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COMMUNICATION

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SPATIAL AND TEMPORAL PATTERNS OF STORK SIGHTINGS (AVES: CICONIIDAE) IN NATIONAL CHAMBAL SANCTUARY OF GANGETIC RIVER SYSTEM

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Abstract: During 1984–86 and 1995–2016 winter surveys five stork species were observed in 12 study zones of the river Chambal in the Ganga tributary system. Comparative temporal and spatial analyses of stork distribution are presented from two broad stretches of the river, 205km of Pali-Rajghat in the upstream and 230km of Rajghat-Pachhnada in the downstream. Different species show different distribution patterns. Study zones IV+V comprising 113km in the upstream and XI+XII comprising 75km in the downstream accounted for 66% of total stork sightings. About 56% of total sightings were recorded downstream of Rajghat. The Painted Storks *Mycteria leucocephala* comprised 52% of total stork sightings. Eleven districts adjoining river Chambal recorded low rainfall prior to 2008 when sighting of storks abruptly increased, particularly in the downstream. It is important to continue the monitoring of water birds in the National Chambal Sanctuary as it could lead to initiating conservation interventions in habitats in the region which experience extreme ecological conditions and fluctuations in populations.

Keywords: Long term ecological monitoring, National Chambal Sanctuary, spatial and temporal, storks of Chambal.

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Author Details: R.K. SHARMA: Former Research Range Officer, National Chambal Sanctuary (NCS); with LAKS authored the first reports on bird and dolphin in NCS; superannuated from service in Madhya Pradesh Forest Department in September 2016. L.A.K. SINGH: Former Asst. Director / Officer-in-Charge, erstwhile Central Crocodile Breeding and Management Training Institute, Hyderabad, Government of India; started the Field Camp of Crocodile Research Centre, Wildlife Institute of India at Deori, National Chambal Sanctuary in 1983. Superannuated from service with Forest and Environment Department- Odisha in December 2010.

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

One of the significant achievements of the crocodile conservation programme (Singh 1999) comprises information collected on ecological associates of crocodiles. In the present paper we have analysed the spatial and temporal patterns of sightings on five species of storks of the National Chambal Sanctuary (NCS) during 1984–2016.

METHODS

River Chambal is being monitored every year since 1983–84 after recession of the monsoon floods to locate populations of Gharial *Gavialis gangeticus*. The survey team consists of at least six members, each one with identified roles to perform. One of the members was exclusively responsible for maintaining notes on birds. Data on five species of storks collected during 1984–85 to 2015–16 is given in Table 1 (Image 1).

All five species of storks discussed here are in Schedule-IV of the Wildlife (Protection) Act, India. According to IUCN Red List the status of Black-necked Stork *Ephippiorhynchus asiaticus* (BirdLife International 2016a) and the Painted Stork *Mycteria leucocephala* (BirdLife International 2016b) are 'Near Threatened', that of the Black Stork *Ciconia nigra* (BirdLife International 2017a) and Asian Openbill (formerly named Openbill Stork) *Anastomus oscitans* (BirdLife International 2016c) are 'Least Concern', and the Asian Woollyneck

(formerly named White-necked Stork) *Ciconia episcopus* is 'Vulnerable' (BirdLife International 2017b).

Since the data is secondary to the gharial survey these may be considered preliminary in nature. Data refers to field work started around the last week of December in the previous calendar year and continuing sometimes till early February. Surveys were carried out from boats and everyday a distance of 30–35 km was covered going downstream. Sightings were made through standard binoculars and occasionally a spotting scope was used (Images 2–7). Field notes were made directly on A-4 size field map-sheets (Singh 1985) or note books.

The study area comprised 12 study zones that are name-based and easily identifiable (Table 2, Fig. 1). For analysis of data the study zones are clubbed under two broad stretches with reference to bridge at Rajghat. Study zone I to VI (205km) are in the upstream and VII to XII (230km) in the downstream. Rajghat is a standard reference point used in our studies in NCS to separate upstream data from downstream. The National Highway-3 leading to Delhi via Gwalior-Morena crosses river Chambal at Rajghat and proceeds through Agra.

