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# Management of problem saltwater crocodiles (*Crocodilus porosus* Schneider) - A case study in the Andaman and Nicobar Islands, India

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**ABSTRACT** - The Andaman and Nicobar Islands comprise a chain of 349 major islands and 223 islets and rocky outcrops, extending over 800km<sup>2</sup> in the Bay of Bengal between latitudes 06° and 14° N and longitudes 92° and 94° E. The archipelago has a total land area of 8249 km<sup>2</sup> and a coastline of 1962 km. The Saltwater Crocodile *Crocodilus porosus* is a common species throughout the Andaman and Nicobar Islands. It can be encountered in open sea, near the shore, mangrove creeks, freshwater rivers and in swamps. Human-animal conflicts have increased with exploitation of natural forest resources in India. The growth of human population, intensified land-use, increased livestock population e.g. goat, cattle, dog, poultry etc., human pressure, modification of natural resources, habitat fragmentation, and lack of foresight in the implementation of policies are some of the factors behind the current disputes. Crocodile attacks on human beings and livestock have been reported since the early 1970s in the Andaman and Nicobar Islands. Recently, a crocodile killed a woman snorkelling at the famous Radha Nagar Beach, Havelock forest division. Immediately, the Department of Environment and Forests of the Andaman and Nicobar Administration urged locals to be vigilant of the presence of crocodiles around Radha Nagar Beach, and a warning sign board was placed on the beach. The Forest Department decided to capture the problematic crocodile, and gathered a team to do so. The captured crocodile was transported and released into the mini zoo at Port Blair, and peace was restored at Radha Nagar Beach. In such a situation, removal of the problem crocodile might provide a temporary fix, but another male will eventually dominate the creek, and may again be a threat to tourism. Possible reasons for crocodile attack on humans include defending individual territories, attractive food-sources such as livestock and other domestic animals, and dumping of high-protein waste food materials on banks or beach areas. The indigenous technology developed for capturing the crocodile is discussed in this paper.

The Andaman and Nicobar islands comprise 572 islands, extending over 800 km. These islands were once a part of the Asian mainland, but were detached some 100 million years ago during the Upper Mesozoic period due to geological upheaval. The existing group of islands constitute the physiographic continuation of the mountainous ranges of the Naga and Lushai Hills, and Arakan Yoma of Burma, through Cape Negrais to the Andaman and Nicobar Islands, and southeast Sumatra. The chains of these islands are the seven 'camel backs' of submerged mountain ranges projecting above sea level, running north to south between 6°45' N and 13°30' N latitudes, and 90°

20' E and 93°56' E longitudes. These islands are tropical, with a warm, moist and equable climate. The proximity of the sea and the abundant rainfall prevent extremes of heat. The mountainous parts of the southern islands receive about 300 cm of rain annually, whereas the northern islands receive less. The period from December to February is comparatively cool due to the effect of the northeast monsoon. Warm weather extends from March to April, the driest months. In May, the southwest monsoon breaks over the area, and continues until October. The variation of temperature over the islands is relatively small (23-31° C).

The crocodiles are among the only living

remnants of reptiles which ruled during the Mesozoic era. Crocodiles are top predators, and as such, perform an important role in maintaining the structure and function of ecosystems (Glen et al., 2007; Leslie & Spotila, 2001; Ross, 1998). They are sometimes described as 'living fossils', highly-evolved and superbly designed for the environment in which they live. In the Indian subcontinent, three species of crocodile occur: the Gharial (*Gavialis gangeticus*), the Saltwater crocodile (*Crocodylus porosus*), and the Mugger crocodile (*Crocodylus palustris*). The diet of crocodiles varies with age, with small crocodiles depending mainly on invertebrates and fish, and adults feeding on large animals including livestock and humans (Ross, 1998).

Crocodiles are declining on a global scale (Whitefield Gibbons et al., 2000). Out of 23 crocodylian species, seven are listed as endangered or critically endangered on the IUCN red list (CSG, 2008). Habitat loss and degradation, introduced invasive species, environmental pollution, disease, unsustainable use and global climatic change have been suggested as the most significant threats (Whitefield Gibbons et al., 2000). The saltwater crocodile occurs in the Andaman and Nicobar Islands, where it grows over 6m in length, and can be encountered in open sea, near the shore, mangrove creeks, freshwater rivers, and swamps.

