भारतीय वन्यजीव संस्थान
Wildlife Institute of India

BUSTARD
RECOVERY PROGRAM

SURVEY REPORT

STATUS SURVEY OF MIGRATORY BIRDS AND KEY WILDLIFE IN BIKANER DISTRICT, RAJASTHAN

2021

Front & Back Cover:
Demoiselle Crane: Dhritiman Mukherjee

STATUS OF WILDLIFE IN BIKANER

Survey Report 2021

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Citation: Dutta, S., Kher, V., Uddin, M., Supakar, S., Karkaria, T., Gupta, T., Paul, I., Pandey, D., Varma, V., Verma, V., Phasalkar, P., Khanra, A., Jora, V. S., Kataria, P. S., Chhangani, A. K., Bipin, C. M., Jhala, Y. V. 2022. Status survey of migratory birds and key wildlife in Bikaner district, Rajasthan. Wildlife Institute of India, Dehradun | TR No/2021/24

STATUS SURVEY OF MIGRATORY BIRDS AND KEY WILDLIFE IN BIKANER DISTRICT, RAJASTHAN

Organised by:
Bustard Recovery Program: Habitat Improvement and Conservation Breeding of Great Indian Bustard

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Funded by:
National CAMPA Authority, MoEF&CC

Acknowledgements

The status survey of wildlife in Bikaner was conducted by the Wildlife Institute of India with the support of Rajasthan Forest Department and Shri Arjun Ram Meghwal, Hon'ble Member of Parliament Bikaner Constituency and Minister of State for Parliamentary Affairs and Culture, Government of India. The Ministry of Environment, Forest and Climate Change (MoEF&CC) provided financial support for this survey under the Endangered Species Recovery Programme (Great Indian Bustard) sanctioned by the National Compensatory Afforestation Fund Management and Planning Advisory Council (CAMPA). We thank the Chief Wildlife Warden of Rajasthan for providing permission to conduct the survey. Offices of the Deputy Conservator of Forest, Assistant Conservator of Forests, Range Forest Officers, Deputy Range Forest Officers, Foresters, and Forest Guards of Bikaner and Chattargarh Forest Divisions are acknowledged for their logistic support and facilitation. We thank the Director, Wildlife Institute of India and Dean, Wildlife Institute of India, for providing academic and institutional support. We would like to express our gratitude to the Vice-Chancellor of Maharaja Ganga Singh University, Bikaner and Principal of Govt. Dungar College, Bikaner, for permission to conduct training workshops and valedictory functions in their respective institutions. We sincerely thank the staff and students of Govt. Dungar College and Maharaja Ganga Singh University for their support and logistic help. We would like to express our gratitude to Major General Gurpreet Singh, 24th Infantry Division and GOC-in-charge, Mahajan Field Firing Range (MFFR), for providing permission and hospitality to survey inside the range. We further thank GOC-in-charge southwest command and the concerned army personnel of MFFR for assisting in the execution of the survey, and Lt Col. Keshvendra Singh for his help. We acknowledge the support of BSF officers for their help in surveying the border areas. We would like to express our gratitude to the management of Gajner Palace for permitting and facilitating the survey of Gajner Lake. The survey wouldn't have been possible without the unconditional support and tireless efforts provided by the Office of Hon'ble Member of Parliament, particularly the support of Mr. Ravi Agarwal and Mr. Ganesh Siyag. Furthermore, we thank Mr. Jitendra Solanki, Mr. Chena Ram (Hanuman Nagar), Mr. Sanjeev Verma (Executive Engineer, Irrigation Department, Chattargarh) for providing organisational support in the execution of the survey. Dr. Dhananjai Mohan, Director WII is specially thanked for reviewing the report.

List of the participants of the status survey of wildlife in Bikaner

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Executive summary (English)

The Bikaner district of Rajasthan supports a wide variety of wildlife that has not been rigorously surveyed in the past. Robust status assessments with reproducible methods are vital for monitoring wildlife trends, particularly in regions like Bikaner that are undergoing large-scale land-use changes, which are potentially detrimental to native wildlife. Therefore, a large-scale survey was organised by the Wildlife Institute of India in collaboration with Rajasthan Forest Department, Government Dungar College and Maharaja Ganga Singh University to assess the status of key wildlife in the Bikaner district of Western Rajasthan. Notably, this survey was planned at the request of Bikaner district residents, who conveyed their wish to conduct a wildlife survey to the Hon'ble Member of Parliament, who invited the Wildlife Institute of India through the Ministry of Environment, Forest & Climate Change to execute the survey. Consequently, the data collection was conducted in a citizen science framework and involved active participation by a diverse group of researchers, frontline staff, University students and wildlife enthusiasts. The survey assessed the distribution and abundance status of key wildlife, particularly migratory, arid-adapted and raptorial species of birds, their habitat associations, potential threats in the landscape, and community perceptions towards conservation.

The Bikaner parliamentary constituency was divided into four sampling blocks (Bikaner, Kolayat, Chattargarh and Mahajan) and overlaid with 144 km^2 (12 x 12 km grid) cells. A total of 89 such cells covering 12,816 km^2 area were extensively surveyed using vehicle transect method. In each cell, dirt-trails or unpaved roads of 16.2 ± 4.1km length were traversed using slow-moving vehicles and animals were recorded during peak activity periods (0700hrs-1300hrs and 1600hrs-1900hrs). Data on iconic native fauna (chinkara, foxes, bustards, cranes and raptors) and key neobiota (dog, pig and nilgai) was collected on these vehicle transects (1442 km total length). Information on small birds, habitat characteristics and anthropogenic disturbances was recorded at regularly placed transect stop-over points (802 points). Major avian congregations or 'hotspots' (carcass dump at Jorbeer, wetlands and lakes at Gajner, Lunkaransar, RD507 and RD750) were surveyed using simultaneous point-counts and line transects. Community perception towards conservation was assessed using structured questionnaires conducted in select households of randomly selected villages. Species' population estimates were obtained using analytical techniques such as distance sampling and simultaneous block counts.

During the survey, 1,880 Chinkara individuals were detected in 684 herds with an encounter rate of 139.78±18.72 individuals per 100km. The estimated density of chinkara in the surveyed area was 4.27±0.65 individuals/km^2, that yielded abundance of 54,745±8,392 individuals in the surveyed area. Similarly, 112 desert foxes were seen during the survey and the density was estimated to be 0.58±0.11 foxes/km^2, yielding abundance of 7,456±1,356 individuals. Other mammals recorded during the survey were - Desert Cat (0.57±0.2 individuals/100km), Nilgai (14.39±2.91 individuals/100km), free-ranging Domestic Dogs (26.07±3.6 individuals/100km) and Indian Wolf (one sighting).

Among large birds, the encounter rate of the Demoiselle Crane was estimated at 5.47±3.14 individuals/100km. The five most common raptor species (individuals per 100 km) were Griffon Vulture (16.44±6.94), Egyptian Vulture (8.73±2.35), Common Kestrel (7.39±0.88), Black-winged

Kite (5.35±0.89) and Long-legged Buzzard (5.13±0.69). Among small birds, 2,859 individuals from 103 species were recorded on point counts. The most abundant species were Common Babbler, Eurasian collared Dove, House Sparrow, White-eared Bulbul, Red-vented Bulbul, Greater short-toed Lark and Variable Wheatear. The total density of small birds, excluding birds in flight and rare species, was estimated at 997±58 individuals/km^2.

A total of 24,674 individual birds belonging to 95 species across 36 families were recorded during hotspot surveys. RD750 had the highest number of individuals and species (15,666 individuals of 76 species), followed by RD507 (6,501 individuals of 34 species), Lunkaransar lake (1,749 individuals of 25 species) and Gajner lake (758 individuals of 38 species). Common Coot, Demoiselle Crane, Common Pochard, Common Teal and Gadwall were the most abundant species that were recorded. Two Endangered (Egyptian Vulture and Steppe Eagle), two Vulnerable (Common Pochard and River Tern), and six Near-Threatened species (Black-headed Ibis, Dalmatian Pelican, Eurasian Curlew, Ferruginous Duck, Northern Lapwing, and Painted Stork) were recorded during the hotspot survey.

The habitat was characterised by flat and mildly undulating terrain, dominated by scrublands followed by agriculture (fallow and cultivated). Active disturbance such as humans or livestock was present in 72% of surveyed plots. Passive disturbance such as fences, electric lines, paved road/ highway etc., was recorded at 87% of the points. In terms of vegetation, the most dominant natural vegetation was Kheemp (*Leptadenia pyrotechnica*) > Khejri (*Prosopis cineraria*) > Bhui (*Aerva sp.*) > Phog (*Calligonum polygonoides*) > Chugh (*Crotalaria burhia*) > Aak (*Calotropis procera*) > Ganthia (*Dactyloctenium scindicum*) > *Prosopis juliflora.*

There was a positive association between the presence of fences and that of cultivation, human, livestock, dog, water-source and power-lines, indicating that fences could be a proxy for other disturbances. We found distinct associations between species and habitat. Plants such as *Leptadenia* and *Calligonum* occurred more in undulating and less disturbed areas. *Aerva* occurred more in sandy, less disturbed areas, whereas *Prosopis juliflora* and *Calotropis procera* occurred more in flat, disturbed areas. Faunal species such as Chinkara decreased in abundance with the proportion of area under cultivation while Nilgai showed an opposite trend. Desert Fox and Desert cat did not show any response to habitat gradients, whereas dogs were more abundant in flat, disturbed areas. Steppe Eagle, Egyptian Vulture and Laggar Falcon decreased in abundance along canal-irrigated areas. Birds such as Eurasian collared dove, Grey Francolin, Indian Robin and Indian Peafowl preferred flat terrain. Presence of disturbances favoured the Common Babbler, Eurasian Collared Dove, Grey Francolin, Red Vented Bulbul and Variable Wheatear, but negatively impacted the Ashy-crowned Sparrow Lark, Greater Short-toed Lark and Yellow-eyed Pigeon.

Questionnaires were conducted with 170 respondents in 61 villages spread over 24 cells. 1.7±1.0% of respondents reported seeing a Great Indian Bustard (*Ardeotis nigriceps)* around their villages in the past 5 years. The reporting frequency of dog, nilgai and fox was higher than that of chinkara, crane and wild pig. More people reported an increasing population trend for neo-colonised species (dogs, nilgai and wild pigs) than for native species (chinkara, fox or crane). On similar lines, more people reported that native biota (particularly chinkara and vultures followed

by cranes and peafowls) have reduced in occurrence over the past few years. Habitat loss due to agricultural expansion and associated activities (fencing, pesticide usage, borewell irrigation etc.) was the most widely reported cause for wildlife decline; other causes being poaching, predation by dogs, climate change and powerlines. A high percentage of respondents (85±3%) were aware of a conservation area (managed either traditionally as *Orans* or by the Forest Department) around their village. 12±3 % of respondents complained regarding encroachment of *Orans* around their villages.

Our survey highlights that Bikaner region is undergoing rapid land-use changes due to intensive irrigated agriculture, infrastructure and industries. To understand their ecological impacts, regular assessments of wildlife populations through standard, reproducible methods become important. Based on this survey and consultation with Rajasthan Forest Department and local experts, the following preliminary recommendations are suggested:

a) greater conservation emphasis on sites such as Jorbeer Conservation Reserve, Deshnok *Oran*, Tokla *Oran*, Bhinjranwali and 750RD,

b) mitigation of potential threats such as power-lines, fences and free-ranging dogs,

c) protection of *Orans* from encroachment and development of grasslands for wildlife/livestock use,

d) development of sites such as RD750 and Lunkaransar lake for ecotourism through careful and consultative planning,

e) and replication of this survey for assessing wildlife trends.

Executive summary (Hindi)

बीकानेर जिला राजस्थान राज्य में स्थित थार मरुस्थल का एक भाग है जो विभिन्न प्रजातियों के वन्यजीवों का आश्रय स्थल है, परन्तु दुर्भाग्यवश इस क्षेत्र का वैज्ञानिक पद्धति से अब तक कोई वन्यजीव सर्वेक्षण नहीं किया गया था। इस क्षेत्र की जैव विविधता व वन्य जीवों की स्थिति एवं अनुमानित संख्या की जानकारी का आकलन अत्यंत महत्वपूर्ण हैं । विशेष रूप से बीकानेर जिले के महत्वपूर्ण क्षेत्र,जो बड़े पैमाने पर औद्योगिक एवं भूमि परिवर्तन के दबाव से गुजर रहे हैं, जो संभावित रूप से वहाँ पाए जाने वाले वन्यजीवों के लिए हानिकारक हैं। पश्चिमी राजस्थान के बीकानेर जिले में पाए जाने वाले प्रमुख वन्यजीवों की स्थिति का आकलन करने हेतु राजस्थान वन विभाग, राजकीय डूंगर महाविद्यालय और महाराजा गंगा सिंह विश्वविद्यालय के सहयोग से भारतीय वन्यजीव संस्थान द्वारा बड़े पैमाने पर सर्वेक्षण द्वारा किया गया। विशेष रूप से, इस सर्वेक्षण की योजना बीकानेर जिले के निवासियों के अनुरोध पर बनाई गई थी, वहाँ के निवासियों ने माननीय सांसद को वन्यजीव सर्वेक्षण करने की अपनी इच्छा से अवगत कराया । उन्होंने इस विषय को महत्त्व देते हुए पर्यावरण, वन और जलवायु परिवर्तन मंत्रालय एवं भारतीय वन्यजीव संस्थान को आमंत्रित कर वन्यजीव सर्वेक्षण करने हेतु अनुरोध किया अतः परिणामस्वरूप, इस सर्वे को सिटीजन साइंस अर्थात सामान्य जन व वन्यजीव प्रेमियों के सहयोग से प्राप्त वैज्ञानिक जानकारी द्वारा आयोजित किया गया। यह सर्वेक्षण शोधकर्ताओं, छात्रों और वन्यजीवप्रेमियों की सक्रिय भागीदारी से किया गया । सर्वेक्षण का प्रमुख उद्देश्य वन्यजीवों और विशेष रूप से प्रवासी, शुष्क-अनुकूलित तथा शिकारी पक्षियों की प्रजातियों के वितरण और प्राचुर्यता का अनुमान लगाना था । इस सर्वे का एक उद्देश्य विभिन्न वन्य जीव प्रजातियों के प्राकृतिक आवास की व आवास संबंधित खतरों की जानकारी एवं वहाँ पर उपस्थित समुदाय की संरक्षण के प्रति धारणाओं पर अधिक से अधिक ज्ञान प्राप्त करना था ।

इस सर्वेक्षण हेतु बीकानेर क्षेत्र को चार ब्लॉक (बीकानेर, कोलायत, छतरगढ़ व महाजन) में विभाजित किया गया और उन्हें पुनः 144 वर्ग किमी (12 X 12 किमी) के ग्रिड में बांटा गया । ऐसे कुल 89 ग्रिड्स (क्षेत्रफल 12,816 वर्ग किमी) का व्यापक सर्वेक्षण किया गया । यह सर्वेक्षण व्हीकल ट्रांसेक्ट पद्धति से किया गया, जिसमे वाहनों की गति निर्धारित (20-30 किमी/घण्टा) रखते हुए औसतन 16.2±4.1 किमी दूरी तय की गयी एवं सर्वेक्षण के दौरान दिखे गए जानवरों की जानकारी नोट की गई । सर्वेक्षण का समय इन जानवरों की गतिविधि के समय के अनुसार तय किया गया था (प्रातः 07:00-अपरान्ह 13:00 एवं अपरान्ह 16:00-सांयकाल 19:00) । इस सर्वे में, बीकानेर क्षेत्र में पाये जाने वाले महत्वपूर्ण वन्यजीव जैसे चिंकारा, गोडावण, कुर्जा और शिकारी पक्षियों के साथ-साथ अन्य जानवर जैसे कुत्ते, सूअर और नीलगाय के बारे में सूचना अर्जित की गई। अतः ट्रांसेक्ट में नियमित दूरी के अंतराल में छोटे पक्षी व उनके आवास व उपस्थित मानव निर्मित संरचनाओ की जानकारी नोट की गई। शिकारी पक्षियों के लिए महत्वपूर्ण व प्रसिद्ध स्थान जोरबीर एवं प्रवासी जलीय पक्षियों के लिए कुछ जरुरी झीले, जैसे RD750 (हनुमान नगर झील), RD507 (संसरदेसर तालाब), गजनेर व लूणकरणसर का सर्वेक्षण पॉइंट काउंट और लाइन

ट्रांसेक्ट पद्धतियों से किया गया। डिस्टेंस सैंपलिंग एवं ब्लॉक काउंट जैसी विश्लेषणात्मक तकनीकों का उपयोग करके प्रजातियों की वितरण एवं आबादी का अनुमान लगाया गया । इस सर्वे में सांख्यिकी निष्पक्ष रूप से कुछ गांवों के कुछ घरों में संरचित प्रश्नावली का उपयोग करके संरक्षण के प्रति सामुदायिक धारणा का आकलन किया गया।

सर्वेक्षण के दौरान चिंकारा के 684 झुण्डो में कुल 1,880 चिंकारा देखे गए, और उनके देखे जाने की दर 139.78±18.72 प्रति 100 कि.मी. पाई गयी। सर्वेक्षित आवास में चिंकारा का अनुमानित घनत्व 4.27 ± 0.65 चिंकारा /km^2 है एवं चिंकारा की अनुमानित संख्या 54,745 ± 8,392 पाई गयी। उसी प्रकार से 112 मरुस्थली लोमड़ी देखी गए और उनकी अनुमानित घनत्व 0.58±0.11 लोमड़ी /km^2 पाई गयी तथा सर्वे क्षेत्र में इसकी कुल अनुमानित संख्या 7,456±1,356 है। अन्य जानवर जिनका सर्वेक्षण हुआ, उनमे मरुस्थली बिल्ली (0.57±0.2 बिल्ली/100 किमी), नीलगाय (14.39±2.91 नीलगाय / 100 किमी), घरेलु कुत्ते (26.07±3.6 कुत्ते / 100 किमी) एवं भेड़िये (सर्व मे एक ही भेड़िया देखा गया, अंतः इसके संख्या का अनुमान नहीं लगाया गया) शामिल है।

बड़े पक्षियों में, डेमोइसेल क्रेन का एनकाउंटर दर 5.47 ± 3.14 पक्षी / 100 किमी अनुमानित है । पांच सबसे आम शिकारी पक्षी की प्रजातियां (प्रति 100 किमी पर पक्षी), जैसे ग्रिफॉन गिद्ध (16.44 ± 6.94), इजिप्सियन गिद्ध (8.73 ± 2.35), कॉमन केस्ट्रेल (7.39 ± 0.88), ब्लैक विंग्ड काइट (5.35 ± 0.89) और लॉन्ग लेग्गड़ बजर्ड (5.13 ± 0.69) देखी गयी । छोटे पक्षियों में, 103 प्रजातियों के 2859 पक्षी को पॉइंट काउंट पद्धत्ति से दर्ज किया गया। सबसे प्रचुर प्रजातियां कॉमन बैबलर, यूरेशियन कोलर्ड कबूतर, हाउस स्पैरो, व्हाइट इयर्ड बुलबुल, रेड वेंटेड बुलबुल, ग्रेटर शॉर्ट टोड लार्क और वेरिएबल व्हीटियर है । दुर्लभ प्रजातियों के पक्षियों को छोड़कर छोटे पक्षियों का कुल घनत्व 997 ± 58 पक्षी प्रति वर्ग किमी अनुमानित है ।

हॉटस्पॉट सर्वेक्षण के दौरान कुल 24,674 पक्षियों की गणना की गयी, जो कि 95 प्रजातियों, जो 36 कुल के अंतर्गत दर्ज किये गए। RD750 में सबसे अधिक पक्षी और प्रजातियां (76 प्रजातियों के 15,666 पक्षी) देखे गए, इसके बाद RD507 (34 प्रजातियों के 6,501 पक्षी), लुनकरणसर झील (25 प्रजातियों के 1,749 पक्षी) और गजनेर झील (38 प्रजातियों के 758 पक्षी) देखे गए थे। कॉमन कूट, डेमोइसेल क्रेन, कॉमन पोचार्ड, कॉमन टील और गडवाल सबसे अधिक संख्या में दर्ज किए गए । दो संकटग्रस्त (Endangered: इजिप्सियन गिद्ध और स्टेपी ईगल), दो असुरक्षित (Vulnerable: कॉमन पोचार्ड और रिवर टर्न), और छह संकट-निकट प्रजातियां (Near Threatened: ब्लैक हेडेड आइबिस, डालमेंसीएन पेलिकन, यूरेशियन कर्लेव, फेरुगिनस डक, नॉर्दर्न लैपविंग और पेंटेड स्टॉर्क) दर्ज की गईं।

सर्वेक्षित क्षेत्र का तलरूप सामान्यतः समतल और मध्यम ऊबड़खाबड़ पाया गया, जिसमें कृषि क्षेत्र (परती और खेती) के बाद झाड़ीदार क्षेत्र का प्रभुत्व है । सर्वेक्षण किए गए भूखंडों के 72% में मानव या पशुधन की उपस्थिति

दर्ज की गयी । मानव निर्मित संरचनाये जैसे तारबंदी, बिजली के तार, पक्की सड़क/राजमार्ग आदि की उपस्थिति 87% शोधित बिंदुओं पर देखी गई। वनस्पति के संदर्भ में, सबसे प्रमुख वनस्पति खींप (*Leptadenia pyrotechnica*) > खेजड़ी (*Prosopis cineraria*) > भुई (*Aerva sp.*) > फोग (*Calligonum polygonoides*) > चघ (Crotalaria burhia) > आक (*Calotropis procera*) > गांथिया (*Dactyloctenium scindicum*) > विलायती बबूल (*Prosopis juliflora*) पाई गई।

तारबंदी की उपस्थिति और खेती, मानव, पशुधन, कुत्ते, जल-स्रोत और बिजली के तारों के उपस्थिति के बीच एक पारस्परिक संबंध संगणित किया गया, जो यह दर्शाता है कि तारबंदी की उपस्थिति अन्य भौतिक संकटों के लिए एक प्रतिनिधि कारक हो सकती है। हमने प्रजातियों और आवास के बीच अलग-अलग सहसम्बन्ध पाये । खींप और फोग जैसे पौधे ऊबड़खाबड़ और अबाधित क्षेत्रों में अधिक पाए गये । भुई रेतीले एवं अबाधित क्षेत्रों में अधिक होता है जबकि विलायती बबूल और आक समतल व बाधित क्षेत्रों में अधिक होता है। चिंकारा प्रजाति के लिए खेती क्षेत्र के अनुपात के साथ संख्या में कमी आयी जबकि नीलगाय की विपरीत प्रवृत्ति देखी गयी । कुत्ते समतल और गॉवों के आस पास अधिक देखे अधिक गये । स्टेपी ईगल, इजिप्सियन गिद्ध और लैगर फाल्कन नहर-सिंचित क्षेत्रों में कम पाए गये । यूरेशियन कोलर्ड डव, ग्रे फ्रेंकोलिन, इंडियन रॉबिन और इंडियन पीफॉउल जैसे पक्षी समतल भूभाग अधिक देखे गए हैं। मानव निर्मित संरचनाओ की उपस्थिति ने कॉमन बैबलर, यूरेशियन कोलर्ड डव, ग्रे फ्रेंकोलिन, रेड वेंटेड बुलबुल और वेरिएबल व्हीटियर को बढ़ावा दिया, लेकिन ऐशी क्राउंड स्पैरो लार्क, ग्रेटर शॉर्ट टोड लार्क और येलो आइड पिजन पर नकारात्मक प्रभाव डाला।