Rainfall data available on the website of India Meteorological Department (IMD 2017) for 11 districts in the Chambal region was consulted for possible explanations to certain temporal sighting patterns. It is in the context that birds determine habitat preferences on their ability to obtain food and shelter against predators and weather (Alonso et al. 1991). The districts consulted in this work are close to the river Chambal or are in the catchment areas of rivers Kali-Sindh and Parbati which

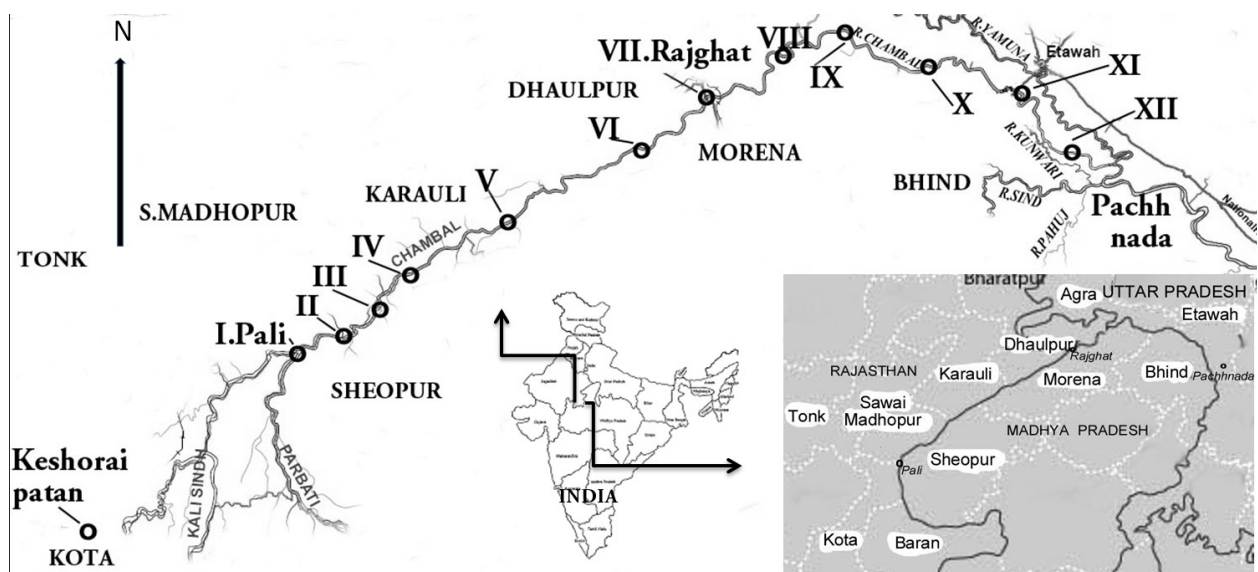


Figure 1. Map of river Chambal showing study zones, I. Pali-Rameswar to XII. Chakarnagar-Pachhnada. District names are in upper case and names of rivers in italics. Inset: Districts adjoining river Chambal. Names of states in inset are in upper case and districts in normal font.

Table 1. Sighting record of storks in National Chambal Sanctuary during 1985 to 2016. Rajghat separates upstream (205km) from downstream (230km).

YEAR	Pali-Rajghat 205km (Upstream)					Rajghat - Pachnada 230km (Downstream)					Total
	BNS	BS	PS	OBS	WNS	BNS	BS	PS	OBS	WNS	
1985	0	82	31	35	0	7	0	21	2	15	193
1986	0	0	28	22	0	7	1	20	0	17	95
1995	0	0	16	23	7	5	0	10	3	4	68
2003	0	6	55	165	5	4	0	20	14	11	280
2004	0	3	28	31	19	2	0	23	8	3	117
2005	0	0	10	43	4	5	12	17	5	3	99
2006	0	2	22	32	9	10	1	8	11	0	95
2007	3	24	17	45	12	6	0	88	12	0	207
2008	0	108	27	7	8	26	0	910	37	6	1129
2009	1	97	40	74	53	3	0	72	25	69	434
2010	1	7	34	124	5	13	0	81	72	7	344
2011	2	0	69	5	22	9	0	9	34	27	177
2012	0	30	7	11	5	4	0	45	17	9	128
2013	2	20	8	12	6	3	0	48	15	14	128
2014	0	9	14	32	20	1	0	38	8	19	141
2015	2	6	50	36	7	17	0	86	8	7	219
2016	1	26	47	10	7	17	0	142	28	3	281
Total	12	420	503	707	189	139	14	1638	299	214	4135
Average ± SD	2 ±1	32 ±38	30 ±18	42 ±43	13 ±13	8 ±7	5 ±6	96 ±213	19 ±18	14 ±17	243 ±249

