

MUGGER (*Crocodylus palustris*) POPULATION IN AND AROUND VADODARA CITY, GUJARAT STATE, INDIA

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Monitoring of over a two decade period (1987–2007) of mugger (*Crocodylus palustris*) population of River Vishwamitri (Gujarat State, India) indicates the present status of the species in and around Vadodara City to be the most noticeable and unique. The population found in Vishwamitri-Dhadhar River System represents a unique case study of relationship between a crocodilian species and humans. The population of muggers is growing with at the rate of 7.77 animals per year and has reached over 100. Also, mugger conflict is increasing; a total of 292 muggers were rescued from human settlements and translocated, including 38% small (under 1 m), 48% large (1 – 2 m) and 14% huge sized (over 2 m) muggers. But few of them returned to the same location in the Vishwamitri River. A total of 14 crocodile attacks were recorded, including six that were fatal. The present study provides recommendations and an action plan for the long-term mugger conservation in the area.

Keywords: conflict, conservation, *Crocodylus palustris*, Gujarat, India, mugger, population, Rescue, reptiles, translocation, urban wildlife.

INTRODUCTION

The marsh crocodile or mugger crocodile (*Crocodylus palustris*) is one of the threatened reptile species in India and legally protected under Schedule I of the Indian Wildlife (Protection) Act, 1972. By the late 1960s, the species was depleted from its distribution range as a result of illegal hunting, fishing and habitat loss. Subsequently, mugger population grew due to legal protection and success in *ex situ* programs, under the FAO-Indian Government project entitled “Indian Crocodile Conservation Project.” It has pulled back the once threatened crocodilian species from the brink of extinction and has placed them on the path to recovery (Singh, 1999).

Now it is considered as nationally “vulnerable” species under IUCN criteria (Molur and Walker, 1998). Presently mugger is common in many parts of India and some of the local population rises healthily and it is creating a problem which is resulting in conflicts between animal and man (Pillai, 1999; Vijayakumar et al., 1999; Jayson, 2002; Whitaker, 2007).

Due to legal protection and conservation efforts from State Forest Department and NGOs, the mugger is found to be common in many water bodies of the state. It is observed that mugger enters human settlements and

creates conflicts in a few places in the State (Vyas, 2007, 2008), including Vadodara City (Vyas, 1993, 1994, 2005a, 2005b, Vyas and Bhatt, 2004; Bhatt, 2000). Mugger population found in and around Vadodara City comes from the Vishwamitri – Dhadhar River System.

METHODOLOGY

Present data is the compilation of 21 year (1987 – 2007) of observations on mugger population of Vishwamitri, along with other gathered information on the basis of various relevant sources such as scientific literature, local newspaper reports, and information from zoos and NGOs who work for crocodile conservation. Also, visits to the sites of incidents and conflict sites and studies regarding the situation along with interviewing the affected people and relatives of victims of the incidents provided additional data. The entire Vishwamitri River and surrounding areas, including water bodies close to the river, which were found used by crocodile, were studied.

STUDY AREA: VISHWAMITRI RIVER

The Vishwamitri – Dhadhar River System is one of the seasonal rivers of Gujarat State. Its flow is from East

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Fig. 1. The map of Vishwamitri – Dhadhar River System and location of various water bodies.

to West in between two large perennial rivers Mahi and Narmada. This river system is containing three major tributaries: Vishwamitri, Dhadhar and Jambuva. All the three tributaries originate from Pavagadh hills and Jambughoda forests (Fig. 1).

The Vishwamitri River originates from western and southern slopes of Pavagadh hills, flows westward through Vadodara City and further gets linked with two other tributaries (Dhadhar and Jambuva near Kothawada village) and finally reaches the Gulf of Khambhat near Khanpur village. Two water reservoirs are constructed on this river system, Sayaji Sarovar near Ajwa village on Vishwamitri River and Dev Dam on Dhadhar tributary, for the drinking and irrigation purposes. Both the reservoirs hold small mugger populations.

