

Crocodile Specialist Group Steering Committee Meeting

Skukuza, Kruger National Park, South Africa

22 May 2016

Regional Report: South Asia and Iran

Bangladesh

The World Bank (WB) funded a project titled “Strengthening Regional Cooperation for Wildlife Protection (SRCWP)” for the South Asian countries. The project objective is to assist the participating governments to build or enhance shared capacity, institutions, knowledge and incentives to collaborate in tackling illegal wildlife trade and other select regional conservation threats to habitats in border areas. The project applied a two-pronged approach: (i) capacity building to address the illegal wildlife trade through regional cooperation; and (ii) habitat protection and management to generate regional conservation benefits and address the human-wildlife conflict, thereby ensuring the conservation of flagship species such as the tiger, snow leopard, rhinoceros and elephant in increasingly fragmented habitats. The interventions would enhance the knowledge and capacity of the relevant agencies of the participating countries - Bangladesh, Bhutan, India and Nepal - to carry out conservation based on a landscape approach and also to address wildlife trafficking.

Under the SRCWP Project administered by the Bangladesh Forest Department (BFD), Centre for Advanced Research in Natural Resources & Management (CARINAM) was awarded a two-year sub-project titled “Population Assessment, Protection and Conservation of Saltwater Crocodiles (*Crocodylus porosus*) in the Sundarban Reserve Forest, Bangladesh” with the following objectives:

- Assess the crocodile population in the wild, including identification of ecologically important habitats including nesting sites
- Protect natural nest sites
- Prepare management and action plan for population recovery

CARINAM started the project activities in March 2014, and which will end in May 2016. Fieldwork has been conducted over the two years and data gathered is currently being analyzed. Transects were selected randomly for the monthly monitoring and surveys conducted during the daytime and limited night surveys. Moreover, dedicated diurnal survey during winter (Jan-Feb) was also done to count the crocodiles through direct sighting. The numbers were very low compared to the available habitat. The Bangladesh Sundarban cover an area of 6000 sq km, where thousands of saltwater crocodiles can survive but unfortunately the initial assessment suggests that the population has drastically declined. The numbers would be disclosed once the analysis is completed and the BFD/WB authorizes the disclosure. No nests were found and no hatchlings observed during this two-year survey suggesting ‘zero’ natural recruitment, which is a cause of serious concern. The study demands further intensive investigation to reveal the factors causing the decline in the natural population of the saltwater crocodiles in the Sundarban, Bangladesh. Through this we would appeal to the donor community to fund this project so that the threats and other potential factors posing hindrances to the natural recruitment are addressed properly. The management plan for

recovery of the natural population is also under preparation to meet the project deliverables but without identifying the underlying causes of the population decline, how much the management plan will help is questionable! The results of the population assessment will be published once the analysis is done and the BFD/WB gives clearance.

The SRCWP Project is also funding a project for the survey of gharials and explores means for recovery and restoration of gharials in their natural habitats - the Padma and Jamuna Rivers. The project is being implemented by IUCN-Bangladesh Chapter

Human-Crocodile Conflict

HCC incidents were not properly recorded in the past but during the survey it was observed that the numbers of such incidents are worth mentionable. The government has, through the Bangladesh Wildlife Act 2012, started giving compensation the victims of HCC.

Meeting of CSG members in Bangladesh

A meeting of the CSG members in Bangladesh was held at the IUCN-Bangladesh office during the visit by Mr. Romulus Whitaker (19 May 2015). The Country Representative, IUCN-Bangladesh presided the meeting. CARINAM's work on Sundarban crocodiles, and performance of the commercial crocodile farms was discussed.

Iran

Conservation measures

- To improve the legal protection, department of the environment increased the fine for illegal killing of Mugger crocodiles from 32 million Rials to 100 million Rials, proposing to increase more.
- The captive rearing center in Riko Kash is developing, keeping more than 40 crocodiles in different life stages, planning to have more public awareness role in the region.
- A project named "Ecosystem approach management of Hure Bahu wetlands (Mugger crocodile habitats)" defined and funded by the Deputy for Natural Environment of DOE which has the main aims of management of crocodile habitats and conducting conservation activities.
- A local interested NGO is planning to establish a farm with conservation and education aims, they have official permissions from DOE and local government, and seeking funds and securing a suitable land. It would need some international and technical supports from the CSG. They started some public awareness and education activities too.
- Members of CSG in Iran tried to participate in the 22nd CSG working meeting, but due to some local problems were unable to attend. Some papers and reports based on the activities and results and the situation of the species in the country were published in the Proceedings. Some other papers have been published in international journals.
- Some public awareness activities and local people participation in activities conducted by local offices of DOE in the region.
- * A book titled "Gandou, Iranian Crocodile" has been compiled by Asghar Mobaraki and Elham Abtin, supposed to be published in 2 months.

