

Government of Bangladesh
Ministry of Environment and Forests
Dhaka, Bangladesh

Asian Development Bank
Global Environment Facility
Government of the Netherlands



WIT. B
PNO-036

Crocodile Conservation Plan

of the Sundarban Forest

TECHNICAL REPORTS- TR No. 24

ADB: BAN 1643/3158

March 2003

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SUNDARBAN BIODIVERSITY CONSERVATION PROJECT

**Crocodile Conservation Plan
of the Sundarban Forest**

Technical Report TR – No. 24

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March 2003

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1. CONTEXT

1.1 Justification

Crocodile (Class *Reptilia*, Order *Crocodylia*, Family *Crocodylidae*) is one of the oldest large vertebrate species group that survived evolution. There are 3 crocodile species in Bangladesh:

- (1) *Crocodylus porosus* (Schneider 1801 - Saltwater Crocodile, Estuarine crocodile)
- (2) *Crocodylus palustris* (Marsh crocodile, Mugger)
- (3) *Gavialis gangeticus* (Gharial)

Freshwater crocodile once occurred in the Sundarban, but became extinct approximately 40 or 50 years ago, but Estuarine crocodile still resides in this mangrove forest. The latter is considered as one of the flagship species of the Sundarban. As the number have declined considerably and there is no sign of recovery, rigorous management of this species is required.

1.2 Agencies involved in crocodile management

Two Government agencies are directly or indirectly involved in Crocodile management in Bangladesh: (a) the Bangladesh Forest Department (Ministry of Environment and Forest), and (b) the Bangladesh Fisheries Department (Ministry of Fisheries and Livestock). As yet, no commercial crocodile farming or ranching is taking place in the country. An experimental breeding programme of Fresh water crocodile (imported from India) is carried out in the Chittagong Zoo.

1.3 Context

This conservation plan has been developed in accordance with the requirements of the Bangladesh wildlife (Preservation) (Amendment) Act, 1974, containing legal provisions for wildlife conservation in Bangladesh. The critically endangered crocodile populations in Bangladesh require improved protection.

The conservation of crocodiles is important as it has a unique role in the ecosystem occupying a top position in the food chain, playing a role in nutrient cycles and maintaining ecological balance in river ecosystems. Moreover, crocodiles can contribute to generate significant economic revenues, from tourism and direct use (e.g. skin, meat, skull, bone). Bangladesh is located near important consumer countries of these products such as China, Japan, Malaysia, Thailand etc.

The objective of this conservation plan is to enhance sustainable conservation of natural crocodile populations in the Sundarban through rearing and restocking into nature for the replenishment of wild population and the promotion of sustainable use initiatives.

2. CURRENT POSITION

Three crocodile species naturally occur in the region: (a) the Estuarine or Saltwater Crocodile (*Crocodylus porosus*) ranges from the North East India to Northern Australia, whereas (b) the Marsh crocodile or Mugger (*Crocodylus palustris*) and (c) Gharial (*Gavialis gangeticus*) are limited to the Indian Sub-Continent only (Thorbjarnarson et al 1992, Webb & Manolis, 1998)

Some Gharials occur in the North West of Bangladesh, but the Sundarban is generally considered outside its ecological range due to the salinity. However, one not confirmed record has been reported. The marsh crocodile is extinct from the Sundarban already for decades but some individuals survive in the Khan Jahan Ali Majar pond near Bagerhat not far from the Sundarban (Rahman, 1990 & Sarker, 1997), and one specimen, originating from this locatiojn is presently found in Khulna Zoo.

Crocodile used to be abundant in the Sundarban in the past (Hussain and Acharya 1994, 1986 & 1982, Rahman et al 1986, Sarker, 1989, Whitaker 1978 & 1982). More recent estimates for the salt-water crocodile population in the Sundarban vary between 40 and 200 (Khan 1982, Hussain & Acharya 1994, Rahman 1990, Sarker 1986). All estimates are, however, based on assumptions and no extensive surveys have been conducted to cover the entire area.

As stated before, Marsh crocodile has been extinct from the Sundarban, but it appears that even the current Estuarine crocodile population is far below its historic level and potential. Comparable areas have a much higher density. In the Northern Australian mangroves and swamps for example 1 – 30 estuarine crocodiles per km of waterway are found. Hunter stories of 50 years ago or more suggest a very abundant crocodile population in those days in the Sundarban. Commercial hunting before 1970 was probably a main cause of the serious depletion of the crocodile populations. At present, Estuarine crocodile in Sundarban faces the following problems:

- The SRF is surrounded by a very densely populated area, therefore human pressure is one of the important threats for crocodiles. About 1.1 million local users reside seasonally in the area for harvesting of forest products and fishing.
- Fishermen very often kill juveniles because they dislike crocodiles. Generally they believe that crocodiles compete with them for fish, and that they are a threat to people.
- Larger crocodiles sometimes prey on juveniles and hatchlings.
- Nesting habitat is poorly known, but it is likely to be minimal because most of the area is frequently flooded with salt water during the wet season. It is also thought that little suitable nesting vegetation exists, but this needs to be confirmed.
- Predation on crocodile eggs by monitor lizards and wild boar is another threat.

3. LEGAL STATUS

All three crocodile species occurring in Bangladesh are listed in the third Schedule of the Bangladesh Wildlife Act (1974), implying their full protection by interdicting hunting, killing and capturing. All three species are also included for Bangladesh in the CITES Appendix I.

4. CONSERVATION PRIORITY

A rigorous conservation program for crocodiles is needed, to avoid extinction of these species in Bangladesh. The Sundarban Estuarine crocodile population is a critical situation and the Marsh crocodile has already been extinct from the Sundarban. The absence of significant population increase during the period from 1973 (ban on hunting) to at present has shown that the population in Sundarban has not the capacity to recover on its own and specific interventions are needed to achieve the management goals.

