## 1<sup>st</sup> Survey of Mugger and Birds in Kaliyashot and Kerwa reservoirs, Bhopal, Madhya Pradesh

A Comprehensive report

February - 2022





Organised By Bhopal Forest Division Supported By Bhopal Birds Conservation Society, Bhopal





मप्र वन विभाग

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Report Submitted to

## **Divisional Forest Officer**

**Forest division, Bhopal** 

Submitted by

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### Acknowledgments

We are indebted to Shri Ravindra Kumar Saxena, Chief Conservator of Forest Bhopal Circle for his initiative and support for the Mugger and Bird survey, without his support this survey wouldn't have been completed. We sincerely appreciate Shri Alok Phatak, Divisional forest officer of Bhopal forest division, for his keen interest and valuable suggestions. We sincerely thank Shri R.S. Bhadoria, SDO, Bhopal Forest Division for inviting us to carry out the training to forest staff and survey work and also for the support and active participation, and for his sustained interest and logistic support and encouragement at every step during the survey. We are also thankful to Range officers and frontline forest staff for their assistance and active co-operation during the survey work. Special thanks to Dr Dhriti Banerjee, Director Zoological Survey of India; Dr S. Sambath, Officer-in-Charge, ZSI-CZRC, Jabalpur for the necessary permission to undertake the survey.

#### **Executive Summary**

To estimate the population of crocodilians and birds in the Kaliyasot and Kerwas reservoirs of Bhopal, a census was carried out for a period of three days from 18th to 20th February 2022. Kaliyasot reservoir has been a safe abode for mugger (Crocodylus palustris), for the past several years, but in the absence of any detailed studies in the past no specific data is available. Extensive study was recently undertaken to establish proper status of the mugger population density. The present study was also carried out for the status of Turtles and other important aquatic bird species present in the area. The habitat features, dam profile, data were also collected. A total of 22 Mugger (9 adults, 12 sub adults, 1 Juvenile, and 2 gharials) were recorded in the study area. Along with this, Indian softshell turtle (Nilssonia gangeticus), and 102 species of aquatic and terrestrial birds were also sighted. Some recommendations have been suggested on the basis of observations during the present survey. The survey results provide baseline information which would assist in developing conservation and management action plan for the area.

## INTRODUCTION

Crocodilians, which include both crocodiles (family Crocodylidae) and Gharial (Family: Gavialidae), are group of large, semi-aquatic reptiles found in most of Africa south of the Sahara, Madagascar, India, Sri Lanka, Southeast Asia, the East Indies, northern Australia, Mexico and Central America, the West Indies, and northern South America. They are poikilo-thermic or ectothermic animals relying on external sources to maintain their body temperatures. India is home to three species of Crocodilians, comprising two species of crocodiles (mugger and salt-water crocodile) and Gharial. Madhya Pradesh holds a good population of both mugger and Gharial, both of which are categorized as globally threatened species. While Gharial- Gavialis gangeticus (Gmelin, 1789) is listed as Critically Endangered with pocketed viable population distributed mostly in Ganges and Chambal, mugger-Crocodylus palustris (Lesson, 1831) is a widely distributed species and is listed as Vulnerable as per the IUCN Red List. Both mugger and gharial is the apex predator of the aquatic ecosystem and is responsible for maintaining a healthy ecosystem. However, due to anthropogenic activities such as pollution, poaching and loss of prey, both the species are threatened in their distribution range.

The Muggers is India's freshwater crocodile and lives in streams, rivers, lakes, reservoirs and ponds almost throughout the country. Muggers usually eat fishes, frogs, snakes, crustacean, birds and large mammals. They also eat dead animals found in or near water and help in keeping the environment clean. Fish forms an important part of the Mugger's diet. When streams and ponds dry out in the hot season, fish are easy to catch in the dwindling waters. Crocodiles usually know the size of animal they can handle and rarely attack anything to big.

