



Reintroduction of the Mugger Crocodile, *Crocodylus palustris*, in India

Christina Jacobson

Introduction

Endangered species management has become an important issue for many countries as animals and their habitats become increasingly threatened. Many international agencies and individual countries have become interested in restoring populations of endangered animals. The International Union for the Conservation of Nature and Natural Resources (IUCN) placed the Mugger Crocodile, *Crocodylus palustris*, in their Red Data Book for endangered species in 1972. In response to this listing, the government of India, along with the United Nations Food and Agriculture Organization (FAO), and United Nations Department of Agriculture (UNDP) undertook a program towards restoring the mugger to its native Indian habitat. Thus far the program has been very successful in restoring numbers of the Mugger through captive breeding, rearing, and releasing. However, they still have much work to do to ensure the program's continued success. This paper will review the restoration project for the mugger crocodile, and will encompass technique, implementation, and evaluation as well as a critique of the project's success.



Mugger crocodile

Background

The mugger crocodile is widely distributed throughout Asia. Its range extends through Bangladesh, Iran, India, Nepal, Pakistan, and Sri Lanka. At one time, the mugger was found in most lowland systems in India. It is an adaptive species that can survive in a wide range of habitats. Hunters and travelers in India during the late 1800s and early 1900s reported that the mugger was very common (Whitaker, 1987). Crocodiles throughout the world are primarily found in wetland habitats. *C. palustris* is primarily found in freshwater lakes, marshes and rivers, or any other area that is slow moving and shallow. However, because they appear to adapt easily to new environments, they have also been found in reservoirs, irrigation canals, and other human-made freshwater bodies (Whitaker and Whitaker, 1989).



The range of mugger crocodiles.

Mugger crocodiles have several features that differentiate them from other crocodiles. They have the broadest snout of any member of their genus. They generally reach maturity between 1.7 and 2.6 meters between the ages of six years to ten years (Whitaker and Whitaker, 1989). Like other crocodylians, this species is known to dig burrows and nest in holes. Females generally lay on average of twenty five to thirty eggs once a year. The muggers diet varies depending on age. Juveniles eat insects, crustaceans and small fish. Adults primarily eat reptiles, amphibians, fish, birds, and small mammals, such as monkeys (Britton, 1995).

The mugger crocodile greatly decreased in number until the early 1970s. Killing of the species for skins was the primary cause of their decline in India (Whitaker, 1987). It was most vulnerable to this during years of drought when hunters could track and kill the animals more easily. Habitat destruction and alteration was another primary cause of species loss. Many dam construction projects that occurred during the 1900s to the 1950s destroyed habitat by removing areas of deep water that provided good cover. Timber operations also destroyed habitat during this same time, by damaging forest ponds and rivers. Egg collection, hunting of crocodiles for meat and medicine, and death from fishing nets also have contributed to their decline (Britton, 1995).

Throughout the 1960s, surveys indicated that numbers of the mugger crocodile were on a swift decline. However, conservation and restoration did not begin in earnest until 1972, when three crocodile species, including the mugger, the saltwater crocodile, *Crocodylus porosus*, and the Gharial, *Gavialis gangeticus*, were placed in IUCN's Red Data Book. Also during this year, the mugger was included in the schedule for the Indian Wildlife Protection Act of 1972 (Choudhury and Chowdhury, 1986). This act provided for greater protection of habitat.

Program Description

In 1975, the Indian Government initiated a large-scale species restoration and reintroduction project with help from the United Nations FAO and UNDP. This project concentrated on the legal protection of wild populations and breeding captives for the purpose of releasing them into protected areas. The Crocodile Conservation project focuses on restoration of crocodiles, including *C. palustris*. Restoration of the mugger has centered on captive breeding, rearing, and reintroduction into native protected habitat through the CCP. The main objectives of this project were as follows:

- To update the species status through surveys,
- To identify habitat that would be suitable for restoration,
- To identify the causes of wild decline and eliminate them,
- To collect wild eggs,

- To reintroduce the crocodiles,
- To carry out research and use the findings for management in the future, and
- To estimate captive breeding units.