The Marsh crocodile is close to extinction in Bangladesh. It deserves to be addressed in this conservation plan, as some of the last appropriate habitat for this species is possibly available in the Northern Sundarban and reintroduction may be considered.

Gharial is not naturally occurring in the Sundarban (as far as officially confirmed), therefore it is outside the scope of this conservation plan.

5. GOAL AND OBJECTIVES

This conservation program is directed at the long-term conservation of crocodiles naturally occurring in the Sundarban and their habitats. Crocodile conservation in natural forest like in Sundarban will ultimately depend on the maintenance of suitable habitats in the face of competing forms of land use.

Goal

Aim of crocodile conservation in the Sundarban Forest is to protect these critically endangered species in their largest natural refuge in Bangladesh and to preserve the genetic resources as well as the sustainable use of crocodile as natural resources in perpetuity.

Objectives

- (a) Maintain viable populations of crocodiles and conserve its habitat by improved protection,
- (b) Ranching and restocking of estuarine crocodile in Sundarban to restore the natural population,
- (c) Feasibility study on the reintroduction of Marsh crocodile in Sundarban,

- (d) To contribute to the development of the sustainable utilization of crocodiles throughout the country;
- (e) To enhance public awareness in and around the Sundarban,
- (f) Improved understanding of population dynamics, distribution and breeding biology of crocodiles;
- (g) Capacity building of people involved in crocodile management.

5. CONSERVATION STRATEGIES

5.1 Protection

Protection measures for crocodile should target law enforcement related to the Wildlife Act. The key habitats should be identified to orient protection measures and illegal trade needs attention as well, where necessary with the assistance of the Fisheries Department and other relevant Government services.

Protection measures for estuarine crocodile should target fishing activities in the Sundarban, mainly by reinforcing the interdiction of fishing in Sanctuaries and by closing smaller canals for fishing in the production zone. Closure of fishing is particularly useful for nesting areas. These sites still need to be identified in Surveys (Deodatus, 2002).

5.2 Ranching & restocking

Ranching and restocking is a widely used strategy to realize crocodile population restoration. The main assumption behind crocodile population restoration by ranching and restocking is, that if populations are reduced below a certain low level by hunting and other causes (e.g. impact of fishing), the population does not have the reproductive capacity to recover on its own.

Crocodile ranching is a mode of captive rearing based on the collection of eggs, hatchlings or juveniles from the wild. In case of our Sundarban, the collection of hatchlings or some juveniles will be more feasible than that of eggs, because egg collection is (1) more difficult, (2) hence more costly, (3) careless transport will cause unnecessary mortality, and (4) disturbance of nests may have a significant detrimental impact on the wild population. By rearing the hatchlings in captivity, the natural mortality is reduced (no predation, no impact of fishing), which will allow a much higher number of offspring from each nest. By releasing the crocodiles after the most vulnerable period of their life has passed (after 3 – 4 years) this artificial reduction of mortality will result in an increase of the natural population.

After a certain number of years depending on the capacity of the ranching programme, the carrying capacity of the area and mortality factors, the restocking programme should be reduced or even stopped. The annual quota of juveniles to be collected should be fixed to be effective.

This method was fruitfully applied in Papua New Guinea, Zimbabwe, South Africa, India and other countries. Egg and hatchling collection from the wild are more efficient and cost effective in areas (a) where crocodylian densities are high, (b) where the habitat is accessible logistically, (c) where the species constructs an obvious mound nest, and (d) the population nests in a short pulse. Bangladesh is less favorable with regard to collection of both eggs and hatchlings, and hence it will be more costly (Webb & Hutton, 1990). Therefore, the development of captive breeding needs to be considered as well. When more experience has been acquired on nesting behaviour in the Sundarban, collection of eggs may be reconsidered.

A detailed plan has been made for the construction of a crocodile rearing station in the Karamjal Visitors Center of the Sundarban (Deodatus, 2001). A crocodile breeding program is also intended to start at the same place. Details for both activities are given in the Master plan for the visitor center and the establishment plan for the Crocodile rearing station. A key issue is the development of a financial mechanism to cover the operational cost using revenues from the visitors. Building experience in crocodile rearing for conservation would simultaneously, contribute to the development of commercial crocodile farming in Bangladesh in the future.

5.3 Feasibility study on reintroduction of marsh crocodile in Sundarban

Marsh crocodile has disappeared from the Sundarban (and most of Bangladesh) since several decades. Hunting and fishing are most probably the main causes of its local extinction. However, increasing salinity may have played a role as well. Only 5 Marsh crocodile (1 male, 3 female, 1 juvenile – March 2003) still survive near the Sundarban in the pond of Khan Jahan Ali Majar pond and they are protected by the guards (Kadem) of a historic mosque. The site has been declared UNESCO World Heritage Site. The ownership of these crocodiles has not been defined by the Government, but the generally it is accepted that they are under the control of the Kadem. Any type of activity with these crocodiles may conflict with religious sentiments of the Kadem and the local population. According to the local people some hatchlings may be found during rainy season in the small creeks close to the pond. However, a researcher from the Dhaka University (Sarker pers. com.) has concluded that the only male in the pond is sterile, as no more hatchlings were seen since several years.

The reintroduction of marsh crocodile can be taken into consideration after the restocking program of Estuarine crocodile has been taken off successfully and practical experience has been developed in the field of crocodile management. As priority should be given to reintroduction of indigenous species varieties, a reintroduction programme will probably depend on the results of a programme to assist the reproduction of the Bagarhat Marsh crocodile.

5.4 Promotion of sustainable use through captive breeding

Crocodiles vary greatly in their social behavior. Some species are communal nesters in the wild, and these usually breed well in captivity. Estuarine crocodile is a solitary nester in the wild, and they often show strong territoriality in captivity, even amongst females. They commonly perform poorly in captivity. However, all species of crocodylians have bred in captivity, and can perhaps be induced to do so on a commercial scale.

