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Cover: Whale Shark *Rhincodon typus* and Reef - made with poster colours. © P. Kritika.



Long-term monitoring of pelicans in National Chambal Sanctuary, India

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Abstract: Monitoring of Gharial *Gavialis gangeticus* in National Chambal Sanctuary (NCS) since 1983 has resulted in collection of data on other ecological associates, located between 25.8474–26.4389 °N, 76.5645–79.2132 °E. One such beneficiary of this long term monitoring program are the pelicans, locally called 'Hawaseel'. Pelican species visiting Chambal from November to March include the Dalmatian *Pelecanus crispus*, Great White *Pelecanus onocrotalus*, and Spot-billed *Pelecanus philippensis*. Species-wise separation of pelicans at the sites of congregation is often difficult. The total number of pelicans counted during the annual census from 2003 to 2016 was 4,429. The study area extends over 435 km comprising 12 study zones, 99% counts were made in the study zones X, XI and XII. These zones stretch over 115 km that occur near the confluence of Chambal with river Yamuna. Here, the river is deep. Other large birds seen with the pelican squadrons are groups of Cormorant *Phalacrocorax carbo*, Painted Stork *Mycteria leucocephala*, Nakta or Comb Duck *Sarkidiornis melanotos*, and the Grey-lag Goose *Anser anser*. Other large birds seen on the riverbanks were the Common Crane *Grus grus*, Sarus Crane *Grus antigone*, Greater Flamingo *Phoenicopterus* species, and Demoiselle Crane *Grus virgo*. The study provides a baseline about the population of pelicans and the availability of large wetland birds in NCS. The biodiversity significance of NCS got highlighted because of the ongoing gharial conservation programme. The Chambal River Sanctuary is a composite unit of several un-notified 'core areas'. The sanctuary fulfills six of the nine criteria for possible consideration as an international Ramsar Wetland.

Keywords: Dalmatian Pelican, Great White Pelican, Spot-billed Pelican, river Chambal, river Yamuna.

सार: राष्ट्रीय चंबल अभयारण्य के आर्द्रभूमि आवास में घड़ियाल की निगरानी के दौरान पेलिकन समेत अन्य पारिस्थितिक सहयोगियों के डेटा संगृहीत हुए थे। इस अंचल में सभी जातिका पेलिकन को 'हवासील' कहा जाता है। पक्षि मण्डली की साइट पर, क्योंकि प्रजातियों को अलग करना मुश्किल है, इस रिपोर्ट में 2003-2016 के दौरान संगृहीत सभी तीन पेलिकन प्रजातियों की कुल संख्या पर डेटा का उपयोग किया गया है। 2003-2016 के दौरान कुल पेलिकन संख्या 4429 थी, जो संख्या 1147 (26%) के साथ वर्ष 2008 में सबसे अधिक थी। 2013 से पेलिकन की संख्या में वृद्धि की प्रवृत्ति है। यमुना नदी से मिलने वाले तीन अध्ययन क्षेत्रों अर्थात्, जोन X, XI और XII में अधिकतम संख्या 4375 (99%) थी। हमारे वार्षिक सर्वेक्षण के दौरान हम, Nakta या कोम्ब बतख (*Sarkidiornis melanotos*), जलकाग के समूहों, (*Phalacrocorax carbo*, *Phalacrocorax fuscicollis*), चित्रित सारस (*Mycteria leucocephala*) और Grey-lag goose (*Anser anser*) फोटो दस्तावेज बनाया है। इसी दौरान नदी किनारे दृश्यमान अन्य प्रजातिका बड़े पक्षियों में शामिल हैं Common Crane (*Grus grus*), Sarus Crane (*Grus antigone*), Greater Flamingo (*Phoenicopterus* species), and Demoiselle Crane (*Grus virgo*)। हम राजस्थान, मध्य प्रदेश और उत्तर प्रदेश को शामिल करते हुए भारत के एक त्रि-राज्य रामसर स्थल (Ramsar site) के रूप में चंबल नदी पर बेहतर ध्यान देने की आवश्यकता पर प्रकाश डालते हैं। अंतर्राष्ट्रीय मान्यता के साथ, यह उम्मीद की जाती है कि चंबल के आर्द्रभूमि जीवों पर अध्ययन जो हमने 1983 में भारत सरकार के आदेश पर शुरू किया था, नए सिरे से जारी रहेगा। वर्तमान अध्ययन का उद्देश्य दलील को मजबूत करना है।

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Author contributions: LAKS identified the studies, analysed and developed the text with illustrations from numerical and photographic data. RKS maintained and contributed the base data on pelican counts with photographs.

