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Sighting trend of the Indian Skimmer (Charidiformes: Laridae: *Rynchops albicollis* Swainson, 1838) in National Chambal Gharial Sanctuary (1984–2016) reflecting on the feasibility of long-term ecological monitoring

OPEN ACCESS

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Abstract: River Chambal, in northwestern India, is a tributary of the Gangetic River system. It flows through the states of Rajasthan, Madhya Pradesh (MP) and Uttar Pradesh (UP), and the National Chambal Gharial Sanctuary (NCGS) encompasses a 572km stretch of the river from Keshoraipatan in Rajasthan to Pachhnada in UP. The sanctuary includes about 15km of river Yamuna after confluence with Chambal. During annual monitoring of Gharial in Chambal the Indian Skimmer, *Rhynchops albicollis* numbers were also counted in 12 study zones for 17 observation years spread between 1984–85 and 2015–16. The number of skimmers was below 355 for 15 of the 17 observation years. Skimmer counts were higher in 1995 at 555 individuals. The count for different study zones is not uniform, but with reference to Rajghat at the crossing of National Highway number-3, the count upstream is lower than downstream with an exception in the year 2011. The river downstream appears to be a better skimmer habitat with better availability of fish, and long stretches of flowing water along low-lying sandy banks. The study calls for continued, coordinated and strengthened attention to NCGS for added conservation of locally migrating birds. The research and management connect in NCGS is a model where long term ecological monitoring has been possible because of simple and implementable protocols that were used unchanged over such a long period by a set of identified field personnel.

Keywords: Birds, Gangetic River system, Indian Skimmer, long term ecological monitoring, National Chambal Sanctuary, *Rynchops albicollis.*

Hindi Abstract: उत्तर पष्चिमी भारत में चम्बलनदी गंगानदी तंत्र की एक सहायक नदी है। यह राजस्थान, मध्य प्रदेष (म.प्र.) एवं उत्तर प्रदेष (उ.प्र.) राज्यों में से होती हुई बहती है। राश्ट्रीय चम्बल घड़ियाल अभ्यारण्य (रा.च.घ.अ.) की कुल लम्बाई राजस्थान के केषोरायपाटन से लेकर उत्तर प्रदेष के पचनदा तक 572 कि.मी. है. इसमें चम्बल, यमुना संगम के बाद पचनदा तक की 15 कि.मी. यमुना नदी की लम्बाई भी सम्मिलित है। वर्श 1984–85 से 2015–16 तक के मध्य 17 अवलोकन वर्शो में अध्ययन क्षेत्र को 12 उप क्षेत्रों में विभाजित कर चम्बल नदी में वार्शिक घड़ियाल सर्वेक्षण के दौरान इण्डियन स्किमर की गणना की गई। 17 अवलोकन वर्शो में से 15 वर्शो में स्किमर की संख्या 355 से नीचे पाई गई थी। वर्श 1995 में स्किमर की सर्वाधिक संख्या 555 पाई गई। नदी के विभिन्न उपक्षेत्रों में स्किमर की संख्या समान नहीं है, लेकिन राजघाट पुल के ऊपरी क्षेत्र की तुलना में निचले भाग में स्किमर संख्या अधिक पाई गई, मात्र वर्श 2011 की संख्या को छोड़कर। चम्बल नदी का राजघाट से निचला क्षेत्र जिसमें मछली की बेहतर उपलब्धता एवं बहते पानी के लम्बे हिस्सों के साथ उथले रेतीले किनारे है वह इण्डियन स्किमर आवास के लिए बेहतर प्रतीत हुऐ हैं। यह अध्ययन स्थानीय स्तर पर प्रवासी (माइग्रेटरी) पक्षियों के अतिरिक्त संरक्षण के लिए रा.च.घ.अ. को निरन्तर समन्वित और मजबूत ध्यान देने की मांग करता है। रा.च.घ.अ. अनुसंधान एवं प्रबंधन के तालमेल का एक ऐसा आदर्ष नमूना है जहां सहज सरल कार्यान्वयन योग्य प्रोटोकॉल के कारण दीर्घकालिक पारिस्थितिक अनुश्रवण संभव हो सका है। कुछ चिन्हित मैदानी कर्मियों के एक समूह द्वारा इतनी लम्बी अवधि तक बिना किसी बदलाव के कार्यरत रहने पर ही अनुश्रवण संभव हुआ है।

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Author Contribution: RKS: member of the study team started in NCS by LAKS in 1983; collected and maintained all data on birds till 2016. LAKS: developed the protocol for collection of data on gharial and ecological associates like birds from 1983–84 onwards; analysed and developed the contents in this paper with RKS.