Nepal

Report not received as of 12 April 2016

Pakistan

The interest in the establishment of Mugger Crocodile (*Crocodylus palustris*) Breeding Centers in Sindh Province continued during the period 2014-2016. The number of Crocodile Breeding Centers increased from 24 to 40 (unofficial figures); all the Breeding Centers have however not registered with the Sindh Wildlife Department. Farmers with large land holdings have established some breeding farms on their lands in *mufassil* (not in the urban areas); only a few farms are located within or around Karachi, the metropolitan city. The experience gained in the management of crocodile populations at Government Breeding Centers at Khar Captive Breeding Center, near Karachi (population of 34 breeding individuals) and at Haleji Wildlife Sanctuary (almost in a wild state, population of 25-30 individuals) in Thatta district has been useful in extending expertise to private breeding centers.

Samzu Breeding Centre and Research Centre at Gadab, Karachi continued to flourish; the 10 acre (4 ha) with 42 adults (12 breeding pairs and 180 hatchlings of the previous year. The habitat includes a large lake, marshy and swampy areas; around 40 nesting/hatching points and scientifically designed hatcheries that can hold up to 400 young at a time for at least 2 years. Jatoi Farm at Nau Shehro-feroze has 50 adult Mugger in captivity. The oldest captive crocodile facility at Manghopir (about 150 individuals) is thriving because of the legendary spiritual attachment of crocodiles with the patron saint.

The purpose of establishing Private Crocodile farms, so far, has mainly been Recreation. However some progressive farmers have been planning to commercially harvest their crocodiles. They are seeking the permission to harvest the captive crocodiles that are now being considered to be burdensome, as in the absence of any harvesting, the increasing population can become burdensome and could also be prone to diseases and competition among themselves. For this they are approaching the Ministry of Environment to grant permission as the crocodile in all the provinces has been included in the lists of Protected animals, whose hunting in any form, is prohibited. The law however is silent on this and, some further probe in this regard, and stakeholders' favourable opinion could be considered before the Permission is granted. Crocodile farming thus could gain the confidence and besides starting the harvesting of surplus males would continue to attract recreation mongers.

Wild Mugger populations in Sindh exist in Deh Akro, Nara canal, Nara desert, Chhotiari reservoir complex and Haleji lake. Bakar and Paksiri, Pakseri, Makhi, Dangewari Lake and Nadiaser Lake are important wetlands in Chhotiari and Deh Akro Complex areas. The estimated population (reported by the protection staff of respective wildlife departments) in the wild and in Public Sector Crocodile Breeding Centers in the year 2015-2016 is as follows:

Sindh: Mugger Breeding facilities in Sindh = 40			2013-14 report
1	Chhotiari reservoir complex and adjoining seepage ponds	128	120
2	Deh Akro complex and adjoining seepage areas	60-70	60-70
3	Nara canal	50	20
4	Nara desert	35	30
5	Haleji lake	20-25	25-30
6	Stragglers in irrigation canals and the fish farms	20	20
7	Khar Breeding Centre, Khirthar National Park	40	34
8	Manghopir shrine, Karachi	150	120

During the two year period there has only been a marginal increase in the number of crocodiles probably due to increased awareness in perception of local communities.



Crocodiles at Manghipir shrine, Karachi

The single facility in the Punjab province at Punjab Wildlife Research Institute, Faisalabad suffered a setback when the hatchlings of the previous years could not survive. Only one female laid eggs in 2015 and vigorously guarded the eggs. Even after 80 days when the hatchlings did not appear and the female lost the interest, the nest was dug out. Remains of 24 eggs were found broken or rotten. Laying of eggs will again be closely watched this year.

