Status of Mugger and its Conservation Problems in Gujarat

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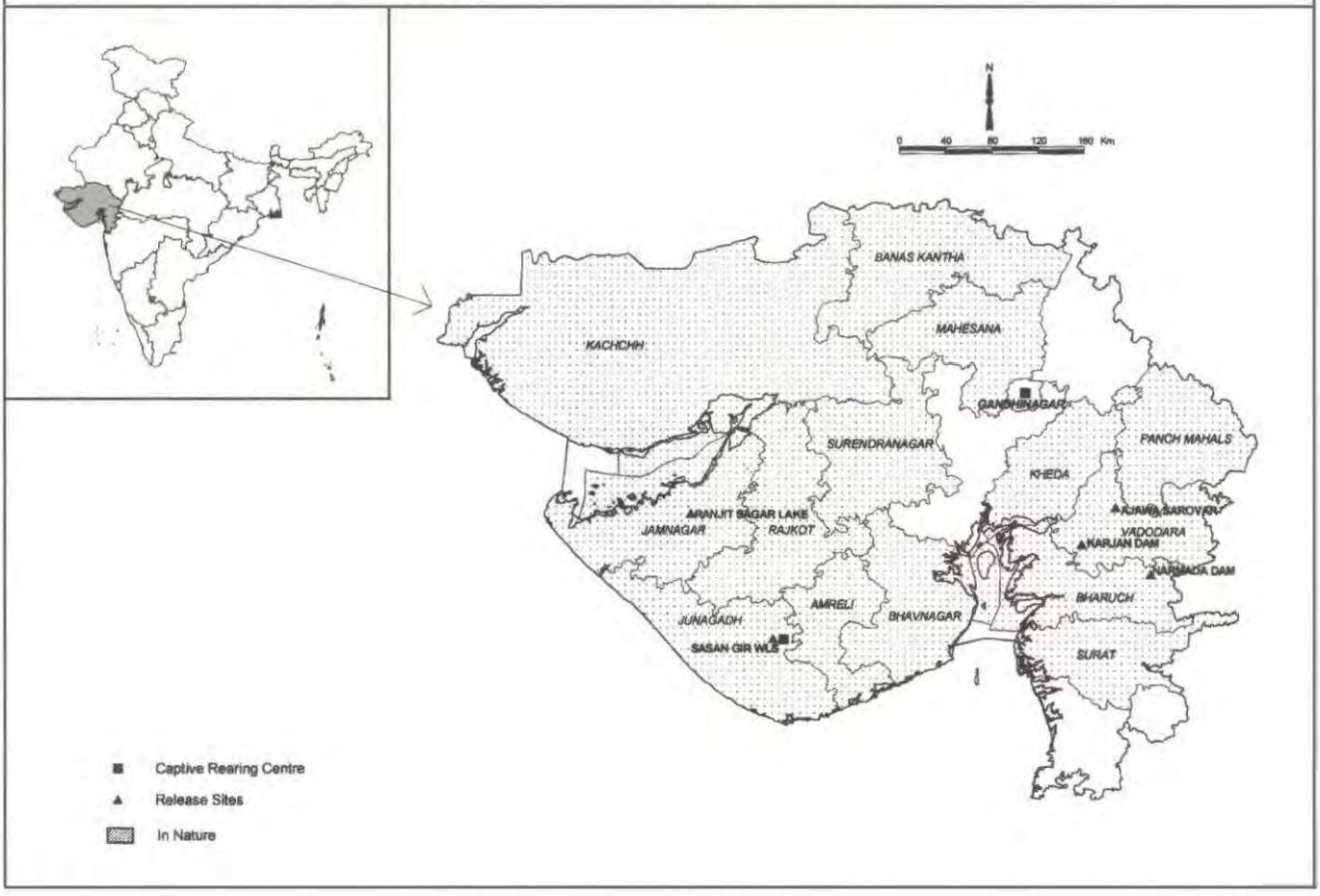
THE MUGGER (*Crocodylus palustris*) has the widest distributional range compared to any of the Asian freshwater crocodilian species (Whitaker and Whitaker 1989). It is a highly adaptable species, occupying a variety of habitats including hill streams, large manmade reservoirs, seasonal tanks, large rivers and small pools in the wilderness and also irrigation channels.