24 ग्रिड में फैले 61 गांवों में से 170 उत्तरदाताओं से कुछ प्रश्न किये गये । जिसमे से 1.7±1.0% उत्तरदाताओं ने पिछले 5 वर्षों में अपने गांवों के आसपास गोडावण देखने की सूचना दी। उत्तरदाताओं के अनुसार कुत्ते, नीलगाय और लोमड़ी की दिखने की आवृत्ति चिंकारा, सारस और जंगली सुअर की तुलना में अधिक पायी गयी । तुलनात्मक अधिक लोगो ने नव-उपनिवेशित प्रजातियों (कुत्तों, नीलगाय और जंगली सूअर) की जनसँख्या में बढ़ोतरी देशी प्रजातियों (चिंकारा, लोमड़ी या क्रेन) की तुलना में अधिक बतायी । इसी तरह, अधिक लोगों ने बताया कि पिछले कुछ वर्षों में चिंकारा और गिद्धों के बाद सारस और मोर के दिखने की दर में भी कमी आयी है। कृषि विस्तार और संबंधित गतिविधियों (तारबंदी, कीटनाशक का उपयोग, बोरवेल सिंचाई आदि) के कारण वन्यप्रजातियों के पर्यावास में हानि हुई है एवं इस कारण को वन्य जीवों की संख्या मे कमी का मुख्य बताया गया है। अन्य कारणों में अवैध शिकार, कुत्तों द्वारा शिकार, जलवायु परिवर्तन और बिजली की तार दर्ज की गयी हैं। तुलनात्मक अधिक उत्तरदाता (85%) अपने गांव के आसपास एक संरक्षण क्षेत्र (पारंपरिक रूप से ओरान या वन विभाग द्वारा प्रबंधित) होने के बारे में अवगत थे। लगभग 12% उत्तरदाताओं ने अपने गांवों के आसपास के संरक्षण क्षेत्रों में अतिक्रमण होने के के बारे में शिकायत की।

इस सर्वे का मुख्य निष्कर्ष यह है कि बीकानेर क्षेत्र में निरंतर भूमि परिवर्तन हो रहा हैं जिसका प्रमुख कारण अत्याधिक सिंचित खेती एवं उद्योगों का विकास हैं, अतः इसका पर्यायवरण पर अत्याधिक प्रभाव पड़ रहा है। यह पारिस्थितिक प्रभाव देखने के लिए नियमित रूप से वन्य जीव गणना करना आवश्यक हैं । वन विभाग एवं स्थानीय विशेषज्ञ के परामर्श व इस सर्वे के आधार पर कुछ महत्वपूर्ण सुझाव दिए गये है, जो निम्न है -

1. जोरबीर संरक्षण रिजर्व, देशनोक ओरण, टोकला ओरण, भिंजरणवाली एवं 750RD जैसे बहुमूल्य छेत्रो में संरक्षक कार्यो को और भी अधिक प्रेरित किया जाना चाइये जैसे क्षेत्रों पर अधिक संरक्षण की आवश्यकता हैं।

2. पॉवर-लाइनों, तार-बंदी (बाड़) और घरेलु कुत्तों जैसे वन्यजीवों के संभावित खतरों का समाधान खोजनाआवश्यक है।

3. ओरानों का अतिक्रमण से बचाव के लिए घास के मैदानों के विकास की आवश्यकता हैं जिससे वन्य जीवों/पशुधन के उपयोग के लिए चारा भी मिलता रहे।

4. 750 RD और लुनकरणसर झील जैसे स्थलों को इको-पर्यटन(पारिस्थितिक पर्यटन) के लिए सावधानीपूर्वक और परामर्शी योजना के माध्यम से विक्सित किया जाना चाहिए आवश्यक है।

5. वन्यजीवों की संख्या में बदलाव और किसी भी तरह के खतरों की सालाना जानकारी के लिए इस प्रकार के सर्वे होते रहना चाहिए|

INTRODUCTION

1. Introduction

Protected areas are the cornerstone of biodiversity conservation. However, they constitute only 6% of the earth's and 5% of India's geographical areas (Jenkins and Joppa 2009; Ghosh-Harihar et al., 2019). A much larger fraction of biodiversity occurs in unprotected multiple-use landscapes. Protected areas are pivotal to, but cannot displace the need of sustaining ecological functions and flow in the larger landscapes around them. Hence, it is important to also focus on landscapes while developing conservation plans and factoring them into developmental goals (Sayer et al., 2013). This is particularly important for India, given the expansion of its large rural population and developing economy into remote wildlife habitats vis-à-vis its general cultural tolerance towards wildlife and low intensity of land uses – factors that are compatible for species' persistence (Rangarajan, 2005). Fundamental to such planning is the spatial information on biodiversity status – abundance, distribution and habitat relationships of representative species and potential threats. Conservation planning in the Bikaner region of the Thar desert will benefit from such systematically collected information on its biodiversity status.

Birds and large mammals elicit strong admiration and innate connection in the human psyche, thereby being the common focus of ecological assessments and conservation programs. The Indian subcontinent hosts a wide spectrum of birds, including many winter migratory species. About 280 long-distance migrants spend their winter in India's rich and warm tropical habitats that lie immediately south of their Palearctic breeding ranges (SOIB 2020). The country lies along three major bird migratory flyways: Central Asian Flyway (CAF), East Asian Australasian Flyway over parts of eastern India (EAAF), and Asian East African Flyway (EAF). India is a signatory to the Convention of Migratory Species, which prescribes science based conservation measures to ensure the survival of migratory species as well as their habitats to provide sustainable benefits to people. Scientific datasets show that CAF migratory terrestrial birds are declining rapidly and species that breed in grasslands and agricultural areas, including those wintering in the Thar desert, are highly affected by land-use changes (Dasgupta et al., 2017, Kher & Dutta, 2021). Similar to birds, the Indian subcontinent is home to a wide variety of mammalian diversity. The Thar desert is also unique in this regard and hosts many species that are not common elsewhere in the country. However, contemporary landscape level changes like the introduction of the Indira Gandhi Canal and the subsequent expansion of settlements and agriculture have *prima facie* caused a dramatic change in the mammal assemblage of the Thar Desert (Prakash, 1997; Islam & Rahmani, 2011; Dookia et al., 2009). Chinkara, a highly revered antelope in Rajasthan, is speculated to have suffered large scale declines owing to the increased human footprint in the desert over the last few decades (Dookia et al., 2009). On the contrary, other species such as the Nilgai and Wild pig seem to have benefited from the irrigation-driven changes (Dutta et al., 2018). However, these observations are backed by scanty evidence; and require landscape level surveys for greater support.

1.1 Bikaner district from a wildlife context

The Thar desert presents an abruptly changing environment for wildlife from antiquity to Anthropocene. This arid, sandy tract forms the eastern limit of the vast Saharo-Iranian desert and blends into wetter, semiarid conditions to the east. Rainfall is sparse at ~200 mm per year, 90%

of which is received during monsoon (June – September), and is intercepted by moderate to severe droughts once in three years (Rao and Roy 2012). However, its paleoclimate was more semiarid and wetter from 2 million years up to 0.25 million years before the present (Dhir et al. 2018). Since then, the climate dried up, characterised by weaker monsoons, extensive sand deposition, and the current arid conditions set in at 4000 years before present. Sediment core analysis of Lunkaransar and other salt lakes indicates such paleoclimatic patterns (Enzel et al. 1999). These changes presumably conferred an advantage to the xeric species over their mesic counterparts. Aridification also restricted human occupation. While organised human societies harnessed the potential of agriculture and livestock in the Indus plains to the west and the east of the Aravalli mountains, the intervening region of Thar remained thinly populated with nomadic hunter-gatherers throughout early human history (Misra 2001, Madella and Fuller 2006, Dhir et al. 2018). Settlements and agriculture expanded into Thar relatively recently, perhaps around 1000 years back. Even then, livelihoods depended on pastoralism; cultivated area was only 15%, and the human population was small, stable and numbered ~6 lakhs in Bikaner in the first half of the 20th century (Dhir et al. 2018). In contrast, the human population exploded by ten folds in the last 60 years, with a recent decadal growth rate of 20-30% (Census data). Perhaps the single major change in regional ecology was brought by the Indira Gandhi Canal, which created an agriculturally intensive corridor in the 1980s. Irrigation and mechanised farming facilitated a four-fold increase of cultivated area in Bikaner during the last 50 years, with crop cover increasing from 15% (1960) to 54% (2011) (Dhir et al. 2018). Much of agricultural expansion came at the cost of erstwhile culturable wastelands or areas owned by the Government that was grazed by livestock, and fallow lands or areas not farmed in current year(s). Consequently, Thar desert, with 70% of its area under cultivation, has become the most intensively farmed arid region, posing novel challenges for its wildlife and ecological sustainability. These land-use changes have exposed the native wildlife, which remained isolated from humans historically, to a sudden and intense wave of anthropogenic pressures. Only *gauchars* or common village grazing lands, *orans* (sacred groves) or lands spared by local communities for wildlife and grazing, cumulatively known as permanent pastures, and forest department lands remain as a refuge for native wildlife. More lately, the region has experienced infrastructural developments in the form of industrial growth, rural electrification and expansion of the road network, adding to the anthropogenic pressures. Increased surface water and plantations lining the canal have facilitated mesic species to (re)establish in the region (Rahmani and Soni, 1997). Thus, ecoclimatic trajectories spanning thousands of years are at risk of being reversed within a few decades, the implications of which are yet to be discerned.

1.2 Objectives

For conservation of migratory birds in India, the National Action Plan proposes measures such as: a) assessing status and distribution of migratory birds in wetlands and terrestrial habitats, b) evaluation of threats and site-specific recommendations to mitigate them, c) involving local communities in conservation activities including citizen science groups, and d) sustainable management of habitats through capacity building and outreach. Similarly, India's National wildlife action plan recommends assessing and evaluating wildlife outside PAs for objective management and targeted species recovery. To further this initiative and develop conservation plans for local wildlife, the Hon'ble Member of Parliament (Bikaner), who is also the Minister of State for Parliamentary Affairs and Culture - GoI, invited the Wildlife Institute of India (WII) through the Ministry of Environment, Forest and Climate Change (MoEFCC) to conduct a status survey on migratory birds and other key wildlife in Bikaner. The WII, in collaboration with Forest Department, local universities, wildlife enthusiasts and citizens, carried out a large-scale wildlife status assessment in the Bikaner district. The focus of this exercise were birds, especially migratory, arid-adapted and raptorial species, and large terrestrial mammals.

Set in this background, the wildlife assessment of Bikaner aims at generating current baselines on key wildlife, their habitats, threats and community perceptions towards conservation so that this information can flow into conservation plans.

Specifically, we:

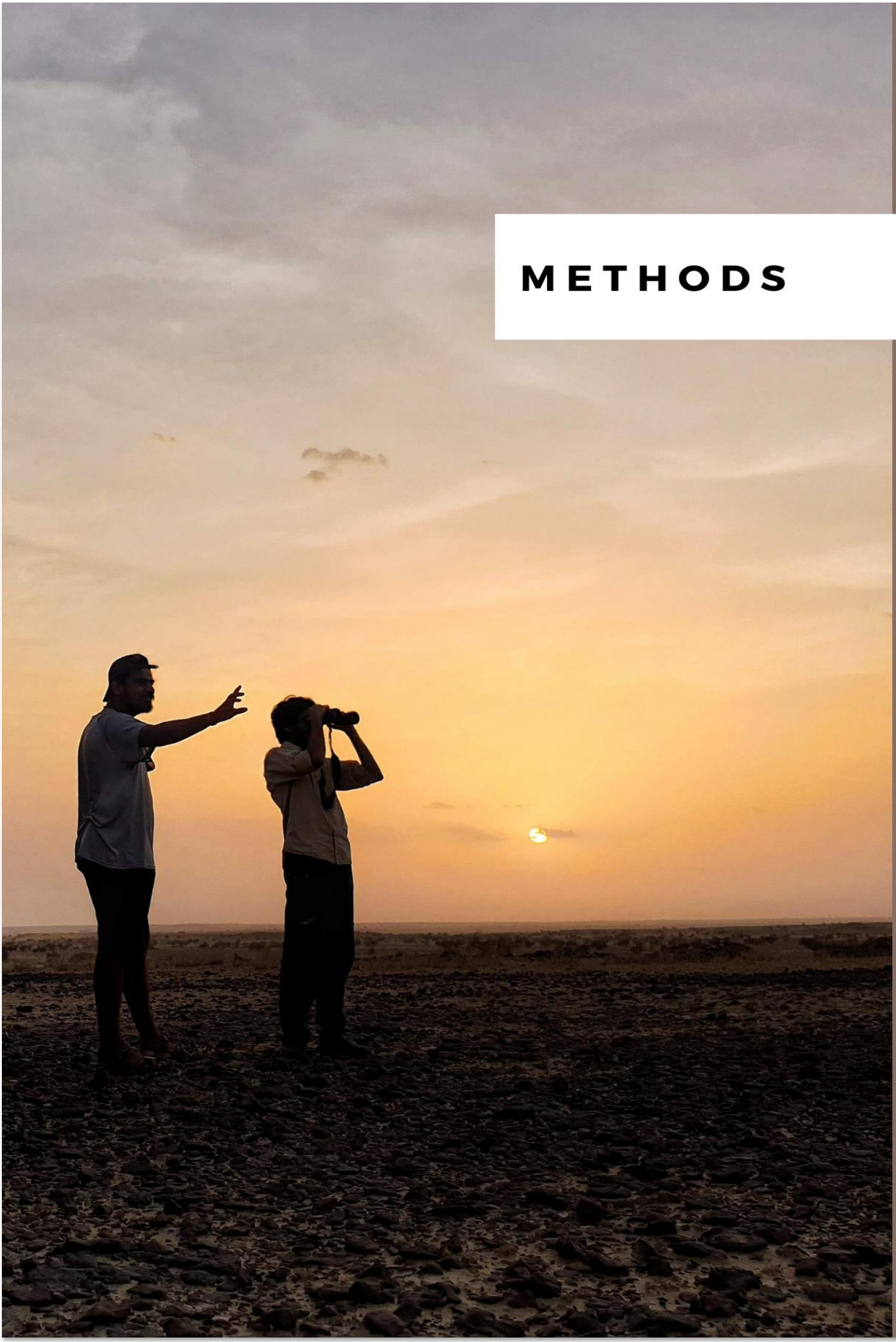
1) estimate the occupancy and (relative) abundance of birds, especially migratory, arid-adapted and raptorial species, and that of key mammals representing xeric and mesic adaptations in the general landscape

2) estimate the abundance of the above taxa in select conservation hotspots

3) assess habitat status, potential threats to wildlife, and species-habitat relationships, and

4) assess community perceptions towards wildlife conservation


Mahindra



METHODS

2. Methods

2.1 Organization of survey

The parliamentary constituency of Bikaner was divided into four sampling blocks which were simultaneously surveyed by 10 teams during February 16-28, 2021. This helped us cover a large area within a short period, thus minimising the influence of bird/animal movements on population parameter estimation. The sampling blocks were headquartered at: a) Bikaner, b) Chattargarh, c) Kolayat, and d) Mahajan; and consisted of about 25 grids/cells of 144 km^2 each. Each team consisted of a Wildlife Institute of India researcher, a local volunteer, an experienced birder and Forest Department guard adept with the locality, and one rugged-terrain vehicle with a driver. Field activities in a sampling block were supervised by a research biologist from the Wildlife Institute of India with several years of field experience in conducting wildlife surveys. Team members were trained to follow a standardised data collection protocol through a workshop and rigorous field exercise prior to surveys.

2.2 Sampling design

Our extensive surveys covered 89 cells (12,816 km^2 area) through a transect effort of 1,442 km. These cells were surveyed using a vehicle transect approach. Data generated from this survey provided estimates of species' occupancy, density and abundance. We parallelly collected data on habitat and disturbance at 802 points on the vehicle transect to estimate the effects of natural and anthropogenic factors on animal populations. Additionally, some sites of exceptional biodiversity value were surveyed using an alternate Hotspot survey method.

2.2.1 Vehicle transects

Dirt trails in survey cells were digitised using Google Earth imagery. Cells were surveyed along dirt trails of 16.2 ± 4.1_{SD} km average length (single continuous or two broken transects) from a slow moving (10-20 km/hr) vehicle. Surveys were conducted from morning to noon (0700-1300) and in late afternoon (1600-1900) when bird/animal activity was highest. This sampling scheme was chosen to optimise the combination of cell size, transect length and efforts required to cover ~20% of the cell area (assuming that species would be effectively detected within ~250 m strips, following Dutta 2012). Data collection on vehicle transects has been described below (section 2.3).

2.2.2 Wetland hotspot surveys

Some birds congregate in large numbers at special habitats, such as migratory waterfowl at water bodies and scavenging birds at carcass dumping sites. We selected bird 'hotspots' based on historical literature and eBird records (Interim report, 2020). Since vehicle transects are not feasible to survey these hotspots, we used an alternative approach. At wetlands (750RD/Hanuman Nagar Jheel, 507RD/Sansardesar Lake/Ghegda Jheel, Gajner and Lunkaransar lake), surveys were conducted using simultaneous block count method. Each

wetland was divided into ‘sectors’ that were surveyed from an ‘observation point’. A team of surveyors spent a minimum of 10 minutes at an observation point and counted all individuals of each species within the assigned sector. Sectors were surveyed simultaneously to avoid duplication in count at large water bodies. Birds flying/crossing over the sector were not considered. To avoid observer bias, counts were averaged from three independent observations of the number of birds.

2.2.3 Community surveys

Questionnaires for conservation perception of local communities were conducted in 30% of surveyed cells. In these cells, we visited 2-3 villages, and up to three residents per village were opportunistically interviewed (questionnaires in Appendix 1). We collected information on the occurrence of the Great Indian bustard (within the last five years) and associated species (Chinkara, Fox, Nilgai and Crane) from village areas, species with increasing and decreasing population trends, perceived threats to wildlife, and perception on local conservation management.

2.3 Data Collection on vehicle transects

2.3.1 Species’ information (key wildlife)

Data on key desert wildlife such as Desert fox, Indian fox, Chinkara, Nilgai, Cranes and raptors, and biotic disturbance (free-ranging dogs) were collected during the vehicle transect survey (data sheet in Appendix 2). For each sighting, the number of individuals, GPS coordinates, distance (using laser rangefinder) and angle (using a compass) were recorded.

2.3.2 Habitat information

Habitat features that could potentially influence species’ distribution, such as land-cover, terrain, substrate, vegetation structure, and disturbances were recorded at every 2 km interval along the transect (see data sheet in Appendix 3). The dominant land-cover (barren/ agriculture/ grassland/ shrubland/ woodland), terrain (flat/ sloping/ undulating), and substrate depending on soil characteristics (rock/ gravel/ sand/ soil) were recorded within a 100 m radius of the point. Vegetation structure was recorded as the percentage of ground covered by short grass and herb (<30 cm, >30 cm), shrub (<2 m), tree (>2 m) and crop within 20 m radius of the point. These covariates were recorded in broad class-intervals (0, 1-10, 10-20, 20- 40, 40-60 and 60-100 %) to reduce inconsistency of observation errors between teams. Vegetation composition was recorded as three dominant plant taxa within a 100 m radius of the point. The presence of anthropogenic factors (human/ dog/ livestock/ machinery) was recorded within a 200 m radius of the point. Presence of infrastructure (settlement/ farm-hut/ metal road/ power-line/ wind-turbine/ water-source/ solar-power-plant/ industrial-use/ fence) was recorded within 500 m radius of the point. The presence of the spiny-tailed lizard, based on detection of burrows within a 10 m radius of the point, was also recorded.

2.3.3 Point counts (Birds)

To collect data on general avifauna, we performed a point count of 10 minutes after every 2 km on transects and recorded the number of birds within 200 m of the observation point (Appendix 4). These point counts were conducted in parallel with the habitat surveys and at the same location. For each bird recorded within the 200 m radius, the species' identification and distance from the point were noted. Birds detected using auditory cues were considered, but those flying over the point were not recorded.

2.4 Analytical methods

2.4.1 Habitat assessment

We mapped the proportional occurrence of land-cover, terrain, substrate, active and passive disturbances in sampling plots grouped within 144 km^2 cells and estimated their mean and SE prevalence across cells to describe the current habitat status at the landscape scale. We examined the spatial association between habitat variables using Pearson's correlation analysis. To identify meaningful habitat patterns and reduce data dimensions, we extracted a few latent factors from the proportional occurrence of land-cover, terrain, substrate, active and passive disturbances in sampling plots at 144 km^2 cells, using factor analysis. We mapped these factors to describe prominent habitat gradients across the landscape.

2.4.2 Vegetation assemblage

We estimated the frequency of occurrence of plant species in sampling plots to describe the current status of vegetation and identify dominant species. We attempted to delineate vegetation assemblages from species' co-occurrences (McCune and Grace 2002) but did not find any strong structuring of the vegetation community. Subsequently, we mapped the frequency of occurrence of dominant plants in sampling plots grouped within 144 km^2 cells and modelled them on habitat factors using binomial Generalised Linear Models in Information Theoretic framework to understand plant-habitat associations.

2.4.3 Population status of key taxa

2.4.3.1 Density of Chinkara and Fox using line transect distance sampling

We used Distance sampling (Buckland et al. 2015) based approach to estimate the density of the two common mammal species in the region, viz. Chinkara and Desert Fox. In this framework, detectability is modelled as a function of perpendicular distance from the line. We calculated perpendicular distance from the sighting distance and angle of sightings. We fitted half-normal, uniform and hazard-rate models with appropriate key adjustments after checking the data for evasive movement and peaking at intermediate distances. The least AIC model was used for inference. Goodness of fit for the selected model was assessed using Chi-square and *Cramer-*

von mises test score. Encounter rate data collected during vehicle transects was corrected using the detection function to obtain density estimates.

Density estimates were then multiplied with the surveyed area to obtain the conservative abundance estimates for the Bikaner district. We did not project our density estimates beyond our sampled area, and thus our estimates represent the 'minimum population size' for the species in Bikaner district. However, the sampled area covered the majority of the distribution of the species within Bikaner district.

2.4.3.2 Density estimation of small birds using point count distance sampling

We used point count based distance sampling to estimate the density of small birds. We used complete bird lists and species with >5 sightings for this analysis. We modelled species' detection probability as a function of distance from the sampling point. Since detectability will also depend on species' traits, we grouped species into 'low', 'medium' and 'high' detectability categories by classifying the distribution of median detection distances into three roughly equal percentile bins. We fitted half-normal, uniform and hazard-rate models with appropriate key adjustments to the frequency of sightings in increasing distance classes, separately for the three detectability groups. The least AIC model was used for inference. We estimated species' encounter rates as flocks detected per plot, nested within cells, using linear mixed effect intercept only models to accommodate the hierarchical data structure, and mean flock size for each species. Thereafter, we estimated species' densities from their encounter rate, flock size, and detectability and generated bootstrap SEs by sampling from normal distributions of the above parameters.

2.4.3.3 Encounter rate of large birds on line transects

We estimated the encounter rate of large bird species (raptors and cranes) as the means and standard error of individuals detected / km along transects grouped into cells.

2.4.3.4 Bird species richness estimation

Species were first classified into five different groups based on their habitat preferences: a) Grassland and desert specialists, b) Habitat generalists, c) Woodland and Forests, d) Synanthropic, and e) Wetland. In each cell, the total observed number of species belonging to each group was calculated and mapped.

2.4.4 Species habitat relationships

We examined species-habitat relationships using generalised linear models (hereafter, GLM) in the Information Theoretic framework to inform conservation management.

For small birds, we modelled species' distribution (proportion of point-counts in a cell occupied by the species) and relative abundance (logarithm of mean number of individuals detected per point in a cell + 1) on habitat factors and canal length, using binomial and gaussian GLMs, respectively. We drew inferences on habitat responses for each species using untransformed parameter estimates (slopes) of predictors from the full models.

For large birds and mammals, we modelled relative abundance (logarithm of mean number of individuals detected km^{-1} + 1) in a cell on habitat factors using gaussian GLM and inferred habitat responses for each species using model-averaged untransformed parameter estimates (slopes) of predictors.


Pc: sherwin

RESULT

3. Results

3.1 Efforts

We surveyed 89 cells covering 12,816 km^{2,} with 54 observers recording data on 1,442 km vehicle transect and 802 habitat samples and point counts (Figure 1).

