



Population and conservation status of Marsh Crocodiles, *Crocodilus palustris* in Karachi Zoological Garden, Samzu Park and Khar Center Karachi, Sindh-Pakistan.

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Abstract: This study represents survey data and review the **population and conservation status** of the Marsh crocodile (*Crocodilus palustris*), throughout various captive habitats situated in Karachi Zoological Garden (KZG), Samzu Park (SP) and Khar Center (KC) Khirthar National Park, Karachi. To achieve this objective the study monitored the distribution of crocodiles and their nests, and nest sites.

In Pakistan, there is only one species of Marsh Crocodile is reported. The Crocodile population is going to decline rapidly from their original habitat and their number at the turn of the last 20th century due to over hunting for their valuable skin and meat and alteration of their habitat used by humans. In this present study we were determined the population and conservational status of Marsh crocodiles from three sites of Karachi Zoological Garden (KZG), Samzu Park (SP) and Khar Center (KC). During our observation we recorded 93 individuals, among them 61 were adults, 08 were juveniles and 24 were hatchlings. They can be ranched but unfortunately in our country the concept of sustainable utilization of wildlife is still not practiced to a large segment of the population. If any loss of this valuable species from the ecosystem it would be consider loss of biodiversity, economic prospective and steadiness of biota.

Keywords: Marsh crocodile, Hunting, Habitat, Status, Sustainable and Population.

1. **INTRODUCTION**

The wildlife farming is a need for private individuals to complement efforts to conserve valuable and threatened species of Pakistan. Government of Pakistan was signed the agreement on the Convention on International Trade in Endangered Species (CITES) for the enhancement of Crocodile population. However, illegal trade and poaching still continues in several parts of the country with impunity which have been attributed to inadequate enforcement of wildlife legislation, irregular game patrol and lack of incentives to staff in game preservation areas. Consequently, the population of many once-abundant wild animal species in Pakistan is very low outside the protected conservation areas and some species are endangered or at the risk of extinction in the nearest future in certain locations, unless urgent remedial actions are taken to improve upon their chances of survival and reproduction. One of the ways of achieving this increase in wildlife population is by encouraging individuals and organizations to participate in wildlife farming and captive management of some wild animal species such as crocodiles which is endangered in Pakistan. This may reduce illegal hunting pressure in wildlife conservation areas. The Crocodylidae family have 23 living species of Crocodiles in the world today (King and Burke, 1989). In Pakistan currently only one crocodylian species of Marsh Crocodile is recorded. It has three families and these three families are recognized on the bases of; i: Shape of snout, ii: Scales behind the head. The

Alligators possess longer snout; the Muggers have broad and blunt snout while the Gavials have thinnest, elongated and beak like jaws. Due to the presence of scales is concerned; the Alligators possess small scales behind their heads, the Muggers have large scales behind their heads while the Gavials possess the bunch of the smallest scales found with skin away from the head near the forearms (Chang *et al.*, 2012, 2013). The Marsh crocodiles with broadest snout can reach with the maximum length of 4.5 meters. The body color of juveniles is light tan and has a black cross banding on their body and on the tail. When they become adults their body color is grey to brown and have little banding on their body. They have enlarged scutes neat the throat area which is helpful for defense and moving very skillfully when they swim in the water (Whitaker, 1989).

The Marsh crocodiles prefer to live in the hole which is near to water. They lay their eggs in the holes in the period of dry months. The age of sexual maturity of females started when they reach the length of 1.82 m while male become sexually mature at the length of above 2 meters. The females lay approximately 25-30 eggs in the hole nests near their habitat. Mostly females dig their burrows for laying the eggs (Whitaker and Whitaker, 1989). It is also reported that in captivity the females lay two clutches in a year but it is not assured in the wild population (Whitaker, 1989). The incubation period of Marsh crocodiles is very short which lasts

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about 55-75 days (Whitaker, 1987). In the summer season the Marsh crocodiles go in the aestivation, it is the period when they become inactive and hide themselves in the deep burrows and maintain their body temperature in the warm environment. In the winter season when the temperature decreases they go in basking condition that is inactive period of Marsh crocodile through which they get the sun light and maintain their body temperature. The female Marsh crocodiles dig hole nests which are about 2 feet deep into the sand in which lay their eggs (Whitaker and Whitaker, 1989). The eggs of Marsh crocodiles which are hard calcareous shell and they have total length of 9×6 cm at both equal ends. When the hatchlings come out from the eggs, the females take them on its top of snout. The hatchlings grow rapidly to adopt in their environment. The juveniles would prefer to feed on crustaceans, insects and they also feed the small fishes. When the Marsh crocodiles become adults they depend upon larger fish, amphibians, reptiles (snakes and turtles) birds and mammalian species. Sometimes they also take down the goat, cow, deer and buffalo species (Groombridge *et al.*, 1982).