The Vishwamitri River flows through Vadodara City (22°19' N 73°13' E), so the sewage of the entire city and other industrial effluents are drained into the river, turning the river immensely polluted. The water of the river turns reddish-black as it passes through the city.

MUGGER CROCODILE — IN THE PAST

Earlier records of Oza (1975) indicate that about 50 mugger crocodiles (*Crocodylus palustris*) have been recorded in Sayaji Sarovar during the early 1970s, but hunting and illegal fishing activities depleted the population and finally they disappeared from the Sarovar altogether within a few years. Due to hunting and fishing activity some mugger population might have migrated to the lower areas of the Vishwamitri River in those times and might have settled there (Vyas and Vyas, 2002).

TABLE 1. Mugger (*Crocodylus palustris*) of Vishwamitri River at Vadodara City, Gujarat, India (between Harni and Vadsar villages)

No.	Year of survey	Number of muggers recorded	Density, mugger per 1 km	Source
1	1993	9	0.36	Vyas, 1994
2	1995	27	1.08	Vijayakumar et al., 1999
3	2001	70	2.80	Vyas and Vyas, 2000
4	2007	100	4.0	This study

Along with the mugger, other few aquatic reptilian species also have been recorded in the river. These are the South Indian flap-shell turtle (*Lissemys p. punctata*), the Indian soft-shell turtle (*Nilssonia gangetica*) and the checkered keelback water snake (*Xenochrophis piscator*). Populations of these species are common and found throughout the river.

MUGGER CROCODILE — IN THE PRESENT

Last three census of mugger, recorded from 25 km river stretch (which flows through the city) indicates that the population of mugger is proliferating. The mugger population is multiplying at the rate of 7.77 animals/year and the population crossed 70 animals in the year 2001, within eight years (Table 1). Probably this is due to the successful breeding of a number of females. Presently, this population is estimated to be about 100 muggers inhabiting the urban stretch of the river.

Nesting Activity. During study, I was able to locate few nesting sites of muggers in the city areas, Sayaji Garden, Bhimnath temple, Muj-mahuda and Kalali. At these five sites, the crocodile nesting activity is noticed every year regularly. Both banks of the river at Sayaji Baug Garden are less disturbed (compared to other sites) and the banks are covered with bushes and hedges. Dogs (*Canis* sp.), jackals (*Canis aureus*), and Indian monitor lizards (*Varanus bengalensis*), predate the nests every year, as recorded at Sayaji Garden, from 1995 to 2005. However, successful hatching was recorded in 1998, 2000, and 2006. Nesting activity at the other three sites is noticed, but there it is difficult to monitor nests and obtain successful results. Because the opposite bank areas are slums and active place for human activities, such as alcohol distilleries.

MUGGER vs. MAM

Since last two decades, it has been noticed that this small mugger population is multiplying due to the par-

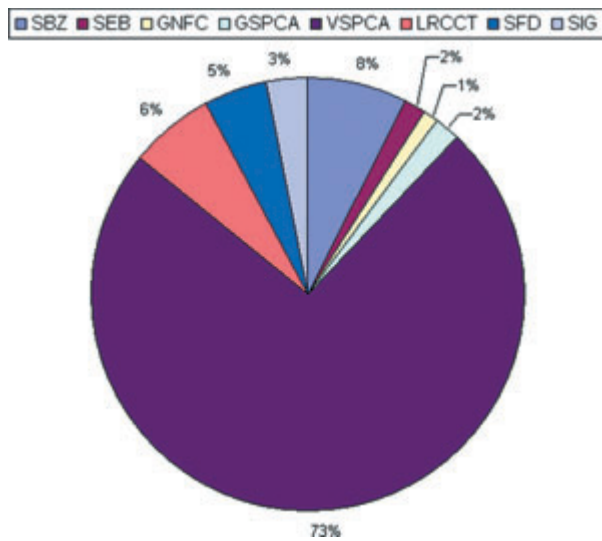


Fig. 2. The graph showing percentages of mugger crocodiles (*Crocodylus palustris*) rescued from Vadodara city during 1987 – 2006 years by various organization (SBZ, Sayaji Baug Zoo; SFB, Staff of Fire Brigade; GNFC, Gujarat Narmada Fertilizer Company; GSPCA, Gujarat Society for the Prevention of Cruelty to the Animals; VSPCA, Vadodara Society for the Prevention of Cruelty to the Animals; LRCCT, Late Rohan Crocodile Charitable Trust; SFD, State Forest Department; SIG, Some of Individuals Group).