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INTRODUCTION

Population studies and radio tracking of Gharial *Gavialis gangeticus* were started in the winter of 1983–84 in National Chambal Gharial Sanctuary (NCGS) (Singh 1985; Habib et al. 2010). This study gave emergence to ancillary field observations and conservation recommendation for various other indicator species (Singh 1999). One of the highlights from 1983–1985 is the richness of wetland birds in Chambal (Sharma & Singh 1986). Long-term monitoring until recent times has offered the scope to better understand the scenario related to the birds of Chambal. The present study on the Indian Skimmer *Rhynchops albicollis* is one such long duration study. It gives an account of the trend of number of skimmers observed in NCGS based on the data collected during Gharial surveys conducted until 2015–16.

River Chambal

River Chambal in northwestern India originates from the Singar Chori peak of Vindhya Range near Mhow Tehsil (=sub-district) of Indore District in Madhya Pradesh (MP). It is a tributary of river Yamuna and thus is a part of the Gangetic River system. After flowing through Rajasthan in the northeast direction Chambal forms the interstate boundary, first along MP-Rajasthan and then along MP-UP (Uttar Pradesh). The final course of the river is through UP from Barecha which is about 35km upstream from Chambal-Yamuna confluence near Bareh. The construction of the Gandhi Sagar Dam (1960) in MP, the Rana Pratap Sagar Dam (1970), Jawaharsagar Dam (1973), and Kota barrage (1960) in Rajasthan have brought changes in the characteristic riparian habitat of Chambal, and the reproductive behavior of Gharial (FAO 1974: 43).

The river bed in the upper stretches of Chambal is rocky with a number of rapids. The perennial characteristic of Chambal is retained because of water from the rivers Kali-Sindh and Parbati in the upper reaches, a large number of small drainages all along its course, and the drainage of three other rivers at Pachhnada around confluence with Yamuna (Fig. 1). The area where five rivers namely, Chambal, Yamuna, Kunwari, Sind and Pahuj form a confluence is known as Pachhnada. From here Yamuna becomes a large river and flows to join river Ganga near Allahabad.

Precipitation in 11 districts that adjoin river Chambal and its immediate tributaries contribute to keep Chambal perennial. The districts are Baran, Bundi, Dhaulpur, Karauli, Kota and Sawai-Madhopur in the state of Rajasthan, Sheopur, Bhind and Morena in Madhya Pradesh, and Agra and Etawah in Uttar Pradesh.

National Chambal Gharial Sanctuary

There are two sanctuaries on Chambal for the conservation of Gharial *Gavialis gangeticus*. The Jawahar Sagar Sanctuary in Rajasthan was gazetted in October 1975, followed by the National Chambal Gharial Sanctuary by the states of UP, Rajasthan and MP in three separate notifications between January 1979 and September 1983. NCGS starts from Keshoraipatan, about 18km after Kota Barrage, and extends up to Pachhnada (Fig. 1). The length of the sanctuary is 572km that includes about 15km of Yamuna after confluence with Chambal. The width of the sanctuary extends out of the riverbank, to cover adjacent important areas in UP, but is limited to 1km on either banks in Rajasthan and MP.

In 1983, the Government of India established a field camp of the erstwhile Central Crocodile Breeding and Management Training Institute of Hyderabad at Deori Campus in Morena District of MP. With author LAKS at its lead the initial objective of the camp was to radio-track and study the movement of young Gharials released under the crocodile conservation programme. Regular monitoring of Chambal for status survey of Gharial population helped generate and build research capacities of biologists and field personnel for NCGS. Every year the entire river is surveyed for data on Gharial as well as the Mugger Crocodile *Crocodylus palustris*, Gangetic Dolphin *Platanista gangetica*, freshwater turtles and wetland birds (Singh & Rao 1984, 1985; Singh 1985; Singh et al. 1984; Singh & Sharma 1985, 2015; Rao & Singh 1987a,b,c; Sharma & Singh 1986, 2014, 2015; Sharma et al. 1995a).