Marsh Crocodile has received the legal protection under the Appendix I listed in Cites. As reported by Baillie and Groombridge (1996) that Marsh Crocodiles are listed “Vulnerable” reptilian species in the world today. In Pakistan the *C. palustris* has received the criterion “Critically Endangered” and “Endangered” by IUCN, respectively. As marked the Crocodiles are key stone species which play a major role to help maintain the ecosystem structure and function through predation on fish, recycling of nutrients in food chains and they also maintain of aquatic habitat during the droughts period (King, 1988). It is reported by Whitaker and Whitaker (1987) that more peoples are killed by buffaloes and cows than Crocodiles in the world. Groombridge (1982) reported that the Crocodiles are threatened from their origin habitat due to the illegal hunting for their valuable skin and meat and in some extent due to alteration of habitat. When these practices are eliminated than we may able to recover their population in wild if we provided suitable habitat (Webb and Smith, 1987). It is the real facts that many crocodilian species have declined from their habitat as compare to another wild species in the world. In Pakistan in adequate scientific data has been published and less research had been done on Crocodiles previously. The aim of this study was conduct to assessed the current population and conservational status of Marsh Crocodiles in the studied areas of KZG, SP and KC Karachi.



Fig. 1. Map of Studied Areas Of Karachi

2. MATERIALS AND METHODS

The surveys were conducted in the areas of Karachi Zoological Garden Samzu Park and Khar Center (KNP) during the year of 2006 to 2009. Surveys were undertaken to determine the population status and conservation of Marsh crocodiles and its associated threats in the studied areas of KZG, SP and KC.

Study Areas:

Karachi Zoological Garden (KZG).

KZG is positioned at Nishter Road and Sir Agha III Road in Karachi Sindh province, Pakistan. It is considered that this garden is oldest after the Lahore Zoo Garden in the country. It was found in the 1978 and previously known as “Mahatma Gandhi Garden” before the partition of sub-continent. The Karachi municipality in 1878 found a Zoo for the public recreation and it was given under the custody of trust. It was opened for public in 1881. After the partition of sub-continent in 1947 the name of this zoo was changed and now it is known as “Karachi Zoological Garden” or “Karachi Zoo”. In this garden the reptilian house was established and extended again in 1992. In the reptilian house the adults, juveniles and hatchlings were kept under the captivity for their conservation and development.

Samzu Park.

SP is situated in Deh Shah Mureed, 11 km from Super Highway Karachi, Sindh, Pakistan. SP has a zoo, a children's play land and many gardens. It is one of the major recreation and amusement place in Karachi. In SP some crocodile individuals were kept in captivity and preserve for the recreation purpose.

Khar Center, Khirthar National Park.

KC is the second largest national park in Pakistan. KNP was included in United Nations world list on National Parks in the year of 1974. Khirthar

National Park (KNP) is located in south-western region of Sindh, north-east to Karachi and Jamshoro, Dadu and Larkana districts and it is positioned at border of Balochistan. The area of KNP is covered on more than 308, 000 hectares. KNP is managed by Sindh Wildlife Department and it has two major centers; I. Khar Center and ii. Karchat Center. KNP is recognized in IUCN Category II in the protected areas of world for the purpose of ecosystem preservation. Khar Center is 95 km away from Karachi near to Hub Dam, whereas Karchat Center is located 160 km away from Karachi. The habitat of hilly areas of KNP is seem to develop the natural scenario for various wild animal species as well as plant species. The world famous and important wild animals of mammals and reptilian species of gazelles, Ibex, wild sheep, wild cats, wolf, lizards, porcupines, snakes, gray and black partridges, eagles, vultures and grouse, houbara bustard and other migratory birds found in the park. The plant vegetation is also comprised on various forms of herbs, shrubs and trees.

