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Caption: *Cyrtodactylus myntkyawthurai*, endemic to Myanmar. Medium: Water colours on watercolor sheet. © Aakanksha Komanduri



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COMMUNICATION

Raptors observed (1983–2016) in National Chambal Gharial Sanctuary: semi-arid biogeographic region suggestions for parametric studies on ecological continuity in Khathiar-Gir Ecoregion, India

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Abstract: The birds of prey or raptors in the National Chambal Sanctuary (NCS) assume importance as they are among the top predators of the region, preying on small crocodylians, turtles, and birds. Our checklist of 30 species of raptors is developed from observations made during winter surveys conducted between 1983 and 2016. The study area covered the course of river Chambal including its confluence with river Kuno that leads from Palpur-Kuno Sanctuary in Madhya Pradesh. The raptors which use the steep and inaccessible mud cliffs of the Chambal landscape include Bonelli's Eagle *Aquila fasciata*, Laggar Falcon *Falco jugger*, Egyptian Vulture *Neophron percnopterus*, White-rumped Vulture *Gyps bengalensis*, Spotted Owllet *Athene brama*, and the Indian Eagle-Owl or Rock Eagle Owl *Bubo bengalensis*. Most of the other raptors noted in NCS appear to visit from and around the adjoining wildlife areas of Rajasthan and Madhya Pradesh. According to two methods of classification the study comes in the semi-arid biogeographic zone or Khathiar-Gir dry deciduous forest ecoregion. The list of raptors from NCS-Kuno has been compared with previous reports and the list available for Sariska Tiger Reserve and Ranthambhore Tiger Reserve in Rajasthan. The present work is the outcome of a long-term ecological monitoring that primarily focused on the Gharial *Gavialis gangeticus* and its ecological associates in water and the riverine shores. The birds of prey demanded time and attention for looking above and away from the water surface or the shorelines. Yet, our meticulous records maintained over 34 years have generated a basal profile that is expected to inspire focused studies on parameters that sustain ecological association of raptors of NCS adjoining forest habitats and wildlife sanctuaries in the ecoregion.

Keywords: Chambal, crocodile predator, ecological continuity, Khathiar-Gir Ecoregion, National Chambal Sanctuary, Palpur-Kuno Sanctuary, Ranthambhore Tiger Reserve, Raptor checklist, Sariska Tiger Reserve, semi-arid biogeographic region.

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Author contributions: RKS contributed the primary checklist and the photographs with URP. LAKS developed the analytical text with illustrations.

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INTRODUCTION

Background to the study

The UNDP/FAO/Government of India Project for Conservation of Crocodiles which was initiated in 1974–75 (Bustard 1999) concluded in 1982 (de Vos 1984) with several significant contributions to a scenario in Indian wildlife conservation (Singh 1999). The next year, at the behest of the Government of India, LAKS from the erstwhile Central Crocodile Breeding and Management Training Institute (CCBMTI), Hyderabad, established and pursued teamed-up research goals in National Chambal Sanctuary (NCS), with headquarters at Deori Village Gharial Rearing Centre in Morena district, Madhya Pradesh. Since then, annual monitoring of Gharials and incidental collection of ecological and biological data of prominent wetland fauna has been carried out with simple protocols, for highlighting the results of wildlife management in NCS.

Much of the research work from NCS in this context is focused on Gharial, Mugger crocodile, Gangetic Dolphins, turtles, and non-raptor birds (Singh & Rao 1984, 1985; Singh 1985; Singh & Sharma 1985, 2015, 2018; Rao & Singh 1987a,b,c; Sharma & Singh 1986, 2014, 2015, 2018; Sharma et al. 1995). Until superannuation in 2016, fieldwork continued with RKS, a key member of the NCS team. The records on the birds of prey during the river surveys were occasional as they demanded attention for looking above and away from the water surface or the shorelines. However, because of meticulous records maintained over a long time, attention was reverted to raptors which are among the biological predators of crocodiles and large birds.

The raptors or birds of prey, while predating upon fish and bird fledglings, also predate through creche of crocodilian hatchlings and small juveniles of Gharial and Mugger. Although cursory remarks on predation aspects have been made in our previous publications, a separate treatment for raptors was not attempted. Sharma & Singh (1986) who covered field studies during 1983–1985, observed 10 species of raptors, namely, Western Osprey *Pandion haliaetus*, Black Kite *Milvus migrans*, Black-shouldered Kite *Elanus axillaris*, Egyptian Vulture *Neophron percnopterus*, White-rumped Vulture *Gyps bengalensis*, Red-headed Vulture *Sarcogyps calvus*, Pallas's Fish Eagle *Haliaeetus leucoryphus*, Tawny Eagle *Aquila rapax*, Western Barn Owl *Tyto alba*, and Spotted Owlet *Athene brama*.

Raptors among crocodile predators

Elsewhere, Vyas (2019) provided a list of predators

which affect nests or young ones of different crocodilian species. In this list, the species of birds that are known to predate on crocodilians are the Crow, Black or Pariah Kite, egrets, Purple Heron, Black-necked Stork, Painted Stork, Sarus Crane, and the White-bellied Sea Eagle. The presence of all species except the White-bellied Sea Eagle, is recorded for NCS (Sharma & Singh 1986). Gopi & Pandav (2006) and Palei et al. (2019) have reported or photographed the White-bellied Sea Eagle *Haliaeetus leucogaster* preying on Saltwater Crocodile *Crocodylus porosus*. The role of raptors in decimating populations of Mugger Crocodile *Crocodylus palustris* by 1975 (Singh 1979) in Similipal Tiger Reserve, Odisha cannot be ruled out, but Singh (1993) gave a list of 25 raptors seen here.

The raptors are among the world's most graceful and spectacular birds for their characteristic display of wings in flight, their body colour, and the size and shape of the tail. The high visual acuity of eagles in bright daylight and the highly sensitive vision of owls with adaptations to dim-light vision has fascinated mankind (Potier et al. 2020). Being predators at the top, the birds of prey live in low numbers. The threats to tropical raptors include habitat destruction, environmental contamination, and persecution or shooting (Bildstein et al. 1998; Prakash et al. 2003; Green et al. 2004; Meteyer et al. 2004; Shultz et al. 2004; Swan et al. 2006a,b; Hernández & Margalida 2009; Zabala et al. 2020).

Out of 292 species of tropical raptors, 76% (222) are completely in the tropics; and most of the forest dwelling tropical raptors are secretive and difficult to study (Bildstein et al. 1998). The Chambal region supports a significant number of raptors and this is evident from numerous casual sightings and anecdotal references, as well as incidental observations. Based on our notes from the riverine landscape, and the taxonomic status given in the IOC World Bird List (Gill et al. 2021), the diurnal birds of prey that include hawks, eagles, and vultures are in the order Accipitriformes, and falcons in the order Falconiformes. Owls, which are nocturnal birds of prey are in order Strigiformes. A few of these species breed in the Chambal landscape. The steep and inaccessible mud cliffs appear to be preferred sites of Bonelli's Eagle, Laggar Falcon, Egyptian Vulture, White-rumped Vulture, Spotted Owlet, and Indian Eagle Owl.

In this note, we present a list of raptors that were incidentally sighted during our annual river surveys in the National Chambal Sanctuary and the Kuno confluence leading to Palpur-Kuno Sanctuary in Madhya Pradesh. Since the presence of some raptors does not get the support of breeding evidence along the Chambal, the raptor lists from Ranthambhore and Sariska have

been compared for possible insight into their presence resulting from local flights and extended home range. We expect our study may stimulate more conclusive knowledge on these aspects from systematic raptor-specific studies in the future in the Chambal landscape within the semi-arid biogeographic zone (Rodgers & Panwar 1988) and the Khathiar-Gir dry deciduous forest ecoregion (WWF 2021).

