COMMUNICATION

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


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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.
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

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**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.
Spatial and temporal patterns of Stork in National Chambal Sanctuary

S Sharma & Singh

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

<table>
<thead>
<tr>
<th>YEAR</th>
<th>Pali-Rajghat 205km (Upstream)</th>
<th>Rajghat - Pachnada 230km (Downstream)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>BNS</td>
<td>BS</td>
</tr>
<tr>
<td>1985</td>
<td>0</td>
<td>82</td>
</tr>
<tr>
<td>1986</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1995</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2003</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>2004</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>2005</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2006</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>2007</td>
<td>3</td>
<td>24</td>
</tr>
<tr>
<td>2008</td>
<td>0</td>
<td>108</td>
</tr>
<tr>
<td>2009</td>
<td>1</td>
<td>97</td>
</tr>
<tr>
<td>2010</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>2011</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>2012</td>
<td>0</td>
<td>30</td>
</tr>
<tr>
<td>2013</td>
<td>2</td>
<td>20</td>
</tr>
<tr>
<td>2014</td>
<td>0</td>
<td>9</td>
</tr>
<tr>
<td>2015</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>2016</td>
<td>1</td>
<td>26</td>
</tr>
<tr>
<td>Total</td>
<td>12</td>
<td>420</td>
</tr>
<tr>
<td>Average</td>
<td>2</td>
<td>±1</td>
</tr>
</tbody>
</table>

Key: BNS – Black-necked Stork, BS - Black Stork, PS - Painted Stork, OBS - Asian Openbill, WNS - Asian Woollyneck
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 to Palighat) and Hauaapura (Study zone-V, 120km point) and Chorfandni (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 2008, after which the sightings


<table>
<thead>
<tr>
<th>Study Zone</th>
<th>Length-km</th>
<th>Progr. km</th>
<th>BNS</th>
<th>BS</th>
<th>PS</th>
<th>OBS</th>
<th>WNS</th>
<th>Total Storks</th>
</tr>
</thead>
<tbody>
<tr>
<td>I Pali-Rameshwar</td>
<td>22</td>
<td>22</td>
<td>0</td>
<td>1</td>
<td>5</td>
<td>55</td>
<td>15</td>
<td>76</td>
</tr>
<tr>
<td>II Rameshwar-Khirkhiri</td>
<td>15</td>
<td>37</td>
<td>0</td>
<td>67</td>
<td>10</td>
<td>76</td>
<td>2</td>
<td>155</td>
</tr>
<tr>
<td>III Khirkhiri-Baroli</td>
<td>20</td>
<td>57</td>
<td>0</td>
<td>11</td>
<td>42</td>
<td>80</td>
<td>20</td>
<td>153</td>
</tr>
<tr>
<td>IV Baroli-Atar</td>
<td>48</td>
<td>105</td>
<td>2</td>
<td>131</td>
<td>199</td>
<td>364</td>
<td>59</td>
<td>755</td>
</tr>
<tr>
<td>V Atar-Sarsaini</td>
<td>65</td>
<td>170</td>
<td>2</td>
<td>210</td>
<td>111</td>
<td>104</td>
<td>51</td>
<td>478</td>
</tr>
<tr>
<td>VI Sarsaini-Rajghat</td>
<td>35</td>
<td>205</td>
<td>8</td>
<td>0</td>
<td>136</td>
<td>28</td>
<td>42</td>
<td>214</td>
</tr>
</tbody>
</table>