(a). FIELD EQUIPMENTS

During the collection of data, we have used the strong torch lights for night surveys to watch their movement and other activities and also we have looked up the burrows of crocodile during day. During the survey fecal pellets of crocodile were collected and saved in plastic bags and labeled it respectively. We have used GPS which was very helpful for the location of areas where the crocodile population found. It was very helpful for measuring, observing and mapping of studied areas. Binocular was used for the identification of different gut contents of crocodile and to focus it clearly to locate them. The captured individuals of crocodiles were measured with measuring tape. During the study, we have used measuring tape for the measurement of eggs, fecal pellets and crocodile individuals. Digital camera was used to take the pictures of crocodiles and its tracks, signs, footprints, egg shells and other evidence of crocodile. Map was helpful for the location of crocodile population and identification of studied areas.

(b). METHODS

Previous surveys have detected low densities and therefore we decided to carry out this study during the wet season (April-October) and winter season (November-March). The current study was done in the sites of KZG, SP and KC and it was based on the already published data, direct sightings and indirect evidence collected from different sources such as interviews from the Directors, game wardens, game watchers and local communities. We were used the vehicles where it was necessary to go in the field survey and used the 7/42 binocular to locate and assess morphology of the species. During the direct sightings

we were counted and determined the sighting habitats, basking sites, swimming at water surface and catching the reflection of eyes during the nocturnal surveys. At the time of Diurnal field surveys we were detect the active Crocodiles, their tracks, trails, foot prints, nesting sites and count them by snap shot technique (observation by crocodile movement) and we were also noticed the time period for their movements and other activities in the water bodies. Whenever possible during the sightings of any crocodile we were noticed their number, position, habitat and behavior. We were recognized the species during the sightings on the morphological bases such as the shape of snout and abdomen (Table 1). If any individual found and we were captured it and we took measurement of body length weight and size. Internationally three categories are applied for their age, size in the habitat that if size of hatchlings (<0.5 m), juveniles (0.5±1.0 m) and adults (>2 m). On the bases of their numbers of individuals in habitat the population status is categorized as rare (<10 individuals), common (10±30 individuals), abundant (>30 individuals) and extinct (no individuals found presently but occurred in the past).

We were monitored the nest sites regularly and the temperature of nests recorded using a 50 cm penetration probe. The presence/absence of Siam weed was also to be recorded to compare thermoregulation of sites with and without it present. Upon time of rupture (Hatching), each nest site was to be checked and numbers of hatched eggs to un-hatched eggs were to be counted, providing a percentage hatch success rate. Nocturnal spotlight surveys are a standard method of surveying crocodilians (Webb and Smith, 1987); reflection of light from a 200,000 candle power spotlight/floodlight off of the eyes allows for detection of the crocodiles. On an encounter the identification was determined and total length estimated. EO (eyes only) was recorded for individuals where further data is visually obscured or missed. The water samples were then tested using a professional heavy metal test kit for the presence and concentration of heavy metals in the water.

3.

RESULTS

The data shown in (Table 1) represents a summary of the result which was collected from the field over the three years crocodile survey. All raw data was compiled and analyzed back in the University for use as a dissertation and later a publication. Of the two potential threats that were monitored for impact on the crocodile population, all water tests of the presence of the heavy metals showed contamination of water. Over the total distance covered and surveyed, different nests sites were found and so as a result the thermoregulations of the nests were monitored.

The study was carried out from the areas of KZG, SP and KC (KNP) in the year of 2006 to 2009 for the purpose of population and conservation status of Marsh crocodile.

