched ______

   Further comments:

Observer: ______

Return this data sheet to:
The Director
Dept. of Wildlife and National Parks
P.O. Box 131
GABORONE, Botswana.
<table>
<thead>
<tr>
<th></th>
<th>LOCALITY:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>YEAR:</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Flying hours searching</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Total flying hours</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Period (s) covered</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Shifts (a.m. &amp; p.m.)</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Average shift length</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Total nest sites in use</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Total nests found</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Total sites re-used</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Total new sites</strong></td>
<td></td>
</tr>
<tr>
<td><strong>No. of sites found from air</strong></td>
<td></td>
</tr>
<tr>
<td><strong>% increase in sites</strong></td>
<td></td>
</tr>
<tr>
<td><strong>% increase of sites found from air</strong></td>
<td></td>
</tr>
<tr>
<td><strong>% increase of sites previously unknown</strong></td>
<td></td>
</tr>
<tr>
<td><strong>% of all sites re-used</strong></td>
<td></td>
</tr>
</tbody>
</table>
**OFFICE SUMMARY SHEET (2)**  
**CROCODILE NEST DATA**

**LOCALITY:** ---------------------

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total number of nests found</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Total exposed to sky</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Total overhung by vegetation</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Total nests found associated with each other</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Range of clutch size</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Total number of egg layers</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>- Range</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>- Average</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Depth of deepest egg</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Average depth of sand over eggs</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

**REMARKS:**
### DATA ON CROPPED AND CAPTURED ANIMALS
#### (CROCODILE MONITORING PROGRAM)

**DATE:**

**LOCALITY:**

<table>
<thead>
<tr>
<th>BODY CHARACTERISTICS</th>
<th>HEAD MEASUREMENTS</th>
<th>SEX</th>
<th>AGE CHARACTERISTICS</th>
<th>COMMENTS ON PECULIARITIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Snout length</td>
<td>Tail length</td>
<td>Total Head length</td>
<td>Max Head width</td>
<td>Head Depth</td>
</tr>
</tbody>
</table>

---

**RETURN FORM:**

DIRECTOR  
DEPARTMENT OF WILDLIFE AND NATIONAL PARKS  
P.O. BOX 131  
GABORONE  
BOTSWANA
QUARTERLY REPORT ON CROCODILE FARMING AND RANCHING ACTIVITIES

Name of company: ___________________________ Date: __________

CROCODILE DATA

CROCODILE CAPTURED FROM THE WILD OR BORN ON FARM

<table>
<thead>
<tr>
<th>Notes</th>
<th>Males</th>
<th>Females</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Adults</td>
<td>Sub-adults</td>
<td>Juve-niles</td>
</tr>
</tbody>
</table>

Exported =
On farm =
Deaths =
Escapes =

(put number in brackets those born and bred on farm)

CURRENT HOLDINGS OF CROCODILES ON THE FARM

<table>
<thead>
<tr>
<th>Notes</th>
<th>Males</th>
<th>Females</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Adults</td>
<td>Sub-adults</td>
<td>Juve-niles</td>
</tr>
</tbody>
</table>

No. on farm =
No. adults breeding =
Max. No. of breeding colony required on farm =

Remaining No. needed to form farm breeding colony =

Total Quota allowed _______
Quota already used _______

(put in brackets those born and bred on farm)
**EGG DATA**

**Date:** ___________________ 19_

<table>
<thead>
<tr>
<th>WILD NESTS</th>
<th>FARM NESTS</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>No.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. eggs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>harvested</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Egg</td>
<td></td>
<td></td>
</tr>
<tr>
<td>mortality</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number</td>
<td></td>
<td></td>
</tr>
<tr>
<td>hatched</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Total quota of wild harvested eggs allowed =
Quota used =

RETURN THIS FORM QUARTERLY TO:

DIRECTOR OF WILDLIFE AND NATIONAL PARKS
P.O. BOX 131
GABORONE, BOTSWANA.
DWNP CROCODILE MONITORING  NEST SEARCH LOG 19.