Among the large shore birds of NCGS there are Sarus Crane *Grus antigone*, Demoiselle Crane *Anthropoides virgo* mixed with Common Crane *Grus grus*, Asian Woollyneck *Ciconia episcopus*, Black-necked Stork *Ephippiorhynchus asiaticus*, Painted Stork *Mycteria leucocephala*, Asian Openbill *Anastomus oscitans*, Black Stork *Ciconia nigra*, Oriental Darter *Anhinga melanogaster*, Black Ibis *Pseudibis papillosa*, Black-headed Ibis (earlier called White Ibis) *Threskiornis melanocephalus*, Eurasian Spoonbill *Platalea leucorodia*, Flamingoes *Phoenicopterus* spp. etc. Shorebird species also included smaller but important populations of River Tern *Sterna aurantia* and Indian Skimmer *Rynchops albicollis* (Sharma & Singh 1986).

The Indian Skimmer is one of the prominent wetland birds visiting river Chambal (Sharma & Singh 1986). It

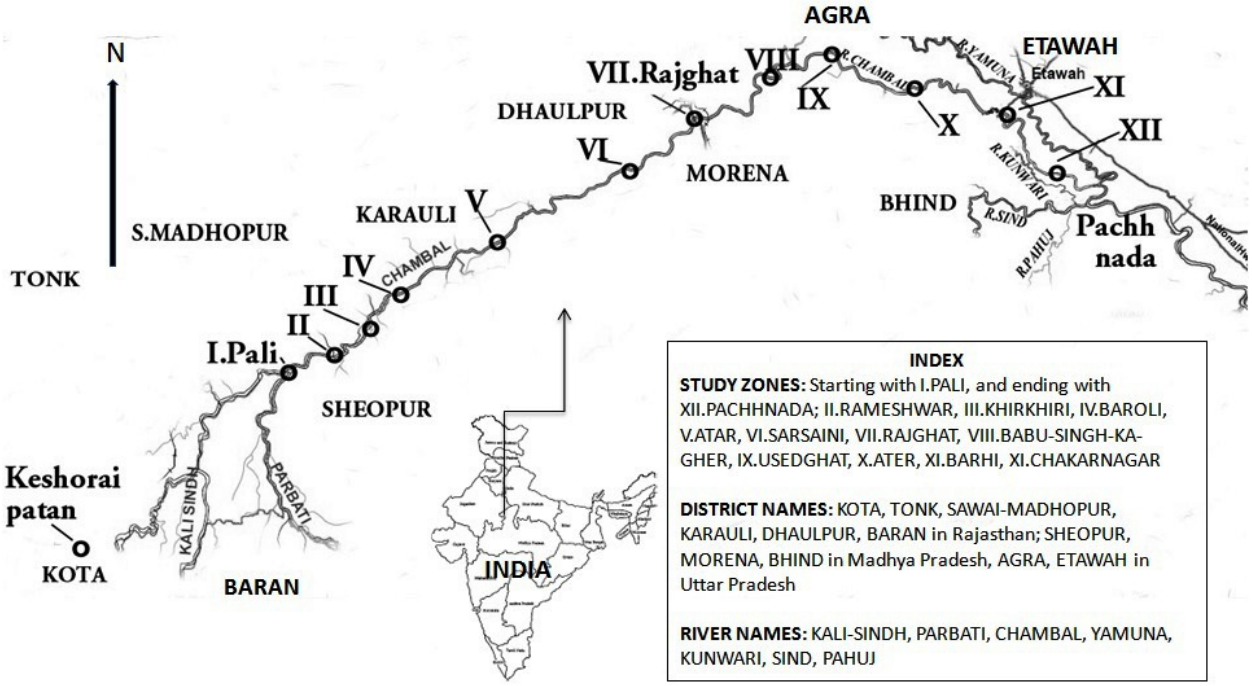

Figure 1. Study area in river Chambal showing Rajghat and twelve study zones between I. Pali-Rameshwar to XII. Chakarnagar-Pachhnada.