The Crocodile Specialist Group (CSG) has also played a large role in the restoration of the mugger crocodile. CSG is a worldwide network including people from science, government and non-governmental organizations. The group operates as part of the Species Survival Commission (SSC) of IUCN. They are the principal advisors to the SSC, IUCN, and its member bodies on the conservation of all crocodylians including the mugger (Crocodile Specialist Group, 1998).

Between 1978 and 1992, 1,193 mugger crocodiles were released into twenty-eight national parks, wildlife preserves, and crocodile sanctuaries. The Crocodile Conservation Project stressed release above all else. Restoration of habitat as a means of species restoration was not a priority. Although this strategy worked well for a long period of time, it is currently undergoing an evaluation as more than eight thousand crocodiles have accumulated at breeding centers with no place, or plans, to release them (Britton, 1995). As a result of management strategies, population numbers are higher, although the populations themselves are still highly fragmented.

During the first phases of restoration the Indian government established many breeding and rearing centers. These stations concentrated their efforts on collecting eggs from the wild, rearing the hatchlings, releasing them into suitable habitats, and monitoring the results. These stations also participated in conducting research on the crocodiles to help improve management. Captive breeding is extremely important to the reintroduction and restoration programs of the mugger crocodile in India. Eggs are usually captured from wild populations and incubated. The young are then reared after hatching. Some centers have also collected juveniles and reared them to adulthood before release. Both of these techniques help protect the eggs from natural dangers such as predation from people and other crocodiles (Choudhury and Chowdhury, 1986). One such facility in Ramatirtha consisted of one egg hatchery, ten hatching pens, twelve yearling pens, and one breeding enclosure. In addition to the animal's buildings, there were also two water pump houses, two water tanks, one laboratory, four halls, and eleven residential buildings (Sagar and Singh, 1993).

Case Studies

Two case studies of efforts that have been undertaken in this program provide good overviews of specific actions that have been used.

Case Study One: Andhra Pradesh

Choudhury and Bustard (1982) provide an interesting example of a successful program and the results and lessons learned through breeding and restocking of the mugger crocodiles in the Andhra Pradesh Conservation Project. This project was a pilot established in 1978 in the state of Andhra Pradesh by the Forest department with assistance from the Indian Government and the CCP in the Nagarjunasagar-Srisailem Wildlife sanctuary. The first steps in this pilot included choosing a release site, selecting the best time to release, and deciding which crocodiles were to be released. The area selected was chosen on the basis that it was a former mugger habitat area

and the fact that it still was suitable for recolonization because of available, protected wetland habitat. Officials chose to release four crocodiles between the monsoon seasons so that the crocodiles would have time to acclimate to their new habitat before the monsoon rains started. The animals chosen were wild caught juveniles that were large enough to defend and feed themselves.

Before officials released the crocodiles they banned grazing and fishing close to the crocodile habitat so that conflicts between crocodiles and humans, and potential environmental degradation could be avoided. The crocodiles were measured, weighed, sexed and marked before release. Officials also took careful precautions during the actual transport and release to protect the crocodiles.

Survival, monitoring, and reproduction are all considered factors of success in any crocodile conservation program. Since the time of release, this project has used observation monitoring to check on survival and movement. All of the four original crocodiles, as well as three of the four crocodiles released in 1978 have been sighted during the three-year period following the release. Officials believe that all of the crocodiles were alive at the end of this period. Although the crocodiles have not moved far, they have started to reproduce. This project was an overall success. It helped to illustrate the importance of careful selection of animals, habitat, and timing (Choudhury and Bustard, 1983).