STUDY AREA

Chambal in northwest India is a clear and fast-flowing river that originates from the Vindhya Range in central India. A stretch of about 572 km of the river Chambal, bordering the states of Madhya Pradesh, Rajasthan, and Uttar Pradesh, constitutes the National Chambal Sanctuary (NCS) (Figure 1). The NCS is protected for conservation and management of the endangered Gharial *Gavialis gangeticus* since 1979.

The biodiversity components of the river under NCS holds a number of indicator fauna which include the crocodylians, chelonians, and avian species. Besides, there are the Gangetic Dolphins and otters. Within the sanctuary limits, the river banks have ravines with sparse ground cover. The natural vegetation comprises of thorn forests, forming most of the boundary for Madhya Pradesh. The nearest forested habitat is in the Kuno-Palpur Wildlife Sanctuary in Madhya Pradesh (Figure 2). However, close to NCS, there are a few forest-based well-known wildlife sanctuaries (WS) in Rajasthan. These include the Jawahar Sagar Wildlife Sanctuary and Ranthambhore Tiger Reserve in Rajasthan.

The habitat from Pali to Chakarnagar in Chambal (Figure 2) comprises the most significant area for the conservation of Gharial. Keeping in mind the conservation significance of the critically endangered gharial and its habitat, the population trends and

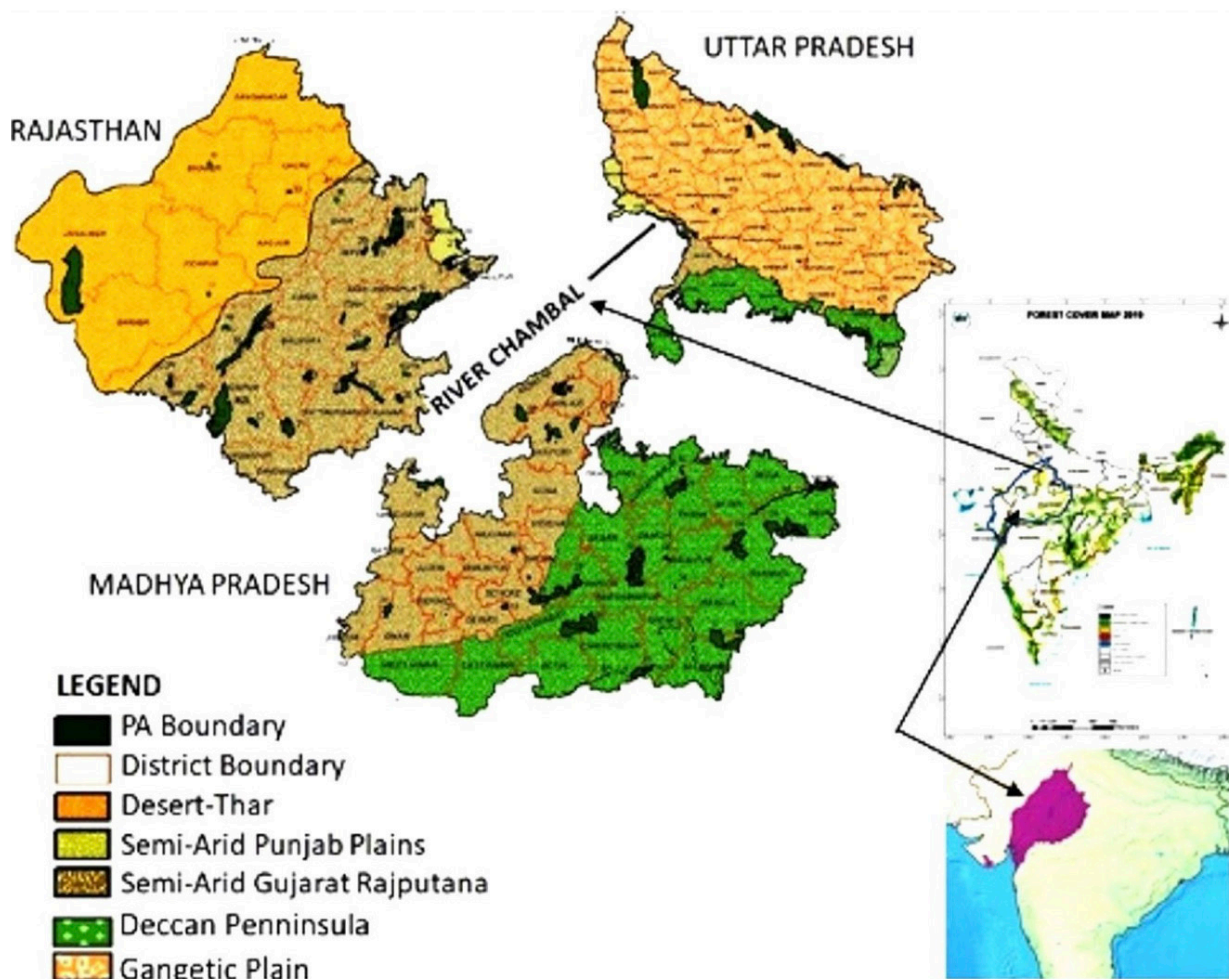


Figure 1. Locations of Wildlife Sanctuaries (PA, protected area boundary) with respect to River Chambal, National Chambal Sanctuary bordering the states of Rajasthan, Madhya Pradesh, and Uttar Pradesh within Khathiar-Gir dry deciduous forest ecoregion (inset, right bottom) in northwestern India. Source maps from ENVIS 2020, FSI 2019, Wikipedia 2021.