Key: BNS – Black-necked Stork, BS - Black Stork, PS - Painted Stork, OBS - Asian Openbill, WNS - Asian Woollyneck



Image 1. 1984–85 - The Chambal Study Team. 2nd from left - L.A.K. Singh, 3rd - R.K. Sharma, 4th - R.J. Rao when B.C. Choudhury joined a trip. © from L.A.K. Singh collection

bring most of the water to Chambal in the post monsoon period (Fig. 1. inset). Six of the districts namely, Baran, Kota, Tonk, Sawai-Madhopur, Karauli and Dhaulpur (Dholpur) are in Rajasthan. The districts of Sheopur, Morena and Bhind are in Madhya Pradesh (MP) and the districts Agra and Etawah are in Uttar Pradesh (UP). Rainfall during October to May was negligible or nil. Therefore, data on total rainfall in each calendar year has been used for interpretation of stork sighting patterns.

RESULTS AND DISCUSSION

(1) Stork sighting - overall pattern

(a) All five species of storks were seen every year in Chambal during the entire study period that started from 1984–85. Year to year, zone-wise and species-wise numbers of storks was highly variable.

(b) Out of total sightings, the Painted Stork (PS) comprised the maximum at 52% followed by Asian Openbill (OBS) 24%, Black Stork (BS) 11%, Asian Woollyneck (WNS) 10%, and Black-necked Stork (BNS) 4%.

(c) Total sighting of storks was 56% downstream.

(2) Zone-wise sighting pattern

(a) Sightings of storks were more in study zones IV, V, XI and XII (Table 2). Zones IV and V comprise a 113km river stretch starting 35km away from Rajghat in the upstream stretch, where the river course is largely rocky. Zones XI and XII comprise 75km starting 155km away from Rajghat in the downstream stretch.

(b) At the species level, the Black Stork and Asian Openbill were sighted more upstream, at 97% and 70%, respectively out of their total sightings. The water amid rocky patches upstream appeared to be favoured by

Table 2. Zonewise record of storks in river Chambal during 1985–2016.

		Study Zone	Length-km	Progr. km	BNS	BS	PS	OBS	WNS	Total Storks
Pali-Rajghat	I	Pali-Rameshwar	22	22	0	1	5	55	15	76
	II	Rameshwar-Khirkhiri	15	37	0	67	10	76	2	155
	III	Khirkhiri-Baroli	20	57	0	11	42	80	20	153
	IV	Baroli-Atar	48	105	2	131	199	364	59	755
	V	Atar-Sarsaini	65	170	2	210	111	104	51	478
	VI	Sarsaini-Rajghat	35	205	8	0	136	28	42	214
Total in Upstream (Zones I-VI)					12	420	503	707	189	1831
Rajghat-Pachhnada	VII	Rajghat-BSGher	35	240	19	9	62	23	30	143
	VIII	BSGher-Usedghat	40	280	41	4	44	22	38	149
	IX	Usedghat-Ater	40	320	14	0	93	44	52	203
	X	Ater-Barhi	40	360	17	1	154	85	52	309
	XI	Barhi-Chakarnagar	38	398	32	0	835	54	20	941
	XII	Chakarnagar-Pachhnada	37	435	16	0	450	71	22	559
Total in Downstream (Zones VII-XII)					139	14	1638	299	214	2304
12 zones: Total number					151	434	2141	1006	403	4135
12 zones: Average ± SD					13 ±13	36 ±68	178 ±239	84 ±92	34 ±18	345 ±278
Upstream zones (I to VI): Average ± SD					2 ±3	70 ±85	84 ±78	118 ±123	32 ±22	305 ±260
Downstream zones: (VII-XII) Average ± SD					23 ±11	2 ±4	273 ±313	50 ±25	36 ±14	384 ±314

Key: BNS - Black-necked Stork, BS - Black Stork, PS - Painted Stork, OBS - Asian Openbill, WNS - Asian Woollyneck. Progr. km - 'km point' progressively ending for the study zones, read from 'zero-km' at Pali.