tipication of a small number of females in breeding and regular recruitments by successful hatchlings, in some remote areas of the river. Also, it was observed that during rainy season, a few crocodiles enter into human settlements through the flooded water drainages and create panic in the city (Vyas and Bhatt, 2004).

Crocodile Rescued. Number of various government organizations, non-government organizations and some individuals (Fig. 2) have rescued mugger from in and around the city, on telephone calls of citizens. Total of 292 muggers have been rescued from in and around the city, including 111 small (less than one meter), 141 large (1 – 2 meters) and 40 huge (>2 m) muggers, during last twenty one year span (1987 – 2007).

The month-wise data show that the highest number (64) of animals were rescued during the August and the lowest number (3), in the April. The trend of rescues indicates that there has been a positive correlation with rainy season. As soon as the rains start, the number of animals in human habitats is found to increase, whereas it decreases in winter and dry seasons (Fig. 3).

The rescued data of twenty years shows that the highest (45) number of muggers were rescued during year 2005, and the lowest number (1) rescued each year during 1987, 1992, 1994, and 1996 (Fig. 4). Also, it has been observed that the mugger problem became frequent

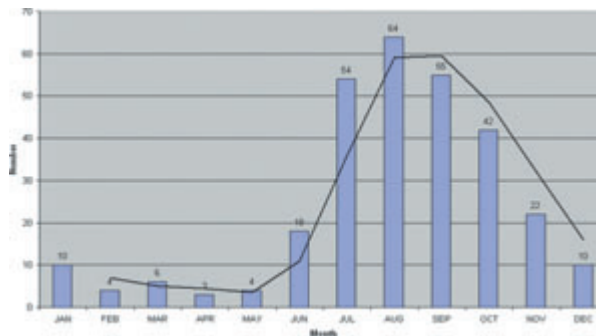


Fig. 3. The graph showing monthwise of rescued muggers (*Crocodylus palustris*) from human settlement areas of in and around Vadodara City.

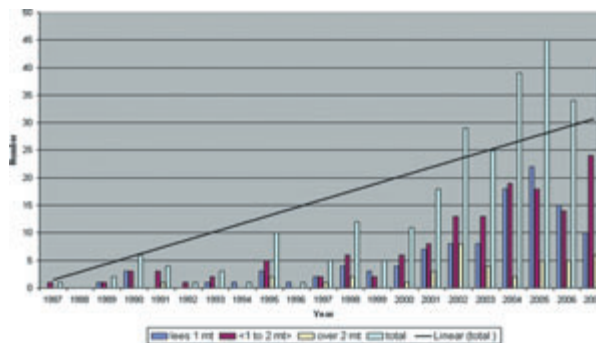


Fig. 4. The graph of mugger (*Crocodylus palustris*) rescued during the study period (1997 – 2007) in and around Vadodara City.

during the floods or after the floods, compared to the other periods.

Crocodile Translocation. Most of the rescued crocodiles, which are caught from the Vadodara district are transferred and released in Sayaji Sarovar (= Ajwa) (according to instruction of Conservator of Forest, Vadodara, State Forest Department), except a few of them released in Karjan Dam, Rajpipla, Narmada Dam, Kevadiya, Dev Dam and Targol Dam (part of Jambughoda Wildlife Sanctuary). Only few rescued muggers were not released back into nature but kept at Sayaji Baug Zoo (Vadodara) and Sakkarbaug Zoo (Junagadh) for display (Vyas, 1998, 2006). Most of the muggers are uniquely marked (employing the scale-clipping method) before they are released into the Sayaji Sarovar, for monitoring.