is listed in Schedule-I under India's Wildlife (Protection) Act, 1972, and is categorized as 'Vulnerable' since 2004 according to the IUCN/SSC Red List of Threatened Species (BirdLife International 2017). Indian Skimmers occur close to large exposed sand bars and islands, which they use for nesting (Ali 2002). The food of the Indian Skimmer is primarily fish. The presence of Indian Skimmer indicates the clarity of water and abundance of small fishes. They have easily identifiable black body colour, a white forehead, collar, and under parts. The tail is forked. The legs are bright red, and the bill is orange-red with a yellow tip. The mandible is longer than the maxilla and is used to scoop the surface of water for collecting food.

METHODS

Data source and survey process

All data on Skimmers were collected during annual cycles of the Gharial survey in Chambal (Images 1–4). While certain field studies on Gharial were continuous and round-the-year, the preparation for annual river survey started after the recession of floods and the appearance of water changing from turbid to clear. Data cited for any specific year is the result of fieldwork that commenced in December of the previous calendar year and continued to the next calendar year. For example, the data for 1985 is the result of survey conducted in the winter of 1984–85, and for 1986 is in the winter of 1985–86.

During the period 1984–85 to 2015–16, spread over 32 monitoring seasons, reliable data on Indian Skimmer of Chambal are collated for 17 years (Table 1). The source of data for the years 1985 and 1986 are from Sharma & Singh (1986), for 1995 from Sharma et al. (1995a), for 2003 to 2014 from Sharma (2012, 2015), and for the years 2015 and 2016 (Sharma et al. 2016).

For Gharial monitoring the entire NCGS is divided into 5-km long grids, with zero-point at Pali. The name of the village on the river bank is also used for quick and easy reference to a location where some observation is made. Depending on navigability of the river all observations between Pali and Pachhnada were carried out either from hand-rowing boat, or from boat fitted with low noise 20HP outboard engine maintained at constant slow speed. For negotiating rapids or waterfalls the survey team walked along the river bank while vacated boat and equipment were hand-lifted. Everyday a distance of about 10–15 km was covered from upstream towards downstream. Birds were sighted through binocular occasionally aided with a spotting scope, and field notes were made directly on A4 size field map-sheets (Singh 1985) or note books. The sea-worthy small aluminum boat and other equipment used in NCGS were of international standard as the project was run by Govt.

Image 1. River Chambal Skimmer birds

Image 2. National Chambal Sanctuary Skimmer on mid-river island

Image 3. Chambal Skimmer eggs in camouflage with surrounding

Image 4. Chambal Skimmer egg and hatchling in camouflage with surrounding

of India/FAO/UNDP and the state forest departments. From 1983 to 2016 equipment brands changed but were efficient enough to identify the skimmers, large birds, gharial, mugger, dolphin, otter and turtles.

Study zones

The field data are consolidated under 12 study zones (Fig. 1, Table 1). Pali (ghat) downstream Parbati-Chambal confluence marks the beginning of study zone-I and Pachhnada marks the end of study zone-XII. Zone-wise data are grouped in two broad stretches, upstream of Rajghat (205km) and downstream of Rajghat (230km). Rajghat on Chambal is at the crossing point of the old Agra-Bombay Highway or National Highway number-3 (NH-3). Rajghat is considered as a major reference point in our previous studies on trend analyses of the Gangetic Dolphin (Singh & Sharma 1985; Sharma & Singh 2014) and crocodilians (Sharma & Singh 2015).

RESULTS

Year wise total number of Indian Skimmers

The total number of Indian Skimmers was below 355 birds for 15 of the 17 observation years (Table 1, Fig. 2). In 1995 there were a total of 555 skimmers, that is an abrupt 33% rise in the upstream and 67% rise in the downstream (Table 2). Otherwise, the trend line showing moving average is wavy with a gradual rise from 2011 to 2016, particularly in the downstream (Fig. 3) area. Rainfall data available for 2004–10 indicate positive relation with skimmer sighting, particularly downstream.