The crocodile plays a vital ecological role as a master predator in the aquatic habitats where it lives. Crocodiles can swallow food whilst submerged without swallowing water, by the contraction of the muscular flaps around the food. They are much more efficient at using the food they eat, with very little wastage, their excellent digestive system even digests bones. The ears comprise a flap situated on each side of the head. The flaps can be opened or closed to facilitate hearing. The eyes are well developed. A third transparent eyelid is used as a screen when a crocodile goes underwater. The metabolic rate of a crocodile is controlled by its body temperature, as it is a cold-blooded animal it basks under the sunlight to maintain its body temperature into a certain range. This unique system allows a crocodile to lie dormant, reduce its metabolic rate and thus utilize the food and oxygen supply in its body very slowly. The male is larger than the female. Sexes are difficult to determine at an early age.

Mating takes place in the water, and a month later the female has to start thinking about laying her eggs. She finds a safe, undisturbed sand or earth bank near the water edge to make her nest. Sometimes she digs several trial nests with her hind feet before choosing the perfect place. Then one night, she lays twenty to thirty eggs and covers them carefully with earth. Crocodiles have two basic nesting patterns, digging a pit in an exposed sandbank and laying eggs in the bottom of it and building a mound nest of a mixture of mud and vegetation and laying their eggs within it. Muggers lay 20-30 eggs in holes during the dry season (March/April) about 40-45 days after mating and incubation for typically 65-70 days. It is listed in Schedule 1 Part II under Wildlife (Protection) act 1972, and it is categorized as vulnerable. Out of the three species of crocodile found in India, the most widespread is the broad-snouted mugger crocodile (*Crocodylus palustris*), also known as marsh crocodile, which inhabits all kinds of freshwater habitats such as rivers, lakes, reservoirs, hill-streams, village ponds and manmade tanks. Like all crocodilians, mugger also basks for long hours, if left undisturbed. They bask mostly at the bank of water bodies, rocks and therefore, permit easy vision under general precautions. Basking behaviour is very well pronounced during the winter season, and therefore, there is a good probability that all animals can be counted in a single operation. Under normal conditions, basking sites of mugger do not change and territorial basking behaviour in crocodilians form a good clue for census.

Crocodilians are reptilian but are more aquatic than terrestrials. Basking is a very striking behaviour of crocodilians as they come out of the water to regulate body temperature. Being ectothermic (body temperature dependent on the Surrounding environment) they lose body temperature during the cool hours of the night and come out during the day for basking to gain back the temperature. During the winter month, if left undisturbed, crocodiles spend long hours for basking on the bank of the water bodies or rocks and Islands. During the summer months, crocodiles avoid the high temperature of the day and spend much of their time floating or submerged in water. Crocodile census is mostly done during winter months, as these animals come out on the water edges and sometimes away from water to bask in winter days. During the census the crucial factors affecting the sighting of crocodiles are air temperature, water temperature, sunshine, wind speed, survey time and water levels.

The surveyor experience also affects detection rate and the ability of the surveyor to detect crocodilians quickly increases with experience. In the areas where there are more than one species living in sympatry and for size estimation, the accuracy can only be obtained through a highly skilled surveyor. For crocodilian census, different survey methods are conducted and replicate counts increase the probability of detecting a real effect. The daylight survey gives an idea about distribution, territory, and microhabitat along with the population structure. Daylight survey can be done either by boat or foot patrolling along the bank.

In Bhopal City Kerwa and Kaliyashot reservoir are one of the most important wetlands around the city along with forest area which increase value of avian diversity. In year 2006 a baseline data of both reservoirs has been made by Bhopal Birds and Bhopal Forest Circle published by the title "Birding in Bhopal" As per this publication avian diversity of Kerwa Reservoir was 105 species and Kaliyashot was 88 Species which shows its richness of avian diversity. This survey of mugger and birds in Kaliyashot and Kerwa Reservoir is proved to be a milestone in the study of biodiversity of Bhopal and helps in making conservation strategies for mugger and birds species.