No captive breeding facility has been reported from Balochistan. Crocodile in the wild have however been reported from North-East Balochistan from Sibi and Jaffarabad districts, Lasbela district, and South-Western stretch from Hingol, Basol and Dashat and Nahang and Kach Kuar in District Gwader, Nari, and Hub. Population surveys have not been conducted recently.

Under natural and farmed conditions, marsh crocodiles in Sindh nest primarily during the hot and moist season between late June and July. A female lays only one clutch of eggs in a nesting season with an average number of 40 eggs. The soft-shelled eggs are on an average of 8 cm in length and 5 cm in width. The eggs are laid during a single laying event, normally at night or early in the morning, into a previously constructed mound nest constructed of soil and vegetation.

In the wild, female marsh crocodiles will reach sexual maturity at around 12 years of age (2.3 m) and males around 16 years of age (3.35 m). In comparison, crocodiles raised in captivity reach sexual maturity at 5 and 7 years of age, respectively for females and males. When a female first reproduces, the number and size of the eggs is small. Additionally, fertility is generally poor and survivability of any resultant hatchlings is reduced. However, after three or four breeding seasons, the number of eggs, egg size, fertility and embryo survivability increases substantially.

WWF Pakistan is working with village communities around the major crocodile habitat in Sindh i.e. Chhotiari reservoir, one of the major crocodile habitat. Within Chhotiari reservoir area Makhi forest is the prime habitat that supports the marsh crocodile along with other wildlife species such as hog deer (*Axis porcinus*), smooth-coated otter (*Lutrogale perspicillata*) and a variety of resident and migratory birds. Makhi Development Organization (envisaging 8 villages in the vicinity) has been established in

coordination with WWF Pakistan with the objective of helping in conservation of natural resources. The community protects the biodiversity and the natural habitats in the area.

Damage to human and livestock populations has not been reported in recent years. Illegal hunting/killing of crocodiles for the purpose of trade seems to have not been resorted to as the dead crocodiles have been found with their skins intact. Crocodile killings have mainly been retaliatory for fear of their attack and/or ward off damages supposed to be inflicted by the crocodiles.

Hatchlings from the wild and even from Government controlled captive populations have been reportedly pilfered for the local influential landlords for stocking captive breeding farms in the private sector.

Water pollution from various sources has been considered to impact crocodile populations in Deh Akro Wildlife Sanctuary, Nara canal Wildlife Sanctuary and Chhotiari Reserve as revealed by water analyses conducted.

Sri Lanka

The first stage of the National Crocodile Survey was initiated and will comprise a long-term monitoring program at Bolgoda Lake system. Under the program, detailed habitat mapping and night time spotlighting to monitor crocodile numbers and demographics will be undertaken. The survey will expand to other selected areas of the island next year. A training workshop on crocodile catching, restraining and transporting has been scheduled for April 2016 as a part of the survey.

CSG members Avishka Godahewa and colleagues organised a training program for 12 rangers of the Dept of Wildlife Conservation (DWC) of Sri Lanka on safe capture, transport and release of problem crocodiles. Although the DWC is the official body managing crocodiles in Sri Lanka, proper training for its rangers is rare and this initiative by CSG Sri Lanka is aimed at building their capacity to restrain and safely relocate problem crocodiles. The group also visited places with a high human-crocodile conflict in Tissamaharama area, and built a crocodile exclusion enclosure with the help of the villagers. The same program will be conducted from 17 to 25 April 2016 for 50 DWC is the official including a power point presentation on crocodiles by Ansem de Silva.

Dinal Samarasinghe's surveys and awareness programs on the saltwater crocodiles in the Nilwala River, the river system with the most attention with regard to crocodile attacks, is continuing and a report of its second phase is in preparation.

Relevant publications

Amarasinghe, A. T., M. B. Madawala, D. S. Karunarathna, S. C. Manolis, A. de Silva and R. Sommerlad. (2015). Human-crocodile conflict and conservation implications of Saltwater Crocodiles *Crocodylus porosus* (Reptilia: Crocodylia: Crocodylidae) in Sri Lanka. *Journal of Threatened Taxa* 7: 7111-7130.

de Silva, A. and R. Somaweera. (2015). Were human babies used as bait in crocodile hunts in colonial Sri Lanka? *Journal of Threatened Taxa* 7: 6805-6809.