<table>
<thead>
<tr>
<th>AREA NAME</th>
<th>NEST SITE NO.</th>
<th>FEMALE PRESENT</th>
<th>TRACKS ONLY SEEN</th>
<th>DUG NUMBER UP</th>
<th>REMARKS OF NESTS</th>
</tr>
</thead>
</table>

PHOTOMAP NO:  NEXT FREE SITE NUMBER BROUGHT FORWARD:  DATE:

---

NO. 32

...
8. ACKNOWLEDGEMENTS

I would like to thank the staff of the Department of Wildlife and National Parks for useful comments on the early drafts of this document. Dr. Jonathan Hutson is thanked for detailed review of the paper and for the useful comments he made on early drafts. Mr. Alistar Graham passed on unpublished information which has improved the presentation greatly. Mr. M.L. Nchunga, Department of Wildlife and National Parks is thanked for the encouragement he gave us and foresight that this paper be developed into a Departmental document. Miss Patricia Modiko typed the final manuscript and is thanked for the expeditious work done.

9. SELECTED REFERENCES


COUNTRY REPORT BY BOTSWANA

CROCODILE MANAGEMENT AND CONSERVATION

M. P. SIMBOTWE

DEPARTMENT OF WILDLIFE AND NATIONAL PARKS,
GABORONE, BOTSWANA.

SUMMARY

The Botswana crocodile population is estimated at about 10,000 animals. Crocodile nests and nest sites have been located in all the major wetlands. Numbers of nests and nest sites increase yearly and nests are held more or less permanent because only a few of them are re-used in successive nesting seasons. Recruitment is good and hatchlings have been found to be in the majority of samples studied.

Farming operations are expanding but problems related to diet and incubation husbandry continue to face the farmers.

INTRODUCTION

Management of wild and farmed populations of crocodiles to ensure sustainable conservation is one of the topics that has recently been addressed in detail by Simbotwe and Matlhare (1988). Various topics of importance to conservation have been discussed and adopted by the Department of Wildlife and National Parks as prequisite and essential requirements to running a ranching scheme in the country. Key concepts developed include; management aims and options, zoning and policy on crocodile capture and harvesting of eggs from the wild including crocodile husbandry. A country-wide crocodile survey and monitoring programme has also been developed (Simbotwe and Matlhare, 1988).

Recent studies have shown that wetlands in Botswana may not support meaningful Agriculture, Fisheries and Livestock Industries (Thompson, 1976).

There are many reasons for this but the most important being depressed primary production. But man has utilized these wetland for over 200 years. Wetland development is suited to small scale development that do little damage to aquatic life and surrounding rangeland. Hence development of wildlife utilization projects based on wetlands resources e.g. crocodiles seems well suited and/or compatible to this environment.
In order to embark on proper management and utilization of crocodile populations, studies on crocodile biology have continued. The first recorded data on the biology of crocodiles was a report by Taylor (1973) on the size structure, reproduction and stomach contents of 500 shot crocodiles. Between 1974 and 1976, a government biologist based at Shakawe collected information on aspects of population biology. The results have been reported by Blomberg (1976), Graham (1976) and Graham et al (1976).

Detailed data on crocodile biology is increasingly becoming available. Recently Simbotwe (1988a, 1988b) and Graham and Simbotwe (in prep) have analysed preliminary data and results of importance in determining off-take levels and data important to management is emerging.

Crocodiles are an integral part of the entire wetlands ecosystem hence unless we understand their ecological role in the wetlands model ecosystem, no meaningful management plan can be arrived at.

MATERIAL AND METHODS

To be able to accumulate appropriate data in the shortest time possible on the population biology of the various crocodile sub-populations in the country, several technical/scientific approaches have been taken in order to;
1. count crocodiles and estimate population size
2. study population demography and ecology
3. count both from the air and ground total numbers of nests made yearly.

To be able to achieve these tasks, a fixed wing plane fitted with a Global Navigation System (GNS) equipment is used. All major channels are grid fixed using the GNS recorder.