## **OBJECTIVES**

- 1. To survey Kaliyasot and Kerwa reservoirs to estimate the population of Crocodilians and birds.
- 2. To suggest measures for long-term conservation of the species in Bhopal.
- 3. To train the frontline staff in monitoring muggers and collecting information year-round.
- 4. To identify birds species and update in old records.

## METHODOLOGY

The survey was coordinated by Shri R.S. Bhadoria, Assistant conservator of Forest, Forest Division Bhopal. The team was led by Dr. R.K. Sharma Wetland Expert and member of IUCN/Crocodile Specialist Group; Dr. Pratyush P. Mohapatra, Scientist D at Zoological Survey of India, Jabalpur and Mr. M. Khalique, Bhopal Birds Conservation Society, Bhopal. The team also consisted of Range Officers, Foresters, Forest Guards, Researchers and other Forest Staff. The crocodile and bird census was conducted for three days from 18<sup>th</sup> to 20<sup>th</sup> February 2022, including one-day training programme ahead of the survey. A total of 40 participants took part in the survey and were trained by the experts followed by field training at Kerwa reservoir. During the preparatory meeting on 18<sup>th</sup> February, the participants were trained by the experts on crocodile census techniques and bird surveys by delivering lectures. The participants were trained to identify different size groups of mugger in their habitats through visual estimation. To estimate the body length of submerged crocodiles if only the front part of the body (up to the beginning of the tail is visible), the total length was calculated by doubling the approximate snout-vent length (2 X SVL) and if only the head (up to the post-occipital scute) is visible then the total body length (TBL) was calculated as 7 times of the head length (7 X HL).

A total of seven survey teams were formed, each comprising 5-6 members to explore the entire area of both Kaliyashot lake and Kerwa reservoirs, of which 4 teams surveyed by boat and three teams by foot-patrolling. Each team was supplied with data sheets to record field observations, binoculars and cameras to spot and take pictures of the crocodiles and birds and a GPS to record the coordinates. Each team was also instructed to interact with the local people and staff to get information on the presence of muggers in the study area. A core team comprising experts visited all the sites to monitor the programme.

The survey started from 8 am to 12:00 noon between the temperature range of 18-24 °C followed by sharing of information by each team. The survey was conducted in February, which is usually the most suitable time for the Mugger survey in the Central India landscape, as the animals can be easily detected when they come out for basking when the water temperature is low. We followed the standard mugger census methodology as provided by Patnaik et al. (2008) and Sharma and Singh (2014).

## **STUDY AREA**

Kerwa and Kaliyashot Reservoirs are located near Bhopal, the capital city of Madhya Pradesh and are an important source of water for the city. The area around the dams is a popular picnic spot that attracts several tourists from Bhopal. Kaliyasot Dam, situated in the outskirts of the Bhopal city is one of the important sources of water for Bhopal and irrigates for over 10,000 Ha of agricultural land in Bhopal and Raisen districts. The dam was constructed for irrigation and has become one of the most popular recreational spots for people, located away from the dense, urbanized city and surrounded by hills and woods. It is fed by the Kaliasot river, a tributary of Betwa and is also fed by the Upper Lake through the Bhadbhada Dam over its downstream. The dam derives its name from Kalyan Strote, one of Raja Bhoj's ministers who developed the Upper Lake spillway. The National Park of Bhopal 'Van Vihar' is situated in the catchment area of Kaliasot River, which also has some scattered settlements. The flow of this river is very limited except in the monsoon season and is around 29 km long (Silawat et al., 2021).



The Kerwa reservoir, situated in the south-western part of Bhopal, is constructed on Kerwa River to provide water for irrigation. With a catchment area of 34.5 km<sup>2</sup> and a gross storage capacity of 25 M cum., it caters to 35 villages of the nearby district for various activities.