Crocodile Attack. A total of 14 attacks by muggers were noted from Vishwamitri – Dhadhar river valley, during last 13 years (1995 – 2007). Among victims of attacks, there were four young boys (9 – 16 years), four women (30 – 45 years) and six men (21 – 45 years). Six

TABLE 2. Records of Mugger (*Crocodylus palustris*) Attack in Entire Vishwamitri-Dhadhar River System (Gujarat, India) from 1995 to 2007

No.	Date	Attack	Part of river system	Victim, sex (age)	Activity of the victim	Location details
1	December 1995	Non fatal	Vishwamitri	Male (9)	Plying on river bank	Parshuram Bhattha, Vadodara City
2	May 1998	Non fatal	Vishwamitri	Female (30)	Washing cloths	Thikaria-Mubark, Padara.
3	August 1998	Fatal	Dhhadhar	Male (10)	Goat	Surwada, Dabhoai
4	April 2003	Fatal	Village Talaw	Male	Fishing	Sama, Vadodara City
5	May 2003	Non fatal	Vishwamitri	Male (40)	River crossed	Thikaria-Mubark, Padara.
6	February 2005	Non fatal	Vishwamitri	Male (40)	Fishing	Vemali village
7	May 2005	Non fatal	Vishwamitri	Female (40)	Washing cloths	Thikaria-Mubark, Padara.
8	April 2005	Non fatal	Vishwamitri	Female (45)	Washing cloths	Vemali village
9	April 2005	Non fatal	Vishwamitri	Male (45)	Fishing	Harni, Vadodara City
10	August 2005	Fatal	Vishwamitri-Dhhadhar	Male (15)	Goat-sheep shepherd	Sehra village, Padara
11	September 2006	Fatal	Vishwamitri	Male (16)	River crossed	Khalipur village, near Vadodara City
12	June 2007	Fatal	Vishwamitri	Male (21)	Fishing	Sama, Vadodara City
13	August 2007	Non fatal	Village Talaw	Female (30)	Cloths washing	Talsat Village, near Vadodara City
14	September 2007	Fatal	Village Talaw	Male (25)	Fishing	Talsat Village, near Vadodara City

TABLE 3. List of Muggers (*Crocodylus palustris*) Found Dead (Killed) from Various Areas of in and around Vadodara, Gujarat

No.	Year	Age group	Location
1	1991	Juvenile	Navi Dharti
2	1992	Subadult	Vadasar
3	1993	Juvenile	Majalpur
4	1997	Juvenile	Navlakhi
5	1998	Adult	Sihora, Padara
6	1998	Subadult	Sontekari
7	2001	Subadult	Transpach Ind., Makarpura
8	2003	Juvenile	Bhutnath, Sama
9	2005	Adult	Place Compound
10	2005	Subadult	Harni
11	2006	Adult	Muj-mahuda
12	2007	Adult large	Lalbaug
13	2007	Adult large	Muj-mahuda
14	2007	Subadult	Manjalpur

attacks were fatal, all on men (Table 2). After the mugger attack, victims' bodies were recovered intact before being eaten by the muggers. It is possible that these were accidental attacks by animals or immediate actions taken by relatives preventing more interaction between the animal and victim. Most of women victims suffered such attacks when washing clothes at the water's edge, whereas men were attacked during the fishing activities.