During the early 20th century, mugger were found commonly all over Gujarat, with fairly good populations in major rivers such as Narmada, Tapi and Mahi of south Gujarat and Watrak in central Gujarat. The Watrak river at Barsan Baroda, 50 km away from Ahmedabad, had the highest concentration with 50-75 mugger at every five kilometres (Acharya, 1949). Earlier, McCann (1938) had reported the presence of mugger only in the Banas river of north Gujarat region, while few muggers also existed in the river Sabarmati and in some of the village tanks in the region (VC Soni, pers. com.).

In 1975, a preliminary survey of mugger was conducted in Gir National Park by Joseph *et.al.* (1975). Subsequently, Whitaker too conducted a survey and reported the mugger population in Gir forest, particularly at Hiran dam (also known as Kamelashwar lake), to be 51 (Whitaker 1978) with at least 15 nesting females. Rashid (1978) stated the wild mugger population in the state to be around 500, with a largest concentration of 200 mugger in Hiran lake and scattered smaller populations of less than 50 individuals in rivers such as Saraswati, Banganga and Ranjitsagar lake in the Saurashtra region. Oza (1975) reported that Ajawa reservoir had more than 100 crocodiles during the early 1960's. Today, the mugger population in this reservoir is around 50.

However, most of these statements are not based on appropriate survey. In fact, all the earlier surveys (except Acharaya 1949) were possibly restricted to the Gir protected area, and none were done on a regular basis. As such, with the exception of some reports on the Gir population, the real status of mugger in the state was not exactly known. But what was clear from the reports during the period 1949-1979 was that the

Figure 8 - Crocodiles in Gujarat



distribution and population of mugger in the state had depleted considerably and that the species was critically endangered. This was mainly due to changes in the fishing methods, hunting and habitat destruction. It had locally become extinct from the Dang district, from where it was last reported at Mulchand in 1954 (Daniel and Shull 1963).

Conservation efforts

The endangered status of the mugger in Gujarat urged the state government to adopt the Indian Crocodile Conservation Project in 1977, which involved the establishment of crocodile breeding and rearing stations. The first captive reared mugger release was done in the Hiran lake (in Gir) on 15 May 1984.

Between 1984 and 1996, the Gujarat State Forest Department had released 973 mugger within the Gir protected area, which included 148 in Kamaleshwar lake, 200 in Rawal dam, 264 in Singota dam, 294 in Machundri dam, 40 in Billiyard – Kankai, 25 in other small waterbodies and two in Jatardi river. Muggers from the Gir rearing centre were also released into the Ranjit Sagar lake, located in Jamnagar district of Saurashtra region, where 13 mugger (12 from the Sasan centre and one caught from the wild) were released in May 1989 (*Source*: Gujarat State Forest Department). Besides, 27

muggers caught from the wild in Bharuch, Kheda, Surat and Vadodara districts in south Gujarat (Vyas 1994) were released in the Narmada dam (14 mugger), Karjan dam (5 mugger) and Ajawa Sarovar (8 mugger).

Impasse in crocodile conservation

As a result of efficient captive breeding programme, by 1995-96, there were about 289 mugger in 10 captive centres in the state. In fact, the stocks at the various rearing centres face a crisis of overcrowding and, consequently, inadequate care. Non-identification of new release sites other than the Gir protected area and the national policy prohibiting any option of commercial use of captive-bred crocodiles, have led to repeated stocking of mugger in the same location. Moreover, the waterbodies where mugger have been released are subjected to severe fluctuations in water level between the monsoon and summer seasons, particularly due to use of water for irrigation purposes. These constraints and problems have resulted in unwanted effects such as cannibalism, emigration and predation during dry periods (Vijay Kumar and Choudhury, 1994).

Thus, the main objective of the conservation project, *i.e.*, to build up the depleted population, suffered due to non identification of new suitable mugger habitats other than Gir for future restocking and a dearth of information on the existence of wild mugger and the survival status of the released mugger in the state. A general feeling that Indian crocodiles were now safe from extinction also led to easing down of the efforts.