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INTRODUCTION

The erstwhile Central Crocodile Breeding and Management Training Institute (CCBMTI) of the Government of India established a Field Research Camp in the campus for gharial project of Madhya Pradesh at village Deori in Morena district. The purpose was to conduct studies on the population of Gharial that was assisted through conservation measures in National Chambal Sanctuary (NCS) since 1978 (Singh 1985, 1999; Bustard 1999).

The camp operated in NCS during 1983–85, but the field work continued in the sanctuary till 2016 by the Madhya Pradesh Forest Department. These exercises helped in understanding the population status and trends of Gharial, Mugger Crocodile *Crocodylus palustris*, Gangetic Dolphin *Platanista gangetica*, river turtles, Indian Skimmer birds *Rynchops albicollis*, five species of storks and thirty species of raptors (Singh 1985; Rao & Singh 1987a,b,c; Sharma & Singh 1986, 2014, 2015, 2018; Singh & Sharma 2018; Singh et al. 2022).

Three species of Pelicans, discussed in the present article, were also sighted and counted during annual surveys for gharial in NCS from 2003 to 2016. The species are the Great White Pelican (GWP), Dalmatian Pelican (DP), and the Spot-billed Pelican (SBP). The IUCN Red List status of DP and SBP is NT (Near Threatened) and GWP is LC (Least Concern) (Birdlife International 2021). This article intends to record the biodiversity significance of NCS in terms of temporal and spatial occurrence of pelicans, locally known as ‘Hawaseel’.

STUDY AREA

River Chambal included under wetland types 11 (rivers, streams – slow-flowing, lower perennial) & 12 (rivers, streams – fast-flowing, upper perennial) (Scott 1989). It is in the semi-arid zone of northwestern India. It is a clear, perennial, and fast flowing river which originates in the Vindhyan range of Madhya Pradesh. The gharial population in Chambal was highlighted in 1974 when the national crocodile survey was conducted (FAO 1974). Notification of the NCS along the river Chambal came in phases from 1978 onwards. A stretch of about 572 km of Chambal sanctuary flows through the states of Rajasthan, Madhya Pradesh (MP) and Uttar Pradesh (UP). Beyond Bhareh in Etawah District of Uttar Pradesh, Chambal forms the Pachhnada confluence with the rivers Yamuna, Kunwari, Sind, and Pahuj.

The updated status given for Important Bird Areas (IBA 1999) in Madhya Pradesh, covers our study area in river Chambal in the IBA site category A1 and A4iii

(Rahmani et al. 2016). Some of the important birds of Chambal and their IUCN status are given here. The species include Red-headed Vulture *Sarcogyps calvus* (CR—Critically Endangered), Black-bellied Tern *Sterna acuticauda* (EN—Endangered), Indian Skimmer *Rynchops albicollis* (EN), River Tern *Sterna aurantia* (VU—Vulnerable), Painted Stork *Mycteria leucocephala* (NT), Black-necked Stork *Ephippiorhynchus asiaticus* (NT), Black-headed Ibis *Threskiornis melanocephalus* (NT), Oriental Darter *Anhinga melanogaster* (NT), Great Thick-knee *Esacus recurvirostris* (NT), River Lapwing *Vanellus duvaucellii* (NT), Laggar Falcon *Falco jugger* (NT), Eurasian Curlew *Numenius arquata* (NT), other rarely seen birds like Great Crested Grebe *Podiceps cristatus* (LC), and the Common Merganser *Mergus merganser* (LC).

MATERIALS AND METHODS

Survey years and data

Annual surveys of Chambal were made ever since 1983 (Supplementary Table A and Table 1). The surveys were conducted from mid-December to mid-February. In specific, the pelican counts were continuously recorded during the years 2003 to 2016, and have been used for understanding their spatial and temporal characteristics. Although three pelican species were visiting Chambal (Images 2–6), it was difficult to segregate them and make species wise separate counts. Therefore, the data was analysed for total pelican counts (Table 1).

Equipment

The survey facilities included an aluminium boat with outboard engines issued by the FAO component of the conservation scheme. These were available round the year with NCS, MP since 1983. One YAMAHA 20 HP engine was used for normal movement, and a 5 HP outboard remained standby. During the survey the motorboat speed was kept at the minimum, depending on the demands for observation and navigability of the river. The accelerator to the engine didn't have calibration expressing speed in terms of km/hour. Several stretches were also covered on foot by walking along the riverbank. To go beyond rapids or the Rahu water fall, the boat and other equipment were hand lifted from negotiable point. Pelicans were counted with the help of a pair of binoculars (Canon image stabilizer 10x30 IS). Occasionally, a spotting scope (Fujinon Japan super field scope 60-5) was used.