Killed Crocodiles. Most of the citizens have a great respect towards the animal but when muggers are found in and around residential areas, citizens are terrified and immediately call to get rid of the animal. Usually, locals call the fire brigade station or volunteers of NGOs for getting rid of the animals. But in a few cases, it is ob-

served that people are so terrified and they killed the animal themselves and threw it in the nearby water-body/garbage or burn it to avoid legal problems. My data show 14 muggers of various age groups were killed by local people, during the last 12 years (1991 – 2007) (Table 3). Most of dead muggers found were either juveniles or sub-adults, except one large-sized individual, which measured 2.5 m, and was a gravid female, found on 17 June 2007 (Fig. 5). On 25 July 2005, a badly injured 2-m mugger with half-cut upper jaw (Fig. 6) was rescued by GSPCA from a small puddle of Fokal village of Savali Tehsil, Vadodara. This one was definitely killed by local people.

CONCLUSIONS AND DISCUSSIONS

The interaction between crocodile and man in Gujarat State has been common and it has a long cultural history. Gujarat is the place where people believed in worshipping crocodile as "Mogra Dev" and believed it as the vehicle of Goddess "Khodiyar Mata" and "Namami Devi Narmade." These are the examples in the State, where both mugger and man are the found in the same vicinity and tolerate each others presence (Vyas, 2003).

From last two decades, I observed that the coexistence with muggers in the State has changed. The tolerance towards the muggers is lost in people, and some desperate people are even ready to eliminate the species. And on the other hand, mugger population is increasing but habitat is shrinking and is encroached by men. Presently, Vadodara City with mugger population of Vishwa-



Fig. 5. One of the largest mugger female (gravid: see inset photograph) found dead and it supposed to be killed and thrown in to water (photo by Rajesh Bhavasar).

mitri River is the best example of tug of war noticed in the state.

This mugger population found in Vishwamitri – Dhadhar River System is a unique case study of relation in between a wild crocodylian species and human beings. Because a small population of muggers is struggling to survive in this non-perennial polluted river under tremendous anthropogenic pressures.

It is believed that during droughts and floods, some of muggers have migrated/washed out from Sayaji Sarovar and settled well in the lower areas of the Vishwamitri River in the 1960s and 1970s (Vyas and Vyas, 2002). If it is the only possibility of this urban mugger mass, then the question is why no muggers were reported or sighted in the city of Vadodara, during 1970 to 1985? There is not a single reference about muggers' presence in this river stretch, especially during these years.

I have willingly checked with local newspapers and senior citizens whether they heard about muggers sighted or reported muggers in the city or in this part of

Shwamitri River, including seniors staff members of Sayaji Baug Zoo (a 128 year old zoo), but I was unable to find any positive reply of presence of muggers in the past. It is surprising that muggers are found in this river stretch only after 1985.

Also, there is another possibility about mugger population found in the river. There are two captive facilities for wild animals, Sayaji Baug Zoo and Maharaja Fathehsinh Rao Zoo Trust (now closed) in Vadodara City and both are maintaining a small population of the species (Rawal, 1999). And some how, few of muggers escaped and they might have established in the river, either they escaped accidentally or through floods. I believe that the presence of mugger population in Vishwamitri is the result of both possibilities. Because every 8 – 10 years, a flood is recorded in the area and river also often flows over the danger mark level and this affects both the zoos (both situated on banks of river). Additionally, there are records of wild animals which escaped and were lost in the floods. However, it is a fact that mugger population is flourishing well in this river sys-



Fig. 6. Five feet long crocodile with half cut upper jaw was rescued by GSPCA from Fokal village, Savali, Vadodara and after treatment the animal was released in Sayaji Sarovar at Ajwa (photo by Rajesh Bhavasar).

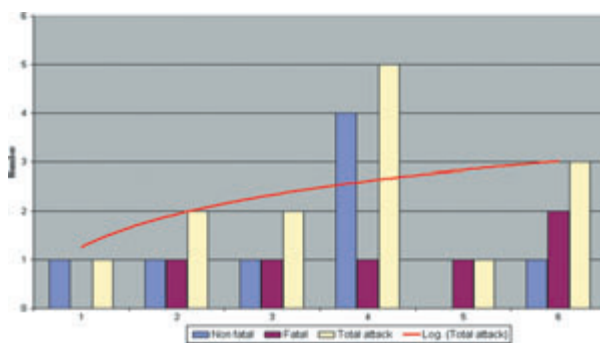


Fig. 7. Trend of mugging attack at Vadodara, Gujarat, India.