Study zones and skimmer count

The count of skimmer in individual study zones was not uniform, varied at average 18±14 (zone-I) to 48±27 (zone-IV). The yearly total count (Table 2, Fig. 3) in upstream zones (I to VI) is always lower than in the downstream zones (VII to XII), with year 2011 as an exception when the count in the upstream zone is higher

Table 1. Sighting of Indian Skimmer in National Chambal Sanctuary during 1985 to 2016

Stretch	Pali-Rajghat 205km (Upstream)						Rajghat-Pachhnada 230km (Downstream)						
	Pali-Rameshwar	Rameshwar-Khirkhiri	Khirkhiri-Baroli	Baroli-Atar	Atar-Sarsaini	Sarsaini-Rajghat	Rajghat-BabusinghGher	BabusinghGher-Usethghat	Usethghat-Ater	Ater-Barhi	Barhi-Chakarnagar	Chakarnagar-Pachhnada	Total
Study Zone	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	12 zones
River length (km)	22	15	20	48	65	35	35	40	40	40	38	37	435
Year	Year-wise number of skimmers recorded in different study zones												
1985	46	0	19	42	13	24	32	54	50	0	45	22	347
1986	36	0	0	34	14	26	46	60	50	0	45	0	311
1995	0	30	0	120	4	36	78	141	72	34	36	4	555
2003	0	0	0	54	6	22	56	38	62	20	66	8	332
2004	0	0	0	55	4	29	26	59	21	82	20	10	306
2005	1	0	0	32	7	29	24	46	0	53	78	0	270
2006	8	0	0	36	41	16	24	58	10	29	60	0	282
2007	11	0	0	22	23	12	36	60	32	42	70	31	339
2008	14	0	0	42	0	47	19	54	28	102	26	22	354
2009	0	0	0	62	0	88	15	52	24	39	0	15	295
2010	0	0	0	18	38	50	10	18	32	50	14	0	230
2011	0	27	0	45	26	56	0	32	27	6	5	0	224
2012	0	18	0	4	0	72	16	50	48	41	52	0	301
2013	9	0	0	72	4	44	13	26	39	30	21	0	258
2014	15	0	0	29	1	59	26	51	26	24	9	62	302
2015	22	0	0	74	7	34	8	32	42	33	0	73	325
2016	0	0	0	70	2	54	14	69	47	57	0	126	439
Total	162	75	19	811	190	698	443	900	610	642	547	373	5470
Average	18	25	19	48	14	41	28	53	38	43	39	37	322
± SD	14	6	0	27	13	20	19	27	16	24	24	39	78

(154) than in the downstream zone (70). This deviation appears to be the result of a declining trend of counts downstream from 2008 onwards.

DISCUSSION AND RECOMMENDATIONS

(1) Long term ecological monitoring (LTEM) in Chambal

River Chambal is a better secured retreat in its geographical region as it encompasses 572km long NCGS, with perennial water flow. The rises in skimmer sighting may have resulted, among other possible reasons, due to good breeding and/or for immigration from wetlands outside Chambal. LTEM in future may further clarify about the influence of ecological factors on skimmer sighting, particularly in different segments and towards downstream from Rajghat.

The present analysis on Indian Skimmer is of preliminary nature as it is a byproduct of Gharial monitoring that started in 1983. Nonetheless, the data refer to spatial and temporal scales that are not available elsewhere. The LTEM has been possible because of simple and implementable protocols that have been used unchanged over 32 years by a set of identified field personnel. All analyses and production of reports were made locally by staff that conducted field studies and have intimate knowledge of the study area.

Normally, much of knowledge on river ecology is from short fragments as it is difficult to approach and

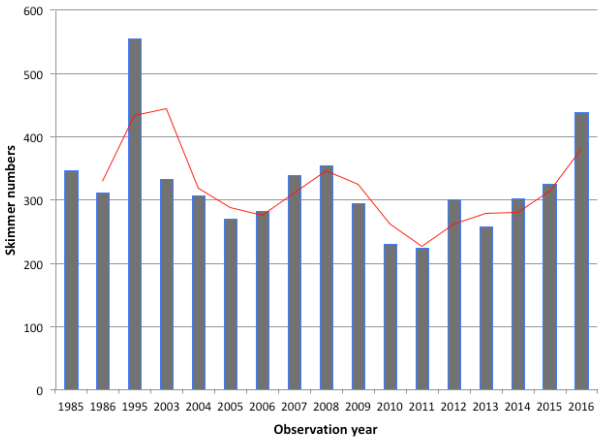

Figure 2. Year wise sightings with moving average trend-line for Indian Skimmer in river Chambal during 1985–2016. Data for 1985 = winter 1984-85, for 1986 = winter 1985–86, etc.