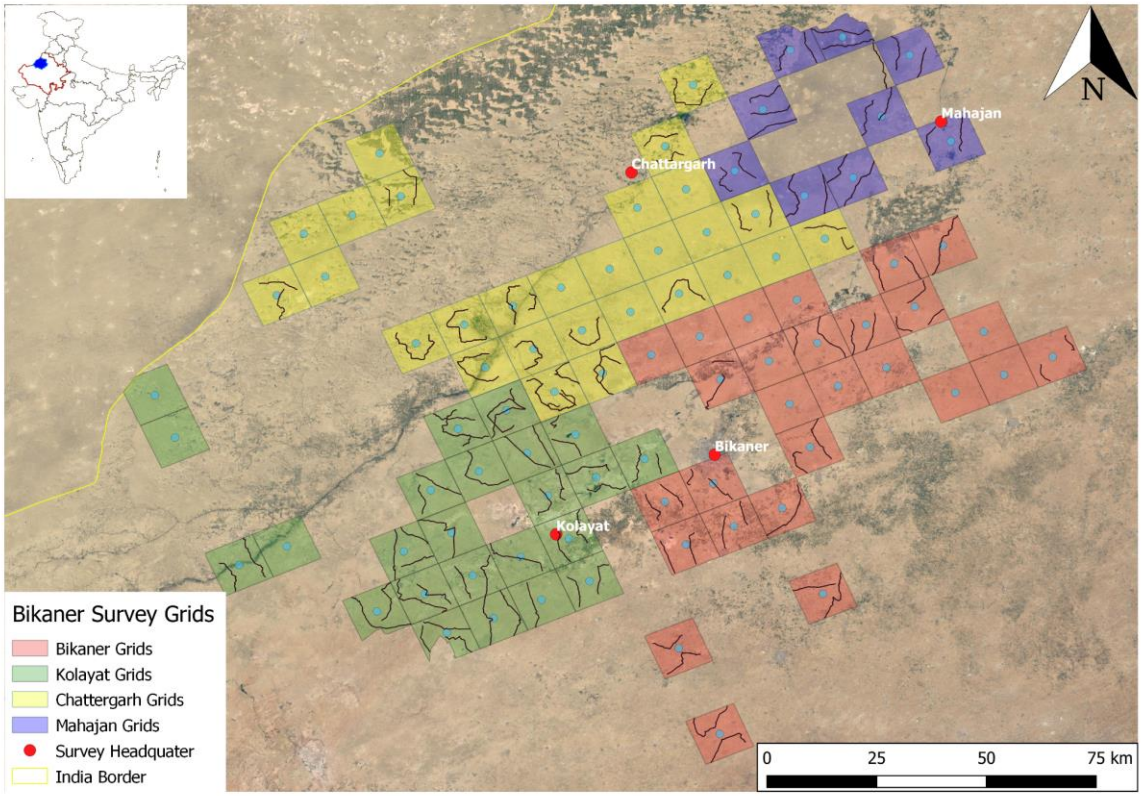


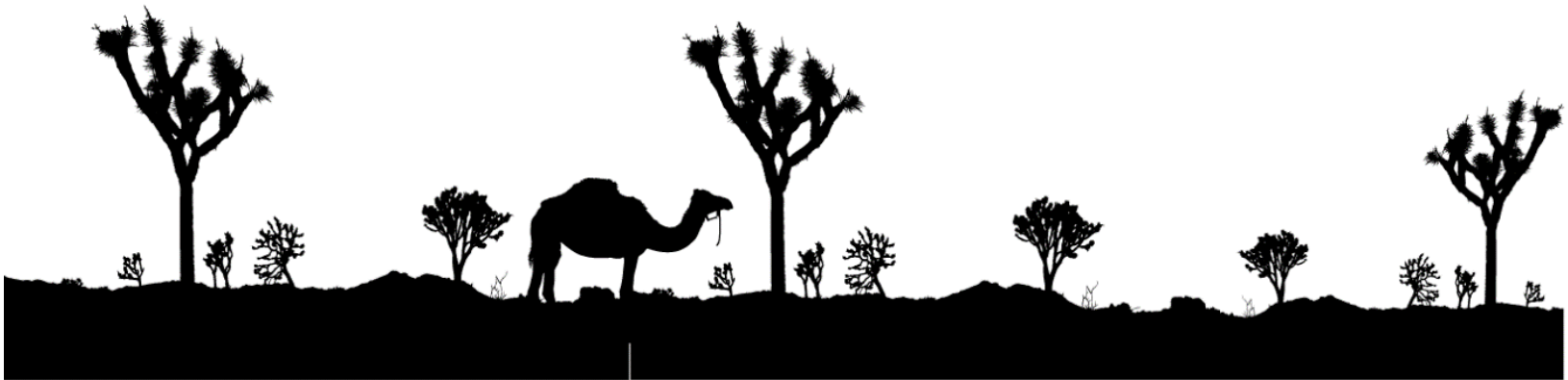
Figure 1. Map of sampled grids (n = 89) divided into subdivisions with trails and point counts displayed.

3.2 Habitat and disturbances

The landscape was characterised by: a) flat followed by undulating terrain (Figure 3); b) soil followed by sand substrate; c) scrubland followed by fallow and cultivated land-cover (figure 2); d) some form of active disturbance (most commonly human and livestock presence) in 72% of plots (Figure 4); and e) some form of passive disturbance (most commonly agricultural fence and power-lines) in 87% of plots (Table 1).

Table 1: Descriptive statistics of habitat variables in Bikaner landscape (2021), measured as the mean and standard error (SE) prevalence of variables within 144 km^2 cells

Feature	Variable	Mean (SE)
Land-cover	Scrubland	0.6 (0.03)
	Fallow	0.35 (0.03)
	Cultivated	0.17 (0.02)
	Grassland	0.15 (0.02)
Substrate	Soil	0.8 (0.02)
	Sand	0.4 (0.03)
	Gravel	0.01 (0.01)
Terrain	Flat	0.55 (0.03)
	Undulating	0.3 (0.01)
Active disturbance	Human	0.6 (0.03)
	Livestock	0.51 (0.03)
	Dog	0.2 (0.02)
	Machinery	0.12 (0.02)
	No active disturbance	0.28 (0.02)
Infrastructure (Passive disturbance)	Power-line	0.52 (0.03)
	Road	0.23 (0.03)
	Settlement	0.19 (0.02)
	Industrial-uses	0.01 (0)
	Farm hut	0.09 (0.02)
	Fence	0.6 (0.03)
	Water-source	0.48 (0.03)
	No infrastructure	0.13 (0.02)



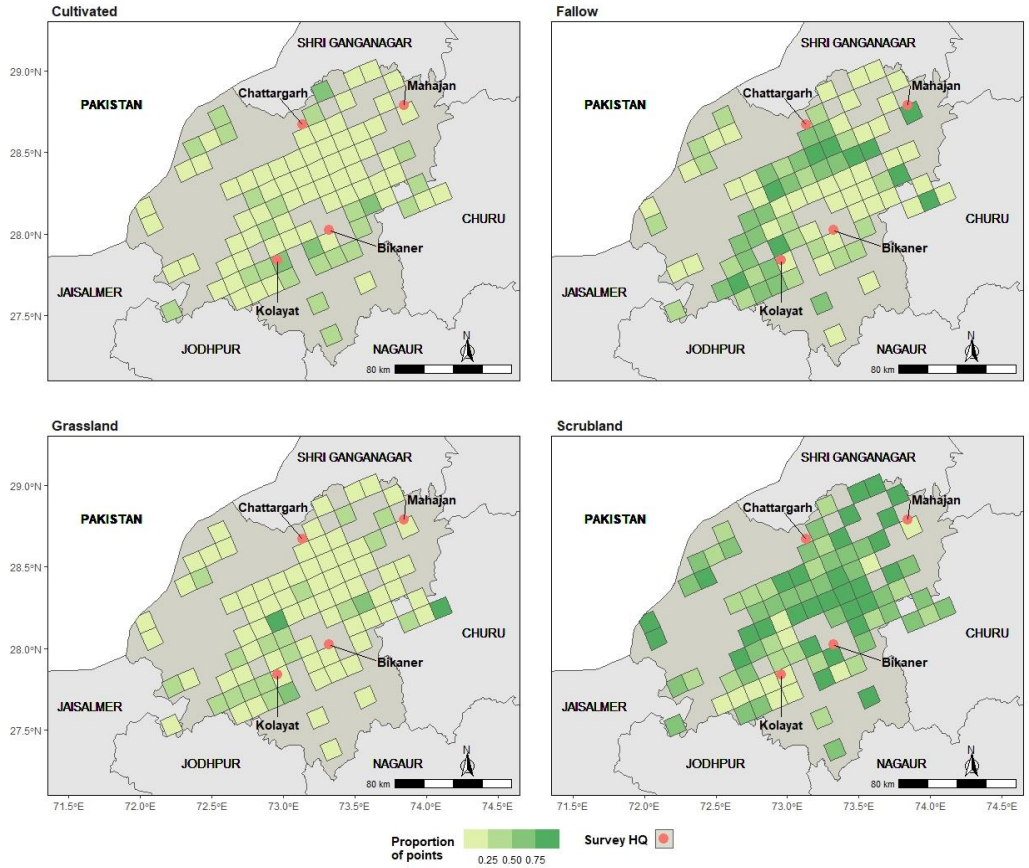


Figure 2. Spatial patterns of land-cover types in Bikaner landscape (2021) measured as the proportion of sampling points having a particular land-cover type within 100 m radius

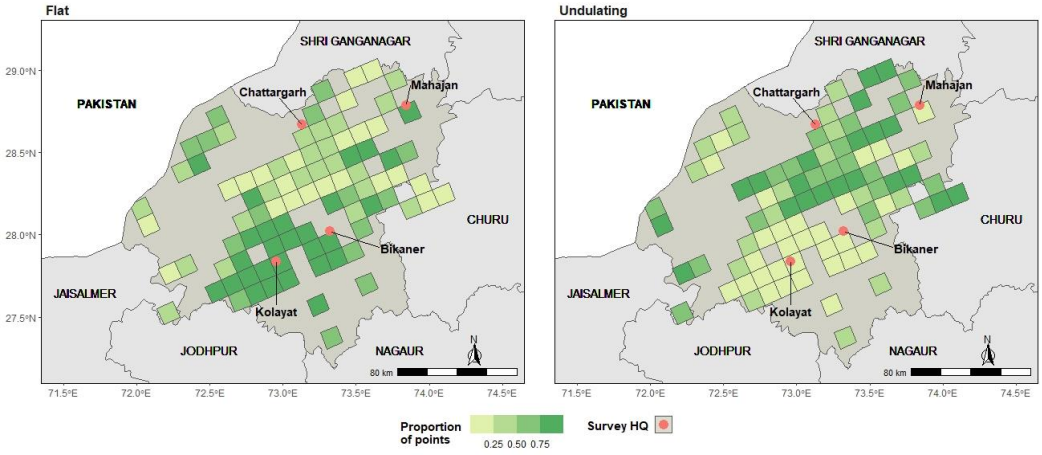


Figure 3. Spatial patterns of terrain in Bikaner landscape (2021) measured as the proportion of sampling points in 144 km^2 cells having a particular terrain type within 100 m radius

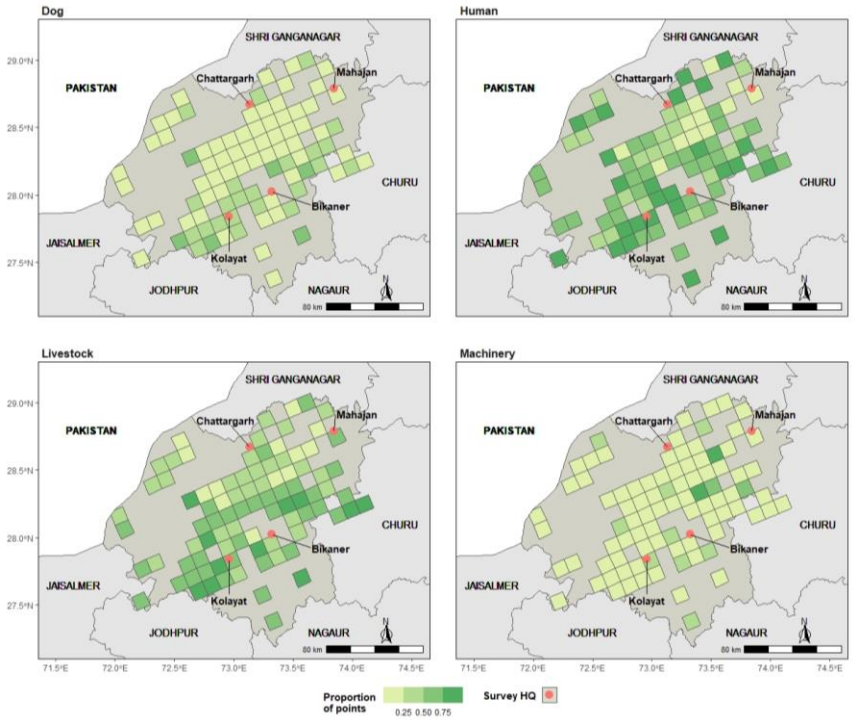


Figure 4. Spatial patterns of active disturbances in Bikaner landscape (2021) measured as the proportion of sampling points in 144 km^2 cells having a particular disturbance within 200 m radius

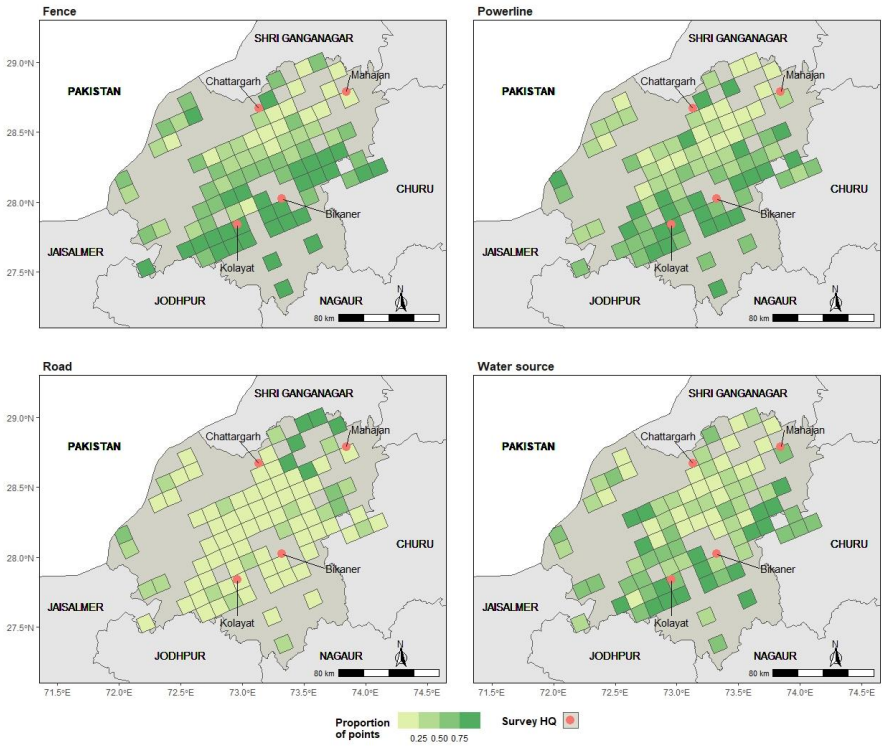


Figure 5. Spatial patterns of passive disturbances in Bikaner landscape (2021) measured as the proportion of sampling points in 144 km^2 cells having a particular infrastructure within 500 m radius

We found two major spatial associations among habitat variables: (1) sandy substrate was positively associated with undulating terrain but negatively associated with flat terrain and soil substrate, (2) presence of agricultural fence was positively associated with cultivation, human, livestock, dog, water-source and power-line presence. Thus, agricultural fences can serve as a single surrogate for disturbances in this landscape (Table 2).

We extracted four latent factors that explained 69% variance in land cover, terrain, substrate, cumulative active and passive disturbances. The first factor represented a gradient of undulating to flat terrain; the second factor represented a gradient of sand to soil substrate; the third factor represented disturbances, and the fourth factor represented the proportion of area cultivated (Table 3). We explored the spatial patterns of these factors (Figure 6) and used them to examine species-habitat relationships.

Table 2. Spatial association of habitat variables characterising land-cover, substrate, terrain, active and passive disturbances in Bikaner (2021), as indicated by strong correlation values (|r| > 0.5)

	HU	LI	MA	DO	SE	IU	PL	RO	FE	WS	FH	FL	SL	UN	SO	SA	GR	GS	CU	FA	SC
Human (HU)									0.6	0.5											
Livestock (LI)									0.54												
Machinery (MA)																					
Dog (DO)									0.53	0.56											
Settlement (SE)																					
Industrial-uses (IU)																					
Power-line (PL)																					
Road (RO)																					
Fence (FE)							0.63			0.63									0.58		
Water-source (WS)							0.58														
Farm-hut (FH)																					
Flat (FL)														-0.9		-0.67					
Sloping (SL)																					
Undulating (UN)																0.61					
Soil (SO)																-0.7					
Sand (SA)																					
Gravel (GR)																					
Grassland (GS)																					
Cultivation (CU)																					
Fallow (FA)																					
Scrubland (SC)																					

Table 3. Interpretation, variance explained and variable loadings of habitat factors extracted from land-cover, terrain, substrate and disturbance data using factor analysis in Bikaner landscape (2021)

Habitat variable	Factor 1	Factor 2	Factor 3	Factor 4
Flat	0.89			
Undulating	-0.92			
Soil		0.96		
Sand		-0.61		
Grassland				
Scrubland				
Cultivation				0.9
Passive disturbances			0.85	
Active disturbances			0.7	
Variance explained	**0.26**	**0.16**	**0.16**	**0.11**

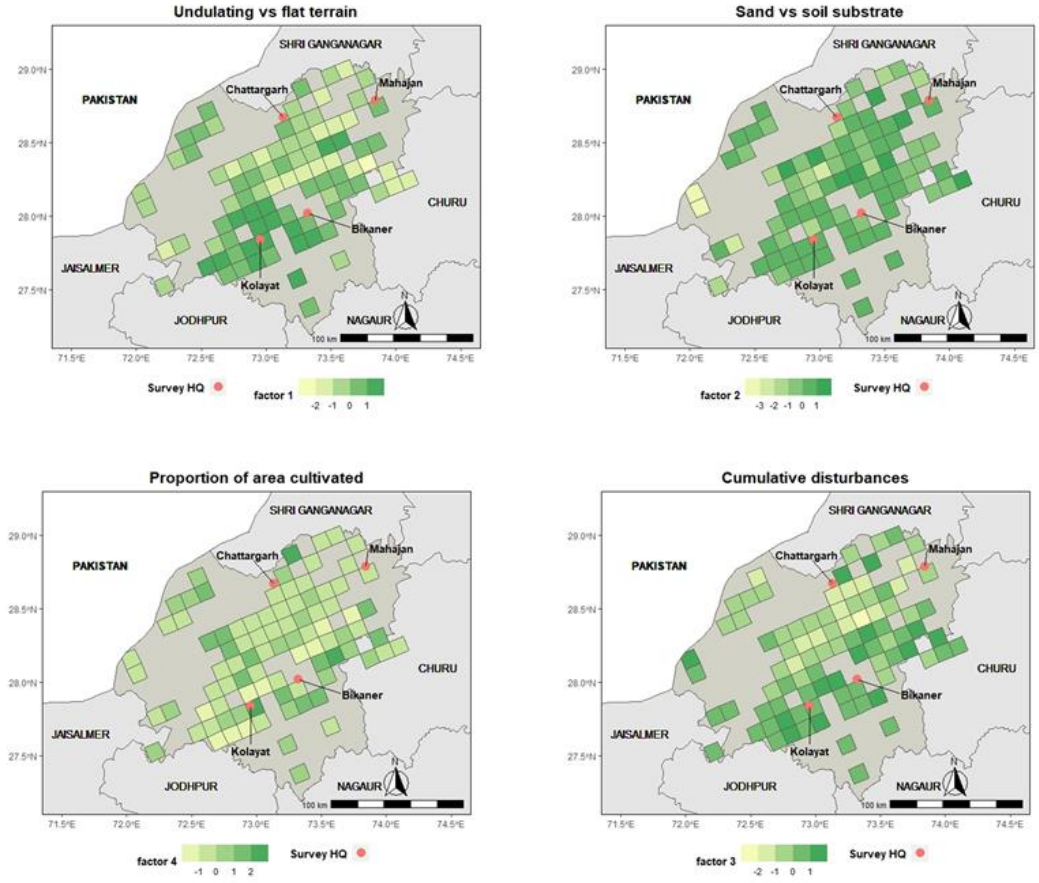


Figure 6. Spatial patterns of habitat factors in Bikaner landscape (2021); (clockwise) factor 1: undulating (yellow) to flat (green) terrain, factor 2: sand (yellow) to soil (green) substrate, factor 3: low (yellow) to high (green) disturbances, and factor 4: low (yellow) to high (green) proportion of area cultivated

3.3 Floristic composition

The natural vegetation of Bikaner was characterised by a few dominant plants such as *Leptadenia pyrotechnica* > *Prosopis cineraria* > *Aerva sp.* > *Calligonum polygonoides* > *Crotalaria burhia* > *Calotropis procera* > *Dactyloctenium scindicum* > *Prosopis juliflora* (occurring in >10% of sampling plots), with another 11 species occurring in <2 % of sampling plots (Figure 7).

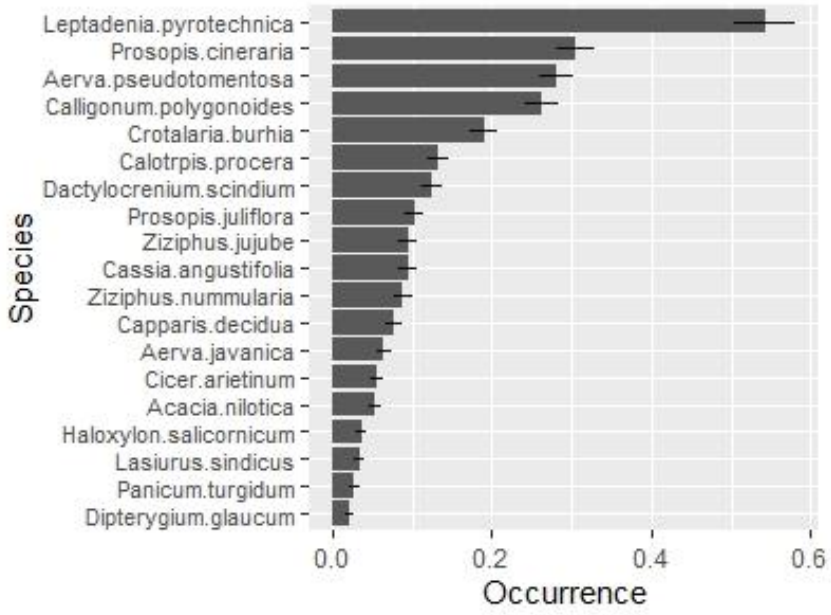


Figure 7. Mean & SE occurrence in sampling plots of plant species in Bikaner landscape (2021)

Dominant plants showed contrasting responses to habitat characteristics and distinct spatial extents of occurrence. *Leptadenia* occurrence was greater in undulating, less disturbed and less cultivated areas distributed across the landscape. *Prosopis cineraria* occurred more in disturbed and cultivated areas located to the south and east. *Aerva* occurrence was greater in sandy, less disturbed areas, in the north and west. *Calligonum* occurred more in undulating, sandy, less disturbed areas located in the north and west. *Crotalaria* and *Dactyloctenium* were associated with less cultivated areas. Whereas the invasive *Prosopis juliflora* and *Calotropis procera* occurrences were greater in flat, more disturbed areas (Table 4 and Figure 8).

Table 4. Plant-habitat relationships in Bikaner landscape (2021): distribution of dominant species (measured as proportion of habitat-plots with the species in a cell) was analysed against habitat factors using binomial generalised linear models and the untransformed mean (SE) parameter estimates for significant effects ($p < 0.1$) are reported. Positive values indicate that the species' occurrence increases with the covariate value and the converse.