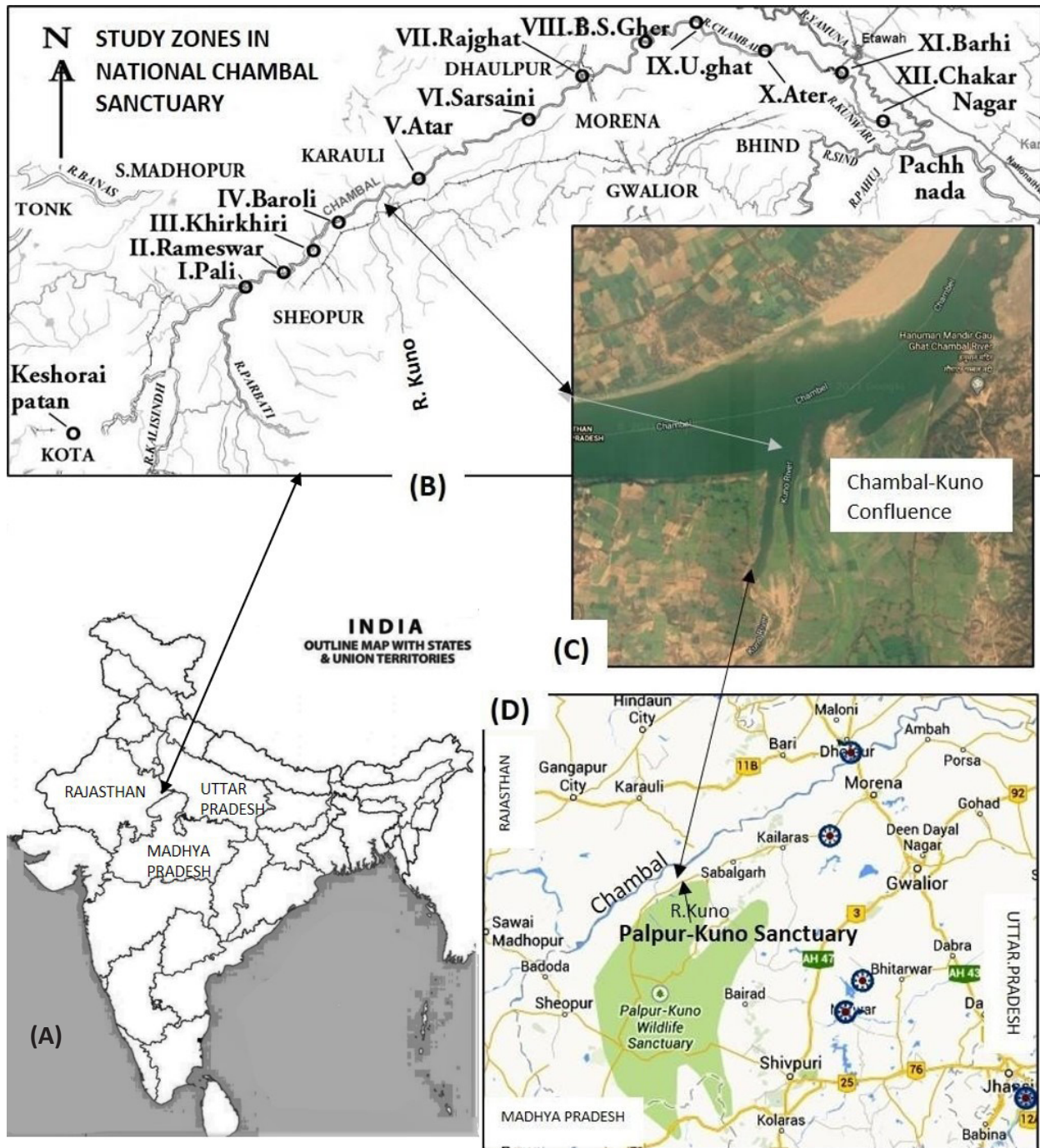


Figure 2. Map of India (A) showing study zones in National Chambal Sanctuary (B), the confluence with river Kuno (C) that originates from Palpur-Kuno Sanctuary (D).

probable threats are among the parameters that have been assessed regularly with defined gaps. Every year, Madhya Pradesh Forest Department takes a systematic initiative to carry out a comprehensive survey to find out the status and distribution of Gharial and its ecological associates in NCS. Sometimes, survey cruises by boat and foot are also extended into the tributaries like,

Parbati, Kali Sindh, Banas, and Kuno.

The Kuno-Chambal confluence is downstream of Nadigaon village which is a nesting site of Gharial and Mugger (Singh 1985; Sharma & Singh 2015). Upstream of Nadigaon, the Baroli sandbank, and Baroli island are considered among the best nesting sites of gharial and offer scope to observe all the sequences of breeding

behaviour by adults and creche formation by hatchlings. The hatchlings congregate around the confluence of the Kuno river, because of the availability of smaller fishes, and for retreat into the tributary during the flood. About 30 km upstream of the Kuno-confluence, the Palpur-Kuno WS was established in 1981 in the state of Madhya Pradesh with an initial area of about 344.68 km². It is a dry deciduous forest forming a part of the Vindhyan hill range.

MATERIALS AND METHODS

The NCS was marked into twelve stretches of smaller study zones (Figure 2 based on Singh 1985) and the area was surveyed by travelling on a motor boat as well as by walking on foot. The surveyors were equipped with 1:50,000 toposheets from Survey of India, A4-size bits of field map sheets, binoculars, and a camera. The team along with the support staff normally moved between 0900 h and 1700 h. during the winter. When moving by motorboat, the transect speeds ranged within 15 km per hour, depending on the demands of the situation and navigability of the stream. Birds were sighted with the help of binoculars (Olympus 10 × 50 mm), occasionally aided with a spotting scope. Field notes were made directly on the field map sheets or notebooks. The bird species were identified using standard field guides, such as Ali (1979, 2002), Naoroji (2011), and Grimmett et al. (2011). Observed species of raptors were recorded along with sighting time and nearest village name and other ancillary information on datasheets. A list of all the raptor species observed in the Chambal and Kuno region is given in Table 1. The recent names and synonyms are according to the International Ornithological Congress-IOC World Bird List (Gill et al. 2021).

RESULTS AND DISCUSSION

1. The Checklist of raptor birds in NCS-Kuno

a) The list of raptors based on our observations comprises a total of 30 species (Table 1 and Supplement Table A). It includes six species of vultures, one osprey, two kites, one shikra, one harrier, three buzzards, five eagles, one kestrel, one hobby, two falcons, and seven owl/owls. The family-wise list incorporates Falconidae four species, Accipitridae 18 species, Tytonidae one species, Strigidae six species, and Pandionidae one species.

b) In our list, a total of nine species falls under the

IUCN threatened categories of Critically Endangered (CR) (3), Endangered (EN) (2), Vulnerable (VU) (1), and Near Threatened (NT) (3) of which six are residents and three are winter visitors. Other 21 species, which includes six winter-visiting species, are with status of Least Concern (LC) (Table 1 and Supplement Table B).

c) Nine of the 30 species listed are winter visitors. These are Cinereous Vulture, Griffon Vulture, Western Osprey (seen through early summer till May), Western Marsh Harrier, Common Buzzard, Pallas's Fish Eagle, Tawny Eagle, Common Kestrel, and Eurasian Hobby (Table 1 and Supplement Table B). A detailed study on their migration pattern to the wetlands of river Chambal may indicate if NCS deserves to be considered as a Ramsar site.

d) Our preliminary observations indicate that the raptors received protection that is available as incidental to Gharial conservation in NCS.

e) In Wildlife (Protection) Act, India the Schedule-IV status is given to Cinereous Vulture, Egyptian Vulture and Red-headed Vulture. This, however, does not match the grave status given to these species under the IUCN as NT, EN, and CR, respectively (Table B). We agree that the Egyptian Vulture or Pharaoh's Chicken appear to be in relatively good numbers but because of their size they might be more prone to killing. The suggestions made here on the possible lift or upgradation of Scheduled status of these three raptors merits the attention of the Ministry of Environment, Forests and Climate Change (MOEFCC) and requires further consultation with established ornithologists of India.

2. Species-wise total sightings

a) The total number of birds counted during the survey period 2003–2016 was 2070, with a range of 85–188, and an average of 148 birds per year (Table 2). The moving average of the number of birds per year appears to indicate that NCS continues to be a good habitat for raptor sighting (Figure 3).

b) In the entire list (Table 1) there are seven species whose total count in 14 annual surveys has been less than five. These are, one bird per one survey for Cinereous Vulture (4 sightings), Griffon Vulture (4 sightings), Common Buzzard (4 sightings), White-eyed Buzzard (2 sightings), Crested Honey Buzzard (4 sightings), Pallas's Fish Eagle (1 sighting), and Dusky Eagle Owl (4 sightings).

c) Pallas Fish Eagle was last seen in 1986 (Supplement Table A) and has not been recorded since then. There has been an increase in the number of sightings of Western Osprey over the years. Although the Western Osprey is considered to be a winter visitor, it is seen in Chambal in

Table 1. Species of raptors observed in National Chambal Sanctuary over 14 surveys during 2003–2016 of Gharial monitoring. Where synonyms exist, the first mentioned name is according to the nomenclature in IOC World Bird List (v11.1) (Gill et al. 2021). Key to IUCN status: CR—Critically Endangered | EN—Endangered | VU—Vulnerable | NT—Near Threatened | LC—Least Concern. ‘Winter’ in migratory status refers to months November to February.