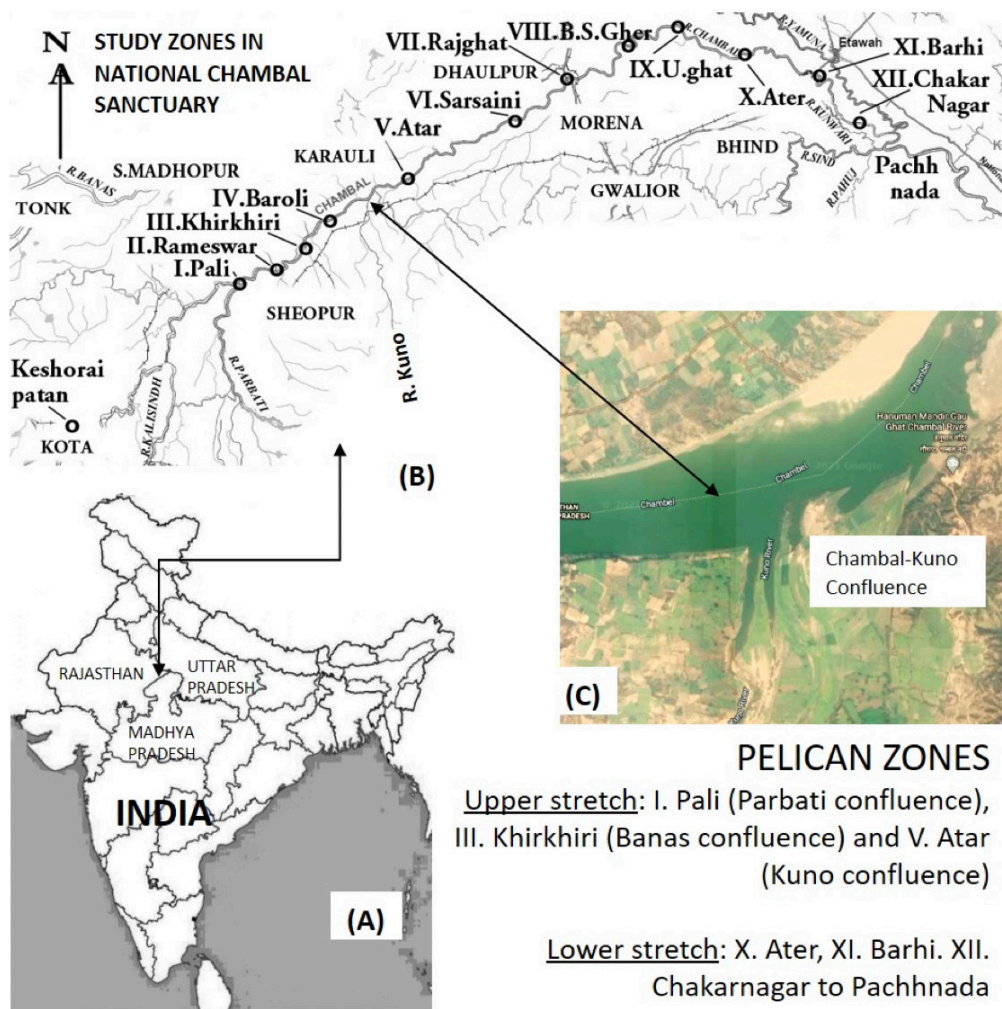


Image 1. A—Map of India | B—showing National Chambal Sanctuary with Pelican zones spread in 12 Study Zones, as observed during 2003–2016 | C—The confluence of rivers like Kuno provide good depth of water for pelican.

Survey team

The survey team comprised of five persons. Two of these were boatmen, one for the outboard engine and the other for manual rowing, with help from all when needed. Three research persons were in the team for identification and record of data. One of the researchers recorded all data exclusively related to birds.

Survey hours

The team moved and made observations during the day. The actual survey hours per day was variable and usually after 0900 h in the morning when fog cleared, and there was good visibility from a distance. A survey day lasted till about an hour before sunset when camping arrangements had to be made before it was dark. Night camps were made on the river bank, or a village overlooking the river. As per a tentative itinerary agreed from the beginning, the research Land Rover or

a four-wheel jeep of the state government was usually available in some close by village in Madhya Pradesh. The vehicle could come to the riverside village only at a few locations.

Data sheets

The 435 km stretch of the river from Pali up to Pachhnada, was divided into twelve study zones (I through XII), starting from Palighat in Rajasthan up to Pachhnada in UP. The zones are name-based and easily identifiable (Image 1, Table 1) by the staff and local people. From 2003 onwards, Garmin GPS sets were introduced in the field. Instead of the coordinate values, the authors have retained the use of the names of locations. Most of these names were identifiable over topographic sheets issued by the Survey of India.

For daily use during the survey, observation sheets were prepared on A4 paper using map copies of 5-km

stretches from the toposheets. Data on pelican and other species were recorded directly on the observation sheets. It showed the exact locations where sightings were made. The protocol of the field survey was based on descriptions given in Singh (1985) for gharial, mugger, turtles, dolphin and all bird species. Birds were identified according to the procedure and description given in Ali (1979, 2002), Grimmett et al (2011), and Gill et al (2021).