Case Study Two: Similipal Tiger Reserve, Orissa

Sagar and Singh (1993) provide another interesting example of a successful Crocodile Conservation Project in which Muggers were restored to their natural environment. In 1979 as part of the Crocodile Conservation project, the field director of the Similipal Tiger Reserve and Hadgain Sanctuary in the state of Orissa oversaw a project to restock and restore the mugger crocodile in this area of its natural habitat. A survey, conducted in the sanctuary, showed that the mugger was nearly extinct in this area. This project started with a captive-breeding program. Young mugger crocodiles were captured, brought to the center in 1979, and were captive reared for five years. Starting in 1984, they were then bred. Providing adequate healthcare was a large component of this program.

This project had three primary objectives: to restore viable mugger populations inside Similipal Tiger reserve; to conduct research to improve results of captive management of mugger crocodiles; and to provide juvenile muggers for release elsewhere in the state (Dani et al. 1991).

Because natural populations in this state were almost extinct, an attempt was made to restock with muggers from one particular geographical region into three river systems. A total of 338 muggers were released between 1984 and 1989. A ten-kilometer stretch was closely monitored through observation. Overall percentage of muggers sighted by researchers was relatively low. The percentages observed seen ranged from 12.1% to 76.1%. Although this seems low, it may be indicative that the river system was large and that the crocodiles may have moved during the monsoon rains. This reserve released more crocodiles after the initial release. They also continued to monitor on a yearly basis to assess the situation. Research and breeding also continued into the future (Sagar and Singh 1993).

These case studies illustrated two typical projects of the program. Although the second was on a much larger scale in terms of size and number of crocodiles released, both used monitoring to assess the effectiveness of their respective projects. They suggest that projects can be done on different scales and still be effective.

Techniques

Many factors are essential for survival and success of the Mugger's release and rearing. Sites must be protected and without severe environmental degradation. Food, water, and nursery grounds must be adequate in the habitat. Dani, Sagar and Singh (1991) have defined ideal mugger habitat as having four major components:

- One that is within their former range.
- A protected area that is not highly degraded.
- An area where they can meet basic requirements like food, adequate water depth, nesting and basking grounds and nursery grounds.
- Land that is protected from flood extremes.

Large human disturbances, such as fishing, must also be absent (Choudhury and Chowdhury, 1986). Some studies also suggest that muggers should be released when they are at least one full meter long and at least six months old (Singh, 1991).

The Ramatiratha captive breeding and management program had found several factors which "...help achieve better survival of young crocodiles" (Dani et al. 1991). One factor is the treatment of adults with vitamin E to improve the number of eggs released by females and the number that eventually hatch. They also discovered that captive rearing helps achieve higher rates of survival in hatchlings as opposed to semi-wild rearing. Captive rearing may reduce mortality from adult crocodiles often kill hatchlings. In addition, they have found that when hatchlings are given food supplements and hatching time is controlled, survival is higher. These techniques are a good example of information sharing that has helped to improve the success of all projects within the program.

Project Evaluation

Evaluation of the program and individual projects has been on going since implementation. Managers use simple observational surveys to estimate the numbers of mugger crocodiles present at any one site. This, in turn, is compared with data of numbers of animals released to assess success. In India there are currently fifty small populations with total numbers of crocodiles ranging from between 3000 and 5000 (Britton, 1995).

Although the CCP has been in implementation for many years, opposition by local people is still a major barrier to success. Singh (1991) believes that involvement of the public is an important factor in the success or failure of a program. FAO/UNDP developed a framework to guide projects. It includes several recommendations.

One is the development of a strong acceptance level by local people of the project.

Another is to protect the interests, both immediate and long term, of fishermen. The third is promotion of commercial crocodile farming with the program so villagers could continue to earn income while restoring the crocodile and protecting its habitat.

As of now many of these programs have not been successful, largely due to opposition by local people, businesses, and units of government that feel threatened by the program. Restoration of crocodile numbers is dependent on providing incentives to maintain the crocodiles and their habitat in a somewhat undisturbed state (Ross, 1998).