	English name	Scientific name	Location	Total raptor counts (max 14 surveys)	Total years when seen (max 14)	IUCN Red List status	Migratory status
1	Cinereous Vulture	<i>Aegypius monachus</i>	Chambal, Kuno	4	3	NT	Winter visitor
2	Egyptian Vulture	<i>Neophron percnopterus</i>	Chambal, Kuno	999	14	EN	Resident
3	White-rumped Vulture (Indian White-backed Vulture)	<i>Gyps bengalensis</i>	Kuno, Chambal	80	14	CR	Resident
4	Indian Vulture (Longbilled Vulture)	<i>Gyps indicus</i>	Chambal, Kuno	12	6	CR	Resident
5	Red-headed Vulture	<i>Sarcogyps calvus</i>	Chambal, Kuno	30	13	CR	Resident
6	Griffon Vulture (Eurasian Griffon)	<i>Gyps fulvus</i>	Kuno	4	4	LC	Winter visitor
7	Western Osprey (Osprey)	<i>Pandion haliaetus</i>	Chambal	562	14	LC	Winter visitor, seen till May
8	Black-shouldered Kite	<i>Elanus axillaris</i>	Chambal, Kuno	39	9	LC	Resident
9	Black Kite (Common Pariah Kite)	<i>Milvus migrans</i>	Chambal, Kuno	62	8	LC	Resident
10	Shikra	<i>Accipiter badius</i>	Chambal	74	14	LC	Resident
11	Western Marsh Harrier (Eurasian Marsh Harrier)	<i>Circus aeruginosus</i>	Chambal	38	13	LC	Winter visitor
12	Common Buzzard	<i>Buteo buteo</i>	Chambal	4	3	LC	Winter visitor
13	White-eyed Buzzard	<i>Butastur teesa</i>	Chambal, Kuno	2	2	LC	Resident
14	Crested Honey Buzzard (Oriental Honey Buzzard)	<i>Pernis ptilorhynchus</i>	Chambal, Kuno	4	4	LC	Resident
15	Bonelli's Eagle	<i>Aquila fasciata</i>	Chambal, Kuno	29	10	LC	Resident
16	Pallas's Fish Eagle	<i>Haliaeetus leucoryphus</i>	Chambal	0	0	EN	Winter visitor
17	Tawny Eagle	<i>Aquila rapax</i>	Chambal	11	5	VU	Winter visitor
18	Crested Serpent Eagle	<i>Spilornis cheela</i>	Chambal	5	4	LC	Resident
19	Changeable Hawk Eagle	<i>Nisaetus cirrhatus</i> (<i>Spizaetus cirrhatus</i>)	Kuno	5	4	LC	Resident
20	Common Kestrel	<i>Falco tinnunculus</i>	Chambal	29	10	LC	Winter visitor
21	Eurasian Hobby	<i>Falco subbuteo</i>	Kuno	6	6	LC	Winter visitor
22	Laggar Falcon	<i>Falco jugger</i>	Chambal	27	13	NT	Resident
23	Red-necked Falcon	<i>Falco chicquera</i>	Chambal	9	7	NT	Resident
24	Spotted Owlet	<i>Athene brama</i>	Chambal	4	4	LC	Resident
25	Western Barn Owl (Barn Owl)	<i>Tyto alba</i>	Chambal, Kuno	5	4	LC	Resident
26	Dusky Eagle Owl	<i>Bubo coromandus</i>	Chambal	4	4	LC	Resident
27	Brown Fish Owl	<i>Ketupa zeylonensis</i>	Kuno	5	4	LC	Resident
28	Indian Scops Owl	<i>Otus bakkamoena</i>	Kuno	7	5	LC	Resident
29	Mottled Wood Owl	<i>Strix ocellata</i>	Kuno	5	4	LC	Resident
30	Indian Eagle-Owl (Rock Eagle Owl)	<i>Bubo bengalensis</i>	Kuno	5	4	LC	Resident

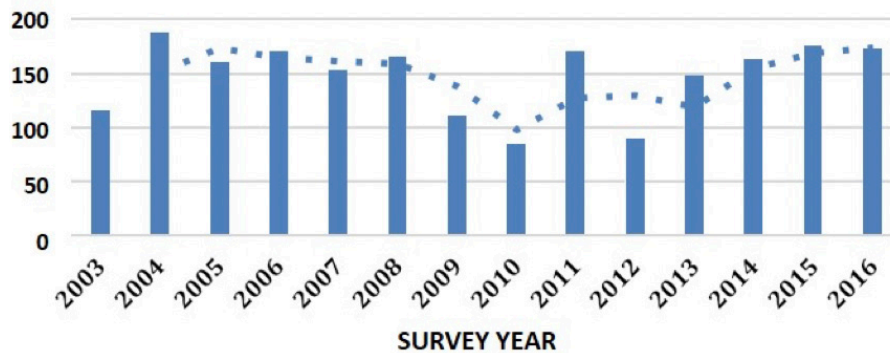


Figure 3. Number of raptor birds counted in different survey years 2003–2016, with moving average of the counts (dotted line) in National Chambal Sanctuary.

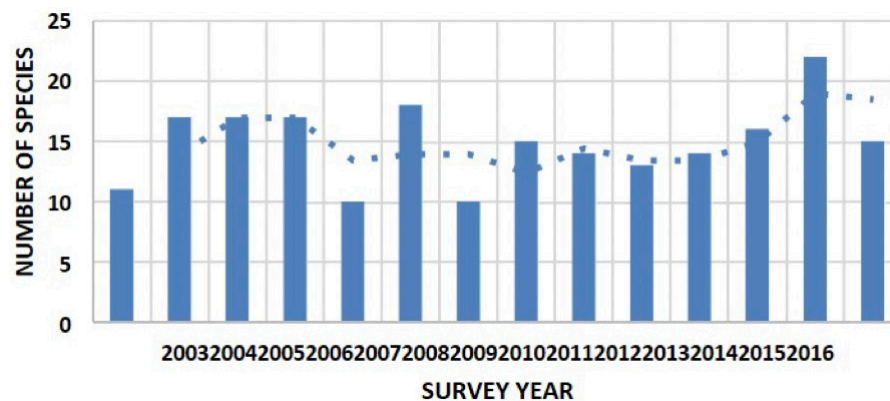


Figure 4. Number of raptor species noted in different survey years 2003–2016 with moving average (dotted line) in National Chambal Sanctuary.

fair numbers until late summer.

d) Indian White-rumped Vultures were found in fair numbers in Chambal Sanctuary and large flocks could be seen until 1990, when a maximum of 304 vultures were recorded (Supplement Table A). Following this, there has been a steady decline. Only a total of four vultures were recorded in 2016

3. Survey-year-wise species sightings (Table 2)

a) Ten species of raptors appear to have NCS in their preferred home range. Seven species were observed for 11 or more of the total 14 continuous annual surveys. These are the Egyptian Vulture (14 years), White-rumped Vulture (all 14 years), Red-headed Vulture (13 years), Western Osprey (all 14 years), Shikra (14 years), Western Marsh Harrier (13 years), and Laggar Falcon (13 years). There were two species that were seen in 10 out of 14 surveys. These species are the Bonelli's Eagle and Common Kestrel (Table 1).

b) During our survey years, 2003 to 2016, the number of species observed per year varied between 10 and 22 species (Table 2, Figure 4). In 1990, only three species of raptors were noted namely, the White-rumped Vulture with 304 counts, Indian Vulture four birds counted and

28 bird counts of Western Osprey (Supplement Table A).

c) Very low sightings or no sighting of a species during any survey indicates the basic territorial characteristics of raptors, the possibility of their long home range, their seasonal and migratory habits, and our winter-season linear survey along the 572 km long Chambal River. Moreover, the survey objectives were targeted at the species seen in the water or on the river banks.

d) The index describing year-wise raptor counts and raptor species is an average of 9.9. This demonstrates a fairly favourable relationship between the habitat of NCS and the appearance of raptors within its landscape. In the beginning, i.e., in 2003 it was 10.5 and in 2016 it was 11.5 with fluctuations between values 5.7 and 15.3 (Table 2; Figure 5).

e) It is expected that the index values may enable to construe conclusion on conservation impacts from NCS with details of ecological parameters influencing the survival and behaviour of raptors through decades since the 1980s.