During the study, in the areas of KZG and KC, the total number of counted crocodiles were ninety three (93), out of this, 61 were adult crocodiles, 08 were juveniles and 24 were hatchlings recorded, (Table 1). During the study, it was recorded that the population of adult Marsh crocodile was highest (30) in KC and the lowest (08) was recorded in SP captivity, the highest (04) population of juvenile crocodile was recorded in KC and the lowest (02) was recorded in KZG captivity. Likewise, the highest population of Hatchlings (14) was recorded in KZG and the lowest (04) was recorded in SP captivity, (Fig 2). During the study, we used measuring tape for the measurements of one selected hatchling (Table 2 and Figure 4, 5, 6, and 7), an adult crocodile (Table 3 and Figure 7) (body length) and an egg sample, (Table 4). During the study, it was observed that captive crocodiles took the food weekly according to their age group and their size, (Table 6 and 7). In the captivity, type of feed were rationed and as well their amount to Marsh crocodile. The type of their feed was included chicken, beef, frogs, lizards, fresh fish and cartilaginous bones. Mostly in captive farm chicken and beef were utilized than any other type of feed. They also utilized fresh fish as a source of protein to the crocodiles while cartilaginous bones and frogs were used depending upon the availability. Crocodiles were internationally categorized according to their estimated weight and their size, (Table 5). The result is indicating that there is increasing interest rate in keeping the Marsh crocodile in the study area but several constraints may be the limiting factor. Although often neglected aspect of wildlife reintroduction programs and very limited governmental support for any conservation measures the crocodile population is not increasing by their numbers.

Table 1. Population status of marsh crocodiles in kzg, sp, kc

S.No.	Name of the Wetland	Adult	Juvenile	Hatchlings
1.	Karachi Zoological Garden	23	02	14
2.	Khar Centre KNP	30	04	06
3.	Samzu Park Karachi	08	02	04
TOTAL		61	08	24

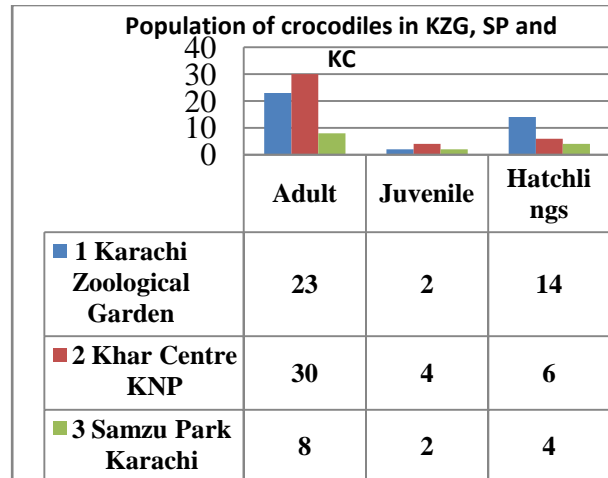


Fig. 2. Mean Graph Showing Population Of Marsh Crocodiles In Areas Of Kzg, Sp And Kc



Fig. 3. A hatchling in KZG

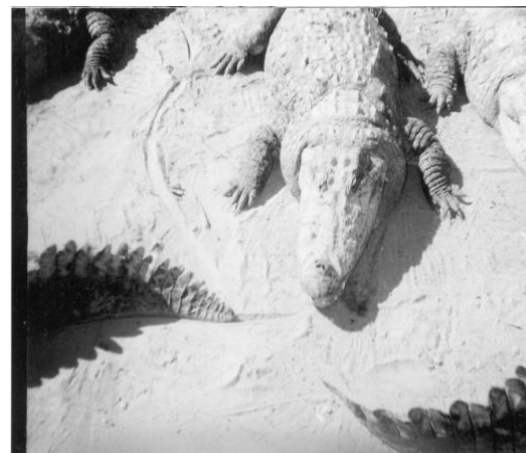


Fig. 4. Adult Crocodile in KC



Fig. 5. Hatchling in KC



Fig. 6. Adult Crocodiles in KZG

Location: KZG
Coordinates: 24°52'34"N,67°01'24"E

Table 2. Body Measurement Of One Selected Hatchling Sample

S. NO.	DESCRIPTION	HATCHLING
1.	Body condition	Alive and active
2.	Length (total)	279.4 mm
3.	Width (at center)	76.2 mm
4.	Head length	50.8 mm
5.	Head width	25.4 mm
6.	Tail length	152.4 mm
7.	Tail width (at top)	20 mm
8.	Tail width (at center)	15 mm
9.	Tail width (at tip)	10 mm
10.	Fore limb length	50.8 mm
11.	Fore limb width	25.4 mm
12.	Hind limb length	63.5 mm
13.	Hind limb width (up)	25.4 mm
14.	Hind limb width (down)	12.7 mm
15.	Nails of fore limb	6 mm
16.	Nails of hind limb	6 mm
17.	Teeth of lower jaw	5 mm
18.	Teeth of Upper jaw	5 mm