Captive breeding is essential if there are no wild crocodylians of commercial value, or if the wild resources are being utilized to their maximum extent. However, from a conservation point of view, ranching is the preferred mode of utilization where possible.

Captive breeding was commonly recommended on the grounds that it takes the pressure off wild populations, even in places where wild egg resources are abundant. Until recently, CITES regulations made breeding more attractive than ranching, even in countries with large wild crocodylian populations. But some crocodile specialists think that this approach is not quite right. Where adults are taken from the wild to stock farms for captive breeding, there may be significant negative effects on the conservation of the wild populations. This is specially so where adults occur in low densities. Captive breeding operations do not create direct incentives to protect wild populations and their habitats. Once a "closed farm" is operating, the conservation benefits may be minimal or non-existent. Ranching, on the other hand, links the commercial viability of a farming operation directly to the maintenance of wild populations, and in many farms today, captive breeding and ranching go hand in hand (Webb *et.al.* 1990).

Stock of captive breeding can be obtained either from the wild as adults or juveniles, or through breeding stock. Wild caught adults should be housed in pens, which provide the appropriate environmental conditions for that particular species. The adult Estuarine crocodiles need lots of space, or be in enclosures in pairs, and appear to do well with shallow and even fluctuating water levels (Halder, 2002). All trade of captive breeding operations involving species in Appendix I and II of CITES, are subject to a number of CITES Resolutions, and must be registered with the CITES Secretariat.

The promotion of sustainable use of crocodiles should be preceded by the development of experience with the ranching and restocking programme and the restoration of the natural population resulting from the same programme, outlined in section 5.2. Therefore, it is recommended to delay the development of commercial use until both experience and a healthy natural population have been achieved.

5.5 Public awareness

The main targets of public awareness campaigns should be fishermen, illegal hunters, traders and law enforcers (e.g. FD, police, customs). The main issues to be dispersed are:

- the ecological importance of crocodiles,
- the economic potential,
- the legislation related to crocodiles.

In a second stage public awareness should target also policy makers and the private sector, to gain support for commercial ranching.

5.6 Research and surveys

Crocodile surveys throughout the Sundarban should be carried out to investigate population structure, population size, nesting habitat, abundance and distribution. The result of these surveys are required to determine (a) population trends & dynamics, (b) appropriate type of capturing, (c) the best sites for collection, and (d) quota for hatchlings collection, (e) mortality related to fishing.

Spotlight counts are the most commonly used survey method. This method has been successfully applied so far in the Sundarban East Sanctuary and the Jongra Khal. Day-time surveys during the cold season of basking adults and sighting records would provide valuable additional information.

Research on Marsh crocodile at Khanjahan Ali Majar Pond should focus on habitat quality for nesting, breeding success and mortality factors.

6. PROPOSED ACTIONS

6.1 Protection

Crocodile protection will be included in the sectorial management plans of the Sundarban (particularly the Fisheries and Wildlife Plans), which implementation should be respected, as well as the enforcement of the Wildlife Act. All field officers involved need to be instructed in that regard. As a result of studies on nesting areas (section 6.6), other khals may be closed for fishing in a later stage.

6.2 Ranching and restocking of Estuarine crocodile

A population restocking programme will be implemented to boost the recovery of the depleted estuarine crocodile population. This programme will be based on the Karamjal Crocodile rearing Station, which has the capacity to restock annually app. 32 subadult crocodiles into the Sundarban, being a significant addition to the natural population. Reared crocodiles will be released until the wild population has increased to a level that will be determined in the population study described in section 6.6.

6.3 Operation of the Karamjal Crocodile Rearing Station

To avoid conflicts causing stress and injuries it is essential to separate different age/size classes. Therefore, 3 different sized and shaped pens are constructed, each responding as much as possible to the requirements of three consecutive age/size classes (Table 1). Usually, the farm population is subdivided in the following age/size classes:

- (1) hatchlings, 0-1 year, 20-70 cm,
- (2) yearlings, 1-2 year, 70-120 cm,
- (3) large rearing stock, 2-3 year, 100-180 cm,

The rearing stock will be alternately kept in 2 pens that are established side by side and connected by a small door to allow shifting of crocodiles without having to lift them by hand. Regular shift (every 2-10 days) is needed for changing water, cleaning and drying of pens. As a result, only half of the pens is normally in use by the crocodiles. In the proposed set up it is possible to include a third pen in the cleaning cycle for yearlings and hatchling, to adjust the capacity if necessary. As hatchlings are easier disturbed than older crocodiles, the visitors should be kept away from the hatchling pens

The water in the crocodile pens gets dirty after a while due to food remains and feces. Dirty basins may cause diseases in crocodiles. Therefore, the water needs to be changed and the basins need to be cleaned regularly. Depending on the number of crocs in a basin and type of food given the periods between cleaning vary from a 2 to 10 days. Each basin is supplied with a discharge pipe (diameter 10-15 cm) and valve to drain the water. Water discharge will be realized through a tube/ditch system in connection with the Khal. Inspection chambers are positioned at junctions to clear away eventual clogging. After draining, the pens can be cleaned with a brush and sun dried for a few days to sterilize the surface. Then basins are filled with water from the nearby Khal using a diesel irrigation pump.

Hatchlings and yearlings feed on insects, shrimp and small crabs, but also small fish and minced/chopped meat may be used as food. Larger crocs need more fish and meat/chicken. The food supply should be proportional to the expected increase of body size (Table 2). The estimated cost of food supply is approximated by using the market price of cheap fish. Chopped chicken is another option. Crocodiles need a high calcium diet and a high fat contents should be avoided. Meat, fish, chickens and crustaceans should always be offered including the bones, feathers, shells and skeletons. Total cost to cover annual food requirements is estimated 2.3 Lakh , if purchases on the market.