Samarasinghe, D.J.S. (2014). *The Human-Crocodile Conflict in Nilwala River, Matara (Phase I)*. Young Zoologists' Association, Sri Lanka.

India

1. Gharial (*Gavialis gangeticus*)

Estimation of Wild Population (Adult): 300-500 individuals survive in Chambal, Katarniaghat, Hastinapur, Gandak, Corbett, Ken and Son River and other populations in main Ganges, Hoogly and Mahanadi.

Captive Stock: Over 1000-1500 (in several Gharial rearing centers)

Distribution: India (Ganges and its tributaries such as Chambal, Son, Ken, Ramganga, Gandak, Sharda, Girwa and Mahanadi in Peninsular India)

Status: Critically Endangered (CR)

An urgent requirement of a concrete action plan has arisen for the conservation of the critically endangered Gharials in India, along with the trans-boundary regions of neighboring countries such as Nepal, Bangladesh, Bhutan and Pakistan. India may be addressed to provide and facilitate surplus stocks of Gharials to be spared for the neighboring countries for re-introduction in Brahmaputra (India), Indus (Pakistan) and Padma in Bangladesh.

Gharial is critically endangered in the wild and there exist only about 1000-1500 animals of various sizes in captive facilities. It is now being bred in several zoos and other captive facilities in India. There is an urgent need to formulate a proper plan for the future of these captive bred and reared Gharial stocks, especially under the direction of Central Zoo Authority, Ministry of Environment and Forest, Govt. of India.

Ongoing Activity – Highlights

1. **The tri-state National Chambal Sanctuary Management Plan** has been prepared by the expert committee formed by the Ministry of Environment and Forest, Government of India, which includes 5 members of the CSG including Romulus Whitakar, B.C. Choudhury, Tarun Nair, Nikhil Whitakar and R.J. Rao. The members approve proposed financial support for annual activities to be taken up by the three provincial states through which the Chambal River flows. The most recent meeting of the tri-state National Chambal Sanctuary Management Plan was held on 5 April 2016.
2. **Gharial Survey**: This is an ongoing study and survey by Dr. Tarun Nair, in collaboration with of Madhya Pradesh Forest Department, Foundation for Ecological Security (FES, Anand), and Ashoka Trust for Research in Ecology and the Environment (ATREE, Bangalore) to determining the status of Gharials and their habitat assessments, especially in Son River and Son and Ken Gharial Sanctuary.
3. **The Gharial ecology and radio telemetry project** is an ongoing study at Chambal River, led by Dr. Jeffery Lang and Madras Crocodile Bank Trust (MCBT) Staff supported by GCA with Indian researchers and collaborations of three state forest department (Uttar Pradesh, Madhya Pradesh, and Rajasthan) and Ministry of Environment, Forests, and Climate Change, Government of India.

In this Gharial ecology study, workshops and education programs were conducted by Ashutosh Tripathi (GCA/TSA staff). Three workshops were conducted for the various levels of FD personnel. Two of these were held in October at Garhaita village on the Chambal in UP for two groups of range officers and staff. Another was held in December at the Deori Centre, near Morena for MP Forest Department officers and staff. A Teachers Training Program carried out for elementary school teachers in Etawah District.

4. **Survival and Dispersal of head-started Gharial (*Gavialis gangeticus*) along Ghaghra-Sarju River system in Northern India:** The Turtle Survival Alliance (TSA) India has initiated a project on the Ghaghra River led by Dr. Shailendra Singh, a CSG member that aims to evaluate the effectiveness of headstarting through staging and incorporating soft release and post release monitoring. Geruwa River in Katarniaghat joins Sharda River to form Ghaghra. The project essentially employs radio telemetry and visual monitoring to compare survival and vagility among cohorts head-started besides evaluating ‘soft’ release strategies. This project would help contribute to a larger understanding of species conservation requirements and will further guide phase wise supplementation in this alternate habitat to eventually establish a satellite population of the species.