Dominant plants	**Factor1**	**Factor2**	**Factor3**	**Factor4**
	Flat (+) vs undulating (-)	Soil (+) vs sand (-)	Disturbances (+)	Cultivation (+)
Leptadenia pyrotechnica	-0.57 (0.08)		-0.35 (0.08)	-0.19 (0.08)
Prosopis cineraria		0.28 (0.08)	0.27 (0.09)	0.23 (0.08)
Aerva sp.		-0.36 (0.08)	-0.42 (0.09)	
Calligonum polygonoides	-0.82 (0.1)	-0.23 (0.08)	-0.46 (0.1)	
Crotalaria burhia		-0.21 (0.08)		-0.3 (0.1)
Dactyloctenium scindium		0.24 (0.12)		-0.8 (0.16)
Calotropis procera	0.52 (0.12)		0.21 (0.12)	
Prosopis juliflora	1.16 (0.19)		0.8 (0.17)	

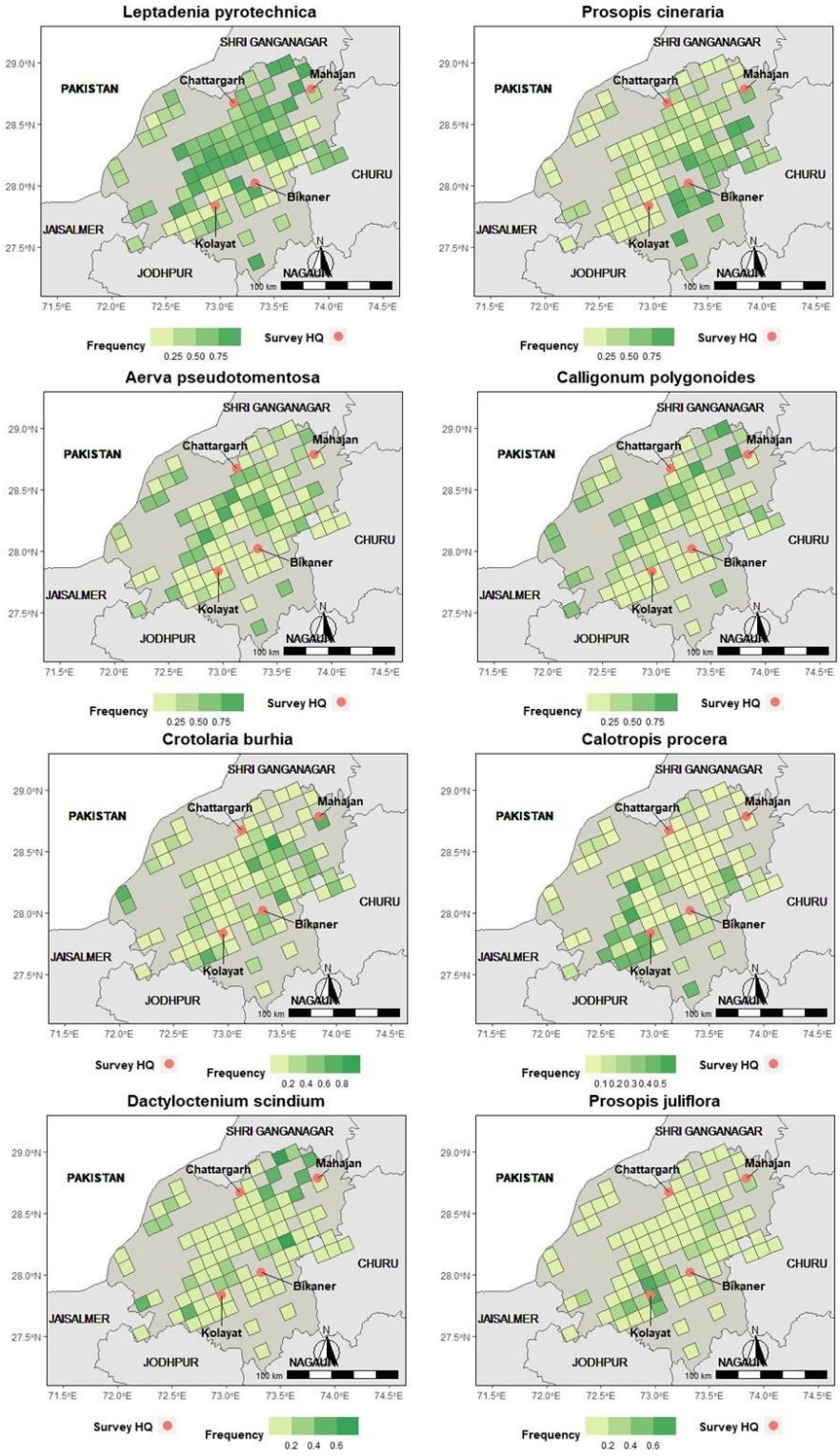


Figure 8. Distribution patterns of plant species represented as low (yellow) to high (green) frequency occurrence in sampling plots in the Bikaner landscape (2021)

3.4 Wildlife population status

3.4.1 Mammals

Data generated from line transect surveys provided estimates of species' occupancy, density and abundance. Data on habitat and disturbance informed us of their effects on animal populations.

3.4.1.1 Chinkara

Our extensive surveys resulted in the detection of 1,880 Chinkara individuals belonging to 684 herds. The encounter rate of Chinkara herds and individuals was 60.39 ± 6.49 per 100 km and 139.78 ± 18.72 per 100 km, respectively. Distance data of these observations was best explained by a half-normal key function with cosine(2) adjustments (X2 = 0.05, p = 0.82) . The estimated herd effective strip width was 136.43 ± 7.28 m for a truncation distance of 330 m. The estimated Chinkara density was 4.27 ± 0.65 animals/km^2 with an average group size of 2.75 ± 0.18. This yields a landscape level abundance of 54,745 ± 8,392 individuals.

3.4.1.2 Desert fox

We detected 122 Desert fox individuals during our survey, with an encounter rate of 9.16 ± 1.34 per 100 km. These observations were best explained by a half-normal key function detection model with cosine(2) adjustments (X2 = 0.02, p = 0.88). The estimated effective strip width was 62.16 ± 6.4 m for a truncation distance of 200 m. The estimated Desert fox density was 0.58 ± 0.11 individuals per km^2 and the average group size was 1.12 ± 0.06. This yields a landscape-level abundance of 7,456 ± 1356 individuals.

3.4.1.3 Other species

Other notable mammals in the Bikaner landscape were the Desert cat (*Felis lybica ornata)*, estimated to be 0.57 + 0.2 individuals per 100 km,

Nilgai (*Boselaphus tragocamelus)*, estimated to be 14.39 + 2.91 individuals per 100km, and free-ranging dogs, estimated to be 26.07 + 3.6 individuals per 100 km.

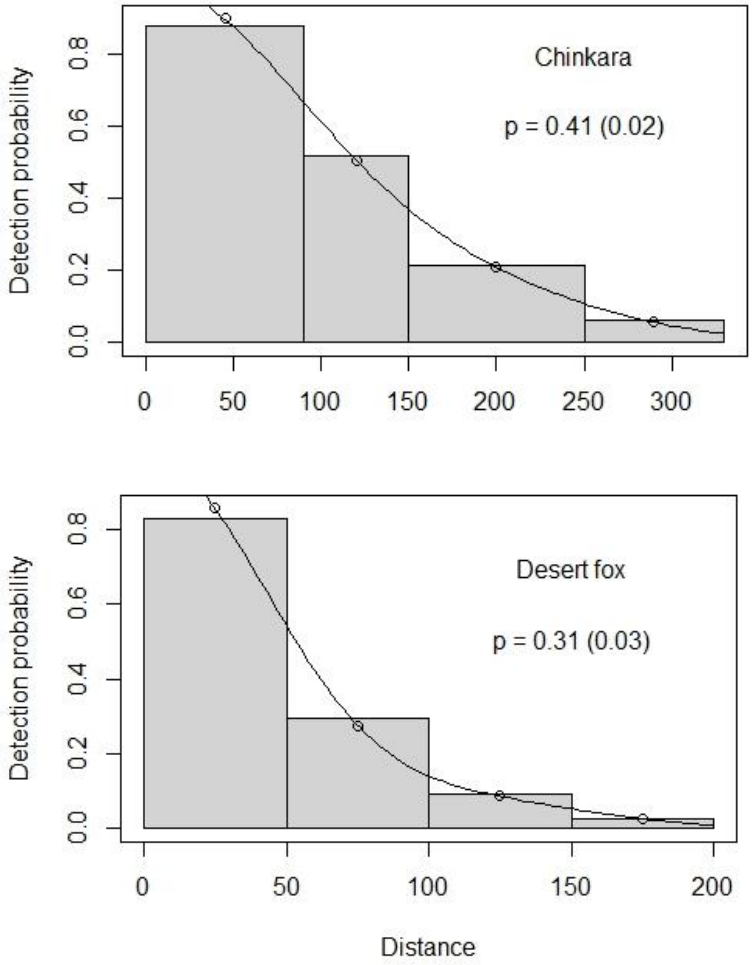
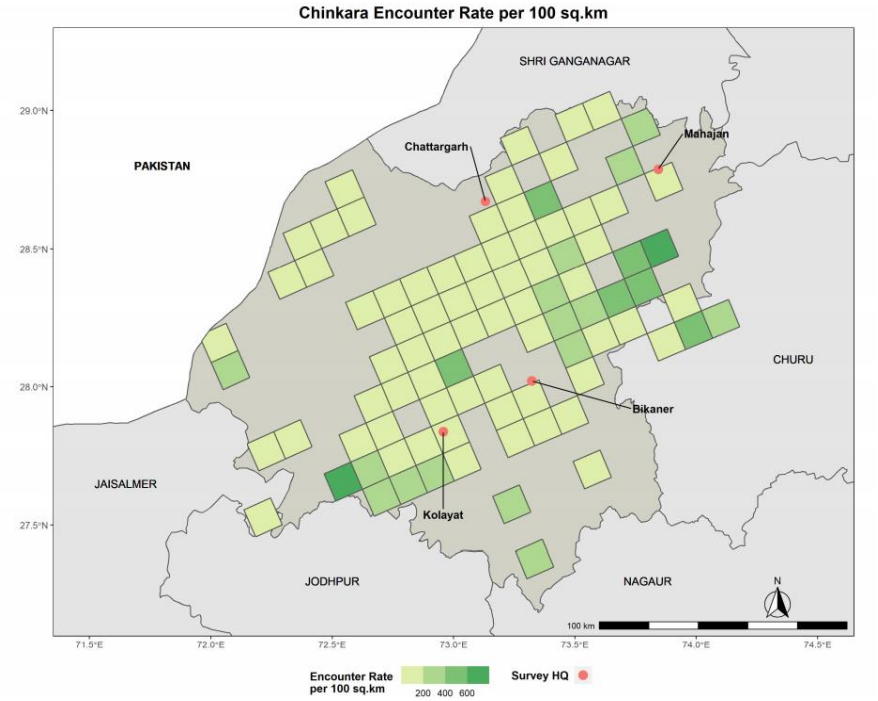


Figure 9. Best fit detection models for Chinkara and Desert fox at line-transects in Bikaner landscape (2021); mean and standard error estimates of species' detection probability also reported



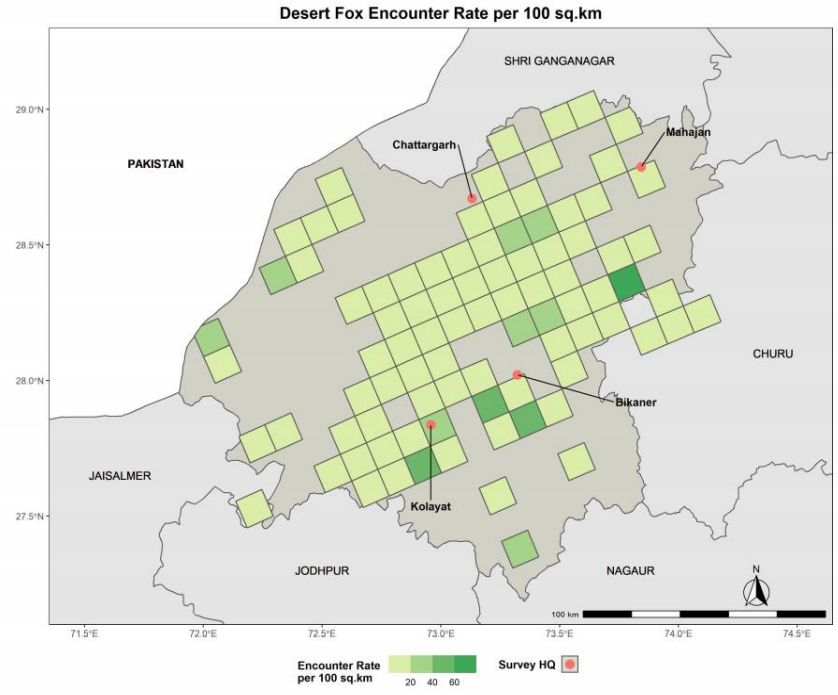


Figure 10. Distribution of Chinkara (top) and Desert fox (bottom) in Bikaner landscape (2021), shown as low (light green) to high (dark green) encounter rates

3.4.2 Large birds

Encounter rate of large birds on line transects showed that Griffon vulture > Egyptian vulture > Common kestrel > Black winged kite > Long-legged buzzard > Steppe eagle > Shikra as the most abundant raptors. The encounter rate of Demoiselle cranes was estimated to be 5.47 (3.14) individuals per 100 km.

Table 5. Mean encounter rate of large birds along with associated standard error. The values are standardised to 100km of vehicle transect effort.

Species	Geometric-mean (SE) individuals / 100 km	Mean (SE) individuals / 100 km
Demoiselle Crane (Grus virgo)	3.47 (1.91)	5.47 (3.14)
Griffon Vulture (Gyps fulvus)	9.95 (3.31)	16.44 (6.94)
Egyptian Vulture (Neophron percnopterus)	7.19 (1.78)	8.73 (2.35)
Cinereous Vulture (Aegypius monachus)	1.24 (0.4)	1.31 (0.42)
Steppe Eagle (Aquila nipalensis)	3.06 (0.55)	3.19 (0.57)
Tawny Eagle (Aquila rapax)	0.6 (0.2)	0.62 (0.21)
Short-toed Snake Eagle (Circaetus gallicus)	0.6 (0.24)	0.62 (0.25)
Eastern Imperial Eagle (Aquila heliaca)	0.31 (0.14)	0.32 (0.14)
Common Kestrel (Falco tinnunculus)	7.08 (0.83)	7.39 (0.88)
Laggar Falcon (Falco jugger)	3.11 (0.67)	3.31 (0.73)
Long-legged Buzzard (Buteo rufinus)	4.94 (0.66)	5.13 (0.69)
White-eyed Buzzard (Butastur teesa)	0.5 (0.23)	0.52 (0.24)
Blackwinged Kite (Elanus caeruleus)	5.04 (0.83)	5.35 (0.89)
Shikra (Accipiter badius)	2.48 (0.55)	2.61 (0.58)
Eurasian Sparrowhawk (Accipiter nisus)	0.54 (0.23)	0.56 (0.25)

3.4.3 Small birds

We recorded 2,859 small birds belonging to 103 species. 640 point counts included all species seen (hereafter 'complete'), and 162 point-counts included only the focal taxa (francolin, quail, courser, sandgrouse, lark, chat and wheatear). We considered 'complete lists' and species with > 5 sightings (n=43 species) while estimating density using distance sampling.

Species were empirically classified into:

a) low-detectability group (n = 23 species) with median sighting distance <60 m and distance data best explained by half-normal cosine detection function;

b) medium-detectability group (n = 18 species) with median sighting distance 60-100 m and distance data best explained by half-normal cosine detection function;

c) high-detectability group (n = 2 species) with median sighting distance >100 m and distance data best explained by a uniform cosine detection function.

Estimated detection probability ranged from 0.05 to 0.44 across groups (Figure 11).

We report landscape level population metrics such as flock encounter rate, flock size and density of these species in Table 7. Species' rank abundance curves were J-shaped (broken-stick) with a few relatively common species and many relatively rare species (Figure 12). The most abundant species were Common Babbler > Eurasian Collared Dove > House Sparrow > White Eared Bulbul > Red Vented Bulbul > Greater Short Toed Lark > Variable Wheatear.

Total density of small birds was estimated to be 997 (SE 58) individuals / km^2, not including birds in flight and rare species.

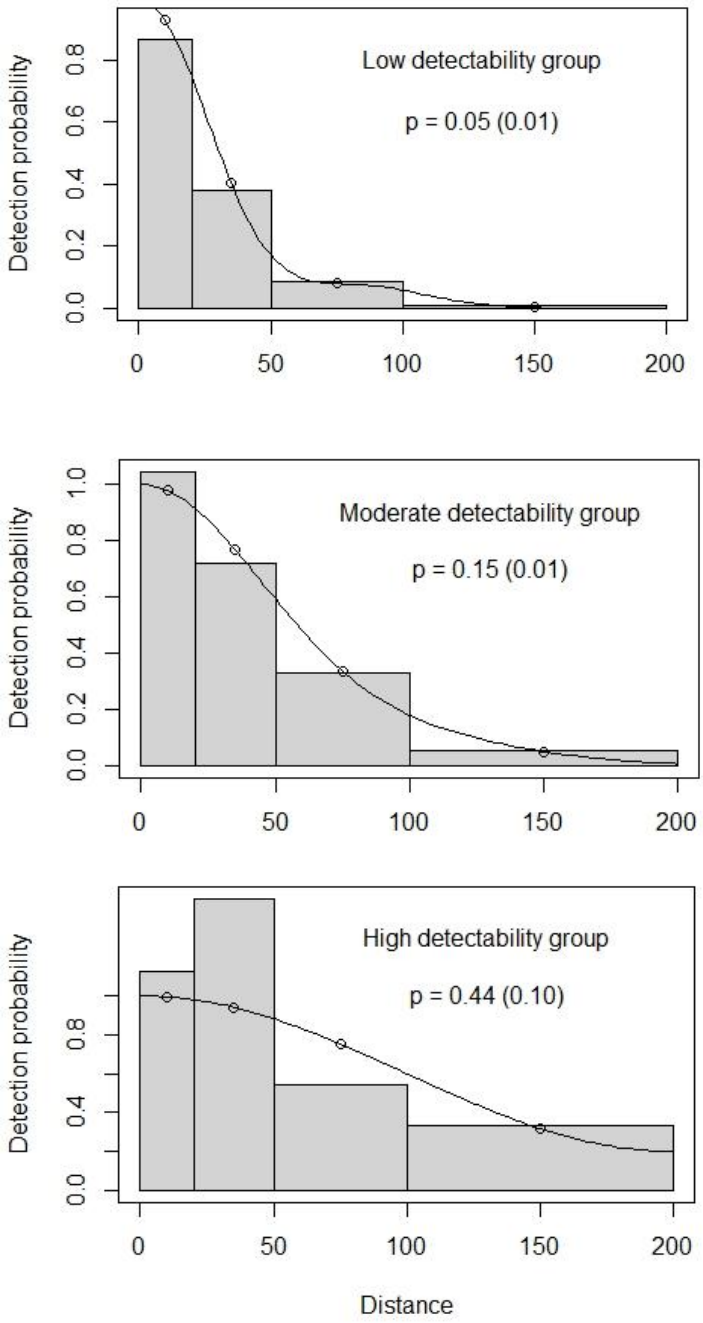


Figure 11. Best fit detection models for low, moderate and high detectability groups of birds at point-counts in Bikaner landscape (2021); estimated mean and standard error proportion of groups detected within 200 m shown for each group

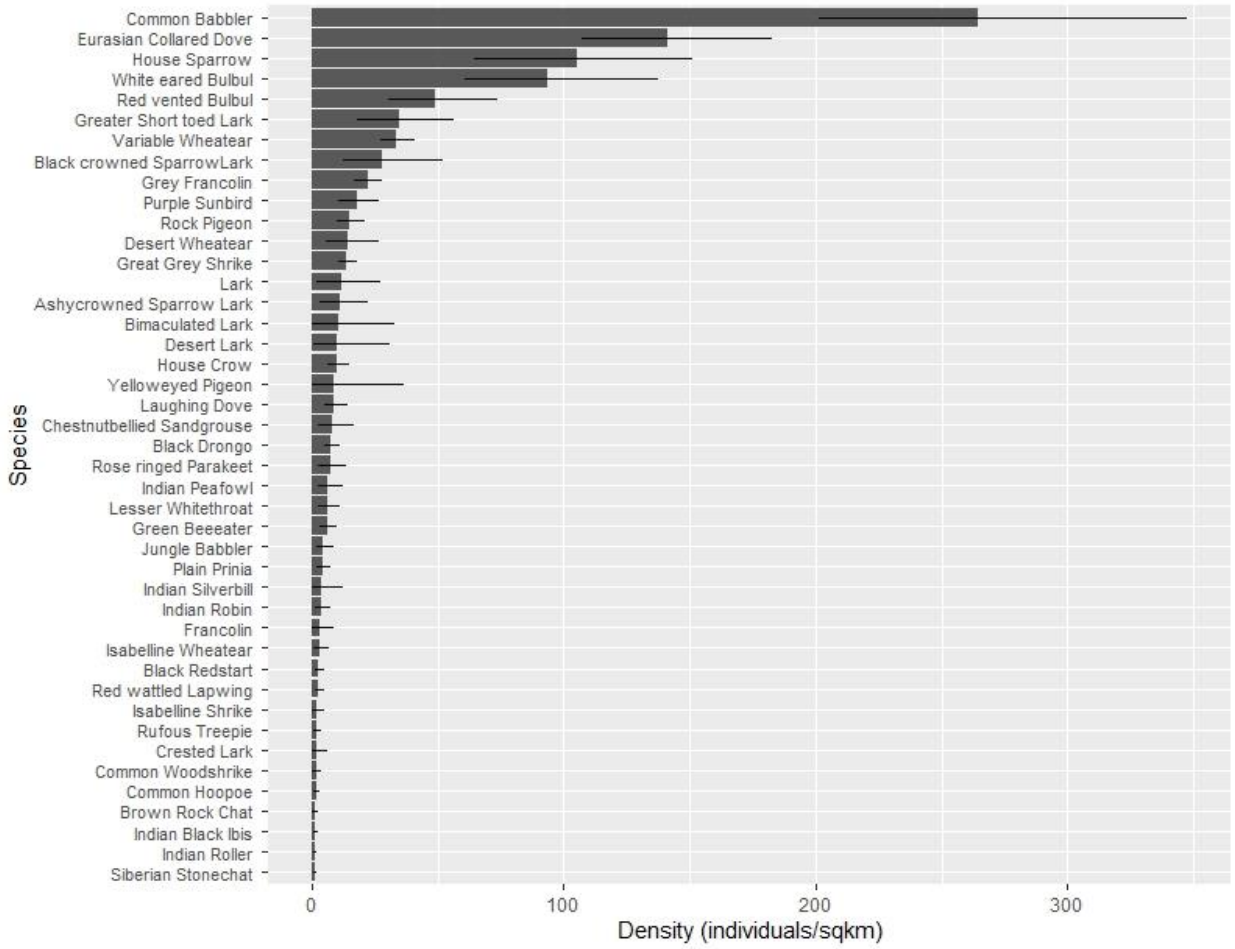


Figure 12. Density (individual / km^2) of small bird species based on point count distance sampling in Bikaner landscape (2021)

Table 6. Population status of bird species estimated as density (individuals per km^2), number of flocks per point (Flock ER), probability of detecting a flock (Det prob) and individuals per flock (Flock size) using point count distance sampling in Bikaner landscape (2021)