Fig. 7. Adult Crocodile in KC Coordinate:
Location: Khar Center 25°11'36"N, 67°01'56"E

Table 3. Body Measurement of one Selected Adult Crocodile Sample

S. NO.	DESCRIPTION	ADULT
1.	Body condition	Active and alive
2.	Length (total)	2895.8 mm
3.	Width (at center)	457.2 mm
4.	Head length	457.2 mm
5.	Head width	254 mm
6.	Tail length	1676.4 mm
7.	Tail width (at top)	254 mm
8.	Tail width (at center)	196.8 mm
9.	Tail width (at tip)	37.8 mm
10.	Fore limb length	457.2 mm
11.	Fore limb width	114.3 mm
12.	Hind limb length	609.6 mm
13.	Hind limb width (up)	203.2 mm
14.	Hind limb width (down)	88.9 mm
15.	Nails of fore limb	40 mm
16.	Nails of hind limb	40 mm
17.	Teeth of lower jaw	40-50 mm
18.	Teeth of Upper jaw	40-50 mm
19.	Segments in tail	33
20.	Teeth Upper and Lower Jaw	30-30

Table 4. Measurement And Weight Of Marsh Crocodile's Egg

S. No.	LOCATION	LENGTH OF EGG (mm)	WIDTH OF EGG (mm)	WEIGHT OF EGG (Grms)
1.	KZG and Khar Center	65	40	160

Table 5. Internationally Categorized Size-Classes of Marsh Crocodiles

S. No.	CROCODILE	SIZE
1.	Adult	1.5 and Over
2.	Sub-Adult	1 to 1.5
3.	Juvenile	50 cm to 1 m
4.	Hatchling	Less than 50 cm

Table 6. International Parameters For The Identification of Marsh Crocodiles

S. No.	BODY LENGTH (m)	BODY WEIGHT (kg)
1.	0.5	0.3
2.	1.0	3
3.	2.0	30
4.	3.0	100
5.	4.0	300
6.	5.0	700

Table 7. Food Intake By Captive Farmed Marsh Crocodiles

S. No:	CROCODILE LENGTH	% OF BODY WEIGHT EATEN PER WEEK	FOOD EATEN PER WEEK (g)
1.	Up to 50 cm	25	150
2.	1 m	15	500
3.	Greater than 2 m	10	3,000

3. DISCUSSION

In Pakistan, some previous studies on Marsh crocodile were carried out by (Groom-bridge, 1982 and Whitaker, 1993). In Haleji Lake Wildlife Sanctuary (HLWS) the population surveys were conducted by Sindh Wildlife Department (SWD) and Pakistan Zoological Survey (ZSD) in 2004 and 2005. The crocodile population were recorded about five hundred only in the areas of Makhi/Bakar lake by Pakistan Zoological Survey of Pakistan in 1997 and about more than one thousand crocodile population in Chotiari Reservoir and its surroundings by Sindh Wildlife Department in 1999-2000 (Javed *et al.*, 2004). Two surveys on Marsh crocodiles were carried out by the Zoological Survey Department of Pakistan in the year of 2004 and 2005 respectively and according to their observation 226 numbers of Marsh crocodile were recorded in Nara Desert Wildlife Sanctuary (NDWS). WWF-Pakistan conducted the Marsh crocodiles'

population survey of Nara Canal in the year of 2008 and in Chotiari Reservoir in the year of 2008-2009. For the study of population status in Sindh the Crocodile Specialist Group (CSG) was done its survey in 2009 (CSG, 2009). It is reported that the population of Marsh Crocodile became extinct in the province of Punjab on account of habitat degradation (Chaudhury, 1993, Khan *et al.*, 1976). While in the rivers of Nari, Hab, Fitiani, Hingol, Dasht, Nahang and Kuch kuar a little numbers of Marsh Crocodiles were reported in the province of Baluchistan (Ahmed, 1986, Ghalib, *et al.*, 1981 and Khan, 1989). Were killed in the years of 1999-2004 (Javed, *et al.*, 2005 and Khan, 1988).