Discussion

The largest barrier that India and the agencies helping to coordinate the restoration of the mugger crocodile face, is what to do next with the Crocodile Conservation Program. Although the mugger is no longer classified as endangered, it is still at risk. The project has had great success in that it has restored the mugger to many areas in India. However, the mugger crocodile population is highly fragmented and opposition by the public is still a major factor in failure of programs. In order to completely restore the mugger crocodile, two main things need to be done. First restoration of habitat should be used to reconnect the fragmentation for further reintroduction, and education along with involvement of stakeholders should be used. Success of the program now depends on finding adequate habitat and the resources to release them as well as monitor the success of each release.

India is a country with an exploding population and these pressures will continue to damage the mugger population.

Restoration and finding of suitable habitat are the largest hurdles that the Crocodile Conservation Project faces. They have proved that they know how to raise and release the crocodiles. They now must focus their attention on finding suitable placement for the animals. Part of this effort will involve the social acceptance of the programs. Many people are still very afraid and ignorant about crocodiles and because of this resist placement. Education and economic incentives should be strongly pushed to counteract this resistance. Although much work remains to restore populations of *C. palustris*, an amazing amount has been accomplished. The mugger is no longer endangered and wild populations are reproducing. The mugger crocodile has started to make a comeback.

Literature Cited

Britton, A. *Crocodylus palustris*: Lesson 1831
Article <www.flmnh.ufl.edu/natsci/herpetology/brittoncrocs/csp_cpal.htm> 1995-98 (Accessed 16, April 1999).

Choudhury, B.C., and H.R. Bustard. 1982. Restocking mugger crocodile *Crocodylus palustris* in Andhra Pradesh (India): Evaluation of a mugger release. *Journal of the Bombay Natural History Society* 79:275-289.

Choudhury, B.C., and Chowdhury. 1986. Lessons from crocodile reintroduction projects in India. *Indian Forester* 112:881-890.

Crocodile Specialist Group. The story of the crocodile specialist group. Article <<http://www.flmnh.ufl.edu/natsci/herpetology/crocs/crocsb.htm#Top>>. 1998 (Accessed April 16, 1999)

Dani, C.S., S.R. Sager, and L.A.K. Singh. 1991. Mugger crocodile research at Ramtirtha: a review. *Indian Forester* 117:881-891.

Ross, J.P. Crocodiles. Status Survey and Action plan. second edition. IUCN/SSC Crocodile Specialist Group. IUCN, Gland, Switzerland and Cambridge, UK. Viii=96pp. <www.flmnh.ufl.edu/natsci/herpetology/act-plan/plan1998a.htm> 1998 (accessed 16. April 1998)

Singh, L.A.K. 1983 Observation on the movement of two captive reared mugger crocodiles, *Crocodylus palustris* when returned to the wild. *Journal of the Bombay Natural History Society* 80:86-90.

Sagar, S.R. and L.A.K. Singh. 1993. Captive Breeding and Rehabilitation of Mugger Crocodile (*Crocodylus Palustris*) In Similipal Tiger Reserve. *The Indian Forester*. 119(10): 807-815.

Sagar, S.R. 1987. Public involvement in the Indian crocodile conservation programmes. pp. 233-237. In: Webb, G., C. Manolis, and P. Whitehead (Eds.). *Wildlife Management: Crocodiles and Alligators*. Surrey Beatty & Sons, Chipping Norton, NSW, Australia.

Whitaker, R. 1987. The management of crocodilians in India. In: *Wildlife Management: Crocodiles and Alligators*. Webb, G.J.W., S.C. Manolis and P.J. Whitehead (eds.).63–72. Surrey Beatty and Sons, Chipping Norton, Australia.

Whitaker, R. and Z. Whitaker. 1989. Ecology of the mugger crocodile. In: *Crocodiles: Their Ecology, Management and Conservation*. A Special Publication of the Crocodile Specialist Group.276–297. IUCN, Gland, Switzerland.