A status survey in mid-90's

In response to these such issues, a survey of mugger in the state was carried (with the support of Fauna and Flora Preservation Society, U.K.) between March 1995 and August 1996. The objectives of the survey were,

1) to know the current distribution and status of mugger in Gujarat.

2) to gather information on the survival and dispersal of the released stocks and the factors governing them,

3) to identify and assess the feasibility of new sites for future reintroduction, and

4) to prepare a management action plan for the conservation and management of the species in the state.

For the survey, the state was divided into four major regions, as follows :

Kachchh - the largest district in the state (45652 km^2 or 24% of thestate area), which fell in the arid tract;

Saurashtra - Rajkot, Jamnagar, Surendranagar, Junagadh (Gir forest), Amreli and Bhavnagar districts;

North Gujarat - Banaskantha, Mehsana, Sabarkantha and

Ahmedabad (including Gandhinagar) districts; and

South Gujarat - Kheda, Panchmahal, Vadodara, Bharuch, Surat, Valsad and Dangs districts.

Several methods were used to compile information on the distribution and status of mugger. The larger geographical area of the state (1,96,024 km^2) with the presence of innumerable number of rivers, rivulets, reservoirs and tanks, did not permit us to carry out an elaborate census of the complete watercourse in the state. However, detailed site-specific census was carried out in waterbodies where from information on presence of mugger was obtained.

Survey results

During the study period, a total of 149 waterbodies, including 14 major dams, 69 medium dams and 66 other waterbodies such as minor dams, lakes, village tanks and 42 locations (each location measures about 5 - 10 km stretch) in 21 rivers were surveyed. Various pressures existed in these waterbodies - 101 were used for irrigation, 8 major dams for generating hydropower, 49 for fishing and 31 for domestic/ drinking water purposes. Further, 40 water bodies were reported to be dry during the drought years, which is a common phenomenon in Kachchh and Saurashtra regions of the state.

Of the 18 district surveyed, there was information on the existence of mugger in 52 waterbodies and 10 rivers in 14 districts (*Table 1*). However, direct sightings of the wild mugger were recorded only in 25 waterbodies and six rivers in six districts - Amreli, Junagarh, Kachchh, Kheda, Panchmahal and Vadodara. Indirect evidences confirmed the existence of mugger in Bharuch and Surendranagar districts. In Ahmedabad, Banaskantha, Bhavnagar, Rajkot, Jamnagar, Sabarkantha, Surat, Mehsana and Valsad districts its existencewas considered highly doubtful, whereas, location information and reports confirmed its local extinction from the Dangs district.

The total number of mugger recorded during the survey was 429, which included 368 adults (>6 ft), 44 sub adults (4 to <6 ft), six juveniles (1.5 to <4 ft) and 11 hatchlings. However, indirect evidences and local reports supported the existence of at least 1653 mugger in Gujarat, of which 1013 (from Sasan and wild caught) were released into various localities of the state. Maximum population was recorded in Junagadh district (306 mugger) followed by Kachchh district (94 : 11 hatchlings and 83 non-hatchlings).

Adults account for 88% of the non-hatchlings. The population structure of mugger mentioned in the results is based, on size structure rather than age structure. Due to high mortality that occurs in hatchlings, their percent may vary greatly within a given population in a short period of time. Hence, the data on

Table 1
Status of mugger in Gujarat in the mid-90's

Region / *District*	*Mugger Reported*	*Recorded*
Kachchh		
Kachchh	186	94
Saurashtra		
Amreli	7	5
Bhavnagar	2	0
Jamnagar	18	0
Junagarh	1272	306
Rajkot	1	0
Surendranagar	8	0
South Gujarat		
Bharuch	51	0
Kheda	11	8
Panchmahal	50	2
Vadodara	37	14
Surat	?	0
North Gujarat		
Banaskantha	7	0
Mehsana	3	0
Total	*1653*	*429*

Table 2
Percent Sightings of Small Size Class Muggers

Region	Number of Non-hatchings	Number of Juveniles & Sub-Adults	Percent
Kachchh	83	19	22.9
Saurashtra	311	29	9.3
South Gujarat	24	2	8.3
North Gujarat	0	0	0
Gujarat	418	50	11.9

hatchlings were eliminated from the population analysis.

