Gharial *Gavialis gangeticus* Needs Urgent Conservation Attention: A Review of Literature

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The gharial, *Gavialis gangeticus* (Gmelin 1789) is a piscivorous reptile endemic to the Indian subcontinent naturally occurring in approximately 20,000 km^2 of riverine habitat along the Indus, Ganges, Mahanadi, Brahmaputra and Irrawaddy river systems (Smith, 1939; Singh, 1978; Whitaker *et al*., 1974; Groombridge, 1987; Whitaker, 1987; Hussain, 1991, 1999, 2009). Gharials prefer calm and quiet areas of fast-flowing rivers. It is currently estimated that there are <200 breeding adult *G. gangeticus* in the wild. This represents a decline in the population of over 80% since the 1940s (a time-span equating to roughly 3 generations), and qualified it for Critically Endangered (CR) listing on the IUCN Red List (Choudhury et al. 2007; http://www.iucnredlist.org/apps/redlist/details/8966/0, accessed 27th February 2011).

As per a report of the Wildlife Trust of India, there are 1,255 gharials in the Chambal river of Madhya Pradesh and 255 in the Gandak river of Bihar (Photo: CPR Environmental Education Centre, Chennai)

The causes of this decline include historic over-hunting for skins, trophies, eggs and indigenous medicine, and more recently the construction of dams, barrages, irrigation canals, siltation, changes in river courses, artificial embankments, sand-mining, riparian agriculture, domestic and feral livestock, pollution and fishing, which remains a major threat as gill nets continue to rapidly kill gharial of all sizes even in protected areas (Hussain, 1999, 2009).

The common name 'gharial' derives from the Hindi

word '*ghara*' meaning pot or vessel, recognizing the resemblance to an inverted pot of the large protuberance at the tip of the snouts of adult male Gharials. Gharials are the only crocodiles that show sexual dimorphism. They are also accorded much importance in Indian mythology, including their depiction as the holy 'vehicle' of the goddess Ganga. Gharials have slender snouts armed with numerous sharp teeth that intersect to trap fish, which are the primary constituent of their diets. Their mating season is during the months of November, December and January. Sand banks, sand bars and sand islands play a significant role in the ecology of Gharials as they are used preferentially as basking and nesting sites (Gharial Multi-Task Force, 2006). Throughout the summer months of March, April and May, female gharial clamber onto sand banks and islands exposed by receding river levels to nest communally, a large number of females using the same sand bank to lay their eggs in the sand (Rao and Singh, 1993). Parental care by the female has been observed for the first few days after birth.They are a long-lived crocodilian species with a generation length (the age at which 50% of total reproductive output is achieved) of 20 years (Rao*et al*., 1995).Reaching a length of up to 6 metres, gharial are also the second-longest crocodilians after the saltwater or estuarine crocodile (*Crocodylus porosus*) majorly found across Australia.

The Gharial is unique as it is the only crocodilian which is sexually dimorphic (males look obviously different from females). They have short legs and spend most of their time in the water. Adults feed primarily on fish for which jaws and interlocking set of 27-29 undifferentiated teeth on each side of upper jaw and 25-26 teeth in the lower jaw (Shah and Tiwari, 2004) have adapted perfectly for holding struggling prey (CSG, 2000). The thin shape gives the snout low resistance under water, which is suited to fast lateral snatching movements under water. Usually Gharials will not reach sexual maturity before 13 years for the male and 16 years for the female, when they are nearly three meter in length (Maskey and Mishra, 1981; Bustard, 1979; Bustard, 1984; Singh, 1999; Whitaker, 1987). One male will guard a harem of several females and will mate with all of them. The mating period occurs for two months during November, December and into January, while nesting happens in March, April and May (Whitaker, 1983). Nesting is done during the dry season in holes excavated in river sandbanks (Whitaker and Basu, 1983; Groombridge, 1987; Bustard, 1980). The breeding life of Gharial is considered to be 50 years and the life span 100 years (Whitaker and Basu, 1983; Singh, 1999). Individuals less than 0.6 meters

long are considered hatchlings, 0.6 to 0.9 meter are yearlings, between 0.9 to 2.7 meter are sub adults and those larger than 2.7 meter are considered adults (Hussain, 1999). Breeding females may lay eggs from 14 to 62 in numbers in one clutch (Maskey, 1989). In the wild, the survival rate of young hatchings is not more than one percent (Singh, 1978; Roy et al., 1982). As all reptiles, Gharials practice a thermo taxis activity (basking) catching sun-ray, upon which their energy depends. Beaches, next to clean and deep water, are the preferred habitat of Gharials (Maskey et al., 1995).