Operational costs could be kept low by using tourist revenues to cover the expenses and/or by the use of confiscated catch from boats found fishing in the Sanctuaries. Other possible cheap sources of food are excess (or ill) deer from the visitor centre and/or by integrating a fish pond in the Visitor Center supplied with vegetal organic waste. It is essential to start with a structural funding mechanism from the beginning, not depending on external sources.

Table 1. Dimensions of pens for different crocodile age classes, making use of existing structures in Karamjal

Croc age (year)	Croc size (m)	pens (m x m)	Water depth (cm)	Pen size (m ²)	Wall height (m)	crocs/m ²	maximum #croc/pen	Number of pens
0 - 1	0.2 - 0.7	2.5 x 5	30	12.5	0.8	4.0	50	4
1-2	0.7- 1.2	5 x 5	60	25.0	1.2	1.6	40	4
2-3	1.2 - 1.8	10 x 12	60	120.0	1.3	0.4	50	2

Table 2. Annual food requirements and mortality of the rearing centre population, assuming a starting stock of 40 hatchlings, using market price of fish (Tk 80) for the estimation of costs

Croc age (year)	Croc size (m)	Starting weight (kg)	Final weight (kg)	Mortality (%)	Stock number	Food (kg/croc)	Food (kg/year)	Food (Tk/year)	Food (US\$/year)
0 - 1	0.2 - 0.7	0.072	1.000	10	40	4	169	13,498	270
1 - 2	0.7- 1.2	1.000	5.000	5	36	18	655	52,364	1,047
2 - 3	1.2 - 1.8	5.000	18.000	5	34	59	2,021	161,673	3,233
Released					32				
Total							2,844	227,535	4,551

6.4 Assistance to the reproduction of the Bagarhat Marsh crocodile

Steps involved in the assistance to the reproduction of the Bagarat Marsh crocodile:

- Using the animals of Khan Jahan Ali Mazar at Bagerhat for expanding the population is only possible if a rearing programme would be locally carried out by the Kadem themselves, with support from FD technical staff.
- The cause should be identified why no more hatchlings are seen in the Sundarban. If nests are made by females (which is confirmed by the Kadem), eggs have to be collected, tested for fertility, and placed in an incubator. For this purpose a simple incubator has to be developed, if possible using solar power, to reduce operational cost.
- If eggs appear not to be fertile, artificial insemination could be considered with semen from Indian males. As far as we know, no experience exists with this technique applied to crocodiles.
- If insemination is found not to be feasible, new breeding stock (particularly males) could be obtained by importing breeding adults from the Madras Crocodile Bank, India if allowed by CITES.
- A strategy has to be developed to bring foreign males and local females together for mating, avoiding disturbance of social crocodile life in the pond.

- Hatchlings should be moved from the incubator to a small rearing unit established locally, with sufficient capacity to rear 20 – 30 hatchlings. Access stock could be moved to Karamjal if the Kadem allow (section 6.3).
- Crocodiles can be released in the pond after 3 years. Over population of the pond needs to be avoided.

6.5 Reintroduction of Marsh crocodile in the Sundarban

Based on experience with rearing and restocking of Estuarine crocodiles and the results of studies carried out under 6.7, a Marsh crocodile restoration plan will be drafted and implemented. The reintroduction of marsh crocodile in Sundarban would encompass the following steps:

- Literature review on habitat requirements of marsh crocodile and a study tour to the Madras Crocodile Bank would provide appropriate experience for the implementation of the programme,
- A study is required for the analysis of risks and impacts.
- A consultative workshop needs be organized to orient the formulation and planning of the programme.
- Breeding stock of maximum Bangladeshi origin should be used (Bagarhat, Khulna Zoo), if necessary, supplemented stock from India, preferably West Bengal.
- The Karamjal rearing station could be used for breeding and raising hatchlings

In the Northern Sundarban, at the end of the Andaria Khal in the middle of the forest there is an old fishing pond (over 100 years old). The area is characterized by large bheels (vast open areas with Phragmites, Cyperus, and open water), which have relatively more fresh water. This area may be appropriate to start reintroduction.

6.6 Promotion of sustainable use

No actions have to be taken within 5 years, until sufficient experience has been obtained and until Sundarban crocodile population has increased significantly.

6.7 Public awareness

Yearly campaigns need to be organized to reach fishermen, illegal hunters, traders and law enforcers (e.g. FD, police, customs) to explain the need of crocodile conservation and its implementation in relation to their respective responsibilities and activities. People awareness can be realized by the following approaches:

- Seminar, workshop, meetings
- Leaflets, posters,
- Documentary film ,

- Publishing through newspaper, television and radio,
- Field visits for direct contact with target groups.

6.8 Research and surveys

Determination of population structure, population dynamics and distribution

Potential khals throughout the Sundarban will be surveyed by the spotlight method to know overall population structure, population dynamics and distribution in relation to habitat of the Estuarine Crocodile population.

Identification of nesting habitat

Nesting habitat of Estuarine crocodile in Sundarban Reserved Forest is poorly known. Surveys need to be carried out to locate the nesting areas and to recommend how these nests are adversely affected, and what types of protection would improve conservation.

Habitat study

A study on habitat requirements of Marsh crocodile will be implemented, based on a desk study on the habits of Marsh crocodile and a field inventory, using GIS, to determine potential habitat.

Study on the impact of fishing

A study should be carried out during fishing season to find out the intensity of hatchlings mortality in their nets. Interviews may be conducted to investigate the attitude of fishermen towards crocodiles and how mortality in this context could be minimized.

Research on predator- prey relationship

The combination of fish stock data, crocodile surveys and feeding habits of crocs (through for example stomach analysis), would allow better understanding of the role of crocodile in the Sundarban ecosystem, particularly in relation to the aquatic resources.