Species	Density (95% CI)	Flock ER (95% CI)	Det prob (SE)	Flock size (SE)
Ashycrowned Sparrow Lark (Eremopterix griseus)	10.95 (3.52 - 22.44)	0.02 (0.01 - 0.035)	0.05 (0.01)	3.21 (0.79)
Bimaculated Lark (Melanocorypha bimaculata)	10.41 (0 - 33.27)	0.01 (0 - 0.016)	0.05 (0.01)	8.4 (4.53)
Black crowned SparrowLark (Eremopterix nigriceps)	28.13 (12.6 - 51.64)	0.05 (0.03 - 0.077)	0.05 (0.01)	3.56 (0.73)
Black Drongo (Dicrurus macrocercus)	7.68 (4.73 - 11.2)	0.1 (0.07 - 0.132)	0.15 (0.01)	1.48 (0.17)
Black Redstart (Phoenicurus ochruros)	2.73 (1.1 - 4.87)	0.02 (0.01 - 0.027)	0.05 (0.01)	1.1 (0.1)
Brown Rock Chat (Oenanthe fusca)	1.24 (0.2 - 2.44)	0.01 (0 - 0.015)	0.05 (0.01)	1 (0)
Chestnutbellied Sandgrouse (Pterocles exustus)	8.3 (2.06 - 16.26)	0.01 (0 - 0.022)	0.05 (0.01)	4.12 (0.74)
Common Babbler (Argya caudata)	264.49 (200.14 - 357.21)	0.41 (0.35 - 0.466)	0.05 (0.01)	4.2 (0.28)
Common Hoopoe (Upupa epops)	1.7 (0.39 - 3.2)	0.01 (0 - 0.02)	0.05 (0.01)	1 (0)
Common Woodshrike (Tephrodornis pondicerianus)	1.73 (0.09 - 3.76)	0.01 (0 - 0.016)	0.05 (0.01)	1.4 (0.24)
Crested Lark (Galerida cristata)	1.85 (0 - 6.15)	0.01 (0 - 0.016)	0.15 (0.01)	4.4 (2.91)
Desert Lark (Ammomanes deserti)	10.03 (0.34 - 32.47)	0.01 (0 - 0.02)	0.05 (0.01)	7.2 (3.28)
Desert Wheatear (Oenanthe deserti)	14.26 (5.41 - 26.76)	0.05 (0.03 - 0.078)	0.05 (0.01)	1.71 (0.45)
Eurasian Collared Dove (Streptopelia decaocto)	141.44 (108.15 - 182.07)	0.68 (0.58 - 0.78)	0.15 (0.01)	3.95 (0.36)
Great Grey Shrike (Lanius excubitor)	13.69 (10.34 - 17.62)	0.22 (0.18 - 0.265)	0.15 (0.01)	1.18 (0.08)
Greater Short toed Lark (Calandrella brachydactyla)	34.89 (19.49 - 55.52)	0.06 (0.03 - 0.077)	0.15 (0.01)	11.86 (1.91)
Green Beeeater (Merops orientalis)	5.86 (3.11 - 9.46)	0.05 (0.03 - 0.07)	0.15 (0.01)	2.32 (0.34)
Grey Francolin (Francolinus pondicerianus)	22.34 (16.96 - 28.31)	0.21 (0.17 - 0.251)	0.15 (0.01)	2.02 (0.11)
House Crow (Corvus splendens)	9.81 (5.8 - 15.14)	0.08 (0.06 - 0.11)	0.15 (0.01)	2.25 (0.33)
House Sparrow (Passer domesticus)	105.15 (64.18 - 150.4)	0.19 (0.15 - 0.226)	0.15 (0.01)	10.7 (1.71)
Indian Black Ibis (Pseudibis papillosa)	0.95 (0.33 - 2.2)	0.02 (0.01 - 0.028)	0.44 (0.1)	3.09 (0.62)
Indian Peafowl (Pavo cristatus)	6.39 (2.5 - 11.97)	0.04 (0.02 - 0.063)	0.15 (0.01)	3.04 (0.66)
Indian Robin (Saxicoloides fulicatus)	3.72 (1.31 - 7.47)	0.02 (0.01 - 0.026)	0.05 (0.01)	1.5 (0.31)
Indian Roller (Coracias benghalensis)	0.93 (0.51 - 1.89)	0.04 (0.03 - 0.061)	0.44 (0.1)	1.14 (0.08)
Indian Silverbill (Euodice malabarica)	3.87 (0 - 11.12)	0.01 (0 - 0.016)	0.15 (0.01)	9.2 (5.37)
Isabelline Shrike (Lanius isabellinus)	1.98 (0.07 - 4.71)	0.01 (0 - 0.016)	0.05 (0.01)	1.6 (0.4)
Isabelline Wheatear (Oenanthe isabellina)	2.89 (0.79 - 6.23)	0.01 (0 - 0.025)	0.05 (0.01)	1.33 (0.33)
Jungle Babbler (Turdoides striata)	4.42 (1.62 - 8.46)	0.03 (0.01 - 0.044)	0.15 (0.01)	3.12 (0.57)
Laughing Dove (Streptopelia senegalensis)	8.58 (4.51 - 14.33)	0.04 (0.02 - 0.055)	0.05 (0.01)	1.46 (0.16)
Lesser Whitethroat (Sylvia curruca)	6.22 (2.18 - 11.34)	0.03 (0.01 - 0.056)	0.05 (0.01)	1.18 (0.13)
Plain Prinia (Prinia inornata)	4.14 (2 - 7.02)	0.02 (0.01 - 0.035)	0.05 (0.01)	1.21 (0.11)
Purple Sunbird (Cinnyris asiaticus)	17.68 (10.05 - 27.22)	0.08 (0.05 - 0.115)	0.05 (0.01)	1.39 (0.08)
Red vented Bulbul (Pycnonotus cafer)	49.01 (31.2 - 74.55)	0.14 (0.1 - 0.176)	0.05 (0.01)	2.31 (0.3)
Red wattled Lapwing (Vanellus indicus)	2.6 (1.02 - 4.64)	0.03 (0.01 - 0.046)	0.15 (0.01)	1.76 (0.22)
Rock Pigeon (Columba livia)	14.91 (10.02 - 20.96)	0.11 (0.08 - 0.14)	0.15 (0.01)	2.63 (0.23)
Rose ringed Parakeet (Psittacula krameri)	7.53 (2.56 - 14.03)	0.07 (0.02 - 0.109)	0.15 (0.01)	2.14 (0.39)
Rufous Treepie (Dendrocitta vagabunda)	1.95 (0.59 - 3.72)	0.01 (0 - 0.019)	0.05 (0.01)	1.14 (0.14)
Siberian Stonechat (Saxicola maurus)	0.9 (0.28 - 1.68)	0.01 (0 - 0.024)	0.15 (0.01)	1.22 (0.15)
Variable Wheatear (Oenanthe picata)	33.19 (27.16 - 40.17)	0.5 (0.43 - 0.575)	0.15 (0.01)	1.25 (0.04)
White eared Bulbul (Pycnonotus leucotis)	93.68 (62.59 - 137.26)	0.21 (0.16 - 0.257)	0.05 (0.01)	2.89 (0.33)
Yelloweyed Pigeon (Columba eversmanni)	8.59 (0 - 32.23)	0.01 (0 - 0.02)	0.05 (0.01)	6.17 (4.77)

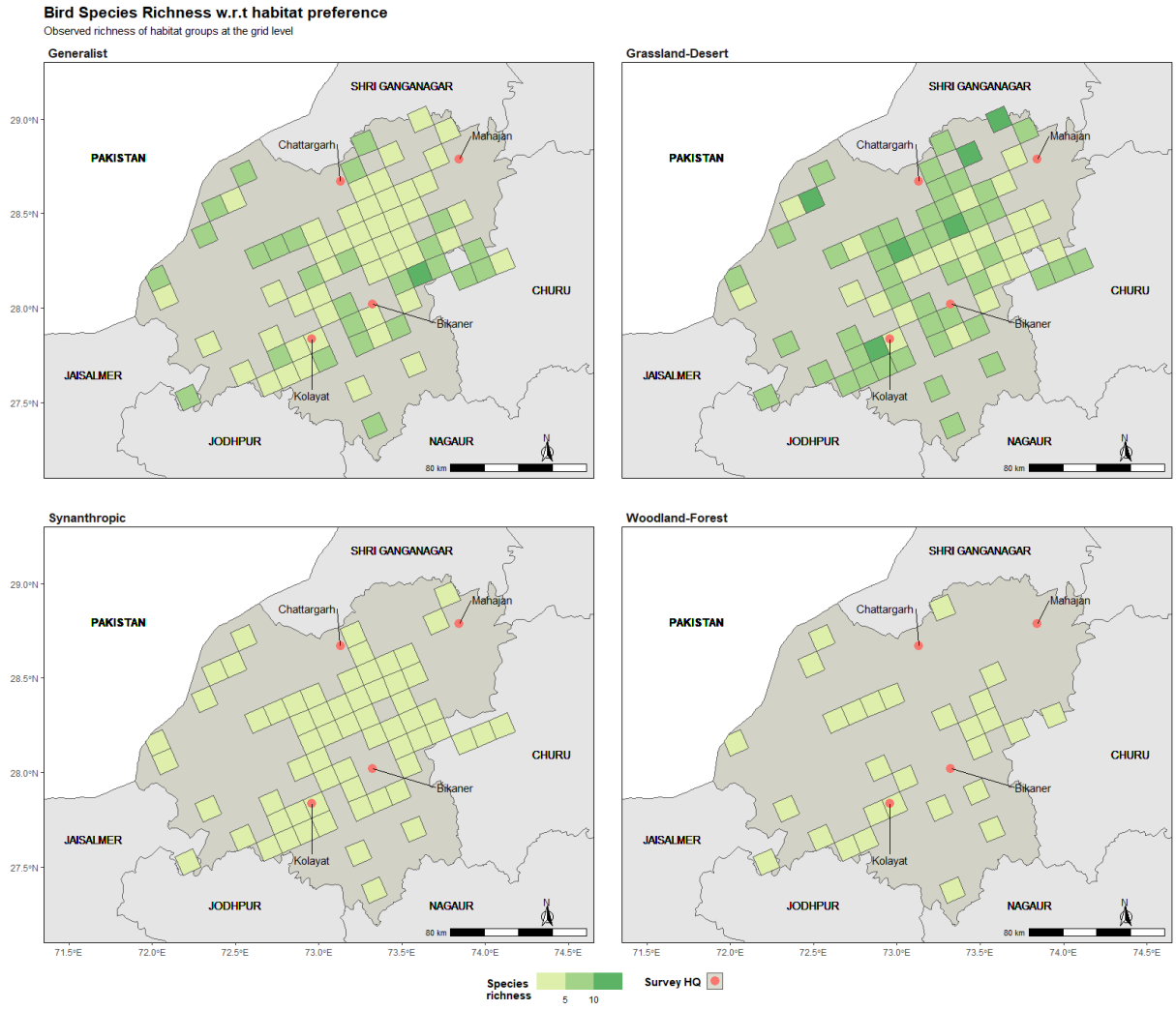


Figure 13. Mean (naive) species richness per point of Generalist (top left), Grassland-Desert specialist (top right), Synanthropic and Woodland-Forest bird species for every 144 km^2 grid in the Bikaner Landscape

3.5 Species-habitat relationships

3.5.1 Mammals

Results of generalised linear models on detection rates of mammals along line transects showed contrasting effects of habitat characteristics on species' abundance at cell-level (Table 7). Chinkara abundance decreased but nilgai abundance increased with the proportion of area under cultivation. Dog abundance was positively associated with flat, disturbed areas. Desert fox and Desert cat abundances did not show any response to these habitat gradients.

Table 7. Habitat relationships of select mammals in Bikaner landscape (2021): species' abundance measured as logarithm of 1 + mean number of individuals detected km^{-1} in a cell analysed against habitat factors using generalised linear models. Model-averaged untransformed mean (SE) parameter estimates of significant effects ($p<0.1$) are reported; positive values indicate that the species' abundance increases with the covariate and the converse.

Species	**Factor 1**	**Factor 3**	**Factor 4**	**Canal**
	Flat (+) vs undulating (-)	Disturbances	Proportion of area cultivated	Canal length
Chinkara (*Gazella bennettii*)			-0.18 (0.06)	
Desert Cat (*Felis lybica ornata*)				
Desert Fox (*Vulpes vulpes pusilla*)				
Dog (*Canis familiaris*)	0.09 (0.02)	0.11 (0.02)		
Nilgai (*Boselaphus tragocamelus*)			0.06 (0.02)	

3.5.2 Large birds

Results of generalised linear models on detection rates of large birds along line transects indicated that Egyptian vulture, Steppe eagle and Laggar falcon abundance decreased in canal-irrigated areas, and Black winged kite abundance increased with disturbances and proportion of area under cultivation (Table 8).

Table 8. Habitat relationships of select large birds in Bikaner landscape (2021): species' abundance measured as logarithm of 1 + mean number of individuals detected km^{-1} in a cell analysed against habitat factors using generalised linear models. Model-averaged untransformed mean (SE) parameter estimates of significant effects (p<0.1) are reported; positive values indicate that the species' abundance increases with the covariate and the converse.

Species	**Factor 1**	**Factor 3**	**Factor 4**	**Canal**
	Flat (+) vs undulating (-)	Disturbances	Proportional area cultivated	Canal length
Demoiselle Crane (*Grus virgo*)				
Griffon Vulture (*Gyps fulvus*)	-0.08 (0.03)			
Egyptian Vulture (*Neophron percnopterus*)				-0.12 (0.06)
Cinereous Vulture (*Aegypius monachus*)				
Steppe Eagle (*Aquila nipalensis*)				-0.05 (0.02)
Tawny Eagle (*Aquila rapax*)				
Short-toed Snake Eagle (*Circaetus gallicus*)				
Eastern Imperial Eagle (*Aquila heliaca*)				
Long-legged Buzzard (*Buteo rufinus*)				
White-eyed Buzzard (*Butastur teesa*)				
Common Kestrel (*Falco tinnunculus*)				
Laggar falcon (*Falco jugger*)				-0.04 (0.02)
Black-winged kite (*Elanus caeruleus*)		0.02 (0.01)	0.03 (0.01)	
Shikra (*Accipiter badius*)				
Eurasian sparrow hawk (*Accipiter nisus*)				

3.5.3 Small birds

Results of generalised linear models indicated that habitat characteristics influenced population status. Common babbler, Eurasian collared dove, Grey francolin, Indian peafowl, Indian robin, Lesser whitethroat, Red vented bulbul and White eared bulbul selected flat over undulating terrain. Effects of anthropogenic variables differed between species. Distribution and abundance of Black crowned sparrow lark decreased, while that of Black drongo, Common hoopoe, Eurasian collared dove, Grey francolin, Indian black ibis, Jungle babbler, Purple sunbird, Red wattled lapwing and Rose ringed parakeet increased with the proportion of area cultivated. Disturbances adversely affected Ashy crowned sparrow lark, Greater short toed lark, and Yellow eyed pigeon but favoured Common babbler, Eurasian collared dove, Grey francolin, Indian Peafowl, Indian Robin, Red

vented bulbul, Rock pigeon and Variable wheatear. Lastly, the canal favoured Indian roller, Rose ringed parakeet and Rufous treepie (Table 9).

Table 9. Bird-habitat relationships in Bikaner landscape (2021): for each species, distribution and abundance were analysed against habitat factors and canal length using generalised linear models and the untransformed mean (SE) parameter estimates for significant effects ($p < 0.1$) are reported. Positive values indicate that the species' distribution and/or abundance increases with the covariate and the converse.

Response	**Distribution (proportion of points occupied)**					**Abundance (Log mean count per point + 1)**				
Predictors	**factor1**	**factor2**	**factor3**	**factor4**	**canal**	**factor1**	**factor2**	**factor3**	**factor4**	**canal**
Species	Flat (+) vs undulating (-)	Soil (+) vs sand (-)	Disturb-ances	Proportion of area cultivated	Canal length	Flat (+) vs undulating (-)	Soil (+) vs sand (-)	Disturb-ances	Proportion of area cultivated	Canal length
Ashy-crowned Sparrow Lark			-0.45 (0.27)					-0.04 (0.02)		
Black-crowned Sparrow Lark		-0.36 (0.15)		-1.11 (0.35)					-0.07 (0.03)	
Black Drongo			0.36 (0.18)	0.51 (0.14)					0.07 (0.02)	
Black Redstart										
Brown Rock Chat										
Chestnut-bellied Sandgrouse										
Common Babbler	0.38 (0.1)		0.17 (0.09)			0.17 (0.06)		0.13 (0.06)		
Common Hoopoe				0.97 (0.46)					0.01 (0)	
Common Woodshrike										
Crested Lark			-3.52 (1.8)	2.09 (1.24)						
Desert Lark						0.05 (0.02)				
Desert Wheatear		-0.43 (0.15)	-0.32 (0.19)							
Eurasian Collared Dove	0.2 (0.09)		0.61 (0.09)	0.24 (0.09)		0.19 (0.07)		0.35 (0.07)	0.16 (0.07)	
Great Grey Shrike										
Greater Short-toed Lark			-0.67 (0.19)					-0.17 (0.07)		
Green Bee-eater										
Grey Francolin	0.35 (0.12)		0.32 (0.12)	0.34 (0.1)	-0.8 (0.42)	0.09 (0.03)		0.08 (0.03)	0.09 (0.03)	-0.25 (0.1)
House Crow				0.26 (0.16)	-1.36 (0.75)					
House Sparrow	0.2 (0.12)	0.2 (0.12)	0.24 (0.12)							
Indian Black Ibis				0.9 (0.32)					0.04 (0.02)	
Indian Peafowl	0.86 (0.37)		0.86 (0.35)			0.06 (0.02)		0.05 (0.03)		
Indian Robin	0.9 (0.5)		0.79 (0.45)			0.02 (0.01)		0.02 (0.01)		
Indian Roller				0.37 (0.17)	1.53 (0.62)		0.01 (0.01)			0.12 (0.03)
Indian Silverbill										
Isabelline Shrike						0.01 (0.01)				0.04 (0.02)
Isabelline Wheatear		-0.66 (0.31)								-0.04 (0.02)
Jungle Babbler				0.74 (0.26)					0.04 (0.02)	
Laughing Dove									0.02 (0.01)	
Lesser Whitethroat	0.65 (0.29)		-0.55 (0.23)		-4.37 (1.97)	0.02 (0.01)				-0.08 (0.04)
Plain Prinia	-0.52 (0.29)					-0.01 (0.01)				
Purple Sunbird			0.37 (0.19)	0.49 (0.14)					0.04 (0.02)	
Red-vented Bulbul	0.35 (0.14)		0.47 (0.15)			0.09 (0.04)		0.08 (0.04)		
Red-wattled Lapwing				0.84 (0.23)					0.05 (0.01)	
Rock Pigeon			0.29 (0.15)					0.07 (0.03)		
Rose-ringed Parakeet				0.65 (0.18)	1.32 (0.63)				0.07 (0.03)	0.22 (0.1)
Rufous Treepie					2.7 (1.33)					0.04 (0.02)
Siberian Stonechat										
Variable Wheatear			0.19 (0.09)					0.06 (0.03)		
White-eared Bulbul	0.44 (0.12)					0.09 (0.05)				0.34 (0.18)
Yellow-eyed Pigeon		-1.17 (0.49)	-1.26 (0.61)				-0.05 (0.02)	-0.03 (0.02)		

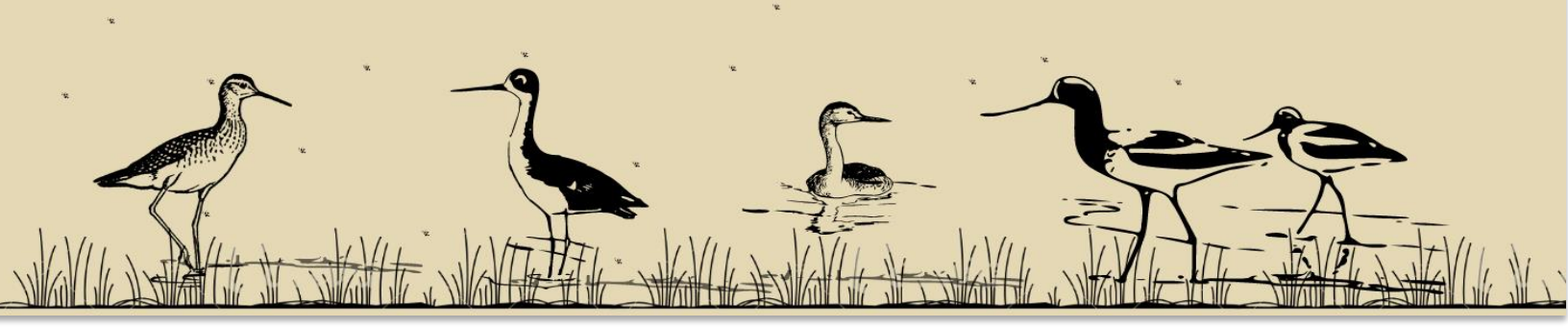
3.6 Wetland Hotspot Survey

A total of 24,674 individuals of 95 species across 36 families were counted in four survey sites. A summary of the species' total count is given below (Table 10). Common Coot (13,707), Demoiselle Crane (1,138), Common Pochard (1,690), Common Teal (1,567), and Gadwall (1,134) were the most abundant waterbirds comprising 78% of total birds counted across all survey sites. Two globally Endangered (Egyptian Vulture and Steppe Eagle), two Vulnerable (Common Pochard and River Tern), and six Near-Threatened species (Black headed Ibis, Dalmatian Pelican, Eurasian Curlew, Ferruginous Duck, Northern Lapwing, and Painted Stork) were encountered (Table 10).

3.6.1 Canal escape wetlands at RD 750 and RD 507

Wetlands formed by the escape channels of the Indira Gandhi Canal (namely RD 507 and RD 750) were seen hosting a large number of waterbirds. The escape water of the canal created these connected interdunal lakes of diverse depth profiles. RD 750 is the largest wetland among the four surveyed water bodies, spread over 15 km^2; RD 507 is a smaller wetland spread across 3 km^2 with three connected water bodies.

We recorded 15,691 individuals of 76 bird species in RD 750 that was dominated by Common Coot (8,814 individuals) > Common Pochard (1,645) > Common Teal (1,231) > Gadwall (930) > Northern Pintail (440). Whereas, we recorded 6,501 individuals of 34 species in RD 507, dominated by Common Coot (4,564) > Common Teal (372) > Gadwall (228) > Northern Shoveler (250). Globally Near-Threatened Dalmatian Pelican (55), Northern Lapwing (1), and Painted Stork (8) were also sighted at RD 507.



3.6.2 Gajner Lake

Gajner Lake is a small human-made lake with about 0.20 km^2 of water spread that is a part of the Gajner Wildlife Sanctuary. Historically, it was a hunting ground for the royal family of Bikaner. In total, 758 bird individuals of 38 species were counted in the Gajner wetland. Common Coot (294) > Common Moorhen (101) > Northern Shoveler (80) were among the most common waterbirds here. Two globally Near-Threatened species (Black headed ibis and Ferruginous Duck) and one globally Vulnerable Species (River Tern) were recorded in Gajner Lake.

3.6.3 Lunkaransar Salt Lake

Lunkaransar is a natural salt lake of around 2.5 km^2 area that attracts many winter migratory waterbirds. We counted 1,749 individuals of 25 bird species in Lunkaransar Lake. Large flocks of Demoiselle Crane (946) > Northern Shoveler (436) > Pied Avocet (126) were recorded here.

Table 10. Summary of birds seen at surveyed wetland hotspots in the Bikaner district. The values in the table represent raw counts of birds quantified through the simultaneous block count method.