The details of release and monitoring of Gharial from Kukrail Gharial Rehabilitation Centre into Ghaghra River near Ghaghraghat (Chhuripurwa village) are as under:

Year	Total No. Gharial released	Soft-release /Hard-release	Radio	Cattle Tags	Total Area Covered	Monitoring effort (days)
2014	62	31/31	10	Yellow/Red	70 km (Ghaghraghat-Ayodhya)	41
2015	65	33/32	Nil	Yellow/Red	70 km (Ghaghraghat-Ayodhya)	46
2016	35	0/35	Nil	Red	70 km (Ghaghraghat-Ayodhya)	8 (continued)

In total 162 Gharials ranging from 1.2 to 1.5 m (3 years of age) were released from Kukrail Gharial Rehabilitation Centre, Lucknow into Ghaghra River between March 2014 and February 2016. All Gharial were trans-located in plastic pipes, covered with a perforated lid from both ends. A soft-release enclosure was constructed enclosing a river-leg of about 200 m. Soft-release animals were kept in the enclosure for 60 and 90 days in 2014 and 2015. The project staff did not conduct the soft-release in 2016 due to changed river course, which disconnected the designated river-leg from the mainstream. During the monitoring efforts the project staff were able to cover a river stretch of about 70 (10 km up and 60 km down from the release site) using a motorboat. Three radioed animals were encountered 30-35 km from the release sites as per the last radio-tracking exercise in November 2015. During the study the project staff recorded a tagged animal near Ayodhya, which was longest observed dispersal

from the release site. Five detached radios buried along riverbanks within 20 km of release site within 2014 and it was assumed that these radios were detached from Gharial either drowned in the commercial fishing operation or killed by fishermen out of fear and radios and/or animals were hid.

There are myths about crocodile in the area and riparian communities often confuse them with mugger crocodile along accidental deaths of non-target river vertebrates in fishing nets being this area unprotected. Preliminary results indicate a survival of about 20-25% of the released animals in the monitored section of 70 km. However monitoring is still going on and monitoring data is being compiled and analysed. The project staff intended to cover another section of about 100 km from Ayodhya to Ghaghra-Ganga confluence in October 2016, to enhance monitoring efforts and conclude this project.

Moreover, the TSA India is working to raise the level of awareness regarding Gharial and other aquatic fauna among selected riparian communities along Ghaghra-Sarju River system. This primarily entails establishing a Community Resource Centre to demonstrate and capacity building among local stakeholders through stakeholder meetings, school education program and providing trainings to adopt conservation linked livelihoods.

5. **An assessment of Gharial population and their breeding status** in the famous Corbett National Park in River Ramaganga has been conducted by Subir Chowfin, in Dhikala, Corbett Tiger Reserve, Uttarakhand. This is an ongoing project.
6. **The Gandak Gharial Restocking Program** implemented by the Wildlife Trust of India and the Bihar Forest Department also continues with notable progress under the technical guidance of Prof. B.C. Choudhury. Under this program around 30 sub-adult Gharials were released in natural habitats in Gandak River in Valmiki Tiger Reserve in Bihar and are being continuously monitored. The Gandak River (a tributary of the Ganga), known as the Narayani in Nepal has historically supported Gharial population, and currently has been found to support a remnant population of the species. It is a less disturbed river and around 300 km long stretch of the river has been a potential habitat to support viable Gharial population. To strengthen the existing Gharial population in the Gandak River, 30 sub-adult captive-bred and 1.55 to 2.6 m long Gharials (at Sanjay Gandhi Biological Park, Patna) were released in three batches (6+12+12) during April 2014 to February 2015. Sex-ratio of the released individuals was 1M:9F. All individuals were uniquely marked by clipping single row tail scutes with unique identification number for post-release monitoring. Additionally, VHF radio transmitters and satellite transmitters were also fitted suitably on four and two individuals respectively. The released Gharials were monitored by conducting long-range river surveys and basking sites surveys apart from radio telemetry. Of the 30 released Gharials, 18 individuals were sighted in the wild following their release. Maximum distance moved by released Gharial has been recorded to about 1000 km. The released Gharials have been found dispersing in the Ganga River and its other tributaries such as Son and Mahananda. One of the released Gharials also crossed the barrage across the river Gandak situated upstream of the release site.
7. The WWF-India implements a restocking program of Gharial in Hastinapur Wildlife Sanctuary through which the Ganges flows. This is the location where around 606 captive-reared juvenile and sub-adult Gharials have been re-introduced by the State

Forest Department of Uttar Pradesh with technical support from the WWF-India and Prof. B.C. Choudhury, involving visual monitoring as well as radio-tracking.