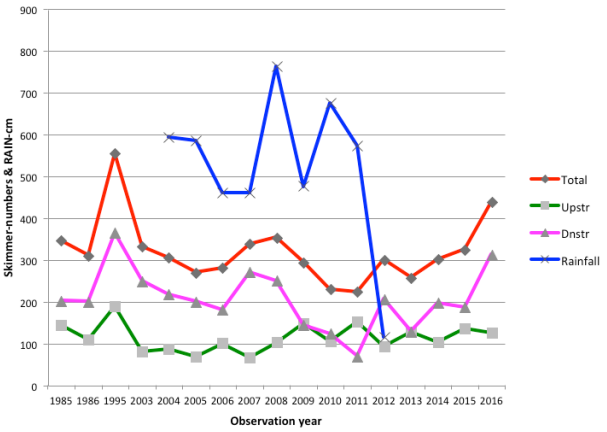

Figure 3. Sighting trend of Indian Skimmer in river Chambal during 1985–2016 with average rainfall (cm) in 11 adjoining districts. Upstream (Upstr) and Downstream (Dnstr) are in reference to location at Rajghat, as described in the text.

study the 'long ribbons of aquatic habitat' (Fausch et al. 2002). We agree with Müller et al. (2010) and Roberts et al. (2017) that despite technological advancements LTEM normally gets neglected because of constraints of some kind of time duration allotted to an academic goal, or the restrictions in funding duration. We also understand that when a novel field method is introduced in wildlife studies the data from the past gets ignored or loses its significance or tend to be forgotten in spite of having long contribution in developing conservation actions. Such new management interventions are more on the cards because of fast advancing approaches in wildlife research (for example, Singh 2014; Pimm et al. 2015; Taylor et al. 2016).

Wildlife monitoring in Chambal is an ideal situation where there was no perceivable 'disconnect between research and managers' (Singh 2014). Monitoring did not suffer the limitations of time and fund, as the process was built into normal programme of sanctuary management. Besides, there is continuity of identified field observers and protocol for data collection. In this light the wildlife organizations linked with the management of the three-state river sanctuary need to plan for inducting new research and monitoring personnel who could serve in the next 20-30 years of NCGS.

(2) Annual biodiversity monitoring and 5-year trend analysis

Gharial, Mugger, freshwater turtles, large wetland birds, Gangetic Dolphin and otter are some of the prominent wildlife species in river Chambal, which share ecological advantages and stress. Some of the stresses are due to fluctuating water flow, because of agricultural practices close to the river bank, impacts of intensive fishing activities by people, and unguided sand mining at ecologically sensitive places (Taigor & Rao 2010; Taigor et al. 2008). Annual monitoring and 5-year analysis of spatial and temporal distribution of biodiversity could form valuable guidelines for revision of management approach in NCGS every fifth year. Appropriate skill development for staff is required before the present anchor persons working from 1980s are no longer available.

(3) Continuation of studies on Indian Skimmer

Observed since 1983–84, river Chambal appears to be one of the best feeding and breeding habitats for skimmers in the southwestern region of the Gangetic system. The total skimmer counts have not declined until 2015–16. Sharma & Bhadoria (2012) recorded 59 numbers of skimmer nests in the study area with 72.21% hatching success in 2012.

The fish population, fishing activities and skimmer sightings in Chambal are more in the downstream stretch which is wide, on open land and outside the deep ravines in Chambal. Farther away from Chambal the scientists of Wildlife Institute of India have located nesting grounds of skimmer in the river Ganga upstream of Allahabad and near the Ganga-Yamuna confluence (Sharma 2017).