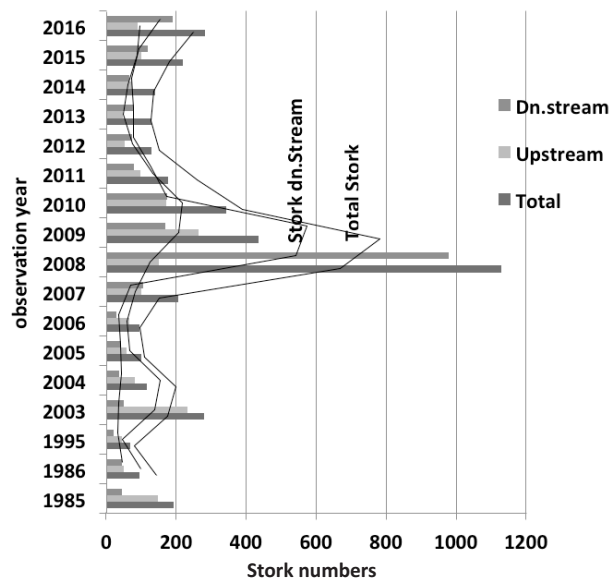


Figure 2. Number of Storks recorded in Chambal during 1984–85 to 2015–16 showing changing trend in counts between upstream and downstream after year 2007. River stretch upstream refers to Pali-Rajghat and downstream refers to Rajghat-Pachhnada.

Openbill Storks and Black Storks. Black Storks which are winter visitors were observed every year mostly at Nadigaon (in Study zone-IV, at 72km point with reference

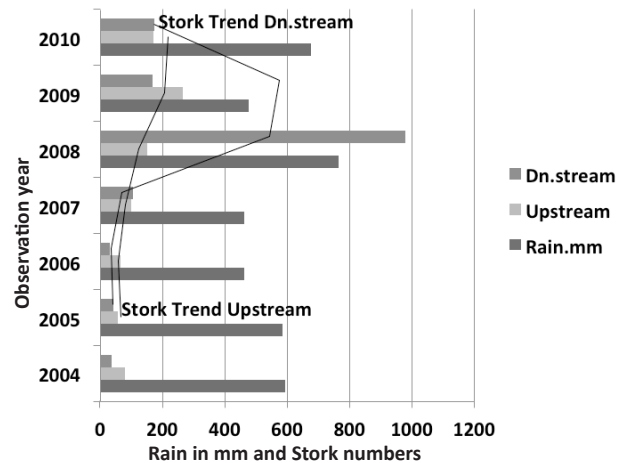


Figure 3. Average rainfall (mm) during 2004–2010 in 11 districts adjoining river Chambal along with changing trend in stork counts upstream and downstream in reference to Rajghat.

to Palighat) and Hauapura (Study zone-V, 120km point) and Chorfanndi (Study zone-V, 123km point).

(c) The Black-necked Stork and Painted Stork had 92% and 77% of their total sightings downstream. The Asian Woollyneck (WNS) had 44% of their presence upstream and 56% downstream (Tables 1 and 2).

(d) The total number of storks sighted upstream was higher from 1984–85 till OBS, after which the sightings

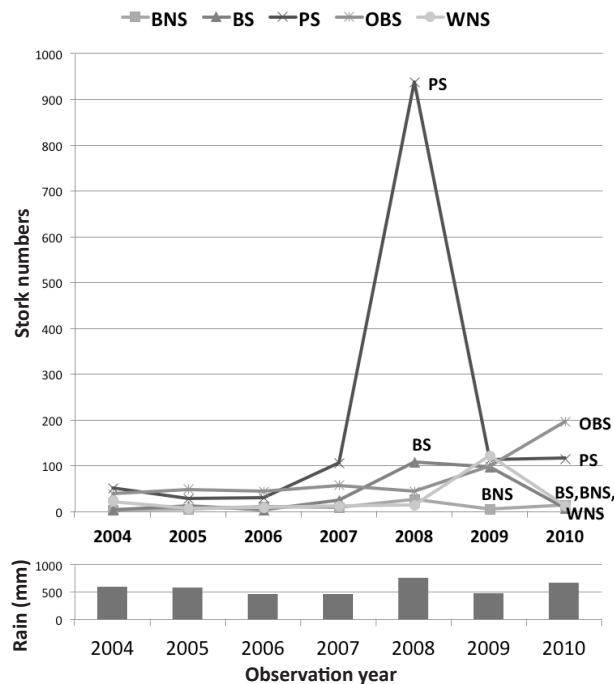


Figure 4. Chambal 2004–10: Rainfall and changing patterns in sighting of five species of Storks.
 BS - Black Stork, BNS - Black-necked Stork, OBS - Asian Openbill, PS - Painted Stork and WNS - Asian Woolly-neck

are more downstream (Figs. 2, 3). In the year 2008 the numbers of Painted Stork were abruptly high (Table 1; Fig. 4), particularly downstream (Table 2).