Order	Family	Species	IUCN status	RD 507	RD 750	Gaj-ner	Lunkar-ansar
Accipitri formes	**Accipitridae**	Eagle (Unidentified)	NA	0	1	0	0
		Egyptian Vulture (Neophron percnopterus)	EN	0	0	0	6
		Osprey (Pandion haliaetus)	LC	0	3	0	0
		Shikra (Accipiter badius)	LC	0	2	1	0
		Short toed S0ke Eagle (Circaetus gallicus)	LC	0	1	0	0
		Steppe Eagle (Aquila nipalensis)	EN	0	2	0	0
Anseri formes	**Anatidae**	Bar-headed Goose (Anser indicus)	LC	4	102	0	0
		Common Pochard (Aythya feri0)	VU	28	1645	0	1
		Common Teal (A0s crecca)	LC	372	1231	0	54
		Eurasian Wigeon (Mareca penelope)	LC	53	337	0	5
		Ferruginous Duck (Aythya nyroca)	NT	1	43	4	0
		Gadwall (Mareca strepera)	LC	228	930	0	0
		Garganey (Spatula querquedula)	LC	125	0	0	0
		Greylag Goose (Anser anser)	NA	0	1	0	0
		Indian Spot-billed Duck (A0s poecilorhyncha)	NA	0	3	0	0
		Mallard (A0s platyrhynchos)	LC	60	89	0	0
		Northern Pintail (A0s acuta)	LC	200	440	25	12
		Northern Shoveler (Spatula clypeata)	LC	250	207	80	436
		Redcrested Pochard (Netta rufi0)	LC	192	158	1	0
		Ruddy Shelduck (Tador0 ferruginea)	LC	0	13	0	0
		Tufted Duck (Aythya fuligula)	LC	6	6	0	0
		Duck (unidentified)	NA	0	29	53	0
Charadrii formes	**Charadriidae**	Little Ringed Plover (Charadrius dubius)	LC	0	59	6	2
		Northern Lapwing (Vanellus vanellus)	NT	1	0	0	0

		Red wattled Lapwing (Vanellus indicus)	LC	9	26	10	13
		Whitetailed Lapwing (Vanellus leucurus)	LC	3	0	0	2
	Glareolidae	Little Pratincole (Glareola lactea)	LC	1	0	0	1
		Small Pratincole (Glareola lactea)	NA	0	5	0	0
	Laridae	River Tern (Ster0 aurantia)	VU	4	3	4	0
	Recurvirostridae	Black-winged Stilt (Himantopus himantopus)	LC	61	3	14	38
		Pied Avocet (Recurvirostra avosetta)	LC	77	1	0	126
	Scolopacidae	Common Greenshank (Tringa nebularia)	LC	0	3	0	0
		Common Sandpiper (Actitis hypoleucos)	LC	0	39	1	7
		Common Snipe (Galli0go galli0go)	LC	0	0	2	0
		Eurasian Curlew (Numenius arquata)	NT	0	0	0	2
		Ruff (Calidris pug0x)	LC	3	33	0	6
		Spotted Redshank (Tringa erythropus)	LC	0	0	0	7
		Temminck's Stint (Calidris temminckii)	NA	0	2	0	0
Ciconiiformes	**Ciconiidae**	Asian Openbill (Astomus oscitans)	LC	0	9	0	0
		Black Stork (Ciconia nigra)	LC	0	31	0	0
		Painted Stork (Mycteria leucocephala)	NT	8	59	0	2
Columbiformes	**Columbidae**	Eurasian Collared Dove (Streptopelia decaocto)	LC	0	0	3	0
		Rock Pigeon (Columba livia)	LC	0	0	10	0
Coracii formes	**Alcedinidae**	Common Kingfisher (Alcedo atthis)	LC	0	1	0	0
		Pied Kingfisher (Ceryle rudis)	LC	0	2	0	0
		Whitethroated Kingfisher (Halcyon smyrnensis)	LC	0	3	0	0
	Coraciidae	Indian Roller (Coracias benghalensis)	LC	1	4	2	0
	Meropidae	Green Beeeater (Merops orientalis)	LC	0	5	0	0
Falconi formes	**Falconidae**	Falcon (unidentified)	NA	0	1	0	0
Galli formes	**Phasianidae**	Grey Francolin (Francolinus pondicerianus)	LC	0	2	4	0
		Indian Peafowl (Pavo cristatus)	LC	0	0	7	0
Grui formes	**Gruidae**	Demoiselle Crane (Grus virgo)	LC	0	192	0	946
	Rallidae	Common Coot (Fulica atra)	LC	4564	8814	294	35
		Common Moorhen (Gallinula chloropus)	LC	4	23	101	8
		White-breasted Waterhen (Amaurornis phoenicurus)	LC	0	0	3	0
Passeri formes	**Alaudidae**	Crested Lark (Galerida cristata)	LC	0	0	0	2
		Lark (Unidentified)	NA	0	0	4	0
	Corvidae	House Crow (Corvus splendens)	LC	0	2	20	0
		Rufous Treepie (Dendrocitta vagabunda)	LC	0	0	2	0
	Dicruridae	Black Drongo (Dicrurus macrocercus)	Lc	2	6	0	0
	Hirundinidae	Barn Swallow (Hirundo rustica)	NA	0	3	5	0
		Dusky Crag Martin (Ptyonoprogne concolor)	LC	0	20	0	0

		Swallow (unidentified)	NA	0	3	0	0
	Laniidae	Isabelline Shrike (Lanius isabellinus)	LC	0	1	0	0
	Leiothrichidae	Common Babbler (Argya caudata)	LC	0	15	0	0
	Motacillidae	Citrine Wagtail (Motacilla citreola)	LC	0	4	0	0
		Grey Wagtail (Motacilla cinerea)	LC	0	1	0	3
		Tree Pipit (Anthus trivialis)	LC	0	2	0	0
		Western Yellow Wagtail (Motacilla flava)	LC	0	7	6	0
		White browed Wagtail (Motacilla maderaspatensis)	LC	0	3	0	0
		White Wagtail (Motacilla alba)	LC	1	53	0	0
	Muscicapidae	Black Redstart (Phoenicurus ochruros)	LC	0	1	0	0
		Variable Wheatear (Oe0nthe picata)	LC	0	1	0	0
	Nectariniidae	Purple Sunbird (Cinnyris asiaticus)	LC	0	2	0	0
	Passeridae	House Sparrow (Passer domesticus)	LC	0	0	4	0
	Rhipiduridae	White-browed Fantail (Rhipidura aureola)	LC	0	2	0	0
	Sturnidae	Common Starling (Sturnus vulgaris)	LC	6	0	0	0
Pelecani formes	**Ardeidae**	Cattle Egret (Bubulcus ibis)	LC	0	6	0	0
		Great Egret (Ardea alba)	NA	1	33	1	0
		Grey Heron (Ardea cinerea)	LC	1	37	6	11
		Indian Pond Heron (Ardeola grayii)	LC	0	3	2	6
		Intermediate Egret (Ardea intermedia)	LC	0	30	3	0
		Little Egret (Egretta garzetta)	LC	0	60	3	0
	Pelecanidae	Dalmatian Pelican (Pelecanus crispus)	NT	55	31	0	0
	Threskiornithidae	Black-headed Ibis (Threskiornis melanocephalus)	NT	0	0	2	0
		Eurasian Spoonbill (Platalea leucorodia)	LC	44	124	1	0
		Indian Black Ibis (Pseudibis papillosa)	NA	0	5	0	0
Podicipedi formes	**Podicipedidae**	Great Crested Grebe (Podiceps cristatus)	LC	0	5	0	0
		Little Grebe (Tachybaptus ruficollis)	LC	14	95	11	18
Psittaci formes	**Psittacidae**	Rose ringed Parakeet (Psittacula krameri)	LC	0	0	6	0
Pterocliforme s	**Pteroclidae**	Sandgrouse (Unidentified)	NA	0	0	0	0
Strigiformes	**Strigidae**	Indian Eagle Owl (Bubo bengalensis)	LC	0	1	0	0
Suliformes	**Phalacro coracidae**	Great Cormorant (Phalacrocorax carbo)	LC	93	57	6	0
		Indian Cormorant (Phalacrocorax fuscicollis)	LC	0	8	13	0
		Little Cormorant (Microcarbo niger)	LC	29	56	38	0
Total				6501	15691	758	1749
Grand Total				**24699**			

3.6.4 Jorbeer Conservation Reserve

Jorbeer is a 56 km^2 Conservation Reserve 12 km from Bikaner city. Jorbeer records a high number of diverse raptor species. Lots of them migrate there during winters. We recorded 11 raptor species, out of which 2 are endangered (Table 11).

Table 11. List of raptors sighted at Jorbeer Conservation Reserve

Species	**IUCN status**
Black Kite (*Milvus migrans*)	LC
Cinereous Vulture (*Aegypius monachus*)	NT
Common Kestrel (*Falco tinnunculus*)	LC
Eastern Imperial Eagle (*Aquila heliaca*)	VU
Egyptian Vulture (*Neophron percnopterus*)	EN
Eurasian Griffon (*Gyps fulvus*)	LC
Himalayan Griffon (*Gyps himalayensis*)	NT
Long Legged Buzzard (*Buteo rufinus*)	LC
Steppe Eagle (*Aquila nipalensis*)	EN
Tawny Eagle (*Aquila rapax*)	VU

3.7 Community perceptions

We targeted 170 respondents from 61 villages in 24 cells for questionnaires. Three samples were rejected from analysis as they included contradictory responses. Samples were largely from the central part of the Bikaner landscape. Only 1.7 (SE 1.0) % respondents (n = 4) had seen the Great Indian Bustard around their villages in the last five years.

When asked about the occurrence of focal species around villages, reporting frequencies were highest for Dog, Nilgai and Fox, followed by Chinkara, Crane and Wild pig (Figure 14). Reporting frequencies were positively correlated among species at the village level (Pearson's coefficient, r = 0.4 - 0.9 among species-pairs). Ordination analyses revealed two major patterns of species' reportings. The first gradient (factor 1 explaining 55% variance was positively correlated with reporting frequencies of all species except Wild pig) indicated general wildlife reporting at a village. The second gradient (factor 2 explaining 10% variance was negatively correlated with Chinkara reporting and positively correlated with Nilgai and Wild Pig reporting) indicated villages with greater Nilgai and Wild Pig reporting and less Chinkara reporting (Figure 14).

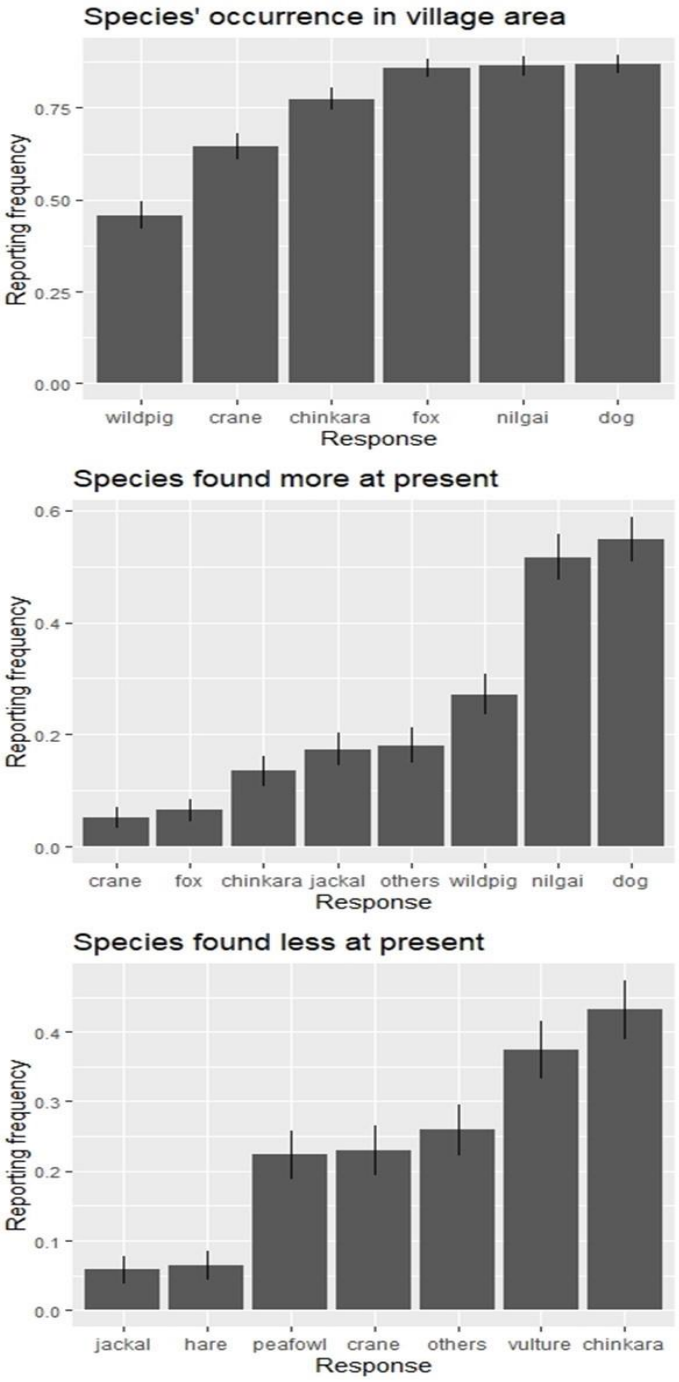


Figure 14. Mean (SE) reporting frequencies of (left) occurrence of focal species, (center) species that currently occur more than earlier, and (right) species that currently occur less than earlier in village areas of Bikaner landscape (2021) based on questionnaires

When asked about species that currently occur more than earlier, reporting frequencies were manifold higher for Dog, Nilgai and Wild pig than for Chinkara, Fox and Crane. Conversely, when asked about species that currently occur less than earlier, reporting frequencies were highest for Chinkara and Vulture, followed by Crane and Peafowl, whereas Dog and Nilgai were not reported (Figure 14).

When asked about causes behind wildlife decline, respondents identified habitat loss due to agricultural expansion and associated borewell irrigation, fencing, pesticide use, and ensuing forage scarcity as important threats alongside poaching, predation by dogs, climate change, and power infrastructure. Among these perceived threats, reporting frequency was highest for habitat loss (Figure 16). Finally, 85 (SE 3) % of respondents were aware of some form of conservation area around their villages, and 42 (SE 5) % of respondents reported that these areas were managed for wildlife protection by the Forest Department or communities (*Orans*), whereas, an equal proportion reported that such areas were not actively managed. Notably, 12 (SE 3) % of respondents complained about recent encroachment of conservation areas adjoining villages.

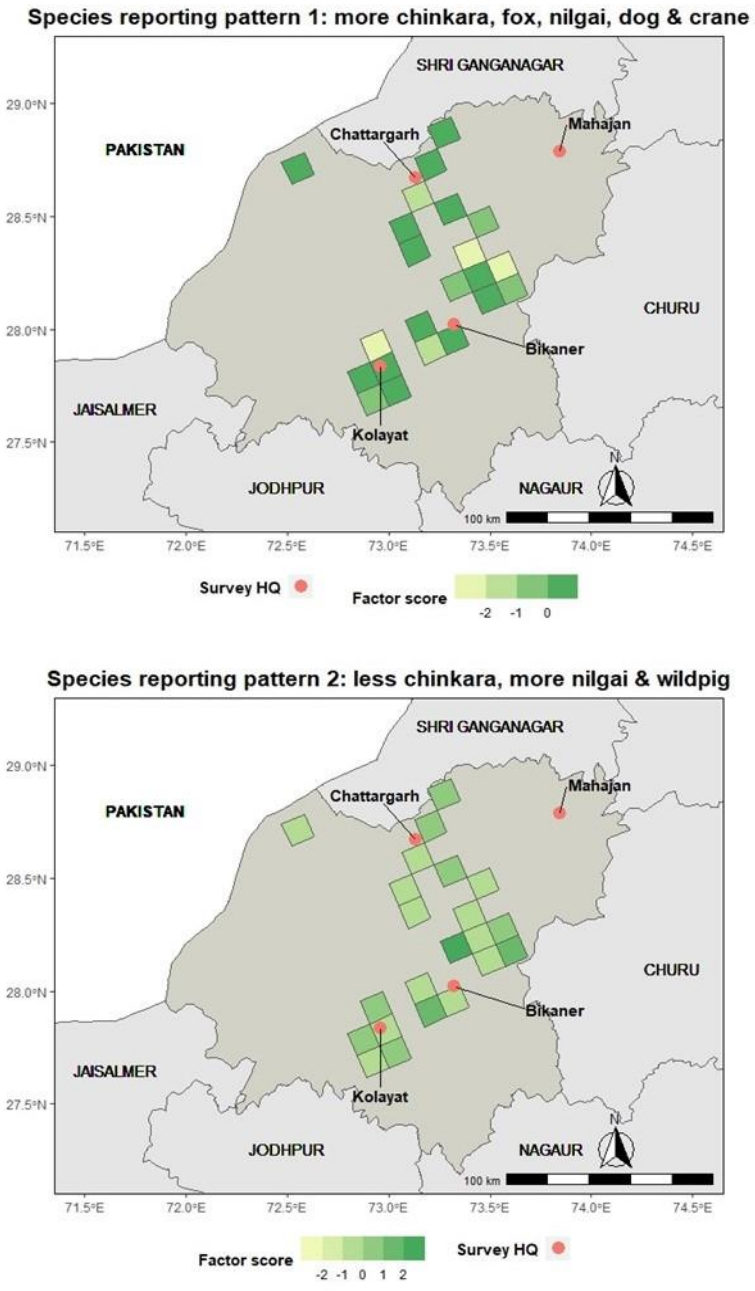


Figure 15. Patterns of species' reporting in Bikaner landscape (2021) based on questionnaires

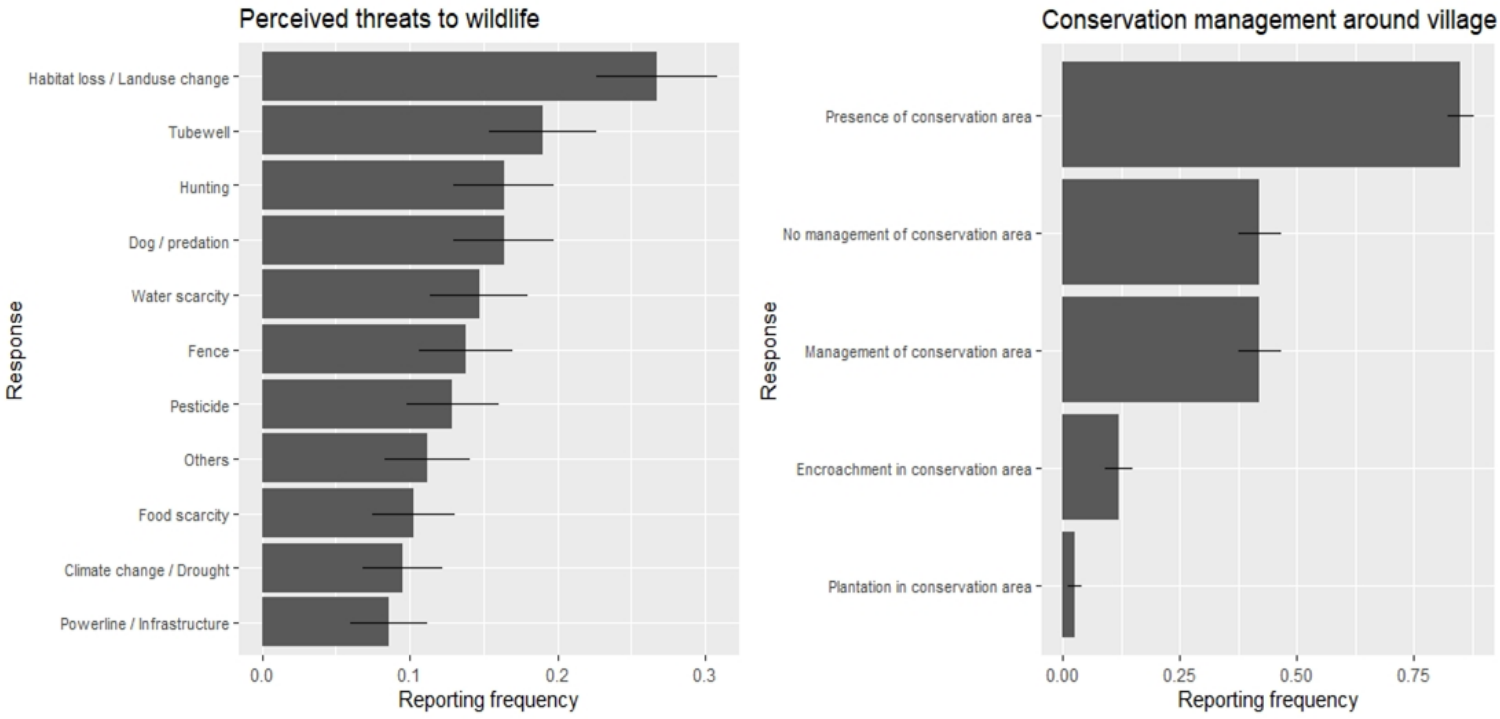


Figure 16. Mean (SE) reporting frequencies of (left) perceived threats to wildlife, and (right) perception related to wildlife conservation management in Bikaner landscape (2021) based on questionnaires

DISCUSSION

4.1 Ecological baselines

Large-scale ecological surveys have rarely been conducted in the Bikaner region. Thus, our study forms a baseline that can facilitate upcoming studies in the region. Such baselines are important for assessing the impacts of environmental changes on native biodiversity, particularly in the current age of land use and climate change. Our survey methodology is reproducible and can be replicated in future. This will provide information on biodiversity and ecological trends and allow a deeper understanding of the effects of large-scale changes in habitat and climate. Through this report, we provide a detailed account of the status of Chinkara and Desert fox in the Bikaner landscape. The chinkara is a revered animal in Rajasthan's culture and is also the state animal of Rajasthan. Yet, few systematic surveys of the species have been conducted. The existing estimates for the Chinkara population in the Bikaner district (Dookia 2009, Kankane 2000) have limited use for temporal comparisons since these surveys have methodological issues such as road-based transects, small sample size, non-representative sampling, and no correction for non-detection. Our estimates will form a robust baseline for comparison across space and time and is comparable with the Thar survey that is regularly conducted in the Jaisalmer district (Dutta et al. 2018). Similarly, the Desert fox, a ubiquitous animal in the desert, is largely under-surveyed and very little information is available about its population status. We present the first landscape wide estimate for the population of Desert fox from the Bikaner landscape.

4.2 Important sightings

1. **Mammals:** One individual of Indian grey wolf was reported from the Chattargarh region during the survey. Wolves have been recorded historically from this landscape (see Jhala and Giles, 1991), but recent records have been sparse.
2. **Birds:** We recorded 10 species of threatened birds. The list includes 7 species of raptors, *i.e.* Indian vulture, Egyptian vulture, Steppe eagle, Eastern imperial eagle, Greater spotted eagle, Indian spotted eagle and Tawny eagle. The rest of the three threatened species were Stoliczka's bushchat, Yellow-eyed pigeon and Common pochard. Egyptian vulture, a resident raptor that breeds in the Bikaner landscape, was recorded in abundance. Similarly, Steppe eagle was encountered commonly with an encounter rate of 3.06 / 100km. However, our generalized linear model showed a decrease in Steppe eagle abundance in canal irrigated areas. Stoliczka's bushchat, a rare and cryptic species, was recorded in Khajuwala and Mahajan Field Firing Range, adding additional distribution records to the range of the understudied bird (Rahmani, 1996). Northern lapwing, a rare winter migrant to northwestern India, was seen in RD 507 wetland.

4.3 Comparison between Bikaner and Jaisalmer landscapes

Our current survey in Bikaner and the regular surveys in Jaisalmer (Dutta et al. 2018) have allowed us to compare the socio-ecological characteristics of these adjoining districts which are similar in terms of bioclimate but have different trajectories of land-use change.

4.3.1 Habitat

Compared to Jaisalmer, the Bikaner district is more undulating with a predominance of sandy substrate. Consequently, the proportion of shrublands is much higher and the proportion of grasslands much lower in Bikaner as compared to the Jaisalmer district. In terms of human artefacts, the proportion of points with powerlines was seen to be higher in Bikaner (0.52) than in Jaisalmer (0.42).

4.3.2 Mammals

The difference in habitat and perhaps the difference in climatic conditions is reflected in the density of two mammal species which we surveyed rigorously. The density of Desert fox was almost four times higher in Bikaner (0.58 per km^2) as compared to Jaisalmer (0.15); that of Chinkara was twice that of Jaisalmer (2.05) in Bikaner (4.27). The potential reasons for these differences are climate (Bikaner is less arid), habitat (Bikaner is more shrubby), terrain (Bikaner is more undulating) and social outlook towards wild animals.

4.3.3 Small birds

The winter bird assemblage in Bikaner was dominated by common species such as Eurasian collared dove, House sparrow, White-eared bulbul and Red-vented bulbul. It was almost completely devoid of understory insectivores (e.g., Desert wheatear, Isabelline wheatear, Cream-coloured courser). This is in stark contrast to the pattern in Jaisalmer district (Kher and Dutta 2021). The probable reason for this might be the lack of productive grasslands and the general agriculturalization of the landscape that have facilitated these generalist species and negatively affected the specialist species.

4.4 Species habitat associations

Bikaner district presents a variety of habitats that can influence the distribution and ecology of local fauna. Apart from the natural features described in the results section, anthropogenic activities (agriculture and livestock grazing) also vary considerably across the landscape. Our analyses looked at how some of these gradients affect the distribution and abundance of key wildlife species at a landscape scale.

For example, the Chinkara, although present across the region, showed a significant decline in abundance with an increase in irrigation and irrigated agriculture. This validates predictions of other studies (Rahmani and Sankaran, 1991i) from the past, which have listed the development of irrigated agriculture due to the Indira Gandhi Canal as a major threat to the Chinkara population in the Thar desert. On the contrary, Nilgai seemed to increase considerably with the increase in the proportion of irrigated agriculture in the cell. A potential reason for the contrasting patterns might be the availability of surface water, which limits the distribution of Nilgai in the non-irrigated parts of the desert.