4. NCS-Kuno raptor names by other authors

a) Lists of NCS raptors that were possible to access for comparison are in Mitra (1979), the management

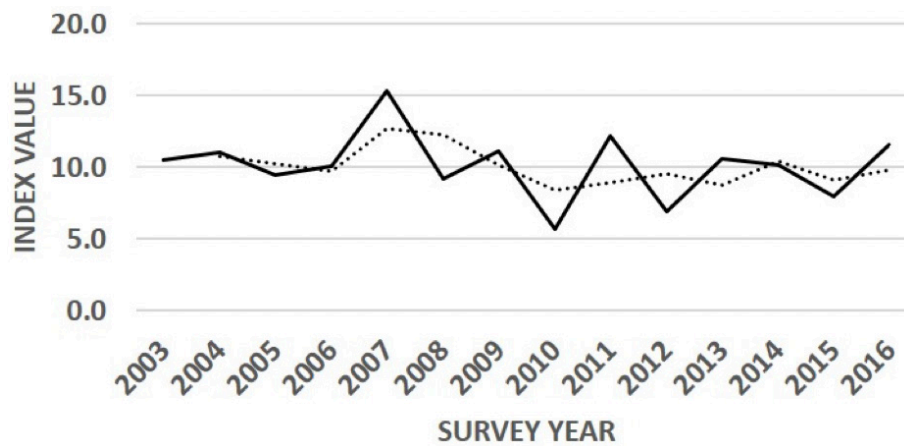


Figure 5. Trend in index value of 'Number of raptor species' and 'Number of raptor birds counted' in different survey years 2003–2016 with moving average (dotted line) in National Chambal Sanctuary.

Table 2. Year-wise survey with record of total numbers of species, raptor birds, and the trend of their index ratio.

Year	Species no.	Raptor count	Bird count / Species count index
2003	11	116	10.5
2004	17	188	11.1
2005	17	160	9.4
2006	17	171	10.1
2007	10	153	15.3
2008	18	166	9.2
2009	10	111	11.1
2010	15	85	5.7
2011	14	170	12.1
2012	13	90	6.9
2013	14	148	10.6
2014	16	163	10.2
2015	22	176	8.0
2016	15	173	11.5
Total	209	2070	-
Average	14.9	147.9	9.9

plan by Sale (1982), a Technical Report by Sharma & Singh 1986, the management plan by Murthy (2004), the consolidated list in Nair & Krishna (2013) and the proposed tri-state management plan by Choudhury et al. 2014. The list by Mitra (1979) was an original survey before our work commenced.

b) Mitra (1979) reported the presence of six raptor species. These were the Laggar Falcon, Pale Harrier, White-eyed Buzzard, Short-toed Eagle, Common Kestrel, and Crested Hawk Eagle (Changeable Hawk Eagle). Out of these, our observations till 2016 confirm the continued sighting of four species. These are the Laggar Falcon,

Kestrel, White-eyed Buzzard, and the Changeable Hawk Eagle.

c) In the consolidated list of the vertebrate fauna of the Chambal basin, Nair & Krishna (2013) furnished a list of 308 bird species under 64 families. This list includes 45 species of raptors. These belong to Falconidae six species, Accipitridae 29 species, Tytonidae one species, and Strigidae nine species.

d) Given the gharial-oriented primary objectives, the season, and nature of our annual river surveys, we agree that our observations will not tally with other lists available for comparison.

NCS-Kuno raptor list compared with Ranthambhore and Sariska (Table 3)

a) Bildstein et al. (1998) mentioned 63 diurnal raptor species in India. Naoroji (2011) mentioned the occurrence of a total of 44 raptor species in the semi-arid biogeographic zone, of which 26 are migrants and 18 are residents.

b) Since Chambal banks offer only the cliffs for limited perch or nest, we have attempted to compare our observed list with sanctuaries of Rajasthan that may be within the active home range of the raptors.

c) Eleven raptor species observed in NCS are also reported from Ranthambhore Tiger Reserve (RTR) (Anonymous 2021) and Sariska Tiger Reserve (STR) (Sultana 2013). These are the Black-shouldered Kite, Western Barn Owl, Common Kestrel, Crested Serpent Eagle, Indian Vulture, Crested Honey Buzzard, Red-headed Vulture, Shikra, Spotted Owlet, Brown Fish Owl, and Indian Scops Owl.

d) Six species are not reported either from RTR or STR. These are the Cinereous Vulture, Common Buzzard, Pallas's Fish Eagle, Changeable Hawk Eagle, Eurasian Hobby, and Indian Eagle Owl. Future studies will confirm

Table-3. Comparison of raptors observed in National Chambal Sanctuary with reports from Ranthambhore Tiger Reserve (RTR) and Sariska Tiger Reserve (STR). Tharmalingam et al 2011 refers to report from Kuno-Palpur Sanctuary. P—Presence mentioned | N—Not mentioned. Ten of these species at serial numbers 2,3,5,7,8,9,16,17,24 and 25 were observed in 1983–85 and reported earlier in Sharma & Singh 1986 (Supplement Table A).

	Common name	Scientific name	Anonymous 2021 (RTR)	Sultana 2013 (STR)	Kuno – Palpur (Tharmalingam et al 2011)
1	Cinereous Vulture	<i>Aegypius monachus</i>	N	N	N
2	Egyptian Vulture	<i>Neophron percnopterus</i>	N	P	P
3	White-rumped Vulture	<i>Gyps bengalensis</i>	N	P	P
4	Indian Vulture	<i>Gyps indicus</i>	P	P	P
5	Red-headed Vulture	<i>Sarcogyps calvus</i>	P	P	P
6	Griffon Vulture	<i>Gyps fulvus</i>	N	P	N
7	Western Osprey	<i>Pandion haliaetus</i>	N	P	P
8	Black-shouldered Kite	<i>Elanus axillaris</i>	P	P	N
9	Black Kite	<i>Milvus migrans</i>	P	N	N
10	Shikra	<i>Accipiter badius</i>	P	P	P
11	Western Marsh Harrier	<i>Circus aeruginosus</i>	N	P	P
12	Common Buzzard	<i>Buteo buteo</i>	N	N	N
13	White-eyed Buzzard	<i>Butastur teesa</i>	N	P	P
14	Crested Honey Buzzard	<i>Pernis ptilorhynchus</i>	P	P	N
15	Bonelli's Eagle	<i>Aquila fasciata</i>	N	P	P
16	Pallas's Fish Eagle	<i>Haliaeetus leucoryphus</i>	N	N	N
17	Tawny Eagle	<i>Aquila rapax</i>	N	P	N
18	Crested Serpent Eagle	<i>Spilornis cheela</i>	P	P	P
19	Changeable Hawk Eagle	<i>Nisaetus cirrhatus</i>	N	N	P
20	Common Kestrel	<i>Falco tinnunculus</i>	P	P	P
21	Eurasian Hobby	<i>Falco subbuteo</i>	N	N	N
22	Laggar Falcon	<i>Falco jugger</i>	N	P	N
23	Red-necked Falcon	<i>Falco chicquera</i>	N	P	N
24	Spotted Owlet	<i>Athene brama</i>	P	P	P
25	Western Barn Owl	<i>Tyto alba</i>	P	P	N
26	Dusky Eagle Owl	<i>Bubo coromandus</i>	P	N	N
27	Brown Fish Owl	<i>Ketupa zeylonensis</i>	P	P	P
28	Indian Scops Owl	<i>Otus bakkamoena</i>	P	P	N
29	Mottled Wood Owl	<i>Strix ocellata</i>	N	P	N
30	Indian Eagle-Owl	<i>Bubo bengalensis</i>	N	N	N

if these are migrants from other parts of the semi-arid biogeographic zone or the adjoining geographic regions.