Total in Upstream (Zones I–VI) 12 | 420 | 503 | 707 | 189 | 1831 |

<table>
<thead>
<tr>
<th>Study Zone</th>
<th>Length-km</th>
<th>Progr. km</th>
<th>BNS</th>
<th>BS</th>
<th>PS</th>
<th>OBS</th>
<th>WNS</th>
<th>Total Storks</th>
</tr>
</thead>
<tbody>
<tr>
<td>VII Rajghat-BSGher</td>
<td>35</td>
<td>240</td>
<td>19</td>
<td>9</td>
<td>62</td>
<td>23</td>
<td>30</td>
<td>143</td>
</tr>
<tr>
<td>VIII BSGher-Usedghat</td>
<td>40</td>
<td>280</td>
<td>41</td>
<td>4</td>
<td>44</td>
<td>22</td>
<td>38</td>
<td>149</td>
</tr>
<tr>
<td>IX Usedghat-Ater</td>
<td>40</td>
<td>320</td>
<td>14</td>
<td>0</td>
<td>93</td>
<td>44</td>
<td>52</td>
<td>203</td>
</tr>
<tr>
<td>X Ater-Barhi</td>
<td>40</td>
<td>360</td>
<td>17</td>
<td>1</td>
<td>154</td>
<td>85</td>
<td>52</td>
<td>309</td>
</tr>
<tr>
<td>XI Barhi-Chakarnagar</td>
<td>38</td>
<td>398</td>
<td>32</td>
<td>0</td>
<td>835</td>
<td>54</td>
<td>20</td>
<td>941</td>
</tr>
<tr>
<td>XII Chakarnagar-Pachnada</td>
<td>37</td>
<td>435</td>
<td>16</td>
<td>0</td>
<td>450</td>
<td>71</td>
<td>22</td>
<td>559</td>
</tr>
</tbody>
</table>

Total in Downstream (Zones VII-XII) 139 | 14 | 1638 | 299 | 214 | 2304 |

Progr. km - ‘km point’ progressively ending for the study zones, read from ‘zero-km’ at Pali.
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 researchers to initiate and sustain because of various terrain and LTEM is difficult for academic institutions or of Gharial that started in 1983–84. NCS is a difficult monitoring (LTEM). The present study has been a part of annual monitoring of prominent ecological associates of Gharial which otherwise limit long term 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.

(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. Therefore, it is an ideal option with academic bodies to set through limited time and funding (For example, Fausch et al. 2002; Muller et al. 2010). Thus, it is an ideal option with academic bodies to set through limited time and funding for LTEM in Chambal counted in terms of decades.

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S Sharma & Singh

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Communications

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-- J. Judas, Gabor Csorba & Petr Benda, Pp. 11379–11390

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-- Dhananjay Chavan Vinayak & Subhash Vitthal Mali, Pp. 11399–11409

Spatial and temporal patterns of stork sightings (Aves: Ciconiidae) in National Chambal Sanctuary of Gangetic River system

The Red-headed Falcon Falco chicquera Daudin, 1800 (Aves: Falconiformes: Falconidae) breeding on Palmyra Palm at Bahour Lake, Puducherry (Pondicherry), India
-- Raveendran Lekshmi & Surendhar Boobalan, Pp. 11416–11422

Fish diversity and the conservation status of a wetland of Cooch Behar District, West Bengal, India
-- Ram Krishna Das, Pp. 11423–11431

Seasonal distribution and abundance of earthworms (Annelida: Oligochaeta) in relation to the edaphic factors around Udupi Power Corporation Limited (UPCL), Udupi District, southwestern coast of India

Breeding behaviour of the Coromandel Marsh Dart Damselfly (Zygoptera: Coenagrionidae: Ceriagrion coromandelianum (Fabricius)) in central India

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-- Sudhanya Ray Hajong & Rodeson Thangkiew, Pp. 11454–11458

Umbrella Starwort Stellaria umbellata Turcz. (Caryophyllaceae): a new record to the flora of the western Himalaya, India
-- Satish Chandra & D.S. Rawat, Pp. 11459–11463

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-- A. Sabeena, V.B. Hosagoudar & V. Divaharan, Pp. 11470–11479

Notes

Pternopetalum latipinnulatum (Apiaceae), a new record for the flora of India
-- Licha Jeri, Nazir Ahmad Bhat & Yogendra Kumar, Pp. 11480–11483

Five new additions to the grass flora of Tripura State, India
-- Sampa Ghosh & Debiyoti Bhattacharyya, Pp. 11484–11492

Response

A preliminary but incomplete checklist of Gujarat spiders
-- R.V. Vyasan & B.M. Parasharya, Pp. 11493–11494

Miscellaneous

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