Habitat associations of carnivore species in the landscape were markedly different from herbivores. The Desert fox did not show any detectable change in density in response to terrain,

substrate, irrigation or proportion of cultivated area in the landscape. This is potentially due to the adaptable nature of the species, which allows it to survive in a variety of habitats, including human-dominated landscapes. However, free-ranging domestic dogs were positively associated with flat terrain and anthropogenic disturbance. Other studies from the Thar desert have shown that free-ranging dogs depend on settlements for subsidies and that their usage is maximum in wildlife areas close to settlements (Mohandas, 2017; Pandey, 2021 unpublished data). Our results are in consonance with this general pattern. We also recorded Desert cats during our surveys but could not discern their habitat relationships due to the small sample size.

For birds, there were three prominent abundance and distribution patterns. Some birds, like the Steppe eagle, Egyptian vulture, Yellow-eyed pigeon, Black-crowned sparrow lark, were significantly less in areas under irrigation and cultivation. These represent the species that are vulnerable to landscape-level land-use change. Raptors were unsurprisingly the worst affected group as they are large ranging and placed higher up on the trophic scale. The second group constituted birds that were favoured by irrigation and irrigated agriculture. Most of these species, such as the Indian Roller, Rufous treepie, Rose-ringed parakeets, were found almost exclusively in irrigated areas; and other studies have shown that their distribution in the area has historically been driven by the Indira Gandhi Canal (Rahmani and Soni 1997). The third group consisted of synanthropic or generalist species that were found in greater numbers in distrubed areas, e.g., Indian peafowl, Black drongo, Eurasian collared dove. Some birds were also associated with terrain: the Indian robin, Indian peafowl, and Common babbler were more widely distributed and abundant in flat terrain.

4.5 Wetlands

Wetlands are important socio-ecological systems and provide ecosystem services to both humans and wildlife. They are particularly important for waterbirds, which depend on them entirely for feeding and breeding. Many of India's wetlands fall on the Central Asian Flyway and are important migratory grounds for Eurasian species. Considering their disproportionate ecological importance, we surveyed one natural and three artificial wetlands. The natural waterbody, Lunkaransar Lake, was an important wintering ground for the Demoiselle cranes, which congregate here in large numbers. The lake also hosts other migratory birds of saline and brackish waters such as Pied Avocet and inland water birds like the Northern shoveler and Great crested grebe. The two artificial water bodies (750 RD and 507 RD), formed by the escape water of the Indira Gandhi Canal, were also found to be rich in migratory avifauna. The 750 RD, which comprises many small and large water bodies, supported a very diverse bird community, probably driven by the higher habitat heterogeneity and, therefore, more foraging niches. A total of 15,666 individuals belonging to 76 bird species were recorded at 750 RD. This included many waterfowls, waders and raptors, most of whom depend entirely on large water bodies.

Some of the species found in these three wetlands are charismatic and sought after by nature enthusiasts and wildlife photographers, thus providing an opportunity for eco-tourism. Eco-tourism could provide an additional livelihood to the people living in the area and help increase environmental awareness. But several factors should be considered before planning an

ecotourism site. Tar road network for accessing the site can facilitate tourism, thereby generating more conservation revenue and livelihoods, but can have adverse effects on the wetland bird communities, through the fragmentation of habitats, restriction on bird movements, increased mortality from collisions, and general disturbances, as shown by some studies (Gois et al., 2018). Notably, all three wetlands are currently managed by local communities for fishing and allied activities that are perhaps compatible with wetland conservation, given the high avian diversity and abundance. Thus, any management intervention in the area should be done in consultation and collaboration with the fishers to avoid negative repercussions on their livelihoods that may arise from stringent restrictions. While this ecosystem is very significant for birds and humans and needs to be conserved, the above factors need to be considered when planning management strategies.

4.6 Social perception

Questionnaires revealed a high degree of wildlife awareness among the local people of Bikaner. Responses pertaining to wildlife status, trends and threats were realistic and in line with expert views on this subject. Reporting frequencies of wildlife trends, particularly the increasing occurrences of Dog, Nilgai and Wild pig, and the decreasing occurrence of Chinkara are congruent with scientific observations on the Thar desert ecosystem (Dutta et al., 2018). Such patterns are believed to result from increased water availability due to irrigation and the concomitant spread of agriculture and human footprint that have facilitated species such as free-ranging Dogs and Nilgai. Respondents identified habitat loss due to agricultural expansion and intensification as the most important threat to regional wildlife and pointed out very specific threats such as borewell irrigation, fencing and pesticide use that are prevalent across the Bikaner landscape. Such extensive changes in land use and the emergence of new infrastructure (particularly power lines - Jhala et al. 2020) is a likely reason behind the disappearance of the Great Indian bustard from much of its historical range in Bikaner. Unsurprisingly, only 2% of respondents reported sighting the species in recent times. Large areas of the Bikaner landscape were reserved for pastoral use as *gauchars* and *Orans* that also harboured wildlife. However, as noted by respondents, such areas have been encroached on for cultivation. Strengthening traditional institutions that are compatible with wildlife will be the key to conservation in such vast, unprotected, yet biodiversity rich landscapes.

4.7 Capacity building through citizen science surveys

Awareness about the natural world is essential for both ecological and human well-being; and generally arises from first-hand experience with plants, animals, wildlife and wilderness. At the same time, structured observations by citizens contribute significantly to our understanding of biodiversity and wildlife. Citizen science is thus considered an important part of modern-day ecological research. We conducted the Bikaner Survey 2021 in a citizen science framework considering the huge potential of large-scale surveys in training research personnel and promoting nature awareness. To achieve these dual objectives, we collaborated with local institutions and civil society and conducted the survey through a volunteer driven effort.

Volunteers and interested students were trained through a two-stage workshop. The first stage consisted of a classroom workshop held at Govt. Dungar College, which sensitized the audience about the biodiversity of the Thar landscape and the basics of ecological research. In the second stage, students and volunteers were taken to the Jorbeer Conservation reserve and trained in ecological survey techniques and instrumentation. 52 students/volunteers attended the workshop and were sensitised towards desert biodiversity. Nineteen students/volunteers further joined us for the large scale surveys and got trained in desert ecology, wildlife survey techniques and basics of field biology.

4. Management implications

The Bikaner region is undergoing large-scale land-use changes due to irrigated agriculture, infrastructure and industries. Natural habitats are reducing, and traditionally conserved *Orans* are being encroached on for agriculture, reducing wildlife habitats and pastures for livestock. Borewell irrigation has flourished in the recent past, posing concerns over groundwater sustainability. Yet, some of these developmental activities are necessary for the social and economic development of the local populace. Moreover, the Bikaner region does not have many PAs, which can safeguard some parts of the landscape from ecologically destructive changes. Consequently, a mixed conservation strategy based on land sparing and land sharing principles is advocated to safeguard conservation priorities along with sustainable development - values that are also shared by the local communities who requested this survey via the Hon'ble Member of Parliament. Traditional conservation ethos is strong in the landscape, and we believe that strategic conservation efforts can find ground support in the region. Local residents interviewed during the survey were aware of the resident fauna, general conservation trends and threats and reported many recent instances of agricultural encroachment of conservation areas. We thus recommend that strategic conservation plans be developed for the region by assessing the impacts of the abovementioned threats on key conservation-dependent species and harmonising their mitigation with objectives of human livelihoods and well-being. In this regard, our survey builds up a foundation for more research to build upon. Yet, given the snapshot nature of our survey, we advocate the need for more long-term and focused studies for planning effective conservation measures. Nonetheless, some of the key recommendations based on this survey, and consultation with the State Forest Department and local Universities/Institutions, are as follows:

1. Sites such as Jorbeer Conservation Reserve, Deshnok Oran, Tokla Oran, Bhinjranwali and 750RD require greater conservation emphasis given their wildlife values. The exact conservation actions should be planned through research followed by consultation between local conservation institutions and stakeholders. Agricultural encroachment in *Orans* needs to be reduced by strict enforcement and strengthening local management institutions through consultation with locals.

2. Impacts of potential threats such as power lines, free-ranging dogs and fences need to be mitigated, preferably across the landscape and at least around these key sites. Power lines are a known cause for collision and mortality of birds and bats. Some key sites where power lines need to be mitigated by installing Bird Flight Diverters include areas with high raptor and waterbird populations such as Jorbeer, Deshnok oran, RD507, RD750,

Lunkaransar Lake. Whereas the large population of free-ranging dogs are a potential threat to native fauna through the effects of predation, competition and disease risk. Our observations in Jaisalmer also suggest that dogs often corner and predate chinkara at fences; hence, their combined presence can be particularly detrimental.

3. Few grassland areas can be restored across the landscape through fencing, grass plantations and restriction of livestock movement in initial years and rotational grazing in subsequent years to benefit grassland specialists that are currently rare or missing in the region and to simultaneously support livestock production. Similarly, a fodder farm model of grassland management (similar to the *vidi* system in Gujarat) can be adopted in some suitable areas to facilitate both wildlife and domestic livestock.

4. Select wetlands can be promoted for ecotourism to generate conservation revenues and livelihoods, although the exact management actions should be carefully planned through consultation with existing stakeholders and research to avoid any unintended detrimental effect on bird conservation and existing livelihoods.

5. The current survey approach can be reproduced once every 4-5 years by the network of conservation institutions and individuals active in this region, in a citizen science framework, to monitor the wildlife trends and highlight important conservation threats for mitigation. The multiple season species' distribution data generated from these surveys can aid in spatial conservation prioritization, wherein some areas are spared for biodiversity and others shared with agricultural production.

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Pc: sherwin

APPENDIX

List of appendices:

1. Data form of questionnaire for assessing community perception towards wildlife
2. Data form for key wildlife sightings in 2-km segments of vehicle trail
3. Data form for habitat characteristics at every 2-km along vehicle trail
4. Data form for bird sampling at point counts
5. Checklist of birds in Bikaner
6. Interim report on the Status of migratory birds and key wildlife in Bikaner, Rajasthan, 2020

Appendix 1: Questionnaire survey for assessing community perception towards wildlife

Date: _____ Cell-ID: _____ Team: _____

Village	Respondent Name	Latitude, Longitude	Q1. Have you seen GIB in last 5 years & where?	Q2. What other species occur here?	Q3. Which of these species do you see more often now?	Q4. What change do you notice in your surroundings?	Q5. What are the main threats to wildlife here?	Q6. Do you have areas for wildlife protection & how are they managed?
1)	1)			Crane / Chinkara / Fox / Nilgai / Wild pig / Dog				
	2)			Crane / Chinkara / Fox / Nilgai / Wild pig / Dog				
	3)			Crane / Chinkara / Fox / Nilgai / Wild pig / Dog				
2)	1)			Crane / Chinkara / Fox / Nilgai / Wild pig / Dog				
	2)			Crane / Chinkara / Fox / Nilgai / Wild pig / Dog				
	3)			Crane / Chinkara / Fox / Nilgai / Wild pig / Dog				
3)	1)			Crane / Chinkara / Fox / Nilgai / Wild pig / Dog				
	2)			Crane / Chinkara / Fox / Nilgai / Wild pig / Dog				
	3)			Crane / Chinkara / Fox / Nilgai / Wild pig / Dog				

Appendix 2: Datasheet for key wildlife sightings in 2-km segments of vehicle trail

Date:__________Cell-ID:________Transect ID:______Team:______________________Trail-length:______(km) Save Track :ID:____________________

Seg ID	Latitude, Longitude	Species	Number	Sighting Distance	Animal Bearing	Transect Bearing	Land-cover
							B / A / G / W / S
							B / A / G / W / S
							B / A / G / W / S
							B / A / G / W / S
							B / A / G / W / S
							B / A / G / W / S
							B / A / G / W / S
							B / A / G / W / S
							B / A / G / W / S
							B / A / G / W / S
							B / A / G / W / S
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							B / A / G / W / S
							B / A / G / W / S
							B / A / G / W / S
							B / A / G / W / S
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							B / A / G / W / S

Notes:

Record Bustards, Cranes, Chinkara, Blackbuck, Fox, Cat, Dog, Nilgai & Wild Pig
Land-cover: **B**arren / **A**griculture / **G**rassland **/ W**oodland **/ Sc**rubland

Appendix 3: Datasheet for habitat characterization at every 2-km along vehicle trail

Date:_____Cell-ID:_____Transect ID_____Team:_____Saved track ID:_____

Seg ID	Time	Weather	Land-cover (100 m radius)	Terrain (100 m radius)	Substrate (100 m radius)	Vegetation Structure (% area in 20m radius)					3 dominant plants natural / cultivated (100m radius)	Active disturbance 100m	Passive disturbance 100 m	Count of Cattle in 2Km seg	Count of Seep/ Goat in 2Km Seg	STL Pr.
						Short grass/ herb (<30 cm)	Tall grass (>30cm)	Shrub (<2m)	Tree (>2m)	Crop						
1		S/C	B / A / G / W/ S	F / S / U	R / G /S / s							H/ D/ L/ M	S/ E/ R/ So/ W/ P/ F/ I			1/0
2		S/C	B / A / G / W/ S	F / S / U	R / G /S / s							H/ D/ L/ M	S/ E/ R/ So/ W/ P/ F/ I			1/0
3		S/C	B / A / G / W/ S	F / S / U	R / G /S / s							H/ D/ L/ M	S/ E/ R/ So/ W/ P/ F/ I			1/0
4		S/C	B / A / G / W/ S	F / S / U	R / G /S / s							H/ D/ L/ M	S/ E/ R/ So/ W/ P/ F/ I			1/0
5		S/C	B / A / G / W/ S	F / S / U	R / G /S / s							H/ D/ L/ M	S/ E/ R/ So/ W/ P/ F/ I			1/0
6		S/C	B / A / G / W/ S	F / S / U	R / G /S / s							H/ D/ L/ M	S/ E/ R/ So/ W/ P/ F/ I			1/0
7		S/C	B / A / G / W/ S	F / S / U	R / G /S / s							H/ D/ L/ M	S/ E/ R/ So/ W/ P/ F/ I			1/0
8		S/C	B / A / G / W/ S	F / S / U	R / G /S / s							H/ D/ L/ M	S/ E/ R/ So/ W/ P/ F/ I			1/0
9		S/C	B / A / G / W/ S	F / S / U	R / G /S / s							H/ D/ L/ M	S/ E/ R/ So/ W/ P/ F/ I			1/0
10		S/C	B / A / G / W/ S	F / S / U	R / G /S / s							H/ D/ L/ M	S/ E/ R/ So/ W/ P/ F/ I			1/0
11		S/C	B / A / G / W/ S	F / S / U	R / G /S / s							H/ D/ L/ M	S/ E/ R/ So/ W/ P/ F/ I			1/0
12		S/C	B / A / G / W/ S	F / S / U	R / G /S / s							H/ D/ L/ M	S/ E/ R/ So/ W/ P/ F/ I			1/0

Notes:

Abbreviations:

Land-cover – B (barren) / A (agriculture) / G (grassland) / W (woodland) / S (scrubland)
Terrain – F (flat) / S (sloping) / U (undulating)
Substrate – R (rock) / G (gravel) / S (sand) / s (soil)
Weather – S (Sunny) / C (Cloudy)
Vegetation composition classes: 0-10, 10-20, 20-40, 40-60, 60-100
Active disturbance: H (Human), D (Dog), L (Livestock), M (Machines – noise/disturbance);
Passive disturbance: S (Settlement), E (Electric lines), R (Road), So (Solar Plant), W (wind turbine) , P (water-source), F (Fence), I (Industrial uses)

Appendix 4: Datasheet for bird sampling at point counts

Date:________________Cell-ID:____________ Transect ID:_______Saved Track ID:____

Seg ID	Latitude, Longitude	Species	Number	Seg ID	Latitude, Longitude	Species	Number

Notes:

Record Birds of Prey (Vultures, Eagles, Buzzards, Kites, Harriers, Falcons, Accipiter etc.) within 500 m from trail

Appendix 5: Checklist of birds in Bikaner

SN	Common name	Scientific name	Order	Family	Conservation status (IUCN)	Source
1	Alexandrine Parakeet	Psittacula eupatria	Psittaciformes	Psittacidae	NT	2
2	Ashy Drongo	Dicrurus leucophaeus	Passeriformes	Dicruridae	LC	1
3	Ashy Prinia	Prinia socialis	Passeriformes	Cisticolidae	LC	2
4	Ashycrowned Sparrow Lark	Eremopterix griseus	Passeriformes	Alaudidae	LC	2
5	Asian Desert Warbler	Sylvia nana	Passeriformes	Sylviidae	LC	2
6	Asian Imperial Eagle	Aquila heliaca	Accipitriformes	Accipitridae	VU	1
7	Asian Openbill	Anastomus oscitans	Ciconiiformes	Ciconiidae	LC	2
8	Asian Pied Starling	Gracupica contra	Passeriformes	Sturnidae	LC	1
9	Asian Plain Martin	Riparia chinensis	Passeriformes	Hirundinidae	LC	1
10	Bank Myna	Acridotheres ginginianus	Passeriformes	Sturnidae	LC	2
11	Bar-headed Goose	Anser indicus	Anseriformes	Anatidae	LC	2
12	Barn Swallow	Hirundo rustica	Passeriformes	Hirundinidae	LC	2
13	Baya Weaver	Ploceus philippinus	Passeriformes	Ploceidae	LC	1
14	Baybacked Shrike	Lanius vittatus	Passeriformes	Laniidae	LC	2
15	Bimaculated Lark	Melanocorypha bimaculata	Passeriformes	Alaudidae	LC	2
16	black bittern	Ixobrychus flavicollis	Pelecaniformes	Ardeidae	LC	1
17	Black crowned SparrowLark	Eremopterix nigriceps	Passeriformes	Alaudidae	LC	2
18	Black Drongo	Dicrurus macrocercus	Passeriformes	Dicruridae	LC	2
19	Black Francolin	Francolinus francolinus	Galliformes	Phasianidae	LC	2
20	Black Kite	Milvus migrans	Accipitriformes	Accipitridae	LC	1
21	Black Redstart	Phoenicurus ochruros	Passeriformes	Muscicapidae	LC	2
22	Black Stork	Ciconia nigra	Ciconiiformes	Ciconiidae	LC	2
23	Blackbellied Sandgrouse	Pterocles orientalis	Pteroclidiformes	Pteroclididae	LC	2
24	Black-breasted Weaver	Ploceus benghalensis	Passeriformes	Ploceidae	LC	1
25	Blackcrowned Night Heron	Nycticorax nycticorax	Pelecaniformes	Ardeidae	LC	2
26	Black-headed bunting	Emberiza melanocephala	Passeriformes	Emberizidae	LC	1
27	Black-headed cuckooshrike	Lalage melanoptera	Passeriformes	Campephagidae	LC	1
28	black-headed gull	Chroicocephalus ridibundus	Charadriiformes	Laridae	LC	1
29	Black-headed Ibis	Threskiornis melanocephalus	Pelecaniformes	Threskiornithidae	NT	2
30	Black-necked Grebe	Podiceps nigricollis	Podicipediformes	Podicipedidae	LC	1
31	Black-necked Stork	Ephippiorhynchus asiaticus	Ciconiiformes	Ciconiidae	NT	1
32	Black-tailed Godwit	Limosa limosa	Charadriiformes	Scolopacidae	NT	1
33	black-throated thrush	Turdus atrogularis	Passeriformes	Turdidae	LC	1
34	Black-winged Kite	Elanus caeruleus	Accipitriformes	Accipitridae	LC	1
35	Black-winged Stilt	Himantopus himantopus	Charadriiformes	Recurvirostridae	LC	2
36	Blue-cheeked Bee-eater	Merops persicus	Coraciiformes	Meropidae	LC	1
37	Blue-tailed Bee-eater	Merops philippinus	Coraciiformes	Meropidae	LC	1
38	Bluethroat	Luscinia svecica	Passeriformes	Muscicapidae	LC	1
39	Blyth's Reed-warbler	Acrocephalus dumetorum	Passeriformes	Acrocephalidae	LC	1
40	Bonelli's Eagle	Aquila fasciata	Accipitriformes	Accipitridae	LC	1
41	Booted Eagle	Hieraaetus pennatus	Accipitriformes	Accipitridae	LC	1
42	Booted Warbler	Iduna caligata	Passeriformes	Acrocephalidae	LC	1
43	Brahminy Kite	Haliastur indus	Accipitriformes	Accipitridae	LC	1
44	Brahminy Starling	Sturnia pagodarum	Passeriformes	Sturnidae	LC	2

45	Bronze-winged Jacana	Metopidius indicus	Charadriiformes	Jacanidae	LC	1
46	Brooks's Leaf-warbler	Phylloscopus subviridis	Passeriformes	Phylloscopidae	LC	1
47	brown crake	Zapornia akool	Gruiformes	Rallidae	LC	1
48	Brown Fish-Owl	Ketupa zeylonensis	Strigiformes	Strigidae	LC	1
49	Brown Rock Chat	Oenanthe fusca	Passeriformes	Muscicapidae	LC	2
50	Brown-headed Gull	Chroicocephalus brunnicephalus	Charadriiformes	Laridae	LC	1
51	Buff-bellied Pipit	Anthus rubescens	Passeriformes	Motacillidae	LC	1
52	Cattle Egret	Bubulcus ibis	Pelecaniformes	Ardeidae	LC	2
53	Chestnutbellied Sandgrouse	Pterocles exustus	Pteroclidiformes	Pteroclididae	LC	2
54	Chestnut-tailed Starling	Sturnia malabarica	Passeriformes	Sturnidae	LC	1
55	Cinereous Vulture	Aegypius monachus	Accipitriformes	Accipitridae	NT	2
56	Citrine Wagtail	Motacilla citreola	Passeriformes	Motacillidae	LC	2
57	Clamorous Reed-warbler	Acrocephalus stentoreus	Passeriformes	Acrocephalidae	LC	1
58	Common Barn-owl	Tyto alba	Strigiformes	Tytonidae	LC	1
59	Common Buzzard	Buteo buteo	Accipitriformes	Accipitridae	LC	1
60	Common Chiffchaff	Phylloscopus collybita	Passeriformes	Phylloscopidae	LC	2
61	Common Coot	Fulica atra	Gruiformes	Rallidae	LC	2
62	Common Crane	Grus grus	Gruiformes	Gruidae	LC	2
63	Common Cuckoo	Cuculus canorus	Cuculiformes	Cuculidae	LC	1
64	Common Greenshank	Tringa nebularia	Charadriiformes	Scolopacidae	LC	2
65	Common Gull-billed Tern	Gelochelidon nilotica	Charadriiformes	Laridae	LC	1
66	Common hawk-cuckoo	Hierococcyx varius	Cuculiformes	Cuculidae	LC	1
67	Common Hoopoe	Upupa epops	Bucerotiformes	Upupidae	LC	2
68	Common Iora	Aegithina tiphia	Passeriformes	Aegithinidae	LC	1
69	Common Kestrel	Falco tinnunculus	Falconiformes	Falconidae	LC	2
70	Common Kingfisher	Alcedo atthis	Coraciiformes	Alcedinidae	LC	2
71	Common Moorhen	Gallinula chloropus	Gruiformes	Rallidae	LC	2
72	Common Myna	Acridotheres tristis	Passeriformes	Sturnidae	LC	2
73	Common Pochard	Aythya ferina	Anseriformes	Anatidae	VU	2
74	Common Quail	Coturnix coturnix	Galliformes	Phasianidae	LC	2
75	Common raven	Corvus corax	Passeriformes	Corvidae	LC	1
76	Common Redshank	Tringa totanus	Charadriiformes	Scolopacidae	LC	1
77	Common Rosefinch	Carpodacus erythrinus	Passeriformes	Fringillidae	LC	1
78	Common Sandpiper	Actitis hypoleucos	Charadriiformes	Scolopacidae	LC	2
79	Common Shelduck	Tadorna tadorna	Anseriformes	Anatidae	LC	1
80	Common Snipe	Gallinago gallinago	Charadriiformes	Scolopacidae	LC	2
81	Common Starling	Sturnus vulgaris	Passeriformes	Sturnidae	LC	2
82	Common Tailorbird	Orthotomus sutorius	Passeriformes	Cisticolidae	LC	1
83	Common Teal	Anas crecca	Anseriformes	Anatidae	LC	2
84	Common Woodshrike	Tephrodornis pondicerianus	Passeriformes	Tephrodornithidae	LC	2
85	Coppersmith Barbet	Psilopogon haemacephalus	Piciformes	Megalaimidae	LC	1
86	Cotton Pygmy-goose	Nettapus coromandelianus	Anseriformes	Anatidae	LC	1
87	Cream-coloured Courser	Cursorius cursor	Charadriiformes	Glareolidae	LC	1
88	Crested Hawk-Eagle	Nisaetus cirrhatus	Accipitriformes	Accipitridae	LC	1
89	Crested Lark	Galerida cristata	Passeriformes	Alaudidae	LC	2
90	Crested Serpent Eagle	Spilornis cheela	Accipitriformes	Accipitridae	LC	1
91	Curlew Sandpiper	Calidris ferruginea	Charadriiformes	Scolopacidae	NT	1
92	Dalmatian Pelican	Pelecanus crispus	Pelecaniformes	Pelecanidae	NT	2
93	Demoiselle Crane	Anthropoides virgo	Gruiformes	Gruidae	LC	2
94	Desert Lark	Ammomanes deserti	Passeriformes	Alaudidae	LC	2
95	Desert Wheatear	Oenanthe deserti	Passeriformes	Muscicapidae	LC	2
96	Dunlin	Calidris alpina	Charadriiformes	Scolopacidae	LC	1