Early literature on crocodiles in India mainly dealt with the biology of the species, and documentation of folklore (D'Abreu, 1915; McCann, 1935; Dharam, 1947). De Vos (1982) prepared a manual on crocodile conservation and management in India which formed the basis for crocodile conservation in India. Ross et al. (2000) discussed the problems of success in crocodile conservation. Many authors reported on aspects such as conservation (Bustard, 1975; Chaudhury & Bustard, 1975), sexing of crocodiles in captivity (Kar & Bustard, 1979), growth of captive crocodiles (Krishnamurthy & Bhaskaran, 1979; Krishnamurthy, 1980; Bustard & Chaudhury, 1980; 1981), attacks on domestic livestock and man (Kar & Bustard, 1981; 1983), food requirement and movement (Singh, 1984a,b; Rao & Chaudhury, 1992) and other issues (Sagar & Singh, 1993; Kumar et al. 1999; Pillai, 1999).

In recent years, human-wildlife conflict has increased worldwide due to growing human populations and associated land use changes (Madden, 2004). Crocodile and alligator attacks are increasing in many parts of the world (Langley, 2005). Many researchers have highlighted these conflict trends in developed nations, including saltwater crocodiles in Australia (Caldicott et al., 2005), Mississippi alligators (*Alligator mississippiensis*) in the USA (Langley, 2005), and mugger crocodiles in Neyyar Wildlife Sanctuary, India (Jayson et al., 2006). Human-crocodile conflict in the Andaman and Nicobar Islands has been poorly documented however. The aim of this study was to assess saltwater crocodile populations, and examine issues of human-crocodile conflict and management of problem crocodiles.

## MATERIALS AND METHODS

To assess the population of crocodiles in the Andaman and Nicobar Islands, data were collected by examination of the available literature. Several personal sightings were also included. Information on human-crocodile conflicts was quantified by interviewing victims, questionnaires, and by visiting sites where attacks have occurred.

## RESULTS AND DISCUSSION

Population estimates of saltwater crocodiles in the Andaman and Nicobar Islands are presented in Table 1. The highest number of crocodiles was reported from the North Andaman Islands, followed by Landfall Island.

### *Human-crocodile conflicts*

About 26 crocodile attacks were reported between 1986 until the present in the Andaman and Nicobar Islands. Details of the various attacks are presented in Table 2. During the period of the present study, no specific time was observed in the pattern of attacks. The attacks took place near the shore and in mangrove creeks. In some cases, there is a relationship with the dumping of waste food on the sea shore. If crocodiles followed regular patterns of such activity, it might have helped them to locate humans, and wait for their arrival. All the attacks followed the known pattern of hunting behaviour reported in crocodiles (Daniel, 1983; Jayson et

Islands	Number of individuals	Reference / Source
North Andaman	15 breeding females; (100 - 200 total)	Whitaker & Whitaker, 1978
North Andaman	50 breeding females	Choudhury, 1980; Choudhury & Bustard 1979
North Andaman	95	Andrews & Whitaker, 1994
Landfall Island	38 adults	Andrews & Whitaker, 1994
North Andaman Islands, North Reef, and Interview Islands	31 adults 10 nests	Andrews & Whitaker, 1994
Middle Andaman	17 adults 9 sub-adults 15 juveniles	Andrews, 1997
Little Andaman	27 adults 11 sub-adults	Andrews, 1997
Rutland, Tarmugli	19 adults 35 sub-adults	Andrews, 1997
Baratang Island	2 adults	Sivaperuman 2008 (Pers. Observation)
South Andaman (Whimberlignunj, Tushnabad, Marina Park, Corbynscove, Caddlegunj)	5 adults 1 sub-adult	Senthil Kumar 2011 (Pers. Observation)
Great Nicobar (Indira Point, Mahar Nallah, Gandhi Nagar, Shastrinagar)	6 adults 3 sub-adults	Questionnaire

**Table 1.** Crocodile population estimates in the Andaman and Nicobar Islands

al. 2006). Large crocodiles over 3 m length were involved in all the major and fatal attacks. Any individuals that occur within areas of recreational use or human occupation can be defined broadly as 'problem crocodiles.'