8. A proposal of the Punjab Forest Department and WWF-India, to re-introduce a small population of sub-adult Gharials in River Sutlaj and Beas (tributaries of Indus) for which a feasibility study has been completed with the involvement of Prof. B.C Choudhury, a member of the Wildlife Institute of India. The Madhya Pradesh Forest Department is now being roped in for providing the release stock.

Future Actions

1. Assisting in Development of management plan for all Gharial supporting habitats in India.
2. Developing a vision plan for the future of Gharial in India through creation of a professional consortium.
3. Evaluate the Gharial Restocking Program and monitor re-stocked/re-introduced Gharials at all the new sites.

2. Saltwater Crocodile (*Crocodylus porosus*)

Estimation of animals in wild: 2500+ at three regions; Andaman (group of islands), Sundarban (West Bengal) and Bhitarkanika (Orissa).

Captive Stock: over 500-600 at few captive facilities, including West Bengal, Orissa, Andhra Pradesh, MCBT, Tamil Nadu and Andaman & Nicobar.

Distribution: East coast of India from Orissa to Sundarban, West Bengal and Andaman Nicobar.

Status: Endangered

Odisha Forest department have been continuing their annual population assessment regularly with technical guidance provided by Dr. Sudhakar Kar. The West Bengal Forest Department (since 2012) and Andaman and Nicobar Forest Department (since 2016) have initiated Saltwater Crocodile population Assessment with guidance from Prof. B.C Choudhury. The West Bengal and Andaman and Nicobar surveys also include mapping of Human-Crocodile Conflict areas and to develop a mechanism to reduce the HCC problem as reports involving the species are reportedly increasing from coastal areas of Andaman and Nicobar, West Bengal (Sundarban) and Bhitarkanika (Odisha).

Future Action

1. Joint trans-boundary salt water crocodile population assessment in Sundarban (large mangrove habitat forest), involving CSG members from India and Bangladesh.
2. An education and awareness campaign for tourist, local inhabitants and forest and wildlife officials in an attempt to address the HCC problems and solutions approaches.

3. **Mugger Crocodile (*Crocodylus palustris*)**

Estimation of Wild Population: 5500+ animals of various sizes in many Indian States.

Captive Stock: 5000+

Distribution: Gujarat, Maharashtra, Rajasthan, Uttar Pradesh, Kerala, Karnataka, Uttarakhand, Tamil Nadu, Orissa, Goa, Haryana, Madhya Pradesh, Rajasthan, Andhra Pradesh.

Status: Vulnerable

Gujarat, Orissa, Maharashtra and Goa Forest Department along with local NGOs have initiated surveys to estimate mugger crocodile population and habitat assessments, along with awareness and training programs.

HCC reports involving the species are reportedly increasing from various states of India, led by Gujarat, Tamil Nadu, Maharashtra and the few other states.

Gujarat, Maharashtra, Rajasthan, Orissa, Uttar Pradesh, Uttarakhand, Karnataka, West Bengal and Tamil Nadu are reporting HCC as a specific area of concern, requiring immediate address. An action plan to mitigate this issue is the need of the hour.

Gujarat Forest Department and Vadodara Municipal Corporation have taken up an initiative and commenced the project to develop a 'Refuge Park' for managing the larger culprit muggers of Vadodara, especially from the urban stretches of Vishwamitri-Dhadhar River.

Ongoing Activity – Highlights

Ongoing project on 'Survey of Habitat Assessment of Crocodiles and steps to Mitigate Human Crocodile Conflict' project is in progress, conducted by Mr. Dhaval Patel and Soham Mukherjee, Voluntary Nature Conservancy, Gujarat (VNC) with the help and financial support by Rufford Foundation and State Forest Department of Gujarat to find out the positive solution for HCC in Gujarat State.

The Madras Crocodile Bank Trust (MCBT) has been a hub of crocodile conservation and research activity in South Asia. The addition of 5 new crocodilians to MCBT include the Critically Endangered Cuban crocodile and 4 species of caiman bringing the total to 18 species here. Collaboration with India's Central Zoo Authority resulted in a workshop for husbandry and management of reptiles. The beginning of an extensive veterinary component has been facilitated by grants received from the CZA, namely for the purchase of temperature recording equipment and a dissection microscope compatible camera. Facilitated by the NGO Dakshin, a project on the fish fed to juvenile/sub-adult crocodilians was initiated, with data largely collected by volunteers. The main impetus of this study is the sustainability of fish catch of the exotic *Oreochromis*, by looking at fish size variability in the areas where fish were caught with cast nets to assess catch per unit effort.