RESULTS

Pelicans in different study years (Table 1, Figure 1)

The total number of pelicans counted during 2003–2016 was 4,429. The highest count was in the year 2008 with 1,147 or 26% of total counts. Although, there is no consistency in the year wise counts, from 2013 there is an increasing trend in the number of pelicans. The trend increased from 110 in 2013 to 788 in 2016.

Pelicans in different study zones (Table 1)

In the last three study zones, i.e., zone X, XI and XII

the count was the maximum, totalling 4,375 (99%) out of 4,429. The counts were 71 in the study zone-X (Ater-Barhi), 784 in zone-XI (Barhi-Chakarnagar) and 3,520 in zone-XII (Chakarnagar-Pachhnada). Other than these, in study zone-I (Pali-Rameshwar) 19 pelicans were counted during the study period. But there were no pelicans observed here during the past five years (Table 1). Besides study zone I, the zones III (Khirkhira-Baroli), and V (Atar-Sarsani) also featured with occasional counts.

Photo documentation of other wetland birds (Images 7–13)

In the course of our annual survey, we photo documented the pelican squadrons while they shared the habitat with groups of Great Cormorants, Painted Stork, Nakta or Comb Duck, Greylag Goose, Common Crane, Sarus Crane, and Greater Flamingos. The Demoiselle Crane were recorded in the beginning years of our observations (Sharma & Singh 1986). However, in the more recent years they were seen in Chambal only for a few days at the start of winter.

Table 1. Numbers of pelicans counted in 12 different study zones of National Chambal Sanctuary during 2003–2016. The data shows the total of all three species namely, Dalmatian Pelican (DP) and Great White Pelican (GWP), with occasional Spot-billed Pelican (SBP). The species-wise details from 1983–1997 is presented in Supplement Table A.

	I. Pali-Rameshwar (22)	II. Rameshwar-Khirkhira (15)	III. Khirkhira-Baroli (20)	IV. Baroli-Atar (48)	V. Atar-Sarsani (65)	VI. Sarsani-Rajghat (35)	VII. Rajghat-BabusinghGher (35)	VIII. BabusinghGher-Usedghat (40)	IX. Usedghat-Ater (40)	X. Ater-Barhi (40)	XI. Barhi-Chakarnagar (38)	XII. Chakarnagar-Pachhnada (37)	Total (435 km)
YEAR	Total number of pelicans in different Study Zones												
2003			13	-	-	-	-	-	3	12	80	-	108
2004	12	-	-	-	-	-	-	-	-	-	-	-	12
2005	-	-	-	2	6	-	-	-	-	6	14	-	28
2006	-	-	-	-	-	-	-	2	-	-	-	-	2
2007	-	-	-	-	-	-	-	-	-	-	-	407	407
2008	2	-	-	-	-	-	-	-	-	21	469	655	1147
2009	-	-	-	-	-	-	-	-	-	32	45	156	233
2010	1	-	-	-	6	-	-	-	-	-	50	214	271
2011	4	-	-	-	-	-	-	-	-	-	12	0	16
2012	-	-	-	-	2	-	-	-	-	-	-	0	2
2013	-	-	-	-	-	-	-	-	-	-	110	0	110
2014	-	-	-	-	-	-	-	1	-	-	4	529	534
2015	-	-	-	-	-	-	-	-	-	-	-	771	771
2016	-	-	-	-	-	-	-	-	-	-	-	788	788
Total	19	0	13	2	14	0	0	3	3	71	784	3520	4429

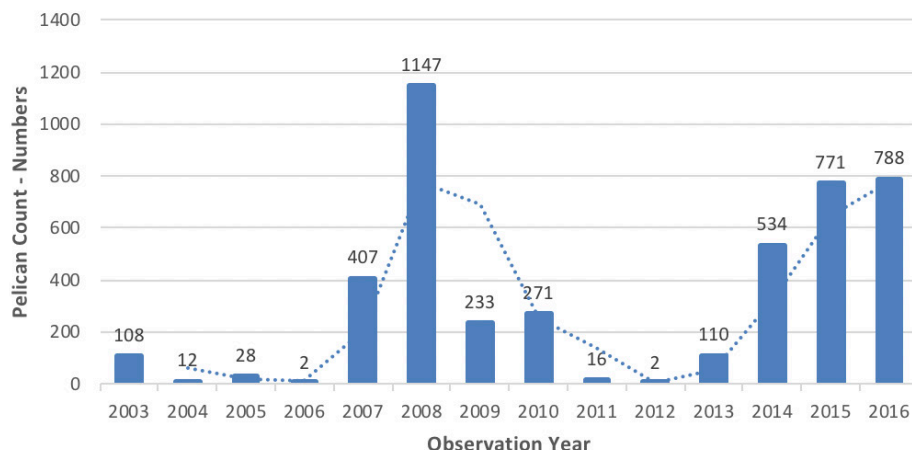


Figure 1. Total numbers of pelican counted in National Chambal Sanctuary during 2003–2016 with trendline showing moving average.