6.7 Capacity building

Capacity building in Crocodile management and research should be emphasized in HRD programmes. At present FD lacks sufficient experience in this particular subject matter. A training of one month for two staff members has been completed in Australia. It is recommended to

organize a visit to the Madras Crocodile Bank and participation to international crocodile conferences in the future (particularly SSC Crocodile Specialist meetings).

7. MONITORING

The principal purpose of monitoring the wild population is to provide an objective means through which any serious general decline, due to any cause, can be detected in sufficient time in order to take mitigating actions. In addition, they allow trend analysis of population size and structure to be quantified and assessed (Parks and Wildlife Commission, 1996).

Spotlight counts over selected river canals in Sundarban will be the standard methods of monitoring Estuarine Crocodile as it provides more detailed information, including population size structure. Spotlight counts for Estuarine Crocodile within selected rivers in the Sundarban will continue until an elaborated monitoring program has been developed. During its implementation, the methodology of the monitoring program will be reviewed and further refined.

Specifically, both the collection of hatchlings and the effect of restocking, needs to be focused by the monitoring system. Marking released crocs and regular capturing are therefore important additional methods for the monitoring programme. Of course an eventual reintroduction programme of Marsh Crocodile would require an adequate monitoring system.

8. REPORTING

Information contained in the various reports and records required under this conservation program will be summarized into an annual report, along with an assessment of the wild population monitoring results, and provided to Ministry of Environment and Forest.

9. PLANNING

Below a work schedule is presented of all proposed activities.

Objective	Activities	Time	Number of (field) trips
Protection	<ul style="list-style-type: none"> ▪ surveillance ▪ review of protection system 	<ul style="list-style-type: none"> ▪ continues 	-
Ranching and restocking of Estuarine crocodile	<ul style="list-style-type: none"> ▪ collection of hatchlings ▪ breeding programme ▪ operation of rearing station 	<ul style="list-style-type: none"> ▪ ongoing, until required population level has been reached 	2 – 4 x 5 days a year for hatchling collection
Reproduction Bagarhat Marsh crocodile	<ul style="list-style-type: none"> ▪ establishing incubation and rearing facilities ▪ rearing 	<ul style="list-style-type: none"> ▪ 2003 – to be determined by monitoring 	every 2 month backstopping
Feasibility study on the reintroduction of Marsh crocodile	<ul style="list-style-type: none"> ▪ desk study ▪ GIS of suitable habitat 	<ul style="list-style-type: none"> ▪ 2003 -2004 	2 x 5 days for ground thruthing
Development of sustainable use	<ul style="list-style-type: none"> ▪ no activities planned yet 	<ul style="list-style-type: none"> ▪ after 5 years 	
Public awareness	<ul style="list-style-type: none"> ▪ action plan to be developed 	<ul style="list-style-type: none"> ▪ ongoing 	to be determined
Research & surveys	<ul style="list-style-type: none"> ▪ Crocodile population surveys covering entire Sundarban 	<ul style="list-style-type: none"> ▪ 2 – 4 month – survey plan to be worked out 	to be determined
	<ul style="list-style-type: none"> ▪ monitoring using spotlight 	<ul style="list-style-type: none"> ▪ annually 	4 x 5 days in Sanctuaries
	<ul style="list-style-type: none"> ▪ Study on nesting habitat and breeding biology in Sundarban 	<ul style="list-style-type: none"> ▪ from April to October, yearly from 2003 to 2005 	to be combined with collection of hatchlings
	<ul style="list-style-type: none"> ▪ Survey on mortality due to fishing 	<ul style="list-style-type: none"> ▪ from 2003 to 2005 	data collection by ARD
	<ul style="list-style-type: none"> ▪ Research on predator-prey relationship in Sundarban by examination of stomach contents ▪ desk study comparing fish stock statistics and crocodile population food requirements 	<ul style="list-style-type: none"> ▪ feasibility should be checked first ▪ after crocodile survey 	
Capacity building	<ul style="list-style-type: none"> ▪ visit to Madras Crocodile Bank ▪ participation to crocodile conference ▪ exchange with zoos and universities 	<ul style="list-style-type: none"> ▪ From 2003 to 2005 	to be determined

10. REQUIRED FUNDING (FOR 3 YEARS)

Indicative budgets are worked out for a number of activities described in the sections above. As most of these activities need to be worked out in detail later, budgets need further elaboration as well. Moreover, funding sources have to be identified. SBCP will cover the crocodile surveys from its wildlife studies budget. The other activities should be covered by GoB funds, the SBCP loan and other sources. Other donors have to be approached to assess their interest (SSC/CSG, USAID, UNESCO, UNDP) GoB should give priority to cover operational costs of the rearing station, to ensure sustainability of this facility. Every year budgets need to be adjusted for inflation (>5%).

Table 3. *Estimated budget for capturing of Adults and hatchlings from the Sundarban for 3 years*

Resources		Unit cost	Unit	Cost (Tk.)
Trawler hire with fuel		1,000	1 X 60 (20 days for 3 years)	60,000
Speed boat for quick take off from the wild	a. Petrol	a. 30	3840 (8 hrs X 20 lit X 24 days)	115,200
	b. Mobil	b. 550	20 cans (1 can/ 200 lit)	11,000
Spotlight 250W		5,000	1	5,000
Battery 12V		8,000	1	8,000
Solar panel		30,000	1	30,000
Rope		5.00	3000 yards	15,000
Plastic Roller		200	4	800
Plastic tape		50	50	2,500
Harpoon		1000	4	4,000
Contingencies (5%)				12,565
Total				263,865

Table 4. Estimated budget for incubation of Eggs

Resources	Unit cost	Unit	Cost (Tk.)
Incubator (local made)	to be determined	1	
Incubation room	available	1	
Thermo regulated heating system (possibly solar)	to be determined		-
Thermometer	500	10	5,000
Hygrometer	5,000	1	5,000
Contingencies (5%)	to be determined		
Total Cost	to be determined		