#### *Capture and translocation of a problematic crocodile*

The Andaman and Nicobar police confirmed that a 25-year-old American tourist was missing from Radha Nagar Beach, Havelock. After a massive search operation, the decomposed body of Lauren Elizabeth Failla was recovered. Immediately, the Department of Environment and Forests urged locals to be vigilant of the presence of crocodiles around the Radha Nagar Beach area, and a warning sign board was placed on the beach. The Department of Environment and Forests decided to

capture the problematic crocodile, in the hope of solving the problem immediately, and a team was gathered for the purpose. The identification of the crocodile was confirmed from a video recording from an underwater video camera which was recovered from the scene, and the characteristic features of the animal were studied thoroughly. The animal was monitored by direct and indirect observation in shallow water, mudflats, mangroves and creeks. It was an adult male and 4.25 meters in length.

#### *Accessories and equipment used for capturing the crocodile*

The following locally-available and indigenously-developed materials were used for capture the crocodile: floating cage of cane and bamboo, harpoons, wire mesh, nylon rope, bamboo pole,

Location	Number of Crocodile attacks	Reference / Source
North Andaman (Kalighat, Kishorinagar and Paschimsagar)	4	Andrews, 1997
South Andaman (Tirur Creek and Shoal Bay Creek)	3	Andrews, 1997
Middle Andaman (Kadamtala Creek, CFO Nallah & Rangat Nallah)	3	Andrews, 1997
Middle Andaman (Kadamtala, Kora Nallah)	2 (1 killed)	Questionnaire & Forest Department Records
Baratang Island	2 (killed)	Questionnaire & Forest Department Records
South Andaman (Havelock, Whimberligunj, Tushnabad, Beach Dera)	6 (4 killed)	Questionnaire & Personal observation
Little Andaman (Machi Dera, Nanchappa Nagar, Nethaji Nagar)	6 (4 killed)	Questionnaire & Forest Department Records

**Table 2.** Numbers of crocodile attacks in the Andaman and Nicobar Islands between 1986 - until present

jerry cans, bundles of discarded PET bottles, fishing buoys, dinghy, and chicken for bait. Three traps were placed in potential sites used by the crocodile.

#### *Capture of the problem crocodile*

After two months of attempts, the problem crocodile was captured. It measured 4.25m in length, an adult male and 480 kilograms of weight. Three floating cages, two sets of net and noose traps were laid in the territory of the crocodile. On 6th June 2010 at 2245 hours, we started routine monitoring activity from Char Nariyal Camp by small fibre boat and loaded with harpoon, search lights, reserve fuel, ropes, mosquito repellents and water. The search was continued, and around 0115 hours we reached the last cage, it was the splashing sound of water which was alerted us. Our Forest Guard spotted the animal first and alerted the team, which was struggling in the cage. The animal sensed our presence and warned us by groaning and performing a couple of dead rolls in despair to cut the jaw rope. At that moment, we decided to harpoon the animal to avoid escape. The harpoon

was a small piece of metal with two sharp inward curving hooks. The metal hook was tied with a 20 m nylon rope and a buoy. Our team made an attempt to place an additional top jaw rope from the boat using a pole. Unfortunately, the jaw rope present in the crocodile was on the initial portion of the snout and was not allowed to insert any more noose. Two of our Forest Guards decided to risk their life by walking close to the animal from the side of mangrove to insert the noose from the inner jaw of the crocodile using a stick. It worked and two additional top jaw ropes were placed. Immediately, the tail was also secured by another team, and then the animal movement was controlled. Thereafter, the animal was secured to the nearby trees at 0400 hours. The captured crocodile was secured in the stretcher, transported to Havelock jetty by dinghy, and subsequently translocated to the Mini Zoo at Port Blair.

This action by the Department of Environment and Forests restored safety and wellbeing for tourists and the local population in Havelock, at least in the short term. However, in such a situation, removal of the problematic crocodile might only

solve a people problem temporarily. Following battles for supremacy, another dominant male will inevitably dominate the area, and may again pose a threat to people and livelihoods.

#### *Possible reasons for attacks*

Crocodile habitat destruction and sharing of the same habitat (syntopy) by humans and crocodiles are the major reasons for such human-crocodile conflict. The increasing human activities such as fishing in the mangrove areas, and crossing the creeks without adequate protection, result in crocodile attacks on humans. One of the possible reasons for attacks on people is territorial defense. During the breeding season from May to June, females are laying eggs and defending nests, and attacks are more common. Dominant males are also likely to defend individual territories.