Sampling is done on an annual basis along all major channels and off-channels and rivers. River lengths are worked out in kilometres and total numbers of crocodiles seen are estimated per kilometre of river. Total shoreline is estimated at 1269 km. Information on population size structure is obtained from a night spotlight survey.

Details on flight plans, procedures in recording crocodile and nest count data including crocodile ranching management records can be obtained in various documents including papers by Simbotwe and Matlhare (1988) and the Botswana Ranching Proposal (see Anon, 1988).

Sampling is confined to specific time of the day, season and is compatible with changes in the hydrological flood regimes (Simbotwe, 1988a).
Additional data is obtained from farms based on cropped crocodile samples. Farmers file in quarterly reports on farm management and also provide additional data on nests, sex and morphological (metric characters) characteristics of captured crocodiles.

CITES controls on trade; use of CITES approved stamps and tags are monitored closely. Farmers are required to adhere to Wildlife and National Parks legislation on crocodiles and veterinary requirements in the country.

DATA ANALYSIS

Crocodile populations inhabiting swamps are very resistant to accurate determination of population size. Hence initial estimates can only be arrived at with caution. But in the long-term interest of the project accurate estimates must be made to avoid determining off-takes that are too small and not economically suitable and conversely dangerously too large to harm the population.

Population size estimates have been determined from the total numbers of crocodiles counted per kilometre of river multiplied by the entire length of perennial river. This is a "common sense index" that is now commonly used conveniently to determine roughly population size estimates before precise methods of determination are arrived at (see Mphande, 1987; Anon,
Because of low reliability attached to crocodile population size data, Botswana discourages capturing wild crocodiles. Until such a time that reliable methods of population estimates are developed, our utilization schemes will continue to be based mainly on nest aerial and ground count survey and monitoring data. A double method is used and combines aerial count routines and ground searches (Graham, 1988). This method minimizes vision bias.

Present data is mainly analysed in form of graphs and histograms. This method is suitable in presentation of data for management (Mackinnon, Mackinnon, Child and Thorsell, 1986).

RESULTS

Habitats

Much of the remaining crocodile habitat constitute the Okavango river and Delta (Figs 1 and 2). The Okavango river and Delta population is estimated to be at 5704, the Zambezi, Chobe/Linyanti and Kwando at minimum of 1185 animals and maximum 2370 whereas the entire length of the Limpopo supports about 2552 crocodiles. Hence the crocodile population in the country is estimated to be at between 9411 and 10626 crocodiles.
Crocodile distribution

Figures 3 and 4 show patterns of distribution of crocodiles as observed from aerial surveys during the peak of flooding (July to August) on the Okavango. No crocodiles have been recorded in the delta during dry outs because crocodiles seek perennial channels and are confined to them during this period.

Population demography

Studies on demographic characteristics of a population are key to population regulation and management. Figures 5, 6, 7 depict size structure, age/sex and body size relationship among a population of crocodiles on the "panhandle" (Shakawe to Seronga).

Figure 5 depicts a typical crocodile population size structure on the Okavango. Two repeated samples taken from the same stream (Kgola Thogo) at time intervals of 3 months a part produced similar results; hatchlings <1 metre were found to be in the majority (50% of sampled age/size group) followed by adults over 3 metres (28%) and animals between 1 and 3 metres were represented the least (22%). A body size structure profile of the crocodile population on the panhandle is shown as Figure 7. Data shows that hatchlings were in the majority of animals sampled in areas where nesting is concentrated most i.e. upper portion of the delta. Adult animals are shown to be uniformly distributed in all localities irrespective of variation in
hunting pressure and hunting successes.

Nesting

Table 1 gives a complete history of crocodile nesting on the Okavango panhandle. Figure 8 shows the distribution of nest sites and nests on the Okavango river. Nests and nest sites are more concentrated on the main channels. A total of 260 nest sites and nests have been recorded since initiation of monitoring in 1974.

Figure 9 shows the location of nest sites and nests on the Zambezi, Chobe/Linyanti and Kwando rivers. Nesting areas are known to occur on the Limpopo river near its tributary the Seoka (Fig.10).