Table 5. Budget for food supply for the crocodile rearing station for five years

	Years :	Tk / year of operation				
		1	2	3	4	5
Food for rearing		14,848	72,448	250,288	250,288	250,288
Fuel		783	3,681	19,838	19,838	19,838
Personnel		p.m.	p.m.	p.m.	p.m.	p.m.
Maintenance construction		20,000	40,000	58,000	58,000	58,000
Maintenance equipment		800	1,600	1,600	1,600	1,600
Contingencies		1,822	5,886	16,486	16,486	16,486
TOTAL		38,253	123,615	346,212	346,212	346,212

Table 6. Budget for equipping Crocodile rearing station at Karamjal

Resources	Unit cost	Unit	Cost (Tk.)
Freezer	30,000	2	60,000
Meat mincer	10,000	1	10,000
Pen cleaning equipment	5,000	-----	5,000
Cool box	5,000	2	10,000
Medicine for treatment	5,000	3 yrs	15,000
Scale	4,000	1	4,000
Biological box	400	1	400
Miscellaneous tools	10,000	-----	10,000
Contingencies (5%)			5,720
Total cost			120,120

Table 7. Budget for research, surveys and public awareness

Activity	Resources	Unit cost	Unit	Cost (Tk.)
Crocodile survey	Trawler hire with fuel (4)	1000	4 X 30 days	120,000
	Crew hire (2X4)	150	8 X 30 days	36,000
	Spotlight (250W)	5000	3	15,000
	Battery (12V)	8,000	3	24,000
	Solar panel	25,000	3	75,000
	Note books and stationary	-----	-----	4,000
	Batteries	70	100	7,000
	GPS, Maps, Measuring tape etc.	-----	Available	
	Food and Water	100	24 X 30 days	72,000
	First Aid	500	4 trips	2,000
sub total				355,000
Survey on fishermen in Sundarban	Trawler with fuel	1000	1 X 15 days	15,000
	Data sheet, Pencils, eraser etc.	-----	-----	3,000
	Food and Water	100	4 X 15 days	6,000
	First Aid	500	3 trips	1,500
subtotal				25,500
Study on predator-prey relationship	Trawler with fuel	1000	1 X 10 days	10,000
	Data sheet, Pencils, Eraser etc.	-----	-----	3,000
	Food and Water	100	4 X 10 days	4,000
	First Aid	500	3 trips	1,500
subtotal				18,500
Motivation and public awareness	Posters	30	2000	60,000
	Video (30 min)	200,000	1	200,000
	Handouts	5	4000	20,000
	Campaign	5,000	30	150,000
subtotal				430,000
Reintroduction of Marsh Crocodile	Feasibility study	-----	-----	150,000
	Acquiring of crocs			200,000
	Breeding (5 yrs)	13,000	x 5 year	65,000
	Rearing	120,000	x 5 year	600,000
subtotal				1,015,000
Contingencies	(5%)			92,200
Total				1,936,200

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APPENDIX 1. IUCN/SSC GUIDELINES FOR RE-INTRODUCTIONS

Prepared by the SSC Re-introduction Specialist Group *

Approved by the 41st Meeting of the IUCN Council, Gland Switzerland, May 1995

INTRODUCTION

These policy guidelines have been drafted by the Re-introduction Specialist Group of the IUCN's Species Survival Commission (1), in response to the increasing occurrence of re-introduction projects worldwide, and consequently, to the growing need for specific policy guidelines to help ensure that the re-introductions achieve their intended conservation benefit, and do not cause adverse side-effects of greater impact. Although IUCN developed a Position Statement on the Translocation of Living Organisms in 1987, more detailed guidelines were felt to be essential in providing more comprehensive coverage of the various factors involved in re-introduction exercises.

These guidelines are intended to act as a guide for procedures useful to re-introduction programmes and do not represent an inflexible code of conduct. Many of the points are more relevant to re-introductions using captive-bred individuals than to translocations of wild species. Others are especially relevant to globally endangered species with limited numbers of founders. Each re-introduction proposal should be rigorously reviewed on its individual merits. It should be noted that re-introduction is always a very lengthy, complex and expensive process.

Re-introductions or translocations of species for short-term, sporting or commercial purposes - where there is no intention to establish a viable population - are a different issue and beyond the scope of these guidelines. These include fishing and hunting activities.

This document has been written to encompass the full range of plant and animal taxa and is therefore general. It will be regularly revised. Handbooks for re-introducing individual groups of animals and plants will be developed in future.

CONTEXT

The increasing number of re-introductions and translocations led to the establishment of the IUCN/SSC Species Survival Commission's Re-introduction Specialist Group. A priority of the Group has been to update IUCN's 1987 Position Statement on the Translocation of Living Organisms, in consultation with IUCN's other commissions.

It is important that the Guidelines are implemented in the context of IUCN's broader policies pertaining to biodiversity conservation and sustainable management of natural resources. The philosophy for environmental conservation and management of IUCN and other conservation bodies is stated in key documents such as "Caring for the Earth" and "Global Biodiversity Strategy" which cover the broad themes of the need for approaches with community involvement and participation in sustainable natural resource conservation, an overall enhanced quality of human life and the need to conserve and, where necessary, restore ecosystems. With regards to the latter, the re-introduction of a species is one specific instance of restoration where, in general, only this species is missing. Full restoration of an array of plant and animal species has rarely been tried to date.

Restoration of single species of plants and animals is becoming more frequent around the world. Some succeed, many fail. As this form of ecological management is increasingly common, it is a priority for the Species Survival Commission's Re-introduction Specialist Group to develop guidelines so that re-introductions are both justifiable and likely to succeed, and that the conservation world can learn from each initiative, whether successful or not. It is hoped that these Guidelines, based on extensive review of case - histories and wide consultation across a range of disciplines will introduce more rigour into the concepts, design, feasibility and implementation of re-introductions despite the wide diversity of species and conditions involved.