e) Out of the 30 raptor species presented in this work from NCS-Kuno, we didn't find reports of 11 species in RTR and two species in STR. The species not reported from STR are the Black Kite and Dusky Eagle Owl. The species not reported from RTR are the Bonelli's Eagle, Western Marsh Harrier, Egyptian Vulture, White-rumped Vulture, Laggar Falcon, Western Osprey, Red-necked Falcon, Tawny Eagle, White-eyed Buzzard, Griffon Vulture, and Mottled Wood Owl.

f) Raptors are known to have long home ranges, and they may be flying to NCS-Kuno for food. Besides, Chambal forms confluences with other perennial tributaries like Kali-Sindh, Parbati, and Banas upstream, and the confluence of five rivers around Pachhnada in the downstream. Future studies may further reveal the relationship between the home range of different raptor species and the riverine habitat.

RECOMMENDATIONS

The National Chambal Sanctuary, which constitutes a part of river Chambal, is included under wetland types 11 (rivers, streams – slow-flowing, lower perennial) & 12 (rivers, streams – fast-flowing, upper perennial) (Scott 1989). As a protected area of national stature, river Chambal is provided with incidental conservation benefits for avian diversity. The river plays a crucial role in supporting local stork populations as well as giving alternate refuge for local migrants during the years with extreme ecological conditions (Sharma & Singh 2018). Similarly, continuous monitoring of wetland habitats in and outside Chambal may highlight the kind of ecological attraction Chambal holds for the skimmer populations of other wetlands in the region (Singh & Sharma 2018).

1. Consideration for the tri-state Chambal Ramsar site

Based on field surveys we have reported in the past on the status and population trends of large shorebirds and Raptor species of NCS (Sharma & Singh 1986; Sharma et al. 1995, 2013). The wetland and the adjoining area of the National Chambal Sanctuary form the habitat for many resident and migratory bird species, of which some are globally threatened. Our study on raptors identifies nine of the thirty raptors under the migratory category, attracted to the wetland landscape of NCS. A detailed study on the migration pattern of raptors and large shorebirds to River Chambal may further highlight the need for improved attention to river Chambal as a tri-state Ramsar site of India. Madhya Pradesh has already initiated the proposal some years back and deserves coordination at the national level.

2. Review of Scheduled status for three species of raptors

As predators, the raptors form one of the top links in the ecological chain and are, therefore, indicators of the health of the environment (Naoroji 2011). Among the most effective predators, the birds of prey keep a constant check on the population of amphibians, reptiles, mammals, and birds, and even on themselves. Found in diverse habitats, they are among the first that are affected by chemical pollution, adverse exploitation, and an overall decline of the habitat. The results from the present study on raptors propose that the MoEFCC consider reviewing the status given under the Wildlife (Protection) Act to Cinereous Vulture *Aegypius monachus*, Egyptian Vulture *Neophron percnopterus*, and Red-headed Vulture *Sarcogyps calvus*.

3. A comprehensive study on raptors of Arid Biogeographic Region / Khathiar-Gir Eco Region

Studies on tiger by Reddy et al. (2012) have already suggested on-ground gene-pool continuity over RTR and Sawai Madhopur National Park (MNP), which are in Rajasthan on the northern side of NCS and the Kuno-Palpur Wildlife Sanctuary (KPWS) of Madhya Pradesh on the southern side of NCS. Only a future study on raptors would further confirm the nature of ecological connectivity of habitats on either side of the National Chambal Sanctuary through the air.

We expect some of the raptors in NCS are visitors from the adjoining habitats of Rajasthan and Madhya Pradesh, within the dry deciduous forest ecoregion. Tharmalingam et al. (2011) reported the presence of 19 raptor species in Kuno-Palpur of Madhya Pradesh, and the list doesn't show the presence of 16 raptors observed in our present list (Table 3). However, out of these 16 species, six are reported from Ranthambhore Tiger Reserve (RTR) and nine from Sariska Tiger Reserve (STR). The observations suggest some continuity in the distribution of raptors in the north and south of river Chambal.

The list of raptor birds given in the present study forms a base for time-related comparison of species-availability and for an impact assessment. It is urged, that detailed studies may be promoted on raptors seen in National Chambal Sanctuary and their possible home ranges extending through other perennial tributaries and forest habitats like those of Kuno and Shivpuri in Madhya Pradesh, and Ranthambhore and Sariska in Rajasthan.

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Image 1. Top. Laggar Falcon *Falco jugger* at Jetpur, river Chambal (3 km upstream from study zone-VII Rajghat). Above. Ravine cliff facing river Chambal, used by Laggar Falcon pair at Jetpur. © Udayan



Image 2. Changeable Hawk Eagle *Nisaetus cirrhatus* at Ker Kho in Palpur Kuno WS. © Udayan

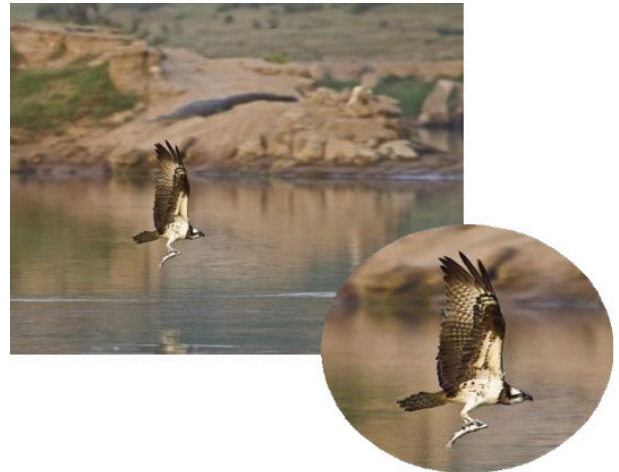


Image 3. Osprey *Pandion haliaetus* while lifting a fish out of water at Daljit Singh ka Pura, river Chambal, seen with a Gharial *Gavialis gangeticus* in the background returning to water after nesting. The location is in study zone-VIII, 45 km downstream Rajghat. © Udayan



Image 4. Bonelli's Eagle eating a bird, at Barsala (48 km downstream from Rajghat, study zone- VIII). © R.K. Sharma



Image 5. Bonelli's Eagle adult with chick at nest built on the ravine facing river Chambal, Chakarnagar in study zone-XII. © R.K. Sharma



Image 6. Dusky Eagle Owl *Bubo coromandus* at Baroli (study zone-III) on Rajasthan bank of Chambal close to Ranthambhore Tiger Reserve and Kaila Devi Wildlife Sanctuary. © Udayan



Image 7. Vultures at nest along Kuno. © R.K. Sharma



Image 8. Egyptian Vulture at Tigri Rithaura in study zone-VII while feeding on carcass of Emydid Turtle in National Chambal Sanctuary. © R.K. Sharma



Image 9. Egyptian Vultures downstream Rajghat at Daljit ka Pura (Study zone-VIII). Immature Egyptian Vultures are distinguishable from their darker body. © R.K. Sharma