Figure-1. Location of study area

## **RESULTS AND DISCUSSION**

During the survey, all the sighted muggers were counted and marked on the field map sheets (Table-1 & 2 and Fig 2 & 3). The survey was repeated for two days and duplicate sightings were eliminated. The total length of the mugger sighted was estimated and noted. The total number of muggers sighted in the survey, in all sizes was found to be 22. The adult population was 09 (40.90%), the population of sub-adults 12 (54.54%) and juvenile 01 (4.54%). The presence of Juvenile supports a viable breeding population, thereby indicating a positive trend in the Mugger population in Kaliyashot Reservoir.

The present survey was done by motorboat, rowing boat, and on foot around the entire periphery of the reservoir. This was a preliminary survey, and a detailed survey should be done in the future. During the survey it was found that there is a scarcity of basking and nesting grounds, so emphasis should be given towards habitat improvement. Sandy areas can be developed at different sites artificially by sand filling. It was also felt necessary to carry out an extensive study on the diversity of aquatic fauna, which forms the major diet for muggers.

## Turtle

Turtles sighted were counted and noted on the datasheets. During the survey two adult Indian Soft-shell turtles-*Nilssonia gangetica* (Cuvier, 1825) were sighted in Kaliyashot Reservoir, which is a species listed in Schedule-I, Part-II of Wild Life (Protection) Act, 1972 and is an Endangered species as per IUCN Red List. Furthermore, an exotic species of Red-eared slider was spotted in the Kaliyasot reservoir, which needs awareness among the public to deter them from releasing these exotic pets into the aquatic ecosystem.



Red-eared slider Trachemys scripta

#### **Birds**

A total of 102 birds species reported in both reservoirs during the survey with in 37 families .Kerwa reservoir has 78 bird species and Kaliyashot has 69 birds species have been recorded (Table No.3). During this survey two Vulnerable species as Common Pochard and River Tern and two species of Near Threatened species as Painted stork and Black-headed Ibis were recorded.

102 birds species recorded in three day survey is reveling the avian richness of the study area.



Figure 2. Crocodile sighting in Kaliyashot reservoir, Bhopal.



Figure 3. Crocodile sighting in Kerwa reservoir, Bhopal

		Kaliyashot Reserv	voir	
	Gps Coordinates	Place	Size	Remarks
S.No				
1.	23°12'23"N	Smritivan,	Adult	Direct sighting,
	77°22'15"E	Kaliyashot		on a small
				exposed rock
				inside water
2.	23°12'15"N	Smritivan,	Adult	Direct sighting,
	77°22'16"E	Kaliyashot		edge of water
3.	23°12'16"N	Smritivan,	Sub adult	Direct sighting,
	77°22'18"E	Kaliyashot		edge of water
4.	23°12'16"N	Smritivan,	Sub adult	Direct sighting,
	77°22'15"E	Kaliyashot		edge of water
5.	23°12'15"N	Smritivan,	Adult	Direct sighting,
	77°22'16"E	Kaliyashot		on land, edge of
				water
6.	23°12'16"N	Smritivan,	Sub adult	Direct sighting,
	77°22'18"E	Kaliyashot		edge of water
				along the water
				hyacinth
7.	23°12'17"N	Smritivan,	Sub adult	Direct sighting,
	77°22'21"E	Kaliyashot		on land, edge of
				water
8.	23°12'18"N	Smritivan,	Sub adult	Direct sighting,
	77°22'23"E	Kaliyashot		on land, edge of
				water
9.	23°12'20"N	Smritivan,	Adult	Direct sighting,
	77°22'23"E	Kaliyashot		on land, edge of
				water
10	23°12'28"N	Smritivan,	Sub adult	Direct sighting,
	77°22'33"E	Kaliyashot		on land, edge of
				water
11.	23°12'22"N	Bhadbhada	Adult	Direct sighting,
	77°22'35"E	Dam, Kaliyashot		on land, edge of
				water