Thus the priority has been to develop guidelines that are of direct, practical assistance to those planning, approving or carrying out re-introductions. The primary audience of these guidelines is, therefore, the practitioners (usually managers or scientists), rather than decision makers in governments. Guidelines directed towards the latter group would inevitably have to go into greater depth on legal and policy issues.

1. DEFINITION OF TERMS

"Re-introduction": an attempt to establish a species(2) in an area which was once part of its historical range, but from which it has been extirpated or become extinct (3) ("Re-establishment" is a synonym, but implies that the re-introduction has been successful).

"Translocation": deliberate and mediated movement of wild individuals or populations from one part of their range to another.

"Re-enforcement/Supplementation": addition of individuals to an existing population of conspecifics.

"Conservation/Benign Introductions": an attempt to establish a species, for the purpose of conservation, outside its recorded distribution but within an appropriate habitat and eco-geographical area. This is a feasible conservation tool only when there is no remaining area left within a species' historic range.

2. AIMS AND OBJECTIVES OF RE-INTRODUCTION

a. Aims:

The principle aim of any re-introduction should be to establish a viable, free-ranging population in the wild, of a species, subspecies or race, which has become globally or locally extinct, or extirpated, in the wild. It should be re-introduced within the species' former natural habitat and range and should require minimal long-term management.

b. Objectives:

The objectives of a re-introduction may include: to enhance the long-term survival of a species; to re-establish a keystone species (in the ecological or cultural sense) in an ecosystem; to maintain and/or restore natural biodiversity; to provide long-term economic benefits to the local and/or national economy; to promote conservation awareness; or a combination of these.

3. MULTIDISCIPLINARY APPROACH

A re-introduction requires a multidisciplinary approach involving a team of persons drawn from a variety of backgrounds. As well as government personnel, they may include persons from governmental natural resource management agencies; non-governmental organisations; funding bodies; universities; veterinary institutions; zoos (and private animal breeders) and/or botanic gardens, with a full range of suitable expertise. Team leaders should be responsible for coordination between the various bodies and provision should be made for publicity and public education about the project.

4. PRE-PROJECT ACTIVITIES

4a. BIOLOGICAL

(i) Feasibility study and background research

An assessment should be made of the taxonomic status of individuals to be re-introduced. They should preferably be of the same subspecies or race as those which were extirpated, unless adequate numbers are not available. An investigation of historical information about the loss and fate of individuals from the re-introduction area, as well as molecular genetic studies, should be undertaken in case of doubt as to individuals' taxonomic status. A study of genetic variation within and between populations of this and related taxa can also be helpful. Special care is needed when the population has long been extinct.

Detailed studies should be made of the status and biology of wild populations (if they exist) to determine the species' critical needs. For animals, this would include descriptions of habitat preferences, intraspecific variation and adaptations to local ecological conditions, social behaviour, group composition, home range size, shelter and food requirements, foraging and feeding behaviour, predators and diseases. For migratory species, studies should include the potential migratory areas. For plants, it would include biotic and abiotic habitat requirements, dispersal mechanisms, reproductive biology, symbiotic relationships (e.g. with mycorrhizae, pollinators), insect pests and diseases. Overall, a firm knowledge of the natural history of the species in question is crucial to the entire re-introduction scheme.

The species, if any, that has filled the void created by the loss of the species concerned, should be determined: an understanding of the effect the re-introduced species will have on the ecosystem is important for ascertaining the success of the re-introduced population. The build-up of the released population should be modelled under various sets of conditions, in order to specify the optimal number and composition of individuals to be released per year and the numbers of years necessary to promote establishment of a viable population.

A Population and Habitat Viability Analysis will aid in identifying significant environmental and population variables and assessing their potential interactions, which would guide long-term population management.

(ii) Previous Re-introductions

Thorough research into previous re-introductions of the same or similar species and wide-ranging contacts with persons having relevant expertise should be conducted prior to and while developing re-introduction protocol.

(iii) Choice of release site and type

Site should be within the historic range of the species. For an initial re-inforcement there should be few remnant wild individuals. For a re-introduction, there should be no remnant population to prevent disease spread, social disruption and introduction of alien genes. In some circumstances, a re-introduction or re-inforcement may have to be made into an area which is fenced or otherwise delimited, but it should be within the species' former natural habitat and range.

A conservation benign introduction should be undertaken only as a last resort when no opportunities for re-introduction into the original site or range exist and only when a significant contribution to the conservation of the species will result.

The re-introduction area should have assured, long-term protection (whether formal or otherwise).

(iv) Evaluation of re-introduction site

Availability of suitable habitat: re-introductions should only take place where the habitat and landscape requirements of the species are satisfied, and likely to be sustained for the foreseeable future. The possibility of natural habitat change since extirpation must be considered. Likewise, a change in the legal/ political or cultural environment since species extirpation needs to be ascertained and evaluated as a possible constraint. The area should have sufficient carrying capacity to sustain growth of the re-introduced population and support a viable (self-sustaining) population in the long run.

Identification and elimination, or reduction to a sufficient level, of previous causes of decline: could include disease; over-hunting; over-collection; pollution; poisoning; competition with or predation by introduced species; habitat loss; adverse effects of earlier research or management programmes; competition with domestic livestock, which may be seasonal. Where the release site has undergone substantial degradation caused by human activity, a habitat restoration programme should be initiated before the re-introduction is carried out.

(v) Availability of suitable release stock

It is desirable that source animals come from wild populations. If there is a choice of wild populations to supply founder stock for translocation, the source population should ideally be closely related genetically to the original native stock and show similar ecological characteristics (morphology, physiology, behaviour, habitat preference) to the original sub-population.

Removal of individuals for re-introduction must not endanger the captive stock population or the wild source population. Stock must be guaranteed available on a regular and predictable basis, meeting specifications of the project protocol.