tem and day by day it is creating problems for the people of Vadodara. Today few wildlife enthusiasts are advocating for saving such wild animal and rescuing them from human settlement areas too. But from last few years it is observed that the trend of mugging-human conflicts has a notable increase (Fig. 7). Such incidents are

increasing due to the increase in mugging census and on other hand the comparative decline in the availability of food and space. Muggers are killed due to terrifying attacks. This shows that some citizens of Vadodara are depressed and do not favor the coexisting muggers. They do not believe in mugging conservation and have lost the patience and lenience towards the species. There has been a rapid increase in the figures of rescued muggers from human settlement areas in last few years, which is a result of the following three possibilities: 1) the growth of mugging population; 2) the awareness among the people; 3) human encroachments increasing on river banks areas. Present data show that the release of rescued muggers from human settlement areas in Sayaji Sarovar is not a suitable solution to the problem. Because it is observed that, some of muggers are re-rescued from the same urban area (Bhatt, 2000), from wherein they were earlier captured (Table 4).

Recapturing same animals from particular areas shows that the released site is unable to accommodate extra numbers of crocodiles, or they come back due to



Fig. 8. A young boy killed by a mugger at Sama, Vadodara (June 2007).

TABLE 4. List of Rescued and Re-Rescued Muggers (*Crocodylus palustris*) from Vadodara City

No.	Details	1 st time rescued	2 nd time rescued	3 rd time rescued
1	ID (Tag) No. Date of Rescued Rescue location Released site	24 07/06/1998 Karelibaug, Vadodara City Sayaji Sarover	24 07/23/2007 Karimpur, Nr. Nimeta, Vadodara City Sayaji Sarover	
2	ID (Tag) No. Date Rescue location Released site	56 07/12/2001 Akota, Vadodara City Ajawa Sarover	56 07/26/2007 Dumad village, highway Ajawa Sarover	56 08/16/2007 Dumad Ajawa Sarover
3	ID (Tag) No. Date Rescue location Released site	67 10/24/2001 GIDC, Makarpura, Vadodara City Sayaji Sarover	67 07/13/2002 Antoli, Nr. Nimeta Sayaji Sarover	
4	ID (Tag) No. Date Rescue location Released site	148 10/26/2004 Vijay Nagar, Tarsali, Vadodara City Sayaji Sarover	148 07/18/2007 Vasana, Nr. Sonkhada Sayaji Sarover	
5	ID (Tag) No. Date Rescue location Released site	233 07/06/2007 Tulsivadi, Karelibaug, Vadodara City Sayaji Sarover (Fig. 8)	233 18/09/2007 Sagar Film city, Vadodara City Sayaji Sarover	

some kind of strong instincts of homing range. Therefore, a detailed study is required to find out the carrying capacity of the Sarovar, size of population and other al-

ternate water body for these animals. It is high time to design an action plan for the species, to evaluate our wildlife conservation strategy and re-formulate policies.

RECOMMENDATION

Here I have few important suggestions in favor of long term conservation of crocodile, after my 21 year study of the mugger population of Vishwamitri – Dhadhar River System:

1. The mugger population of Vishwamitri River should be monitored, regularly.
2. Every 5 – 7 years, a mugger survey to be carried out in the entire river system.
3. Locate nests and shift the eggs for artificial incubation to control the population.
4. Prevent encroachments on the river bank.
5. Rescued muggers should be released at new water bodies after being uniquely marked for identification.
6. Notorious and culprit large-sized muggers should be kept in captive facilities/zoos.
7. Launch an awareness program to propagate conservational value of muggers
8. Design new action plan at state levels on mugger crocodile.
9. Create a rescue and rehabilitation center for such wild animals.
10. A good coordination agency in between the state forest department, and other NGOs, Zoos and local wildlife enthusiasts is required as a mediator.

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