12.	23°12'15"N	Back Water	Sub adult	Direct sighting,
	77°22'35"E	Near		on land, edge of
		Bhadbhada		water
		Dam, Kaliyashot		
13.	23°11'54"N	Kaliyashot	Sub adult	Direct sighting,
	77°23'06"E	Backwater		on land, edge of
				water
14.	23°11'35"N	Near Kaliyashot	Adult	Direct sighting,
	77°23'49"E	Bridge		on land, edge of
				water
15.	23°12'02"N	Mahakali Mata	Sub adult	Direct sighting,
	77°23'51"E	Mandir,		on land, edge of
		Kaliyashot		water
16.	23°12'07"N	Mahakali Mata	Adult	Direct sighting,
	77°23'55"E	Mandir,		on land, edge of
		Kaliyashot		water
17.	23°12'03"N	Mahakali Mata	Sub adult	Direct sighting,
	77°24'00"E	Mandir		in water
18.	23°12'11"N	Pt.Khusilal	Sub adult	Direct sighting,
	77°24'16"E	Ayurvedic		edge of water
		Hospital		
19.	23°12'18"N	Pt.Khusilal	Juvenile	Direct sighting
	77°24'18"E	Ayurvedic		
		Hospital		
20.	23°12'16"N	Pt.Khusilal	Adult	Direct sighting,
	77°24'24"E	Ayurvedic		on land, edge of
		Hospital		water
21.	23°11'36"N	Near Walmi	Adult	Direct sighting,
	77°23'50"E			on land, edge of
				water
		Kerwa Reservo	ir	
22.	23°10'24"N	Near Kushalpura	Sub adult	Indirect
	77°21'17"F	Village, Kerwa		evidences,
		Lake		fishermon
				IISHEITHEIT

Name of site	Adult (>1.8m)	Subadult (1.2- 1.8m)	Juvenile (0.9- 1.2m)	Yearling (0.45- 0.9m)	Hatchling (<0.45m)	Total
Kerwa and Kaliyashot Reservoir	09	12	01	0	0	22

## Table-2 Sighting number of Muggers in Kerwa and Kaliyashot Reservoir



Table-3. Sightings of Avian Species in Kaliyashot and Kerwa Reservoirs

				ROUTE-1	ROUTE-2
S.No	FAMILY	COMMON NAME	SCIENTIFIC NAME	KERWA RESERVOIR	KALIYASHOT RESERVOIR
	PODICIPEDIDAE				
1		Little Grebe	Tachybaptus ruficollis	•	•
	PHALACROCCORACIDAE				
2		Large Cormorant	Phalacrocorax carbo	•	•
4		Little Cormorant	P.niger	•	•
	ARDEIDAE				
6		Grey Heron	Ardea cinerea	1	•
7		Cattle Egret	Bubulcus ibis	•	•
8		Large Egret	Casmordius albus	•	•
9		Intermediate Egret	Mesophoyx intermedia	•	•
10		Little Egret	Egretta garzetta	•	•
11		Black-crowned Night Heron	Nycti <mark>co</mark> rax nycticorax	•	
12		Purple Heron	Ardea purpurea	•	•
13		Pond Heron	Ardeola grayll	•	•
14		Striated Heron	Butorides striata	1000	•
	CICONIIDAE				
17		Painted Stork	Mycteria leucocephala	•	•
18		Openbill Stork	Anastomus oscitans	•	•
19		Woolly-necked Stork	Ciconia episcopus	•	•
	THRESKIORNITHIDE				
20		Black-headed Ibis	Threskiornis melanocephalus	- Jel 18	•
22		Black Ibis	Pseudibis papillosa	-/-5-	•
23		Glossy Ibis	Plegadis falcinellus	AN .	•