Implications on population

Among the non-hatchlings, the percent sightings of juvenile and sub-adults, recruitment into the population was recorded high (22.9%) in the Kachchh region whereas it decreased to 9.3% and 8.3 % in the Saurashtra and South Gujarat regions respectively (*Table 2*). The record of 12% (n=50) of the sub-adults indicates a low natural recruitment in the state and this could be due to high loss in the egg and hatchling stages. Predation and environmental factors are the two major causes for the loss of eggs during the post hatching periods (Thorbjanarsan, 1989) and hatchlings, which tend to reduce the number of hatchling entering into adult classes in the wild.

Very few sightings of the juvenile class and also of sub-adults indicated that high crocodile density might have triggered density dependent population control which may have led to complete exclusion of smaller individuals from the main population or mortality via mechanisms such as cannibalism. Schmidt (1924) reported similar observation at Hondrus, where he recorded a high crocodile density with a total absence of small juveniles. Juvenile mortality becomes a bottleneck to population growth (Hutton, 1984). Added to this, the spatial segregation of crocodiles by size class may represent a difference in the physical habitat requirements of different sized crocodile or it may reflect social factors and agnostic encounters between size classes (Messel *et al.* 1984). These could be some of the possible reasons for the less sighting of small size class mugger in the state.

Though mugger were generally reported as a friendly and peaceful animal for both cattle and man, the human-livestock-crocodile conflicts were escalating due to increased pressure on mugger habitats. Between 1991 and 1996, there were 10 cases reported of attacks on human by adult male mugger (three each in Kachchh and Saurashtra and four in the south Gujarat region) during the period. Of these, nine attacks occurred between May and July when the water level was very low.

Conservation and management

Past debates on crocodile conservation and management focused largely on the population within the protected areas, which provide favorable reserves and virtual absence of intensive agriculture. These features add up to a conservation equation for protected area mugger populations, which is very different from the populations that exist outside. There were a good number of mugger recorded outside the protected areas in Kachchh, Saurashtra and the south Gujarat region.

Crocodile conservation is not a simple case of preservation. Over the year, there have been major changes in the types of threats to mugger. The early actions, when mugger habitats were still relatively undisturbed, were almost entirely concerned with limiting their killing. Now, the most invidious threat to mugger is not excessive killing, but disruption of their habitat, because of which most of the species may never regain their historical numbers.

There are other complex challenges to crocodile conservation as well. The Kachchh region is entirely an arid tract where droughts are a recurring phenomenon whereas south Gujarat region is a heavy rainfall tract. As such, it is essential to develop a management strategy specific to each region which would be sensitive to regional variations in habitat quality and conservation potential, and also emphasizes on resources in areas of maximum benefit to statewide crocodile conservation.

The management plan also needs to recognize the social dimension to the problem. Agriculture puts an enormous pressure through direct competition with crocodiles. Use of reservoir water for irrigation purposes during between February and June leads to a decrease in water level, which coincides with the crocodile egg laying and hatching period, and this causes tremendous nest losses. There is no denying the paramount importance of agricultural development and food production for the ever-increasing human population. However, it should be also noted that surface water irrigation, the oldest form of irrigation, requires large quantities of water, as the losses in the form of infiltration, evaporation *etc.* are enormous. As such, water extraction for irrigation from mugger habitats needs to be regulated during the breeding season through application of modern techniques like sprinkler, drip irrigation *etc.*

Moreover, the sharing waterways by people and crocodiles give rise to conflicts also need to be resolved, since such conflicts create a significant impact on the survival of mugger in the unprotected areas. The success of any conservation programmes is strongly dependent on the support and active participation of local people and, as such, managing people-crocodile interface becomes essential, which some of the earlier debates and

plans have ignored or trivialized. Concrete measures must be taken to avoid potentially disastrous consequences of human deaths resulting from crocodile attack where sharing of common water bodies by mugger and human exists. A high priority should be given to the interests and needs of the local people and measures be taken to provide them alternative resources where possible.