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सारांश

राष्ट्रीय चंबल अभ्यारण्य (NCS) में शिकारी पक्षी (रैपटर्स) महत्व रखते हैं क्योंकि वे इस क्षेत्र के शीर्ष शिकारी पक्षियों में से हैं, जो छोटे मगरमच्छों, कछुओं और अन्य पक्षियों का शिकार करते हैं। रैपटर्स की 30 प्रजातियों की हमारी चेकलिस्ट 1983 और 2016 के बीच शीतकालीन सर्वेक्षणों के दौरान किए गए अवलोकनों से विकसित की गई है। इस अवधि में हमने जिस क्षेत्र में सर्वेक्षण किया उसके अंतर्गत राष्ट्रीय चंबल अभ्यारण्य और चंबल कूनो नदी के संगम के क्षेत्र मध्य प्रदेश सीमा में आते हैं। चंबल परिदृश्य के बीहड़ की खड़ी और दुर्गम मिट्टी चट्टानों का उपयोग करने हेतु जो शिकारी पक्षी पहचाने गए हैं उनमें बॉनलीज ईगल, लागर फाल्कन, इजिप्शियन वल्चर, व्हाइट रैम्पड वल्चर, स्पोर्टेड आउलेट, इंडियन ईगल आउल आदि अन्तर्भूक्त हैं। राष्ट्रीय चंबल अभ्यारण्य में वर्णित अधिकांश अन्य रैपटर्स क्रमशः राजस्थान एवं मध्य प्रदेश के आसपास के वन्यजीव क्षेत्रों से तथा समीपवर्ती क्षेत्रों के आगतुक माने जाते हैं। वर्गीकरण के दो तरीकों के अनुसार यह इलाका अर्ध शुष्क जैव भौगोलिक क्षेत्र या खाटिहार गिर शुष्क पर्णपाती वन क्षेत्र में आता है। एनसीएस-कूनो की सूची की तुलना पिछली रिपोर्ट्स एवं राजस्थान की सरिस्का टाइगर रिजर्व और रणथंबोर टाइगर रिजर्व के लिए उपलब्ध सूची से की गई है। वर्तमान कार्य एनसीएस में वर्ष 1983 से प्रारंभ किए गए घड़ियाल (गेवियलिस गेंजेटिक्स) एवं अन्य जलीय जीवों की दीर्घकालीन परिस्थिति की निगरानी का परिणाम है। शिकारी पक्षियों को देखने के लिए पानी की सतह एवं तटरेखा से और दूर तक देखने के लिए समय और ध्यान देने की जरूरत मांग की है। फिर भी, 34 वर्षों में बनाए गए हमारे सावधानीपूर्वक रिकॉर्ड ने एक बुनियादी रूपरेखा तैयार की है, जो उन मापदंडों पर केंद्रित अध्ययनों को क्रियान्वित करने के लिए प्रेरित करती है जो एनसीएस के आसपास के वन आवासों और वन्यजीव अभ्यारण्य के पारिस्थितिक तंत्र को बनाए रखते हैं।

Supplement Table A. Year-wise presence and count record of different raptor species in National Chambal Sanctuary (NCS). Data for 1983-85 contained information for a checklist and published with other details in Sharma and Singh 1986. Surveys during 1987-1989 and 1991-2002 were limited to certain stretches of NCS and for raptors are treated as 'No data'. N—No data or Not observed, O—Observed. CR—Critically Endangered | VU—Vulnerable | EN—Endangered | NT—Near Threatened | LC—Least Concern.

Sno	Common name	Scientific name	1983-85	1986	1987-1989	1990	1991-2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	TOTAL raptor number	Seen in how many years	SUM for raptor groups (row)	Remarks
1	Cinereous Vulture	<i>Aegypius monachus</i>	N	N	N	N	N	N	N	2	N	N	N	N	1	N	N	N	1	N	N	4	3		NT, rare, winter visitor
2	Egyptian Vulture	<i>Neophron percnopterus</i>	0	11	N	N	N	62	116	102	98	72	60	41	22	88	36	61	94	67	80	999	14		EN, common
3	White rumped Vulture	<i>Gyps bengalensis</i>	0	32	N	304	N	8	7	9	8	6	5	4	2	3	4	5	6	9	4	80	14		CR, rare, resident
4	Indian Vulture	<i>Gyps indicus</i>	N	N	N	4	N	3	N	2	N	2	N	N	1	2	N	N	N	2	N	12	6		CR, rare, resident
5	Red headed Vulture	<i>Sarcogyps calvus</i>	0	2	N	N	N	2	1	2	4	2	4	2	1	2	N	3	1	4	2	30	13		CR, rare, resident
6	Griffon Vulture	<i>Gyps fulvus</i>	N	N	N	N	N	N	N	N	1	N	1	N	N	N	1	N	N	1	N	4	4		LC, rare, winter visitor
			Listed 3	3	N	2	N	4	3	5	4	4	4	3	5	4	3	3	4	5	3		54		
7	Western Osprey	<i>Pandion haliaetus</i>	0	4	N	28	N	27	35	21	30	50	51	40	29	59	25	57	32	52	54	562	14		LC, winter visitor, upto summer
8	Black-shouldered Kite	<i>Elanus axillaris</i>	0	3	N	N	N	N	3	2	N	N	5	6	4	N	N	3	5	7	4	39	9		LC, common, resident
9	Black Kite	<i>Milvus migrans</i>	0	2	N	N	N	8	11	N	12	N	10	N	9	N	6	N	2	4	N	62	8		LC, common, resident
10	Shikra	<i>Accipiter badius</i>	N	N	N	N	N	1	2	3	5	9	7	6	5	4	5	6	7	8	6	74	14		LC, common, resident
11	Western Marsh Harrier	<i>Circus aeruginosus</i>	N	N	N	N	N	N	2	3	1	4	6	5	2	2	1	2	1	3	6	38	13		LC, occasional, winter visitor
12	Common Buzzard	<i>Buteo buteo</i>	N	N	N	N	N	N	1	N	2	N	N	N	N	N	N	N	1	N	N	4	3		LC, rare, winter visitor
13	White eyed Buzzard	<i>Buteo teesa</i>	N	N	N	N	N	N	N	1	N	N	N	N	N	N	N	1	N	N	N	2	2		LC, rare, resident
14	Crested Honey Buzzard	<i>Pernis ptilorhynchus</i>	N	N	N	N	N	N	1	N	1	N	N	N	N	N	N	N	1	N	1	4	4		LC, occasional, resident
15	Bonelli's Eagle	<i>Aquila fasciata</i>	N	N	N	N	N	2	N	N	N	N	4	2	1	2	4	2	4	3	5	29	10		LC, occasional, resident
			Listed 3	3	N	1	N	4	7	5	6	3	6	5	6	4	5	6	8	6	6		77		
16	Pallas's Fish Eagle	<i>Haliaeetus leucorhynchus</i>	0	1	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	0	0		EN, rare, winter visitor
17	Tawny Eagle	<i>Aquila rapax</i>	0	1	N	N	N	N	N	4	N	N	2	N	1	N	2	N	N	N	2	11	5		VU, rare, winter visitor