Data from 1974 to 1979 surveys show a marked trend of decreasing numbers of nest sites and nests downstream towards the delta (Fig.11). Data from current surveys (1987) show a similar trend (Fig.12). Fig.13 shows that a good number of nests recorded were previously not known hence newly made. These newly made nests were located below photo map 8 and towards Seronga (Fig.8).

Figure 14 shows that the number of nest sites and nests increase yearly whereas Fig.15 shows that new sites and nests are made yearly. But these have been shown to decline over successive years of sampling. The sharp increase for 1987 is noted and is a result of cumulative data when sampling resumed after eight years.
Figure 16 shows presence of re-used nests on the Okavango. However, this is a declining relationship and fewer nests are re-used over the years. Out of 260 known nests and nest sites on the Okavango river (Fig. 8), only 74 (28%) were found to be still in active use in the 1987 sampling season.

Utilization

Two farms are currently operating and have been registered with CITES. The Okavango swamps crocodile farm is situated in Ngamiland District 12 km out of Maun village. Established in 1983, the farm can hold over 4,000 crocodiles. Wildlife Services Botswana was established in 1984. It is based at Kazungula outside Kasane village in Chobe District. The farm can hold 2,000 crocodiles. The farms have successfully established breeding units of 90 to 70 breeding animals respectively. Both farms hope to go into skin production by 1989.

The business is expanding and two other farms are likely to open soon. The Ngarang i farm is based at Shakawe and the Limpopo farm in Tuli Block. Current farm operations have invested heavily and the two employ between them nearly 50 local citizens. This excludes fishermen who locate nests for the farmers. A Ngamiland crocodile farming cooperative is under consideration.
Farmers will stock 1.2m crocodiles in the Moremi Wildlife Reserve as a gateway to the Okavango. The planned date for this activity is 4th November, 1988.

Farm management

Information based on returns from farmers show that feeding and egg incubation pose most problems. Hatching success ranged from 45 to 82% for the two farms over the past year. Hatching success has been poorest among farm eggs. Diseases have not been a problem but hatchlings have died from cold and renal failure due to excessive feeding on high protein meat diet.

A fish and meat diet has proved to be ideal diet for the Nile crocodile in Botswana. Hatchibility is affected by egg infertility, egg rotting due to poor control of water in the incubation medium (vermiculate), embryonic deaths and/or neonate deaths.

DISCUSSION

Preliminary findings reveal patterns in crocodile data that are key indicators useful in population regulation management. We now have an idea of the size of the crocodile population in the country. Additionally, we are getting to understand seasonal distribution patterns among the Okavango crocodiles. Crocodiles
show a wide distribution over the delta during flood seasons, but they get localized to the main channels that do not run our during seasons of low water. This is what seems to happen to the delta fish population as well (Thompson, 1976). Delta water at this time has large expanses of de-oxygenated water associated with emergent swamp plants (Thompson, 1976).

Crocodiles between 1 metre and just over 2 metres were consistently found in low numbers in comparative samples. This is apparently the group faced with most growth and survivor problems. It is this age/size group at which point the growth and survivorship curves cross (see Graham, 1976; Figures 1 and 3). This age/size group is also suitable for purposes of stocking farms to establish viable breeding units. These animals are not wary and can easily be handled by a small capture team. This makes them vulnerable.

A body size profile was worked out in order to determine the implication of crocodile capture on the Okavango panhandle and the consequences of the downstream decrease in nesting. Nothing out of the ordinary was recorded as adult animals were found to be uniformly distributed. But hatchlings were found to be in the majority in places where most nesting occurs.

Nesting data has lead us to conclude that areas between Shakawe (Map 1) and the Okavango river eastern channel and areas opposite Ngamaseri channel (Fig. 12) are important nesting areas.
that should be carefully managed in the long-term to ensure the survival of the Okavango population. The majority of nest sites still in use are found here.