A complete protection to crocodiles throughout state is at present an impractical consideration, because most of these are found in remote areas with no or little law-enforcement. The recovery of mugger in many parts of its historical range will be very difficult, because of heavy human usage, the antipathy of man towards crocodiles, as well as human and livestock population expansion and other associated factors that cause habitat destruction.

An education programme needs to be designed to eliminate apprehensive beliefs about dangerous interactions between people and crocodiles throughout the state but more particularly in areas where the restocking of crocodiles is contemplated. However, at the same time, the 'problem' crocodiles (broadly defined as those attacking human and livestock or residing in human habitations, where their presence constitutes a risk to people and livestock) from unprotected areas must be identified and removed from the wild and assigned to captive centres which would enhance the genetic viability of the captive stock.

But it is very important to avoid restocking in high crocodile density areas, because it results in an overlap in habitat use by different size class, which may lead to cannibalism and out migration of smaller size classes. Based on the hydrological characteristics of the water body (during dry and wet periods), the restocking has to be regulated. Therefore, it is suggested to stop further restocking within the Gir sanctuary. Monitoring the major mugger population area is very essential to understand the effects of the implementation of the project. The formulation of state level Crocodile Monitoring Committee (CMC) by subject experts, Forest Department officials and NGO's would be of great help in this direction. It would also enhance the information base, help in prioritizing site specific management issues and evolving appropriate strategies.

References

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CHAVAN, SA (1979) - Distribution and conservation of crocodiles in and around Gir wildlife sanctuary. *Indian J. of Forestry* 2 (3) 266-268.

DANIEL, JC and EM SHULL (1963) - List of the reptiles and

Crocodile rearing centres

Gharial, Kukrail (Uttar Pradesh)

Mugger, Hyderabad (Andhra Pradesh)

Saltwater crocodile, Dangmal (Orissa)

Management and research

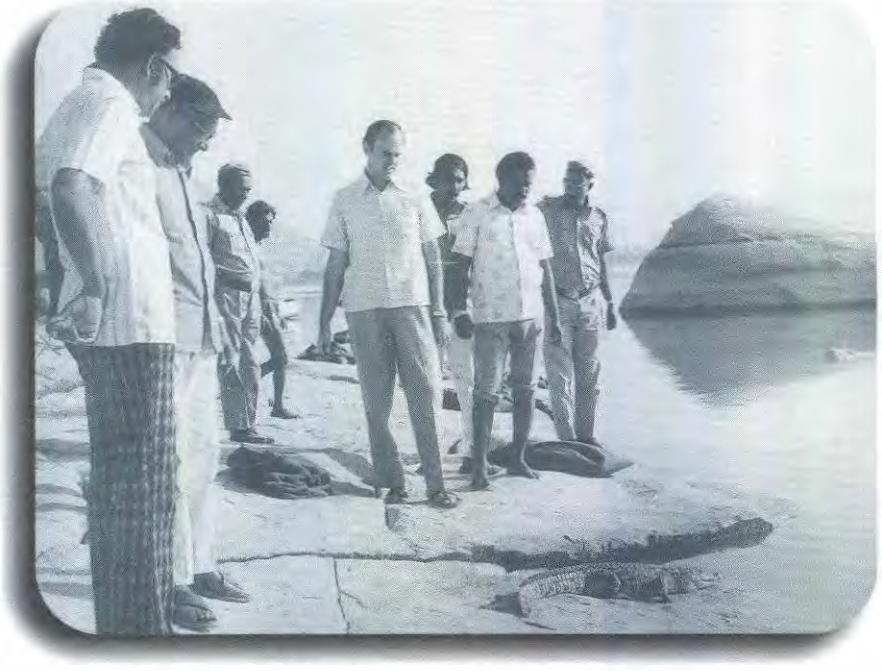
Cloacal probing for sexing a crocodile

Wild mugger egg collection, Gir (Gujarat)

Blood sample collection

Release and monitor

Gharial release
Satkoshia Gorge (Orissa)



Mugger release
Krishnagiri (Tamil Nadu)

Post-release monitoring
Bhitarkanika (Orissa)