The presence of livestock and other domestic animals on the sea shore may also attract crocodiles to inhabited areas. In addition, the dumping of waste food materials on the sea shore provides an added attraction for the crocodiles e.g. chicken waste, fish waste, other food waste etc. The high human population density on the sea shore contributes to the human-crocodile conflict. The best solution is to change people's behaviour so that they are unlikely to encounter crocodiles. The provision of enclosures within which people can access the water's edge in safety to use the beaches is possible on the Andaman and Nicobar Islands. It is also possible to manipulate the size distribution of the crocodiles by removing some of the larger and more dangerous individuals to other locations in the Islands (Ross, 1998). The relocation problem of crocodiles has been suggested as a management strategy in Australia (Walsh & Whitehead, 1993).

#### *Community Awareness and Participation*

The Department of Environment and Forests in the Andaman and Nicobar Islands promotes crocodile awareness among residents and visitors by disseminating educational information via brochures, pamphlets and warning boards. A public awareness campaign is repeated regularly to minimise crocodile attacks, with sign boards placed at popular beaches. A research programme is recommended, to monitor the effectiveness of

policies and human-crocodile relationships in the Andaman and Nicobar Islands, in order to minimise human-crocodile conflict in the future.

### REFERENCES

- Andrews, H.V. 1997. *Population dynamics and ecology of the saltwater crocodile (Crocodylus porosus Schneider) in the Andaman and Nicobar Islands*. Interim report. Phase III. Submitted to the Andaman and Nicobar Forest Department and the Centre for Herpetology (AN/C-3-97). 6 pg.
- Andrews, H.V. & R. Whitaker. 1994. *Population dynamics and ecology of the saltwater crocodile (Crocodylus porosus Schneider) in the Andaman and Nicobar Islands*. Interim survey report. Phase II. Submitted to the Andaman and Nicobar Forest Department and the Centre for Herpetology (AN/C-2-94). 18 pg.
- Bustard, H.R. 1975. Crocodile conservation in India. *Tiger Paper* 2, 17.
- Bustard H.R. & B.C. Chaudhury 1980. Parental care in the Salt water crocodiles (*Crocodylus porosus*) and management implications. *J. Bombay nat. Hist. Soc.* 77, 64-69.
- Bustard, H.R. & B.C. Chaudhury 1981. Marking crocodiles for release back into the wild for subsequent identification. *Indian Forester* 102, 447-485.
- Caldicott, D.G.E., D. Croser, C. Manolis, G. Webb & A. Britton 2005. Crocodile attack in Australia: An analysis of its incidence and review of the pathology and management of crocodylian attacks in general. *Wilderness & Environmental Medicine* 16, 143-159.
- Choudhury, B.C. 1980. The status, conservation and future of the saltwater crocodile (*Crocodylus porosus*, Schneider) in North Andaman Island, Union Territory of Andaman & Nicobar Islands. Indian Crocodiles- Conservation and Research. *Oocl. Publ. No. 1*, pp 1-7.
- Chaudhury, B.C. & H.R. Bustard 1975. Restocking Mugger crocodile *Crocodylus palustris* (Lesson) in Andhra Pradesh: Evaluation of a pilot release. *J. Bombay nat. Hist. Soc.* 79, 275-289.
- Choudhury, B.C. & H.R. Bustard 1979. Predation on natural nests of the saltwater crocodile