Image 2. A squadron of pelicans in National Chambal Sanctuary. © R.K. Sharma.



Image 3. Morphological variations among pelicans seen: A—darker legs and darker plumage on lower back to posterior end | B—dull underparts and legs. © R.K. Sharma.

DISCUSSION

Spatial occupation

Pelicans appear to have preferred the study zones X, XI, and XII which is a stretch of 115 km from Ater to Pachhnada. Majority of the counts, i.e., 99% were recorded here. In this stretch, the water course is deep. In the region around the confluence of Chambal with Yamuna, nylon set netting for fishing exists in deep water, but killing of pelicans is not confirmed. In upper stretches of Chambal, the appearance of pelicans in study zones I (Pali-Rameshwar), III (Khirkhiri-Baroli), and V (Atar-Sarsani) appear to be due to the conditions created at the confluences of rivers Parbati, Banas, Seep and Kuno. Here, the water depth and food availability are better. It is possible that the pelicans have avoided the stretches where adult breeding Gharials are present. These aspects need to be further studied.

Migration of pelicans to Chambal

Of the roughly 1,220 regularly occurring species of birds in India, 280 are long distance migrants, 116 are migrants within the subcontinent, and the remaining species are residents, either sedentary or showing local movements (State of Indian Birds 2020). Out of 310 species of wetland birds in India 107 species are winter migrants (Kumar et al. 2005). The sighting of pelicans in river Chambal may be due their local migration.

The Spot-billed Pelican (SBP) is a resident and local migrant species breeding in Brahmaputra valley and a few other locations in southern India. Some of the locations in Andhra Pradesh are the deltas of Krishna and Godavari. A famous location in Tamil Nadu is the Pulicat which borders Andhra Pradesh (Subramanya 1996; Talukdar 1999; Kannan & Manakadan 2005). Pandav

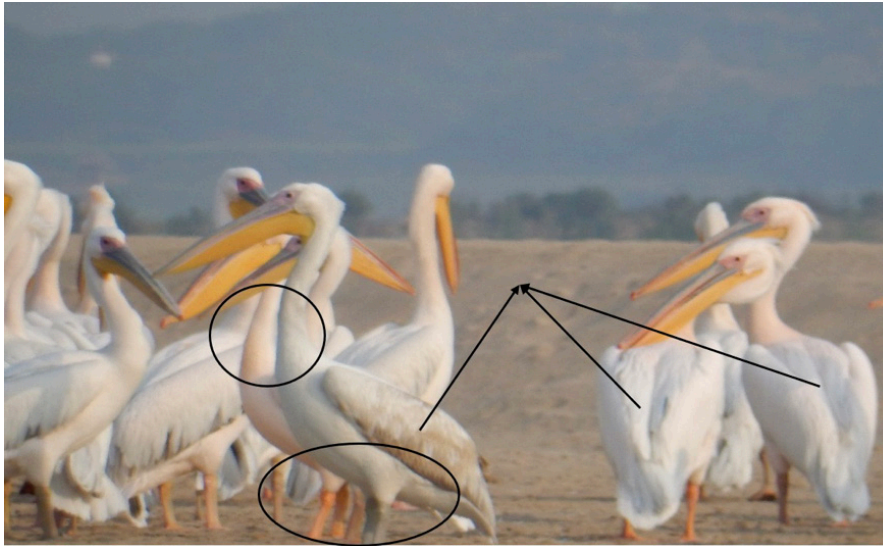


Image 4. Morphological variations among pelicans seen in the regions of neck, leg and back. Based on Salim Ali (2002), pelicans with pink legs are Great White Pelican (GWP), grey legs are Dalmatian Pelican (DP), and those with black spots on upper mandible are Spot-billed Pelican (SPB). GWP also have forehead ending in a point above bill. © R.K. Sharma.