It is reported by (Ahmed, 1990, Chang, *et al.*, 2012, 2013 and Javed, *et al.*, 2004) that in Sindh province small population of Marsh Crocodile inhabitant in the areas of Manghopir, Karachi Zoological Garden, Samzu Park and Khar Center Karachi district, Haleji Lake Wildlife Sanctuary Thatta district (Captive/Wild), Chotiari Wetland Complexes Sanghar district (Wild), Deh Akro II Wildlife Sanctuary Shaheed Benazirabad district (Wild), Nara Canal Wildlife Sanctuary Khairpur district (Wild) and New Jatoi Farm Naushehferroze district (Captive). We were observed that from the last decades the population of Marsh Crocodiles in the sites of Chotiari Wetland Complexes, Deh Akro II Wildlife Sanctuary and Nara Canal Desert Wildlife Sanctuary the individuals were in thousands numbers but currently the situation is different and their numbers are small due to the illegal fishing, hunting, alteration of habitat, water shortage, Dam construction (Chotiari Dam). We were recorded the only 93 individuals of Crocodiles in three localities of KZG, SP and KC Karachi (**Table 1**). Hatching success rate of the eggs was found to be site specific in wild condition and was observed below 40 % whereas in captivity it was found about 60 % (Data not shown). In the modern world now captive breeding is the important source for the production of hides in different countries of Colombia (Caiman, *Caiman crocodylus*), Thailand (Siamese Crocodile, *Crocodylus siamensis*), South Africa (*Crocodylus niloticus*) and Mexico (Morelet's Crocodile, *Crocodylus moreletti*), Zimbabwe (*Crocodylus niloticus*) and in other parts of the world (Ross, 2001).

Crocodiles are important elements of the biota they live and we do not yet know what effect their disappearance would have on the balance of nature (Grizmeks, *et al.*, 1975). Crocodiles serve as source of raw materials where their skin are exported and used for the shoes, belts, handbags, medicines, ornamental, etc., production due to high demand for skin trade (Young, 1981). So that it is the need of time that the people should be aware about the importance of

correlation of species with their ecosystem through the scientific study. We were analyzed the quality of water in the laboratory that some harmful physicochemical parameters were examined which may cause the hazard effect on the health of Crocodile population (Data not shown). It is indispensable for the survival of wildlife that the wild life Sanctuaries, game reserve areas and conservational strategies and strict law should be practiced. The purpose of domesticating crocodiles for recreation may not unconnected with the fact that watching these reptiles in their artificial habitats is quit enjoying and appealing to many naturalists.

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REFERENCES:

Ahmed, A., (1986) The distribution and population of Crocodiles in the province of Sindh and Balochistan (Pakistan). *J. Bombay Nat. Soc.*, (83): 220-223.

Ahmad, A., (1990) Pakistan. *Crocodile Specialist Group Newsletter* 9 (2):15-16.

Alderton, David, (1991) Crocodiles and Alligators of the world. Facts on file, New York.

Baillie, J. and B. Groom-bridge., (1996) [compiled and edited by]. 1996 IUCN Red List of threatened animals. The IUCN Species Survival Commission. Gland, Switzerland: IUCN. 70 pp. Introduction, 368 Pp.

Chang, M. S, G. S. Gachal, A. H. Qadri, (2012) Bio-ecological status, Management and Conservation of Marsh Crocodiles (*Crocodylus palustris*) in Deh Akro 2, Sindh–Pakistan. *Sindh Univ. Res. Jour. (Sci. Ser.)* Vol. (44): (2) 209-214 (2012).

Chang, M. S, G. S. Gachal, A.H. Qadri, T. Jabeen, S. Baloach, M. Y. Sheikh (2012) Distribution and Population Status of Marsh Crocodiles, *Crocodylus Palustris* in Nara Desert Wildlife Sanctuary (NDWS) Sindh, Pakistan. *Sindh Univ. Res. Jour. (Sci. Ser.)* Vol.44 (3): 453-456 (2012).

Chang, M.S, G.S. Gachal, A.H. Qadri, Zohra Khowaja and Mumtaz Khowaja, (2013). Ecological status and

threats of marsh crocodiles (*Crocodylus palustris*) in Manghopir Karachi. *International Journal of Biosciences*. Vol. (3): No. 9. 44-54.