- (*Crocodylus porosus* Schneider) on North Andaman island with notes on the crocodile population. *J. Bombay nat. Hist. Soc.* **75**, 43-49.
- CSG 2008. Conservation Status, Vol. 2008. IUCN - Crocodile Specialist Group.
- D' Abreu, E.A. 1915. Note on the Mugger (*Crocodylus palustris*) contents of their stomach's, folklore, etc. *J. Bombay nat. Hist. Soc.* **23**, 780.
- Daniel, J.C. 1983. *The Book of Indian Reptiles*. Bombay Natural History Society. pp11.
- De Vos, A 1982. *A Manual on Crocodile Conservation and Management in India*. FAO Project IND/82/003, Dehra Dun, Uttar Pradesh.
- Dharam, A.K. 1947. Mating and the parental instinct of the Marsh crocodiles (*Crocodylus palustris*). *J. Bombay nat. Hist. Soc.* **47**, 175.
- Glen, A.S., C.R. Dickman, M.E. Soule & B.G. Mackey 2007. Evaluating the role of the dingo as a trophic regulator in Australian ecosystems. *Austral Ecology* **32**, 492-501.
- Jayson, E.A., C. Sivaperuman & P. Padmanabhan 2006. Review of the reintroduction programme of the Mugger crocodile *Crocodylus palustris* in Neyyar Reservoir, India. *Herpetological Journal* **16**, 69-76.
- Kar, S.K. & H.R. Bustard 1979. Sexing of crocodiles in captivity. *Indian Forester* **106**, 545-546.
- Kar, S.K. & H.R. Bustard 1981. Attacks on domestic livestock by the saltwater crocodiles (*Crocodylus porosus*) in Orissa, India. *British Journal of Herpetology* **6**, 135-136.
- Kar, S.K. & H.R. Bustard 1983. Saltwater crocodile attacks on man. *British Journal of Herpetology* **25**, 377-382.
- Krishnamurthy, V.S. 1980. Some observations on the growth of captive crocodiles. *J. Bombay nat. Hist. Soc.* **77**, 516-521.
- Krishnamurthy, V.S. & R. Bhaskaran 1976. Growth studies on two species of crocodiles in captivity. *J. Bombay Nat. Hist. Soc.* **73**, 532-533.
- Kumar, V.V., R. Vayas & B.C. Chaudhury 1999. Status of Mugger in Gujarat State (India). *Crocodile Specialist Group Newsletter* **18** (2), 7-8.
- Langley, R.L. 2005. Alligator attacks on humans in the United States. *Wilderness & Environmental Medicine* **16**, 119-124.
- Leslie, A.J. & J.R. Spotila 2001. Alien plant threatens Nile crocodile (*Crocodylus niloticus*) breeding in Lake St. Lucia, South Africa. *Biological Conservation* **98**, 347-355.
- Madden, F. 2004. Creating coexistence between humans and wildlife: global perspectives on local efforts to address human-wildlife conflict. *Human Dimensions of Wildlife* **9**, 247-57.
- McCann, C. 1935. The Mugger (*Crocodylus palustris*) feeding on large water beetles (*Cybister* sp.). *J. Bombay nat. Hist. Soc.* **38**, 409.
- Pillai, K.G.M. 1999. Crocodile conservation in Kerala. *Envis* **2** (1), 58-61.
- Rao, R.J. & B.C. Chaudhury 1992. Sympatric distribution of gharial *Gavialis gangeticus* and Mugger (*Crocodylus palustris*) in India. *J. Bombay nat. Hist. Soc.* **89** (3), 312-315.
- Ross, J.P. 1998. *Crocodiles. Status Survey and Conservation Action Plan*, 2nd edition. IUCN/SSC Crocodile Specialist Group. IUCN, Gland, Switzerland and Cambridge UK.
- Ross, J.P., M.S. Cherkiss & F.J. Mazzotti 2000. Problems of success: Conservation consequences of crocodilian-human conflict. Pp. 442-445 In *Crocodiles, Proceedings of the 15th Working Meeting of the Crocodile Specialist Group*, IUCN-The World Conservation Union, Gland Switzerland and Cambridge UK.
- Sagar, S.R. & L.A.K. Singh 1993. Captive breeding and rehabilitation of Mugger crocodile (*Crocodylus palustris*) in Similipal Tiger Reserve, Orissa, India. *Indian Forrester*. **119** (10), 807-815.
- Singh, L.A.K. 1984a. Observations on food requirement and food conservation in the Mugger (*Crocodylus palustris*) reared in captivity. *J. Bombay nat. Hist. Soc.* **80**, 418 - 423.
- Singh, L.A.K. 1984b. Observations on the movement of two captive-reared Mugger crocodiles, *Crocodylus palustris* Lesson when returned to the wild. *J. Bombay nat. Hist. Soc.* **80**, 86-90.
- Walsh, B. & P.J. Whitehead 1993. Problem crocodiles, *Crocodylus porosus*, at Nhulunbuy, Northern Territory: An assessment of relocation

- as a management strategy. *Wildl. Res.* **20** (1), 127-135.
- Whitaker, R. & J.C. Daniel 1978. The status of Asian crocodiles. *Tiger Paper* **5**, 6.
- Whitaker, R. & Z. Whitaker. 1978. A preliminary survey of the saltwater crocodile (*Crocodylus porosus*) in the Andaman Islands. *J. Bombay nat. Hist. Soc.* **76**, 311-323.
- Whitfield Gibbons, J., David, E., Scott, B., Travis, J., Ryan, B., Kurt, A., Buhlmann, C., Tracey, D., Tuberville, B., Brian, S., Metts, B., Judith, L., Greene, B., Tondy Mills, B., B., Y.L., Sean Poppy, B., Christopher, T., & Winne, B. (2000) The global decline of reptiles, Déjà Vu Amphibians. *BioScience*, 653–666.
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