Individuals should only be removed from a wild population after the effects of translocation on the donor population have been assessed, and after it is guaranteed that these effects will not be negative.

If captive or artificially propagated stock is to be used, it must be from a population which has been soundly managed both demographically and genetically, according to the principles of contemporary conservation biology.

Re-introductions should not be carried out merely because captive stocks exist, nor solely as a means of disposing of surplus stock.

Prospective release stock, including stock that is a gift between governments, must be subjected to a thorough veterinary screening process before shipment from original source. Any animals found to be infected or which test positive for non-endemic or contagious pathogens with a potential impact on population levels, must be removed from the consignment, and the uninfected, negative remainder must be placed in strict quarantine for a suitable period before retest. If clear after retesting, the animals may be placed for shipment.

Since infection with serious disease can be acquired during shipment, especially if this is intercontinental, great care must be taken to minimize this risk.

Stock must meet all health regulations prescribed by the veterinary authorities of the recipient country and adequate provisions must be made for quarantine if necessary.

(vi) Release of captive stock

Most species of mammal and birds rely heavily on individual experience and learning as juveniles for their survival; they should be given the opportunity to acquire the necessary information to enable survival in the wild, through training in their captive environment; a captive bred individual's probability of survival should approximate that of a wild counterpart.

Care should be taken to ensure that potentially dangerous captive bred animals (such as large carnivores or primates) are not so confident in the presence of humans that they might be a danger to local inhabitants and/or their livestock.

4b. SOCIO-ECONOMIC AND LEGAL REQUIREMENTS

Re-introductions are generally long-term projects that require the commitment of long-term financial and political support.

Socio-economic studies should be made to assess impacts, costs and benefits of the re-introduction programme to local human populations.

A thorough assessment of attitudes of local people to the proposed project is necessary to ensure long term protection of the re-introduced population, especially if the cause of species' decline was due to human factors (e.g. over-hunting, over-collection, loss or alteration of habitat). The programme should be fully understood, accepted and supported by local communities.

Where the security of the re-introduced population is at risk from human activities, measures should be taken to minimise these in the re-introduction area. If these measures are inadequate, the re-introduction should be abandoned or alternative release areas sought.

The policy of the country to re-introductions and to the species concerned should be assessed. This might include checking existing provincial, national and international legislation and regulations, and provision of new measures and required permits as necessary.

Re-introduction must take place with the full permission and involvement of all relevant government agencies of the recipient or host country. This is particularly important in re-introductions in border areas, or involving more than one state or when a re-introduced population can expand into other states, provinces or territories.

If the species poses potential risk to life or property, these risks should be minimised and adequate provision made for compensation where necessary; where all other solutions fail, removal or destruction of the

released individual should be considered. In the case of migratory/mobile species, provisions should be made for crossing of international/state boundaries.

5. PLANNING, PREPARATION AND RELEASE STAGES

Approval of relevant government agencies and land owners, and coordination with national and international conservation organizations.

Construction of a multidisciplinary team with access to expert technical advice for all phases of the programme.

Identification of short- and long-term success indicators and prediction of programme duration, in context of agreed aims and objectives.

Securing adequate funding for all programme phases.

Design of pre- and post- release monitoring programme so that each re-introduction is a carefully designed experiment, with the capability to test methodology with scientifically collected data. Monitoring the health of individuals, as well as the survival, is important; intervention may be necessary if the situation proves unforeseeably favourable.

Appropriate health and genetic screening of release stock, including stock that is a gift between governments. Health screening of closely related species in the re-introduction area. If release stock is wild-caught, care must be taken to ensure that: a) the stock is free from infectious or contagious pathogens and parasites before shipment and b) the stock will not be exposed to vectors of disease agents which may be present at the release site (and absent at the source site) and to which it may have no acquired immunity.

If vaccination prior to release, against local endemic or epidemic diseases of wild stock or domestic livestock at the release site, is deemed appropriate, this must be carried out during the "Preparation Stage" so as to allow sufficient time for the development of the required immunity.

Appropriate veterinary or horticultural measures as required to ensure health of released stock throughout the programme. This is to include adequate quarantine arrangements, especially where founder stock travels far or crosses international boundaries to the release site.

Development of transport plans for delivery of stock to the country and site of re-introduction, with special emphasis on ways to minimize stress on the individuals during transport. Determination of release strategy (acclimatization of release stock to release area; behavioural training - including hunting and feeding; group composition, number, release patterns and techniques; timing).

Establishment of policies on interventions (see below).

Development of conservation education for long-term support; professional training of individuals involved in the long-term programme; public relations through the mass media and in local community; involvement where possible of local people in the programme.

The welfare of animals for release is of paramount concern through all these stages.

6. POST-RELEASE ACTIVITIES

Post release monitoring is required of all (or sample of) individuals. This most vital aspect may be by direct (e.g. tagging, telemetry) or indirect (e.g. spoor, informants) methods as suitable.

Demographic, ecological and behavioural studies of released stock must be undertaken.

Study of processes of long-term adaptation by individuals and the population.

Collection and investigation of mortalities.

Interventions (e.g. supplemental feeding; veterinary aid; horticultural aid) when necessary.

Decisions for revision, rescheduling, or discontinuation of programme where necessary.

Habitat protection or restoration to continue where necessary.

Continuing public relations activities, including education and mass media coverage.

Evaluation of cost-effectiveness and success of re- introduction techniques.

Regular publications in scientific and popular literature.

Footnotes:

1 Guidelines for determining procedures for disposal of species confiscated in trade are being developed separately by IUCN.

2 The taxonomic unit referred to throughout the document is species; it may be a lower taxonomic unit (e.g. subspecies or race) as long as it can be unambiguously defined.

3 A taxon is extinct when there is no reasonable doubt that the last individual has died