Chaudhry, A. A., (1993) Status of crocodiles in Pakistan. *Crocodile Specialist Group Newsletter* 12 (1): 19-20.

Ghalib, S. A, H. Rahman, F. Iffat, and S. A. Hasnain, (1981). A checklist of the reptiles of Pakistan. *Rec. Zool. Surv. Pakistan* (8): 37-59.

Groomridge, B. and L. Wright, (1982) *The IUCN Amphibia – Reptilia Red Data Book*. Part 1, test dines, Crocodylia, Rhynchocephalia. IUCN: 426 Pp.

Grzimek, B., W. Meise, G. Niethammer, and J. Steinbacher, (1975) Deel VIII: Vogels 2. 2e druk. In B. Grzimek (ed.), *Het leven der dieren*. Uitgeverij Het Spectrum, Utrecht/Antwerpen.: 741 Pp.

Javed, H. I., and H. Rehman, (2004) Status of marsh crocodile (*Crocodylus palustris*) in Sindh. *Rec. Zool. Surv. Pakistan* (15): 22-30.

Javed, H. I., H. Rehman, and S. Fakhari, (2005) On the status of Marsh crocodile in Balochistan. *Rec. Zoological Survey Pakistan* 16, 40-45.

Khan, M. S. and M. R. Mirza, (1976) An annotated checklist and key to the Reptiles of Pakistan. Part-I: *Chelonia and Crocodylian*. *Biologia*. 22, 211-221.

Khan, A. A., (1988) The crocodiles of Pakistan: a dwindling resource. *Tiger Paper* (July-Sept.): 18-20.

Khan, A. A., (1989) *Crocodile Specialist Group Newsletter* 8 (July-Sept.): 5-6. Khan, M.K. 1987. *Crocodile Specialist Group Newsletter* 6 (Jan.-Dec.):.

King, F.W., (1988) Crocodiles: Keystone wetland species. Pp. 18-19 in *Wildlife in the Everglades and Latin American wetlands*. Abstracts of the Proceedings of the 1st Everglades National Park Symposium, Miami 1985, ed. by D.H. Dalrymple, W.F. Loftus and F. S. Bernardino.

Rao, R J. (1994) Ecological studies of Indian crocodiles, an overview. In *crocodiles Proceedings of the 12th working Meeting of the crocodile specialist group*. IUCN, Gland Switzerland. 259-273.

Ross, J.P. (2001) Commercial captive breeding of crocodylians. Paper appended to Hutton *et al.* (2001). Tarsitano, Samuel F., Eberhard Frey, and Jurgen Riess., (1989). *The evaluation of the Crocodylia; A conflict*

between morphological and biochemical data. *Am Zool.* 29, 843-856.

Thorbjarnarson, J. B and S. G. Platt, (2000) Population status and conservation of Morelet's crocodile *Crocodylus moreletii*, in northern Belize. *Biol. Conserv.* 96 (1): 21-29.

Tikader, B. K., (1983) Threatened Animals of India. *Zoological Survey of India, Calcutta*, 307 pp.

Webb, G.J.W. and A.M.A. Smith, (1987) Life history parameters, population dynamics and the management of crocodilians. Pp. 199-210 in *Wildlife Management: Crocodile and Alligators*, ed. By G.J.W, S.C. Manolis and P.J. Whitehead. Surrey Beatty & Sons: Chipping Norton.

Whittaker, R.J., (1987) An application of Detrended Correspondence Analysis and Non-metric Multidimensional Scaling to the identification and analysis of environmental factor complexes and vegetation structures. *Journal of Ecology*, 75, 363-376.

Whitaker, R and Z. Whitaker (1989) Ecology of the mugger crocodile. In: *crocodiles. Their Ecology, Management and conservation*. A Special Publication of the Crocodile Specialist Group. ICUN, Gland, Switzerland. 276-297.

WWF-Pak, (2008) *Detailed ecological assessment of fauna, including limnological studies at Chotiari reservoir: Indus for All Program under Indus Eco-region Conservation Program 2008*. World Wide fund for nature, Pakistan. 1-175.

Young, J. Z. (1981) *The life of Vertebrates*, 3rd edition, Oxford University Press New York, USA.