Crocodiles are important for several aspects, such as their existence indicates the healthy aquatic ecosystem and their hide and meat has a big commercial value (Whitaker, 1987). As a "keystone species" crocodile maintain structure and function in aquatic ecosystem by their activities (King 1988). These ecological roles include selective predation on fish species, recycling of nutrients and maintenance of wet refugia during drought season. Crocodiles are very important to the river ecosystem and to humans. They contribute to the health of the ecosystem and biodiversity. They are the top predator and as such are an essential part of the biodiversity of these habitats (Deppert, 2004). They prey on the slow moving predatory fish thus removing the diseased individuals, thereby maintaining good stocks of commercially valuable fish in any water body. Few studies done in Africa, Australia and America indicate that the presence of crocs in a water system actually boosted fish stocks (Deppert, 2004). A loss of any species of crocodilian would represent a significant loss of biodiversity, economic potential and ecosystem stability (IUCN, 1998). Crocodiles are called the indicators of a clean aquatic environment and play a crucial role in freshwater ecosystems. These crocodiles feed on the weak and sick fish keeping the fish population strong and healthy. They also keep the water clean and uncontaminated by scavenging on dead animal matter. Without the crocodiles in the water systems, the larger predator fish will eat the smaller commercially important fish, resulting in a smaller population of fish for the fishermen. The crocodiles will eat the larger predator fish thereby allowing a greater population and commercial catch of fish in the river.

Bangladesh:A review of crocodiles in Bangladesh (Cox and Rahman 1994) prompt that though fewer numbers of the species continued to be reported into the 1980's it's going to not be found in the wild. The species is heavily impacted by fishing activities and habitat degradation. A part of the distribution on the Padma River is periodically moved into Indian jurisdiction as the river channel changes during floods. Stray individuals are reported occasionally. However, surveys area unit required to prove whether or not there's a breeding population of Gharial in Bangladesh.

Bhutan: The Gharial is believed to be extinct. (T. maskey 2006)

India: The Chambal watercourse has out and away from the biggest population of breeding Gharial within the wild, with around 48% of the whole population (IUCN 2008). In 2007, 77 nests were found at intervals the Chambal Sanctuary whereas 24 were found in Katerniaghat life Sanctuary (Rao 2007). In 2006, 2 nests were set within the Son watercourse Sanctuary (Andrews 2006). Recent reports confirm that stray animals may persist in the upper Brahmaputra River. A cause for concern was the forceful decline of *G. gangeticus* in the Chambal during the winter of 2007-2008. A poisonous substance is suspected, and the resulting deaths of over 100 Gharial, including around 60% of the sub-adults as well as some adult females in the lower Chambal, represents a significant loss. Evidence points toward pollution as the main cause for this event and is yet another indication that India's rivers are dying (GCA 2008). Most of the country's rivers aren't any longer capable of supporting their once-abundant life, with solely fragments of appropriate environment remaining (GCA 2008; IUCN 2009).

Nepal: Six nests were counted in 2006 within the Chitwan parkland (16 nests were recorded there in 1977) and also the total population of mature *G. gangeticus* in the country is estimated 35 (IUCN 2009). Around three hundred animals were free in Chitwan, so again, an introduction has not worked, though maybe this supplementation has helped avert total extinction (GCA 2008).

Pakistan: During in-depth surveys underneath taken by WWF-Pakistan under the "Indus for All Programme and Pakistan Wetlands Programme" in 2008 and 2009, there was no indication of the presence of Gharial. The species is considered virtually extinct in Pakistan.

Myanmar: Historic reports of Gharial have not been verified for many years. (Whitaker, 1975)

After the 17th CSG (Crocodile Specialist Group) meeting, a task force was established to focus on the Gharial and ensure that effective conservation plans were established, and more importantly, what actions were carried out based on these plans. Since 2006 the Gharial Conservation Alliance (GCA; www.gharials.org) has established a presence among the present *G. gangeticus* Range States. In June 2009, the ground-controlled approach convened a Gharial Pre-Species Recovery coming up with Workshop, during which the CSG participated (Webb 2009), and from that the primary draft of a Gharial Species Recovery Plan was developed (GCA, pers. Comm.). GCA additionally expedited a radio-telemetry study on Gharial movement within the space stricken by the 2007-2008 winter die-offs. GCA/CSG personnel also confirmed the presence of a fourth breeding population in India: the Ramganga River, Corbett Tiger Reserve, and Uttarakhand State.