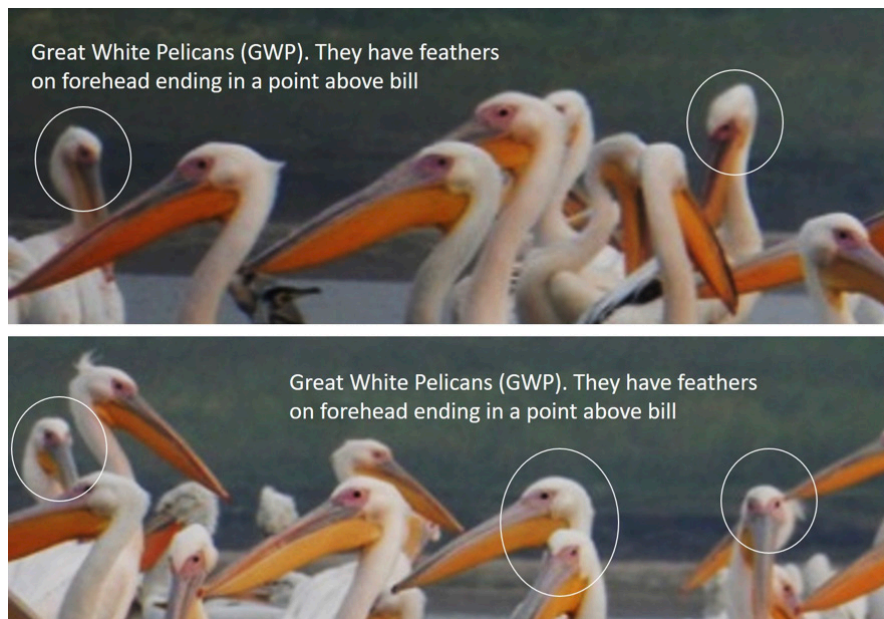


Image 5. Distinguishing feature of Great White Pelican (GWP). © R.K. Sharma.

(1996) found a flock of 24 SBP roosting in the heronry during July–October 1993 in Bhitarkanika Wildlife Sanctuary of Odisha. SBP were seen in 1991 in Dihaila Jheel in Shivpuri, Madhya Pradesh (IBA 1999). Rahmani (1987, 1991) reported SBP in Karera Bustard Sanctuary, M.P. during 1986–87. Karera is in the direction closer to Pali (study zone-I).

GWP is a habitat specialist, largely depending on open water areas (Thirunaranan et al. 2017). The

migration routes and stop over sites of GWP are poorly known (Izhaki et al. 2002). DP have been reported in Delhi by Ganguli (1975) and Urfi (2003). Rahmani et al (2021) in their work for the Madhya Pradesh Biodiversity Board, drew attention to the threatened birds of Madhya Pradesh. In this context they mentioned that the DP population in India is about 20,000–25,000 (Rahmani et al. 2021). A dedicated study on pelicans is expected to trace the status of migration and arrival

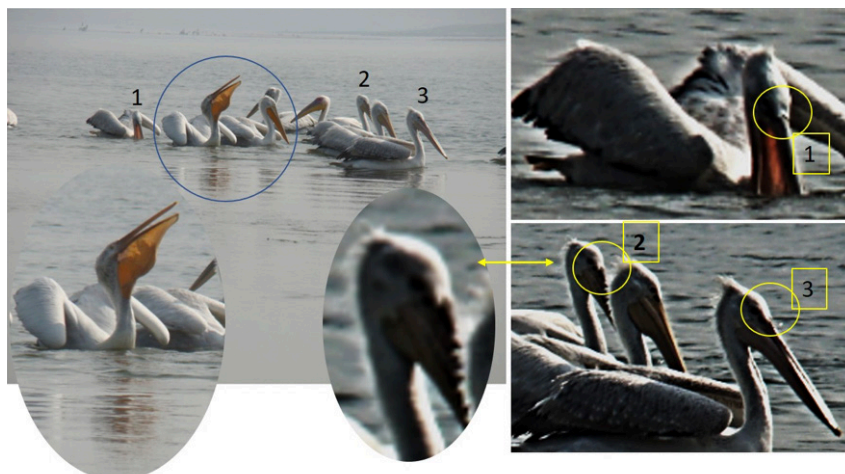


Image 6. Dalmatian Pelican swallowing fish. DP is distinguished from forehead feathers which end in a concave crescent (1,2,3 and inset). © R.K. Sharma.



Image 7. Pelicans with Greylag Geese *Anser anser* and cormorant. © R.K. Sharma.

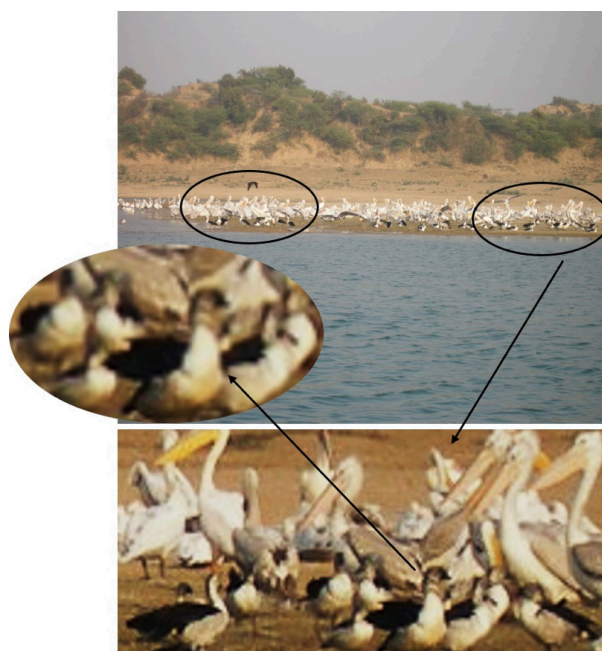


Image 8. Chambal pelicans with Nakta or Comb Duck *Sarkidiornis melanotos*. © R.K. Sharma.