	ANATIDAE				
24		Lesser whistling Teal	Dendrocygna javanica	•	•
25		Ruddy Shelduck	Trdorna ferruginea		•
26		Northern Pintail	Anas acuta	•	•
27		Spot-billed Duck	Anas poecilorhyncha	•	•
28		Comb Duck	Sarkidiornis melanotos		•
29		Norther Shoveler	Anas clypeata		•
30		Common Pochard	Aythya ferin <mark>a</mark>	1	•
31		Red crested Pochard	Rhodonessa rufino		•
32		Gadwall	Anas strepera		•
33		Eurasian Wigeon	Anas penelope	11	•
	ACCIPITRIDAE				
34		Black- <mark>Should</mark> ered Kite	Elanus caeruleus	• 1	•
35		Oriental Honey- Buzzard	Pernis ptilorhyncus	•	
36		Black Kite	Milvus migrans	·/· •	•
37		Shikra	Accipiter badius	•	



Ruddy Shelduck Trdorna ferruginea

38		Crested serpent Eagle	Spilornis cheela	•	
	PHASIANIDAE				
39		Grey Francolin	F.pondicerianus	•	
40		Indian Peafowl	Pavo cristatus	•	
	RALLIDAE				
41		White breasted Waterhen	Amaurornis phoenicurus	•	•
42		Purple Swamphen	Porphyrio porphyrio	•	•
43		Common Moorhen	Gallinula chloropus	•	•
44		Eurasian Coot	Fulica atra	•	•
	JACANIDAE				
45		Bronze-winged jacana	Metopidius indicus	•	•
46		Pheasant-tailed jacana	Hidrophasianus chrurgus	•	•



River Tern Sterna aurantia

	RECURVIROSTRIDAE				
47		Black-winged Stilt	Himantopus himantopus	•	•
	SCOLOPACINAE				
48		Green Sandpiper	Tringa ochropus		•
49		Marsh Sandpiper	Tringa stagnatilis		•
50		Common Sandpiper	Actitis hypoleucos		•
	CHARADRIIDAE				
51		Red wattled Lapwing	Vanellus indicus	•	•
52		Little Ringed Plover	Charadrius dubius		•
	LARIDAE				
53		River Tern	Sterna aurantia	•	•
54		Brown headed Gull	Chroicocephalus brunnicephalus	•	•
55		Little Tern	Sterna albifrons	•	•



Spot-billed Duck Anas poecilorhyncha

	COLUMBIDAE				
56		Blue rock Pigeon	Columba livia	•	•
57		Eurasian Collared Dove	Streptopelia decaocto	•	•
58		Spotted Dove	S.chinensis	•	•
59		Laughing Dove	S.senegalensis	•	•
60		Oriental Turtle Dove	Sterptopelia oreintalis	•	•
	PSITTACIDAE				
61		Rose-ringed Parakeet	Psittacula krameri	•	
62		Plum-headed Parakeet	Psittacula cyanocephala	•	
	CUCULIDAE				
63		Greater Coucal	Centropus sinensis	•	
	STRIGIDAE				
64		J <mark>ungle</mark> Owlet	Glaucidiun radiatum	•	- V.
	APODIDAE				
6 <mark>5</mark>		Littl <mark>e Swift</mark>	Apus affinis	•	
	ALCEDINIDAE				
66		Pied Kingfisher	Ceryle rudis	•	•
67		Common Kingfisher	Alcedo atthis		•



Asian Openbill Stork Anastomus oscitans

68		White-throated Kingfisher	Halcyon smyrrnensis	•	•
	MEROPIDAE				
69		Green <mark>Bee-eater</mark>	Merops orientalis	•	
	CORACIIDAE				
70		Indian Roller	Coracias benghalensis	•	
	UPUPIDAE				
72		Common Hoopoe	Upupa epops	•	•
	BUCEROTIDAE				
73		Indian Grey Hornbill	Ocyceros birostris	•	
	CAPITONIAE				
74		Coppersmith Barbet	Megalaima haemacephala	•	
	ALAUDIAE				
75		Indian Bushlark	Mirafra erythroptera		•
76		Crested Lark	Galerida cristata	555	•
77		Rufous <mark>-taile</mark> d Lark	Ammomanes phoenicurus		•
78		Ashy-crowned Sparrow lark	<mark>Eremopterix</mark> grisea	1/2	•
	HIRUNDINIDAE				
79		Barn Swallow	Hirundo rustica	60.0	•
80		Wired-tailed Swallow	Hirundo smithii		•
81		Red-rumped Swallow	Cercropis daurica		•