Sno	Common name	Scientific name	1983-85	1986	1987-1989	1990	1991-2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	TOTAL raptor number	Seen in how many years	SUM for raptor groups (row)	Remarks
18	Crested Serpent Eagle	<i>Spilornis cheela</i>	N	N	N	N	N	N	N	N	2	N	N	1	N	N	N	1	N	N	N	5	4		LC, occasional, resident
19	Changeable Hawk Eagle	<i>Spizaetus cirrhatius</i>	N	N	N	N	N	1	N	N	1	N	N	N	N	N	N	2	N	1	N	5	4		LC, occasional, resident
			Listed 2	2	N	N	N	1	N	1	2	N	1	1	1	N	1	2	N	2	1		13		
20	Common Kestrel	<i>Falco tinnunculus</i>	N	N	N	N	N	2	N	3	N	4	N	N	2	1	1	2	4	6	4	29	10		LC, Common, winter visitor
21	Eurasian Hobby	<i>Falco subbuteo</i>	N	N	N	N	N	1	N	N	1	N	1	N	N	1	N	N	N	1	N	6	6		LC, rare, winter visitor
22	Laggar Falcon	<i>Falco jugger</i>	N	N	N	N	N	2	N	2	1	2	2	4	4	2	2	2	1	1	2	27	13		NT, rare, resident
23	Red-necked Falcon	<i>Falco chitragera</i>	O	N	N	N	N	N	N	1	2	N	2	N	1	1	N	N	N	1	1	9	7		NT, rare, resident
			Listed 1	N	N	N	N	1	3	3	3	2	3	1	3	4	2	2	2	4	3		36		
24	Spotted Owlet	<i>Athene brama</i>	O	1	N	N	N	N	N	1	1	N	N	N	N	N	N	N	1	1	N	4	4		LC, rare, resident
25	Western Barn Owl	<i>Tyto alba</i>	N	1	N	N	N	N	N	1	N	N	1	N	N	N	N	N	2	N	1	5	4		LC, rare, resident
26	Dusky Eagle Owl	<i>Bubo coromandus</i>	N	N	N	N	N	N	N	1	1	N	N	N	N	1	N	N	N	1	N	4	4		LC, rare, resident
27	Brown Fish Owl	<i>Ketupa zeylonensis</i>	N	N	N	N	N	1	1	N	N	2	N	N	N	N	N	1	N	N	N	5	4		LC, rare, resident
28	Indian Scops Owl	<i>Otus bakkamaena</i>	N	N	N	N	N	N	1	N	N	N	2	N	N	N	2	N	N	1	1	7	5		LC, occasional, resident
29	Mottled Wood Owl	<i>Strix ocellata</i>	N	N	N	N	N	N	N	1	N	N	1	N	N	2	N	N	N	1	N	5	4		LC, occasional, resident
30	Indian Eagle Owl	<i>Bubo bengalensis</i>	N	N	N	N	N	1	N	N	N	N	2	N	N	N	1	N	N	1	N	5	4		LC, occasional, resident
			Listed 1	2	N	N	N	1	4	3	2	1	4	N	N	2	2	1	2	5	2		29		
			Listed 10	10	No data	3	No data	11	17	17	17	10	18	10	15	14	13	14	16	22	15	2070	209		
			Noted presence, good localities, and total number (Sharma and Singh 1986)	66	No data	339	No data	116	188	160	171	153	166	111	85	170	90	148	163	176	173	2070	209	209	
			TOTAL no of raptor birds counted in the year																					209	209
			Index: Ratio Bird / Spp numbers	6.6		113.0		10.5	11.1	9.4	10.1	15.3	9.2	11.1	5.7	12.1	6.9	10.6	10.2	8.0	11.5	Average Index 2003-2016=	9.9		

Supplement Table B. Raptors of National Chambal Sanctuary and their international and national status of protection with recommendation. CR—Critically Endangered | VU—Vulnerable | EN—Endangered | NT—Near Threatened | LC—Least Concern.

Species Sl. No.	English name	Scientific name	IUCN Status	Status in Wildlife Act, 1972	Cites Appendix	Migratory status
1	Cinereous Vulture	<i>Aegypius monachus</i>	NT	Schedule-IV Cannot hunt without permission	II	Winter visitor
2	Egyptian Vulture	<i>Neophron percnopterus</i>	EN	Schedule-IV	II	Resident
3	White-rumped Vulture (Synonym: Indian White-backed Vulture)	<i>Gyps bengalensis</i>	CR	Schedule-I	II	Resident
4	Indian Vulture (Synonym: Long-billed Vulture)	<i>Gyps indicus</i>	CR	Schedule-I	II	Resident
5	Red-headed Vulture	<i>Sarcogyps calvus</i>	CR	Schedule-IV	II	Resident
6	Griffon Vulture (Synonym: Eurasian Griffon)	<i>Gyps fulvus</i>	LC	Schedule-IV	II	Winter visitor
7	Western Osprey (Synonym: Osprey)	<i>Pandion haliaetus</i>	LC	Schedule-I Fully protected	II	Winter visitor, seen till May
8	Black-shouldered Kite	<i>Elanus axillaris</i> (Syn: <i>E. caeruleus</i>)	LC	Schedule-IV	II	Resident
9	Black Kite (Syn: Common Pariah Kite)	<i>Milvus migrans</i>	LC	Schedule-IV	II	Resident
10	Shikra	<i>Accipiter badius</i>	LC	Schedule-IV	II	Resident
11	Western Marsh Harrier (Synonym: Eurasian Marsh Harrier)	<i>Circus aeruginosus</i>	LC	Schedule-IV	II	Winter visitor
12	Common Buzzard	<i>Buteo buteo</i>	LC	Schedule-IV	II	Winter visitor
13	White-eyed Buzzard	<i>Butastur teesa</i>	LC	Schedule-IV	II	Resident
14	Crested Honey Buzzard (Synonym: Oriental Honey Buzzard)	<i>Pernis ptilorhynchus</i>	LC	Schedule-IV	II	Resident
15	Bonelli's Eagle	<i>Aquila fasciata</i> (Syn: <i>Hieraetus fasciatus</i>)	LC	Schedule-IV	II	Resident
16	Pallas's Fish Eagle	<i>Haliaeetus leucoryphus</i>	EN	No mention	II	Winter visitor
17	Tawny Eagle	<i>Aquila rapax</i>	VU	Schedule-IV	II	Winter visitor
18	Crested Serpent Eagle	<i>Spilornis cheela</i>	LC	Schedule-IV	II	Resident
19	Changeable Hawk Eagle	<i>Nisaetus cirrhatus</i> , Syn. <i>Spizaetus cirrhatus</i>	LC	Schedule-IV	II	Resident
20	Common Kestrel	<i>Falco tinnunculus</i>	LC	Schedule-IV	II	Winter visitor
21	Eurasian Hobby	<i>Falco subbuteo</i>	LC	Schedule-IV	II	Winter visitor
22	Laggar Falcon	<i>Falco jugger</i>	NT	Schedule-I	I (One)	Resident
23	Red-necked Falcon	<i>Falco chicquera</i>	NT	Schedule-I	II	Resident
24	Spotted Owlet	<i>Athene brama</i>	LC	Schedule-IV	II	Resident
25	Western Barn Owl (Synonym: Barn Owl)	<i>Tyto alba</i>	LC	Schedule-IV	II	Resident
26	Dusky Eagle Owl	<i>Bubo coromandus</i>	LC	Schedule-IV	II	Resident
27	Brown Fish Owl	<i>Ketupa zeylonensis</i> (Synonym: <i>Bubo zeylonensis</i>)	LC	Schedule-IV	II	Resident
28	Indian Scops Owl	<i>Otus bakkamaena</i>	LC	Schedule-IV	II	Resident
29	Mottled Wood Owl	<i>Strix ocellata</i>	LC	Schedule-IV	II	Resident
30	Indian Eagle-Owl (Synonym: Rock Eagle Owl)	<i>Bubo bengalensis</i>	LC	Schedule-IV	II	Resident

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