The majority of the new nests are now made downstream, i.e. among nest sites below photomap 8 i.e. towards Seronga. Changes in channels, sandy bars and sandy banks and formation of levees including less disturbance away from the heavily settled panhandle may be the reason for this phenomena. But we can only speculate at the present moment. However, Colt (1961) stated that crocodiles nest gregariously were not disturbed.

Numbers of active nests are increasing yearly. This is crucial to Botswana’s ranching schemes. However, in interpreting such data one must be careful because yearly increases in total numbers of nests and nest sites recorded may track skill and searching ability that may result from continuously refined skills and knowledge of the area the study was done. Here a double method using both aerial and ground searches is useful and minimizes all types of associated biases in data (Graham, 1988). Hence data in the early years of sampling may not be reliable at all. When skill and knowledge of the area is mastered then an assumption can be made that sampling over the years was uniform.

Sandy bars and banks, extensive stands of papyrus and Phragmites beds may be used as resting and basking sites as well as areas where to lay eggs. Hippos indirectly help crocodiles by
creating routes and channels that lead to nesting sites (Blomberg, 1976).

Farmers have pledged to release 1.2m crocodiles in the Moremi Wildlife Reserve on the 4th of November. Here the crocodile is fully protected and the released ranched stock should survive. While farming remains promising, incubation husbandry remains a major problem. Embryonic deaths, neonate failure to hatch out, runts and prenatal deformities are still commonly recorded. Plans to solve these physiological problems are under way.

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LEGENDS TO FIGURES

FIG. 1 Crocodile distribution in Botswana

FIG. 2 Okavango Delta and Kwando/Linyanti Swamp

FIG. 3 Crocodile distribution on the Okavango river and Delta in 1986/1987 survey

FIG. 4 Crocodile distribution on the Okavango river and Delta in 1987/1988 survey

FIG. 5 Size structure of crocodiles sighted from a night spotlight survey between Shakawe and Seronga

FIG. 6 Age/size structure of crocodiles captured from Shakawe on the Okavango river during February, March and April, 1987 capture season

FIG. 7 Body size distribution of crocodiles sighted and/or captured on the panhandle. Sample localities are: 1 (Bet camp and Jannies), 2 (North of Shakawe), 3 (South Lagoon), 4 (Lloyd's to North Shakawe), 5 (Matswabi Island), 6 (South to Jannies), 7 (Bridge Lagoon), 8 (Sepopa to Seronga), 9 (Seronga north to south Seronga)
FIG. 8 Okavango river map showing nesting sites and nests

FIG. 9 The Zambezi, Chobe/Linyanti and Kwando river map showing nesting sites and nests

FIG. 10 The Limpopo river map showing nesting sites on the Limpopo and its confluence with the Motloutse river

FIG. 11 Distribution of nests on the Okavango river in 1979

FIG. 12 Distribution of nests on the Okavango river in 1987

FIG. 13 Patterns of distribution of new and old re-used nests on the Okavango in 1987

FIG. 14 Number of nests made on the Okavango river over successive years of monitoring

FIG. 15 Percent of all nest sites and nests previously unrecorded plotted against time (years)

FIG. 16 Percent known sites and nests re-used plotted against time (years)
Fig. 2
Okavango Delta and Kwando/Linyanti Swamp

MAJOR RIVERS

OKAVANGO
NG-GOKHA
MOLANACHIRA
KWANDO
LINYANTI/CHOBE
SAVUTI
SANTANTADIBE
BOTETI
BORO
THAOGE

PERMANENT SWAMPS
SEA SONAL SWAMP

50 Km
Map serial number down stream

Percent of all known sites

1987
Fig. 13

New nests
Old nests
n = 74

Map serial number → downstream

Number of nests

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

0 1 2 3 4 5 6 7 8 9 10
Number of nests and sites vs. Year

- Sites
- Nests


Data points:
- 1974: 20
- 1975: 40
- 1976: 60
- 1977: 80
- 1978: 100
- 1979: 120
- 1987: 140

Fig. 14
Percent known sites and nests reused

Year