Large Cormorant Phalacrocorax carbo

82		Streaked throated swallow			•
	LANIIDAE				
83		Bay-backed Shrike	Lanius vittatus	•	
84		Long-tailed Shrike	Lanius schach	•	•
	DICRURIDAE				
85		Black Drongo	Dicrurus macrocerus	•	•
	STRUNIDAE				
86		Asian Pied Starling	Sturnus contra	•	•
87		Common Myna	Acridotheres tristis	•	•
	CORVIDAE				
88		Rufous Treepie	Dendrocitta vagabunda	•	
89		Jungle Crow	Corvus macrorhynchos	•	
	MOTACILLIDAE				
90		Ye <mark>llow W</mark> agtail	Motacilla flava		•
91		Citrine Wagtail	Motacilla citreola	•	•
92		White-browed Wagtail	Motacilla maderaspatensis	•	•
	PYCNONOTIDAE				
93		Red vented Bulbul	Pycnonotus cafer	16.00	•
	TIMALIINAE				
94		Common Babbler	Turdoides caudates	•	
95		Large grey Babbler	Turdoides malcolmi	1. Je/ /s	
96		Jungle Babbler	Turdoides striatus	-/•**	
	NECTARINIIDAE				
97	1	Purple Sunbird	Cinnyris asiatica	•	
	CISTICOLIDAE				
98		Common Tailorbird	Orthotomus sutorius	•	
99		Jungle Prinia	Prinia sylvatica		

100		Ashy Prinia	Prinia socialis	•	
101		Plain Prinia	Prinia inornata	•	
	ZOSTEROPIDAE				
102		Oriental White-eye	Zosterops palpebrosus	•	



White-browed Wagtail Motacilla maderaspatensis



Black-winged Stilt Himantopus himantopus

## RECOMMENDATIONS

- 1. Continuation of crocodile and gharial monitoring at least every year through capacity building and training of frontline staff concerning mugger and turtle conservation.
- 2. Continuous study on status survey of muggers in both Kaliyasote and Kerwa lakes to understand their ecology, habitat utilization, dispersion, territoriality, nest site selection and human-crocodile interaction in the human-dominated waterscape areas of Bhopal. Biological monitoring (through different seasons) is essential for the proper management of the reservoir ecosystem and its biotic resources. Careful monitoring of the mugger population in the Reservoir should be continued. It is recommended that special emphasis be given to the protection of mugger nesting sites, especially during the nesting season.
- 3. To prepare a long-term conservation action plan for muggers and turtles of Bhopal
- 4. Putting of signage in crocodile inhabiting areas and maintenance of bathing guards to avoid negative interaction with humans.
- 5. Awareness among visitors, farmers, fishermen, students and other stakeholders through ICT materials and print and television media, may help gain attention for conservation of these threatened species.
- 6. Increase of vegetation cover along the banks used by the mugger and creation of inviolate zones for both mugger and gharial by fencing crucial areas used by both the species.
- 7. Setting of a rapid response team by trained forest staff to deal with crocodile rescue instances during floods

8. Revival/ initiation of an aquatic reptile research centre in Bhopal to study the biology and behavior of crocodilians and turtles specifically in Kaliyasote Lake.

9. As Kaliyasote is not the natural environment for the Gharials, the thriving individuals may be rehabilitated in their natural habitat or are to be kept in captivity.

10. Bhopal city development plan and well as the Watershed Development Programme of Bhopal to include crocodile management in their development projects.

11. An annual census of key aquatic fauna and major aquatic birds should be done throughout the water body. Census is also required to provide information on the rate of change in population trends.

12. Regular monitoring of area should be needed specially in winter bird migration.

13. Training and awareness program should be needed for the fisherman and stakeholders of the area to conserve avian diversity and muggers.

## **GLIMPSES OF ACTIVITIES**



