patterns for all three species identified in NCS. Their movement in relation to adjoining wetlands also needs to be addressed.

Core zone of National Chambal Sanctuary

Visual assessments indicate that the transverse profile of NCS varies at different places along the length of the river. The differences are with respect to combinations relating to the hydrological characteristics, rocky surface, rapids, sand bar, small islands, roads communicating with villages, on-shore cultivation, and

usage of the river for bathing and washings. There are sand-mining activities at places. Therefore, without attempting to have core and buffer zones along 572 km length of the river, the tri-state system of management has focused on the entire sanctuary. In this approach, it has been possible to sustain diversity of faunal indicators in NCS over the last 44 years.

Suggestion for 'Chambal River Ramsar site'

National Chambal Sanctuary is the longest national river sanctuary that offers vast scope for education,



Image 9. Chambal pelicans with Painted Stork *Mycteria leucocephala*. © R.K. Sharma.



Image 10. Pelicans with cormorant in National Chambal Sanctuary. © R.K. Sharma.



Image 11. Common cranes in National Chambal Sanctuary. Adult, chick, crows and riverside camp by local people are shown above. © R.K. Sharma.



Image 12. Sarus Cranes lack fear of people near crop and river ghats in National Chambal Sanctuary. Sarus are seen with smaller wetland birds Nakta (Comb Duck) and River Tern. © R.K. Sharma.

research and conservation. The proposal for recognition of NCS as a RAMSAR site was last processed in October 2008 by the principal chief conservator of forests (Wildlife), Madhya Pradesh. Coordination meetings were held by the state forest officers of Madhya Pradesh, Rajasthan and Uttar Pradesh, with WWF-India and experts from Wildlife Institute of India. In the light of findings from our studies, we present a discussion on the fulfilment of RAMSAR criteria by NCS, for possible reference in future.

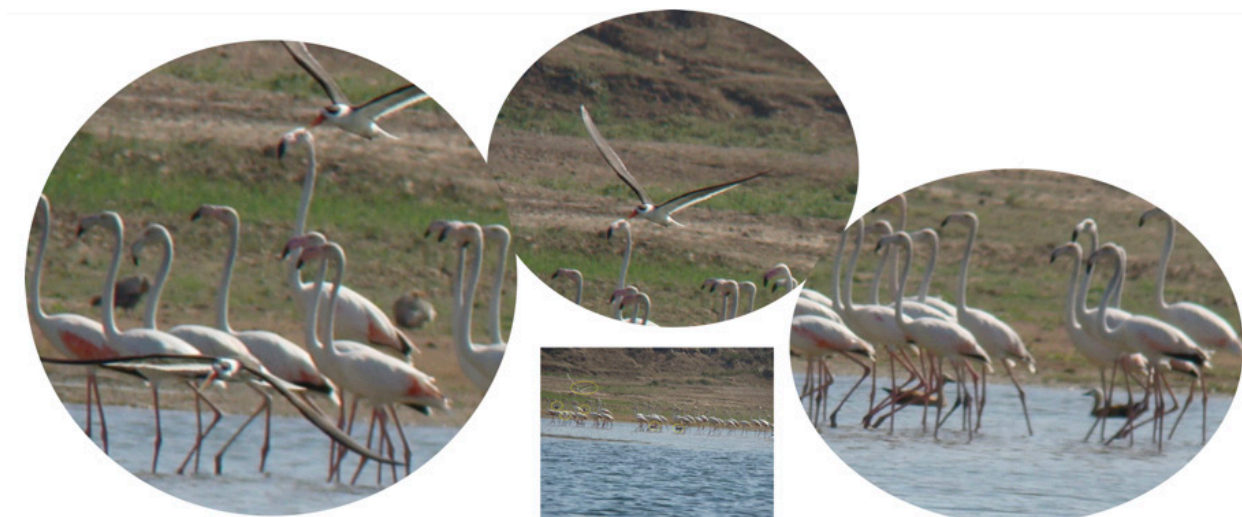


Image 13. Greater Flamingos with smaller wetland birds Indian Skimmer, Brahminy Duck and geese in National Chambal Sanctuary. © R.K. Sharma.