HCC in several Indian states has been a concern since the early 2000s, with field visits made to 6 states in India. The State Governments of Chhattisgarh and the Union Territory

of the Andaman Islands were given on-site demonstrations on the safe capture, restraint, and transport of crocodilians. Crocodile workers from other countries including Nepal, Cambodia, and Bangladesh came over to MCBT for training. The Wildlife Trust of India sent their WREN members for a onsite emergency management-related hands on workshop. Our next *in-situ* venture is a return to the Andaman Islands for a renewed training/monitoring program for front-line staff, and perhaps most importantly to discuss what to do with “problem animals”.

Data for management of large numbers of crocodilians on-site at MCBT relate to growth rates, feed consumption/preferences, stocking density and morbidity, “teachers” for non-feeding hatchlings, enrichment, water table monitoring, and periodic testing of water quality. Temperature sex determination work continues with the gharial, with constant temperature in the lab vs. natural (transplanted) nests open to daily temperature fluctuation. The low ratios of males produced at constant temperatures suggests a pattern similar to that of TSD in the Australian freshwater crocodile. Nest attendance studies in the Gharial have shown females attending nests, even when surface sand temperatures range between 35 and >40C.

Reproductive biology of the dwarf caiman *Paleosuchus palpebrosus* has shown females displaying apparently aberrant nest maintenance, with three females in 2014 sharing one nest. Nest sharing has also been seen in other mound nesters at MCBT, such as the Yacare caiman and African slender-snouted crocodile.

With the advent of cheaper game cameras, nocturnal studies provide a means to correct for volunteer/staff daytime observations. Cameras focus on behavior related to social interactions, in particular parental care, timing/duration of nest construction, monitoring of paired “problem” animals, and nest defense/tolerance of conspecifics in a nest vicinity. Novel behavior is a subject of interest now, with examples of crocodiles stalking garden lizards (*Calotes versicolor*), to the reaction of a new object placed in the enclosure, i.e. a camera trap.

MCBT has strived to upgrade facilities, both for the benefit of the reptiles here, and as well as a zoo visitor’s experience, hence the Master Plan which was laid out under guidelines stipulated by the Central Zoo Authority. Improved signage, immersion exhibits, and android phone applications are just a few of the developments that are being developed.

With current densities of crocodiles at MCBT ranging from 0.4-1.2 sq m/crocodile, the importance of introducing commercial utilization of *Crocodylus palustris* needs to be addressed. 300 female muggers, with an average clutch size of 25 eggs and average fertility of a clutch at 70%, gives a total of 2500 animals of harvestable size in three years, after deducting losses during incubation and hatchling/yearling mortality. India’s wildlife laws do not permit harvest of ‘wildlife’ however, the captive mugger at Madras Crocodile Bank are many generations away from the wild and are now ‘livestock’ as much as goats, sheep, pigs and chickens.

Future Research and Management Initiatives

1. A nation wise database regarding the HCC of two species, namely Mugger and Saltwater crocodile to be created/ maintained.

2. An urgent need to formulate an effective conservation plan for Gharials, also suggesting solutions for the other two problematic crocodilian species (mugger and Salty).
3. Formulate a protocol for rescue and release of mugger crocodiles, especially for HCC identified Indian states, and ensure strict adherence to it, by the State Forest Department.
4. Formulate a protocol for autopsy and post-mortem procedures for the sudden/suspicious croc deaths (three Indian crocodilians) in nature.
5. Nationwide evaluate program of the Gharial reintroduction and re-stocking and its status.

Prepared by: Anslem de Silva, CSG Regional Chair, South Asia & Iran, with inputs from S.M.A. Rashid (Bangladesh), Raju Vyas and Prof. B.C. Choudhury (India), Asghar Mobaraki and Elham Abtin (Iran), Abdul Aleem Chaudhry (Pakistan) and Ruchira Somaweera (Sri Lanka)

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