Protection of suitable habitats (India): All protected areas that harbor gharial (Chambal, Katerniaghat, Corbett, Ken and Son River) need effective protection. Habitats contiguous with established Protected Areas (Ghagra below Katerniaghat life Sanctuary and the Yamuna below National Chambal Sanctuary) should be enclosed as these areas are also important for the long-term survival of the species. The Central and State Governments should maintain the integrity of stream ecosystems so that they can harbor aquatic fauna. This includes controlling the pollution of rivers by industry, development of infrastructure, and river fishing.

Monitoring existing populations (India): A program of continuous observation of Gharial populations is crucial. The 2007/2008 die-off of 113 sub-adult and adult Gharial along the Chambal from what has been identified as a nephrotoxin(s) (Whitaker et al. 2008) serves as a harsh warning. Nesting and basking sites should be identified and mapped; census techniques need to be refined so that they are scientifically credible.

Identification and Minimization of negative anthropogenic influences (India): This wide-ranging action needs to include all the stakeholders such as the Ministry of Irrigation and Water Resources, river development, local fishing methods, sand mining and general human/livestock disturbances of Gharial habitats. These activities that negatively impact the entire riverine ecosystems need to be identified, pinpointed and mapped.

Ensure that conservation programs involve local people (India): Major threats to Gharial include accidental drowning in fishing nets, and often, animals found entangled are intentionally killed or de-beaked by fishermen. In some areas, collecting Gharial eggs for native consumption is an additional threat. A comprehensive program involving local people awareness generation in the conservation of Gharial is vital to ensure the long-term and continuing success of any management program. This set up should embrace instructional materials, signs, and instill pride amongst the locals in having such a rare crocodilian reptile in their rivers.

Research (India): Research, encouraged by the Ministry of Environment and Forests and State Wildlife Authorities, needs to address key management issues such as the Gharials role in the ecosystem, fish ecology, relationship between Gharial and Mugger (*Crocodylus palustris*), establish minimum water flow needed for the survival of Gharial and other river fauna as well as investigate the genetic relationship of remnant populations. Socioeconomic studies are also needed to better understand the impact of local anthropogenic pressures on the habitat. This is essential so as to draft realistic management plans.

Development of international coordination: Gharial populations present in the rivers that run between India and Nepal. Independent conservation programs are running in every country. Coordinated management of those shared populations would enhance conservation effectiveness. Joint surveys, training, comparison of population trends and coordinated regulations and protection can lead to enhancement in the population of the Gharials.

Gharials need immediate conservation attention for its' immediate survivability. Its' endemic presence in the Indian subcontinent deserves more coordinated approach in the concertedconservation of the species. Some of the recommendations are listed as under;

- A pan-Asian coordinated project is to be undertaken

for region specific species conservation.

- Habitat Conservation of all crocodile species is urgently required. Madras Crocodile Bank and Trust is doing amazing work on this initiative. In-Situ and Ex-Situ conservation practices done in this bank deserves special mention. Gharial Ecology Project (GEP) conceived by Madras Crocodile Bank and Trust in Chambal is a dedicated initiative on these lines.
- Secondary chemical poisoning has proved fatal for the in-breeding populations of Gharials across India. The Croc Bank played a crucial role in saving the remaining populations and has extensively worked on the ecology of the Gharials. Such projects require proper funding and coordinated supported from the Ministry of Environment, Forests and Climate Change (MOEFCC), Government of India.
- Lack of skill in handling Gharials resultin local fishermen damaging Gharials caught in their fishing nets, by chopping off the tips of the jaws. Care must be taken to prop open the jaws of such damaged animals, so that the animal can breathe without nostrils through its open mouth via its throat.
- Gharials struggle little when captured in nets, and must be removed quickly to avoid any injuries. Once the snout is tied shut, and the limbs are restrained, a burlap bag over the head to cover the eyes results in minimal stress during capture and handling in boats and on land. Once released, Gharials become alert and bound for the water.
- Recent fluctuations in temperature changes, sea-level rise, influx of salinity in fresh water, bioaccumulation of toxic pollutants in riverine water has resulted in dangerous decline in Gharial populations. Pollution and river damming is a big threat to these species.
- Radio tagging of Gharials help in tracking the movement of these species. GEP is doing commendable work in radio tracking of these threatened species. It has marginally helped in increase of populations and requires further developments.

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