Ramsar-criteria fulfilment by NCS

A Ramsar site has to fulfil one of the nine criteria (Anonymous 2022). Besides, the responsible stakeholders are expected to remain committed for maintenance & sustenance of the ecological, hydrological, and socioeconomic characteristics of the site. NCS meets six of the nine criteria for the international Ramsar-tag.

River Chambal in NCS is recognised under the wetland types 11 and 12 (Scott 1989), with ecological continuity in the semi-arid biogeographic zone (Rodgers & Panwar 1988), which is also termed in the Khatiar-Gir Ecoregion in India (WWF 2021). The studies on spatial and temporal trend of several indicator species from NCS for more than thirty years, testify the significance of the sanctuary as a 'site of international importance for conserving biological diversity (Ramsar Group-A Criterion 1).

Out of the Ramsar criteria under Group-B, NCS fulfils five criteria namely 2, 3, 4, 8 and 9, as it supports a number of internationally important faunal species and the associated ecological communities. Long term monitoring the conservation-assisted populations of Gharial, the Mugger, and the Gangetic Dolphin. Since 2010, the Gangetic Dolphin is recognised as the national aquatic animal of India. NCS holds populations of the unique freshwater turtles *Batagur kachuga* (CR), *Batagur dhongoka* (CR), *Chitra indica* (EN), *Nilssononia gangeticus* (EN), the Smooth Coated Otter *Lutra perspicillata* (VU), and at least 308 species of resident and migratory wetland birds (Nair & Krishna 2013) (Criterion 2). Continued support for Long-Term Ecological Monitoring (LTEM) is expected to strengthen the importance of

these species for maintaining the biological diversity in the semi-arid biogeographic zone (Criterion 3).

NCS satisfies the Ramsar Criterion 4 as the river supports or provides refuge to several migrating bird species at a critical stage in their life cycles (Sharma & Singh 2018; Singh & Sharma 2018; Singh et al. 2022; and the present study). In fulfilling the Ramsar Criterion 9, the 572 km long river within NCS supports more than 1% of the individuals in population of wetland-dependent non-avian animal species namely the Gharial.

In the context of Ramsar Criterion-9, we refer here to the suggestion by Dubey & Mehra (1959) for more specific and long-term study on the fish fauna. The study continues to provide a general, yet landmark, ecological picture of the fish resource and fisheries in Chambal from the location of Gandhi Sagar dam up to River Yamuna. The fish fauna comprised sub-mountain and plain-land species. It is important because, of the 71 species they recorded, 46 are important for fisheries. The game-fish species include *Tor tor*, *Barilius bola* and *Puntius thagunio*. *Hilsa* is generally known as a long-range migratory species from estuaries of Bay of Bengal through Ganga and Yamuna. Such migration may not be entirely for breeding but also for feeding. During our work in 2000s, Tilapia and a Sting Ray was also reported by the fishermen. A series of dams and the Kota barrage have been constructed over Chambal but fish population do not seem to be severely affected as local consumption is extremely low. Big fishing enterprises were not existing and fishing practice was extremely low compared to that which existed in the Yamuna.

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Supplementary Table A. Pelican counts in National Chambal Sanctuary during 1983–1997. GWP—Great White Pelican | SBP—Spot-billed Pelican | DP—Dalmatian Pelican. There were no observations during 1998–2002.

Study Zone	River Zones and length in kms												
	I+II	III	IV+V	VI+VII+VIII+IX	X		XI		XII		Total		Grand Total all 3 species
	Pali-Rameshwar-Khirkhiri (22+15))	Khirkhiri-Baroli (20)	Baroli-Atar-Sarsani (48+65)	Sarsaini-Rajghat-BabusinghGher-Usedghat-Ater (35+35+40+40)	Ater-Barhi (40)		Barhi-Chakarnagar (38)		Chakarnagar-Pachhnada (37)				
YEAR	All 3 spp.	GWP+SBP	All 3 spp.	GWP+SBP	GWP+SBP	DP	GWP+SBP	DP	GWP+SBP	DP	GWP+SBP	DP	GWP+SBP+DP
1983–85	0	1	0	0	-	-	-	-	-	-	1	-	1
1986	0	0	0	0	-	-	-	-	-	-	0	-	0
1987	0	0	0	0	-	-	-	-	10	-	10	-	10
1988	0	0	0	1	1	-	-	-	9	2	11	2	13
1990	0	0	0	0	5	2	3	-	14	5	22	7	29
1994	0	0	0	0	-	-	-	-	53	6	53	6	59
1996	0	0	0	0	-	-	43	6	65	9	108	15	123
1997	0	0	0	0	4	-	25	7	51	10	80	17	97
Total	0	1	0	1	10	2	71	13	202	32	285	47	332



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