Skimmers are gaining recognition as indicators of good health of a river. New breeding locations of the skimmer have been discovered in Son Gharial Sanctuary (Dilawar & Sharma 2016). Interests in studies on skimmer have picked up in recent years even outside the Gangetic system. For example, Rajguru (2017) and Debata et al. (2017) have separately studied and

Table 2. Sighting of Indian Skimmer along 205km upstream and 230km downstream of Rajghat in National Chambal Sanctuary during 1985 to 2016

Calendar Year	Observation Year	Pali-Rajghat 205km	Rajghat-Pachhnada 230km	Chambal Study Area 435km
1985	1	144	203	347
1986	2	110	201	311
1995	11	190	365	555
2003	19	82	250	332
2004	20	88	218	306
2005	21	69	201	270
2006	22	101	181	282
2007	23	68	271	339
2008	24	103	251	354
2009	25	150	145	295
2010	26	106	124	230
2011	27	154	70	224
2012	28	94	207	301
2013	29	129	129	258
2014	30	104	198	302
2015	31	137	188	325
2016	32	126	313	439
	Average	115	207	322
	± SD	33	71	78

reported on skimmer at Mundali of river Mahanadi in Odisha State. Continuous monitoring of skimmer habitats in and outside Chambal will highlight the kind of ecological attraction Chambal holds for the skimmer populations of other wetlands in the region.

(4) Nests on sand and maintenance of flowing water level

Water release from barrages and dams for irrigation purposes is a sensitive humanitarian issue but when it is sudden, high or uncontrolled it could negate the annual nesting efforts of birds, crocodiles and turtles. In 1978 on an egg collection trip to Chambal LAKS pointed about his experience to Sri J.J. Dutta, the then Chief Wildlife Warden, Madhya Pradesh who took up the subject effectively with irrigation authorities at Kota. The irrigation authorities cooperated for the conservation issues. More recently Sundar (2004) has reiterated the subject in the context of birds that the nests get washed away because of rising water level in the river. Controlled release of water should be an all-time code of conduct to continue so that downstream areas do not experience more than three to four feet rise in water level when natural process of nesting and egg incubation continues on low lying river sand beds.

(5) Public awareness and involvement

Involvement of local people has been a very successful aspect in crocodile conservation (Singh 1987). Considering the vastness of the area and limited resource of field personnel in NCGS, public involvement is more important. It always needs manifold strengthening with participation and support of local villagers for work related to protection of habitat, collection of information about bird arrival, animal movements in river, intelligence on wildlife matters, and help during annual monitoring of biodiversity. They can also contribute to prevent destructive activities of stray cattle and dogs.

(6) Forest cover for Chambal basin

Although it is out of scope for discussion on impact of forest cover on precipitation recorded in Chambal watershed, during the course of analysis we have observed that the total forest cover in 11 Chambal districts has decreased from 8,989km^2 to 8,211km^2 according to assessments made for years 2001 and 2017 (FSI 2001, 2017). In 2017 the area of very dense forest is 0.1%, moderately dense forest is 27.5% and open forest is 72.5% out of the total forest area. Our studies on Dolphin and Mugger over 30 years have demonstrated

impeding threat due to decreasing flow and level of water particularly in the upstream of Chambal (Sharma & Singh 2014, 2015).

(7) Maintenance of water quality in Chambal

Studies on the effect of industrial contaminants, pesticide residues and sewage effluents on birds and hatching success were beyond the scope of this study. We remember that until 1985 we had no hesitation to directly drink water from Chambal, when drinking water from a stream joining the river affected LAKS once. Subsequently, a study was carried out on possible identification and impact of organo-chemical contaminants in water and nesting sand of Chambal (Sharma 1990) but nothing was conclusive. In the last 30 years industries have grown all around the catchments of Chambal. A few studies have also addressed the pollution-related subjects (Mathur et al. 1991; Sharma et al. 1995b; Mathur & Maheswari 2006). It is important that proper assessments should be continued and authorities of the cities posing threat to the water quality of Chambal implement actions to reduce or nullify the adverse effects. It is required from this stage onwards for future survival and sustenance of biodiversity in Chambal.

(8) Compatible ecotourism in river sanctuary

Ecotourism in sanctuaries is increasing in various forms. It should be compatible with wildlife conservation and the carrying capacity of the river sanctuary (Singh 2013). The visitors attracted to NCGS should be educated through guides to remain away from sand banks used by birds for colonial nesting or reptiles for basking, resting and nesting.

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