(3) Rainfall and stork sighting

(a) Sighting of storks increased in the year 2008 when rainfall was also the highest.

(b) Rainfall in Chambal region was 21% less in 2006 and 2007 compared to the year 2005. In 2006, 10 out of 11 districts had less rainfall.

(4) Implications of the study

(a) The presence of water birds offers indications about ecological conditions and productivity of wetland ecosystems (For example, Scott 1980, 1989; Li et al. 2009). The present study on the sighting of stork species in Chambal has been possible because it has overcome most of the problems which otherwise limit long term ecological monitoring (LTEM). The present study has been a part of the annual monitoring of prominent ecological associates of Gharial that started in 1983–84. NCS is a difficult terrain and LTEM is difficult for academic institutions or researchers to initiate and sustain because of various reasons like, a ribbon-like 570km long study area of the river, difficulty in negotiating the river or approaching the river bank, security issues, and overcoming the

difficulties of targets set through limited time and funding (For example, Fausch et al. 2002; Muller et al. 2010). Therefore, it is an ideal option with academic bodies to remain associated with NCS management by stationing a set of researchers who offer service continuity for LTEM in Chambal counted in terms of decades.

(b) The LTEM of stork and other birds in Chambal have not been presented properly to draw attention of specialist bodies like the International Waterfowl and Wetlands Research Bureau (Scott 1980, 1989) and Wetland International (Li et al. 2009). With advances in internet search and enhanced mechanisms of indexing the present work is expected to stimulate more organized and detailed LTEM of waterfowl over ecological time scale in the entire Chambal region.

(c) The present study indicates that river Chambal may have played a crucial role in supporting local stork populations as well as giving alternate refuge for local migrants during years with extreme ecological conditions. This aspect needs more studies and better understanding as there is national as well as international concern for the status of storks and other water birds.

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Image 2. Asian Openbill Stork in National Chambal Gharial Sanctuary.



Image 5. Asian Openbill Stork and Gharial group in National Chambal Gharial Sanctuary.



Image 6. Painted Stork and many other waterbirds on sand bank in National Chambal Gharial Sanctuary.



Image 3. Asian Woolly-necked Stork in National Chambal Gharial Sanctuary.



Image 4. Black-necked Stork, Grey Heron and *Kachuga tecta* sharing habitat in National Chambal Gharial Sanctuary.



Image 7. Painted Stork on rock and background high ravine in National Chambal Gharial Sanctuary.

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सारांश

गंगा सिस्टम की सहायक चम्बल नदी में वर्ष 1984-86 एवं 1995-2016 तक शीत ऋतु में 05 स्टॉक प्रजातियों की उपस्थिति के आंकड़ों को देख-देखकर आलेखित किया गया एवं पांच प्रजातियों के स्टॉक की वितरण संख्या के आंकड़ों का तुलनात्मक स्थानिक एवं लौकिक विश्लेषण किया गया है। चम्बल नदी के 205 कि.मी ऊपरी भाग पाली से राजघाट एवं 230 कि.मी. राजघाट से पचनदा को दो बड़े भागों में विभाजित कर तथा पूरे अध्ययन जोन को 12 उपक्षेत्रों में बांटा गया है। अध्ययन जोन 4 एवं 5 में जो 113 कि.मी. राजघाट से ऊपरी भाग में है, तथा अध्ययन जोन 11 एवं 12 जो 75 कि.मी. राजघाट के निचले भाग में है, वहां कुल मिलाकर स्टॉक की 66 प्रतिशत संख्या पाई गई। लगभग 56 प्रतिशत स्टॉक की संख्या राजघाट से निचले हिस्से में देखी गई, सभी पांच प्रजातियों में पेन्टेड स्टॉक 52 प्रतिशत देखा गया। चम्बल नदी के आसपास के 11 जिलों में वर्ष 2008 से पूर्व कम वर्षा हुई तथा चम्बल के निचले क्षेत्र में वर्ष 2008 में स्टॉक की अचानक रूप से वृद्धि हुई थी। राष्ट्रीय चम्बल अभ्यारण्य में नदीय तट के पक्षियों का निरंतर अनुश्रवण करने के लिये आग्रह किया जाता है, जिससे भविष्य में पक्षियों की संख्या में उतार-चढ़ाव एवं पारिस्थितिकी परिवर्तन होने पर चर्चा की जा सकती है।





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