97	Dusky Crag Martin	Ptyonoprogne concolor	Passeriformes	Hirundinidae	LC	2
98	Eastern Orphean Warbler	Sylvia crassirostris	Passeriformes	Sylviidae	LC	2
99	Egyptian Vulture	Neophron percnopterus	Accipitriformes	Accipitridae	EN	2
100	Eurasian Collared Dove	Streptopelia decaocto	Columbiformes	Columbidae	LC	2
101	Eurasian Curlew	Numenius arquata	Charadriiformes	Scolopacidae	NT	2
102	Eurasian Hobby	Falco subbuteo	Falconiformes	Falconidae	LC	1
103	Eurasian Marsh Harrier	Circus aeruginosus	Accipitriformes	Accipitridae	LC	1
104	Eurasian Sparrowhawk	Accipiter nisus	Accipitriformes	Accipitridae	LC	1
105	Eurasian Spoonbill	Platalea leucorodia	Pelecaniformes	Threskiornithidae	LC	2
106	Eurasian Wigeon	Mareca penelope	Anseriformes	Anatidae	LC	2
107	Eurasian Wryneck	Jynx torquilla	Piciformes	Picidae	LC	2
108	European Roller	Coracias garrulus	Coraciiformes	Coraciidae	LC	1
109	Ferruginous Duck	Aythya nyroca	Anseriformes	Anatidae	NT	2
110	Finsch's Wheatear	Oenanthe finschii	Passeriformes	Muscicapidae	LC	1
111	Gadwall	Mareca strepera	Anseriformes	Anatidae	LC	2
112	Garganey	Spatula querquedula	Anseriformes	Anatidae	LC	2
113	Glossy Ibis	Plegadis falcinellus	Pelecaniformes	Threskiornithidae	LC	1
114	Graceful Prinia	Prinia gracilis	Passeriformes	Cisticolidae	LC	2
115	Great Cormorant	Phalacrocorax carbo	Suliformes	Phalacrocoracidae	LC	2
116	Great Crested Grebe	Podiceps cristatus	Podicipediformes	Podicipedidae	LC	2
117	Great Egret	Ardea alba	Pelecaniformes	Ardeidae	LC	2
118	Great Grey Shrike	Lanius excubitor	Passeriformes	Laniidae	LC	2
119	Great Thick-knee	Esacus recurvirostris	Charadriiformes	Burhinidae	NT	1
120	Great White Pelican	Pelecanus onocrotalus	Pelecaniformes	Pelecanidae	LC	1
121	Greater Coucal	Centropus sinensis	Cuculiformes	Cuculidae	LC	1
122	Greater Flamingo	Phoenicopterus roseus	Phoenicopteriformes	Phoenicopteridae	LC	1
123	Greater Painted-snipe	Rostratula benghalensis	Charadriiformes	Rostratulidae	LC	1
124	Greater Scaup	Aythya marila	Anseriformes	Anatidae	LC	1
125	Greater Short toed Lark	Calandrella brachydactyla	Passeriformes	Alaudidae	LC	2
126	Greater spotted eagle	Clanga clanga	Accipitriformes	Accipitridae	VU	1
127	Green Beeeater	Merops orientalis	Coraciiformes	Meropidae	LC	2
128	Green Sandpiper	Tringa ochropus	Charadriiformes	Scolopacidae	LC	1
129	Greenish Warbler	Phylloscopus trochiloides	Passeriformes	Phylloscopidae	LC	1
130	Grey Francolin	Francolinus pondicerianus	Galliformes	Phasianidae	LC	2
131	Grey Heron	Ardea cinerea	Pelecaniformes	Ardeidae	LC	2
132	Grey Wagtail	Motacilla cinerea	Passeriformes	Motacillidae	LC	2
133	Grey-breasted Prinia	Prinia hodgsonii	Passeriformes	Cisticolidae	LC	1
134	Grey-headed Canary-flycatcher	Culicicapa ceylonensis	Passeriformes	Stenostiridae	LC	1
135	Greylag Goose	Anser anser	Anseriformes	Anatidae	LC	2
136	Grey-necked Bunting	Emberiza buchanani	Passeriformes	Emberizidae	LC	1
137	Griffon Vulture	Gyps fulvus	Accipitriformes	Accipitridae	LC	2
138	Hair-crested Drongo	Dicrurus hottentottus	Passeriformes	Dicruridae	LC	1
139	Hen Harrier	Circus cyaneus	Accipitriformes	Accipitridae	LC	1
140	Himalayan Griffon	Gyps himalayensis	Accipitriformes	Accipitridae	NT	1
141	House Crow	Corvus splendens	Passeriformes	Corvidae	LC	2
142	House Sparrow	Passer domesticus	Passeriformes	Passeridae	LC	2
143	Hume's Leaf-warbler	Phylloscopus humei	Passeriformes	Phylloscopidae	LC	1
144	Indian Black Ibis	Pseudibis papillosa	Pelecaniformes	Threskiornithidae	LC	2
145	Indian Bushlark	Mirafra erythroptera	Passeriformes	Alaudidae	LC	2
146	Indian Cormorant	Phalacrocorax fuscicollis	Suliformes	Phalacrocoracidae	LC	2
147	Indian Courser	Cursorius coromandelicus	Charadriiformes	Glareolidae	LC	1

148	Indian Eagle Owl	Bubo bengalensis	Strigiformes	Strigidae	LC	2
149	Indian Golden Oriole	Oriolus kundoo	Passeriformes	Oriolidae	LC	1
150	Indian Grey-Hornbill	Ocyceros birostris	Bucerotiformes	Bucerotidae	LC	1
151	Indian Paradise-flycatcher	Terpsiphone paradisi	Passeriformes	Monarchidae	LC	1
152	Indian Peafowl	Pavo cristatus	Galliformes	Phasianidae	LC	2
153	Indian Pitta	Pitta brachyura	Passeriformes	Pittidae	LC	1
154	Indian Pond Heron	Ardeola grayii	Pelecaniformes	Ardeidae	LC	2
155	Indian Robin	Saxicoloides fulicatus	Passeriformes	Muscicapidae	LC	2
156	Indian Roller	Coracias benghalensis	Coraciiformes	Coraciidae	LC	2
157	Indian Scops-owl	Otus bakkamoena	Strigiformes	Strigidae	LC	1
158	Indian Silverbill	Euodice malabarica	Passeriformes	Estrildidae	LC	2
159	Indian Spot-billed Duck	Anas poecilorhyncha	Anseriformes	Anatidae	LC	2
160	Indian spotted creeper	Salpornis spilonota	Passeriformes	Certhiidae	LC	1
161	Indian Spotted Eagle	Clanga hastata	Accipitriformes	Accipitridae	VU	1
162	Indian Thick-knee	Burhinus indicus	Charadriiformes	Burhinidae	LC	1
163	Indian Vulture	Gyps indicus	Accipitriformes	Accipitridae	CR	1
164	Indian White-eye	Zosterops palpebrosus	Passeriformes	Zosteropidae	LC	1
165	intermediate egret	Ardea intermedia	Pelecaniformes	Ardeidae	LC	2
166	Isabelline Shrike	Lanius isabellinus	Passeriformes	Laniidae	LC	2
167	Isabelline Wheatear	Oenanthe isabellina	Passeriformes	Muscicapidae	LC	2
168	Jacobin Cuckoo	Clamator jacobinus	Cuculiformes	Cuculidae	LC	1
169	Jungle Babbler	Turdoides striata	Passeriformes	Leiothrichidae	LC	2
170	Jungle Prinia	Prinia sylvatica	Passeriformes	Cisticolidae	LC	1
171	Kentish Plover	Charadrius alexandrinus	Charadriiformes	Charadriidae	LC	1
172	Laggar Falcon	Falco jugger	Falconiformes	Falconidae	NT	2
173	Large billed Crow	Corvus macrorhynchos	Passeriformes	Corvidae	LC	2
174	Large Grey Babbler	Argya malcolmi	Passeriformes	Leiothrichidae	LC	2
175	Laughing Dove	Streptopelia senegalensis	Columbiformes	Columbidae	LC	2
176	Lesser Black-backed Gull	Larus fuscus	Charadriiformes	Laridae	LC	1
177	Lesser Goldenbacked Woodpecker	Dinopium benghalense	Piciformes	Picidae	LC	2
178	Lesser Kestrel	Falco naumanni	Falconiformes	Falconidae	LC	1
179	Lesser Sandplover	Charadrius mongolus	Charadriiformes	Charadriidae	LC	1
180	Lesser Whistling-Duck	Dendrocygna javanica	Anseriformes	Anatidae	LC	1
181	Lesser Whitethroat	Sylvia curruca	Passeriformes	Sylviidae	LC	2
182	Little Cormorant	Microcarbo niger	Suliformes	Phalacrocoracidae	LC	2
183	Little Egret	Egretta garzetta	Pelecaniformes	Ardeidae	LC	2
184	Little Grebe	Tachybaptus ruficollis	Podicipediformes	Podicipedidae	LC	2
185	Little Pratincole	Glareola lactea	Charadriiformes	Glareolidae	LC	2
186	Little Ringed Plover	Charadrius dubius	Charadriiformes	Charadriidae	LC	2
187	Little Stint	Calidris minuta	Charadriiformes	Scolopacidae	LC	1
188	Little Swift	Apus affinis	Apodiformes	Apodidae	LC	1
189	Longbilled Pipit	Anthus similis	Passeriformes	Motacillidae	LC	2
190	Long-legged Buzzard	Buteo rufinus	Accipitriformes	Accipitridae	LC	2
191	Long-tailed Minivet	Pericrocotus ethologus	Passeriformes	Campephagidae	LC	1
192	Long-tailed Shrike	Lanius schach	Passeriformes	Laniidae	LC	1
193	Macqueen's Bustard	Chlamydotis macqueenii	Otidiformes	Otididae	VU	1
194	Mallard	Anas platyrhynchos	Anseriformes	Anatidae	LC	2
195	Marsh Sandpiper	Tringa stagnatilis	Charadriiformes	Scolopacidae	LC	1
196	Montagu's Harrier	Circus pygargus	Accipitriformes	Accipitridae	LC	1
197	Northern Lapwing	Vanellus vanellus	Charadriiformes	Charadriidae	NT	2
198	Northern Pintail	Anas acuta	Anseriformes	Anatidae	LC	2
199	Northern shoveler	Spatula clypeata	Anseriformes	Anatidae	LC	2
200	Olive-backed Pipit	Anthus hodgsoni	Passeriformes	Motacillidae	LC	1
201	Oriental Darter	Anhinga melanogaster	Suliformes	Anhingidae	NT	1

202	Oriental Honey-buzzard	Pernis ptilorhynchus	Accipitriformes	Accipitridae	LC	1
203	Oriental Magpie-robin	Copsychus saularis	Passeriformes	Muscicapidae	LC	1
204	Oriental Pratincole	Glareola maldivarum	Charadriiformes	Glareolidae	LC	1
205	Oriental Skylark	Alauda gulgula	Passeriformes	Alaudidae	LC	2
206	Oriental Turtle-dove	Streptopelia orientalis	Columbiformes	Columbidae	LC	1
207	Osprey	Pandion haliaetus	Accipitriformes	Pandionidae	LC	2
208	Pacific Golden Plover	Pluvialis fulva	Charadriiformes	Charadriidae	LC	1
209	Paddyfield Pipit	Anthus rufulus	Passeriformes	Motacillidae	LC	2
210	Paddyfield Warbler	Acrocephalus agricola	Passeriformes	Acrocephalidae	LC	1
211	Painted Sandgrouse	Pterocles indicus	Pteroclidiformes	Pteroclididae	LC	2
212	Painted Stork	Mycteria leucocephala	Ciconiiformes	Ciconiidae	NT	2
213	Pale Sand Martin	Riparia diluta	Passeriformes	Hirundinidae	LC	1
214	Pallas's Fish Eagle	Haliaeetus leucoryphus	Accipitriformes	Accipitridae	EN	1
215	Pallas's gull	Ichthyaetus ichthyaetus	Charadriiformes	Laridae	LC	1
216	Pallas's Sandgrouse	Syrrhaptes paradoxus	Pteroclidiformes	Pteroclididae	LC	1
217	Pallid Harrier	Circus macrourus	Accipitriformes	Accipitridae	NT	1
218	Pallid Scops Owl	Otus brucei	Strigiformes	Strigidae	LC	1
219	Peregrine Falcon	Falco peregrinus	Falconiformes	Falconidae	LC	1
220	Pheasant-tailed Jacana	Hydrophasianus chirurgus	Charadriiformes	Jacanidae	LC	1
221	Pied Avocet	Recurvirostra avosetta	Charadriiformes	Recurvirostridae	LC	2
222	Pied Bushchat	Saxicola caprata	Passeriformes	Muscicapidae	LC	2
223	Pied Kingfisher	Ceryle rudis	Coraciiformes	Alcedinidae	LC	2
224	Pin-tailed Sandgrouse	Pterocles alchata	Pteroclidiformes	Pteroclididae	LC	1
225	Plain Leaf-Warbler	Phylloscopus neglectus	Passeriformes	Phylloscopidae	LC	1
226	Plain Prinia	Prinia inornata	Passeriformes	Cisticolidae	LC	2
227	Plum-headed Parakeet	Psittacula cyanocephala	Psittaciformes	Psittacidae	LC	1
228	Purple Heron	Ardea purpurea	Pelecaniformes	Ardeidae	LC	1
229	Purple Sunbird	Cinnyris asiaticus	Passeriformes	Nectariniidae	LC	2
230	Purple Swamphen	Porphyrio porphyrio	Gruiformes	Rallidae	LC	1
231	Purplerumped Sunbird	Leptocoma zeylonica	Passeriformes	Nectariniidae	LC	2
232	Red Avadavat	Amandava amandava	Passeriformes	Estrildidae	LC	1
233	Red breasted Flycatcher	Ficedula parva	Passeriformes	Muscicapidae	LC	2
234	Red Collared Dove	Streptopelia tranquebarica	Columbiformes	Columbidae	LC	2
235	Red Phalarope	Phalaropus fulicarius	Charadriiformes	Scolopacidae	LC	1
236	Red vented Bulbul	Pycnonotus cafer	Passeriformes	Pycnonotidae	LC	2
237	Red wattled Lapwing	Vanellus indicus	Charadriiformes	Charadriidae	LC	2
238	Redcrested Pochard	Netta rufina	Anseriformes	Anatidae	LC	2
239	Red-headed Bunting	Emberiza bruniceps	Passeriformes	Emberizidae	LC	1
240	Red-necked Falcon	Falco chicquera	Falconiformes	Falconidae	NT	1
241	Red-necked Phalarope	Phalaropus lobatus	Charadriiformes	Scolopacidae	LC	1
242	Red-rumped Swallow	Cecropis daurica	Passeriformes	Hirundinidae	LC	1
243	Red-tailed Shrike	Lanius phoenicuroides	Passeriformes	Laniidae	LC	1
244	Red-tailed Wheatear	Oenanthe chrysopygia	Passeriformes	Muscicapidae	LC	1
245	Red-throated Flycatcher	Ficedula albicilla	Passeriformes	Muscicapidae	LC	1
246	Red-whiskered Bulbul	Pycnonotus jocosus	Passeriformes	Pycnonotidae	LC	1
247	River Tern	Sterna aurantia	Charadriiformes	Laridae	NT	2
248	Rock Bush-Quail	Perdicula argoondah	Galliformes	Phasianidae	LC	1
249	Rock Pigeon	Columba livia	Columbiformes	Columbidae	LC	2
250	Rose ringed Parakeet	Psittacula krameri	Psittaciformes	Psittacidae	LC	2
251	Rosy Starling	Pastor roseus	Passeriformes	Sturnidae	LC	1
252	Ruddy Shelduck	Tadorna ferruginea	Anseriformes	Anatidae	LC	2
253	Ruff	Calidris pugnax	Charadriiformes	Scolopacidae	LC	2
254	Rufous fronted Prinia	Prinia buchanani	Passeriformes	Cisticolidae	LC	2
255	Rufous Treepie	Dendrocitta vagabunda	Passeriformes	Corvidae	LC	2

256	Rufoustailed Lark	Ammomanes phoenicura	Passeriformes	Alaudidae	LC	2
257	Rufous-tailed Scrub-Robin	Cercotrichas galactotes	Passeriformes	Muscicapidae	LC	1
258	Saker Falcon	Falco cherrug	Falconiformes	Falconidae	EN	1
259	Sand Martin	Riparia riparia	Passeriformes	Hirundinidae	LC	1
260	Sarus Crane	Grus antigone	Gruiformes	Gruidae	VU	1
261	Savanna Nightjar	Caprimulgus affinis	Caprimulgiformes	Caprimulgidae	LC	1
262	Scaly-breasted Munia	Lonchura punctulata	Passeriformes	Estrildidae	LC	1
263	Shikra	Accipiter badius	Accipitriformes	Accipitridae	LC	2
264	Short toed Snake Eagle	Circaetus gallicus	Accipitriformes	Accipitridae	LC	2
265	Short-eared Owl	Asio flammeus	Strigiformes	Strigidae	LC	1
266	Siberian Stonechat	Saxicola maurus	Passeriformes	Muscicapidae	LC	2
267	Sind Sparrow	Passer pyrrhonotus	Passeriformes	Passeridae	LC	2
268	Singing Bushlark	Mirafra cantillans	Passeriformes	Alaudidae	LC	1
269	Sirkeer Malkoha	Taccocua leschenaultii	Cuculiformes	Cuculidae	LC	1
270	Small Minivet	Pericrocotus cinnamomeus	Passeriformes	Campephagidae	LC	2
271	Small Pratincole	Glareola lactea	Charadriiformes	Glareolidae	LC	2
272	Spanish Sparrow	Passer hispaniolensis	Passeriformes	Passeridae	LC	1
273	Spotted Dove	Spilopelia chinensis	Columbiformes	Columbidae	LC	1
274	Spotted flycatcher	Muscicapa striata	Passeriformes	Muscicapidae	LC	1
275	Spotted Owlet	Athene brama	Strigiformes	Strigidae	LC	2
276	Spotted Redshank	Tringa erythropus	Charadriiformes	Scolopacidae	LC	2
277	Spotted Sandgrouse	Pterocles senegallus	Pteroclidiformes	Pteroclididae	LC	1
278	Steppe Eagle	Aquila nipalensis	Accipitriformes	Accipitridae	EN	2
279	Stoliczka's Bushchat	Saxicola macrorhynchus	Passeriformes	Muscicapidae	VU	2
280	Streak-throated Swallow	Petrochelidon fluvicola	Passeriformes	Hirundinidae	LC	1
281	Striated Babbler	Argya earlei	Passeriformes	Leiothrichidae	LC	2
282	Striated Heron	Butorides striata	Pelecaniformes	Ardeidae	LC	1
283	Striolated Bunting	Emberiza striolata	Passeriformes	Emberizidae	LC	1
284	Sulphur-bellied Warbler	Phylloscopus griseolus	Passeriformes	Phylloscopidae	LC	1
285	Sykes's Warbler	Iduna rama	Passeriformes	Acrocephalidae	LC	1
286	Tawny Eagle	Aquila rapax	Accipitriformes	Accipitridae	VU	2
287	Tawny Pipit	Anthus campestris	Passeriformes	Motacillidae	LC	1
288	Temminck's Stint	Calidris temminckii	Charadriiformes	Scolopacidae	LC	2
289	Terek Sandpiper	Xenus cinereus	Charadriiformes	Scolopacidae	LC	1
290	Tree Pipit	Anthus trivialis	Passeriformes	Motacillidae	LC	2
291	Tufted Duck	Aythya fuligula	Anseriformes	Anatidae	LC	2
292	Variable Wheatear	Oenanthe picata	Passeriformes	Muscicapidae	LC	2
293	Water Pipit	Anthus spinoletta	Passeriformes	Motacillidae	LC	1
294	Western Koel	Eudynamys scolopaceus	Cuculiformes	Cuculidae	LC	1
295	Western Reef-egret	Egretta gularis	Pelecaniformes	Ardeidae	LC	1
296	Western Yellow Wagtail	Motacilla flava	Passeriformes	Motacillidae	LC	2
297	Whiskered Tern	Chlidonias hybrida	Charadriiformes	Laridae	LC	1
298	White browed Wagtail	Motacilla maderaspatensis	Passeriformes	Motacillidae	LC	2
299	White eared Bulbul	Pycnonotus leucotis	Passeriformes	Pycnonotidae	LC	2
300	White Wagtail	Motacilla alba	Passeriformes	Motacillidae	LC	2
301	White-bellied Drongo	Dicrurus caerulescens	Passeriformes	Dicruridae	LC	1
302	White-bellied Minivet	Pericrocotus erythropygius	Passeriformes	Campephagidae	LC	1
303	White-bellied Treepie	Dendrocitta leucogastra	Passeriformes	Corvidae	LC	1
304	White-breasted Waterhen	Amaurornis phoenicurus	Gruiformes	Rallidae	LC	2
305	White-browed Fantail	Rhipidura aureola	Passeriformes	Rhipiduridae	LC	2

306	White-cheeked Barbet	Psilopogon viridis	Piciformes	Megalaimidae	LC	1
307	White-eyed Buzzard	Butastur teesa	Accipitriformes	Accipitridae	LC	2
308	White-rumped Vulture	Gyps bengalensis	Accipitriformes	Accipitridae	CR	1
309	Whitetailed Lapwing	Vanellus leucurus	Charadriiformes	Charadriidae	LC	2
310	White-tailed Sea-eagle	Haliaeetus albicilla	Accipitriformes	Accipitridae	LC	1
311	White-throated Fantail	Rhipidura albicollis	Passeriformes	Rhipiduridae	LC	1
312	Whitethroated Kingfisher	Halcyon smyrnensis	Coraciiformes	Alcedinidae	LC	2
313	Wire tailed Swallow	Hirundo smithii	Passeriformes	Hirundinidae	LC	2
314	Wood Sandpiper	Tringa glareola	Charadriiformes	Scolopacidae	LC	1
315	Woolly-necked Stork	Ciconia episcopus	Ciconiiformes	Ciconiidae	VU	1
316	Yellow-crowned Woodpecker	Leiopicus mahrattensis	Piciformes	Picidae	LC	1
317	Yellow-eyed Babbler	Chrysomma sinense	Passeriformes	Sylviidae	LC	1
318	Yelloweyed Pigeon	Columba eversmanni	Columbiformes	Columbidae	VU	2
319	Yellowlegged Green Pigeon	Treron phoenicopterus	Columbiformes	Columbidae	LC	2
320	Yellowthroated Sparrow	Gymnoris xanthocollis	Passeriformes	Passeridae	LC	2
321	Yellow-wattled Lapwing	Vanellus malabaricus	Charadriiformes	Charadriidae	LC	1
322	Zitting Cisticola	Cisticola juncidis	Passeriformes	Cisticolidae	LC	1

Abbreviations:

1 = eBird data,

2 = survey record

भारतीय वन्यजीव संस्थान
Wildlife Institute of India

BUSTARD
RECOVERY PROGRAM

INTERIM REPORT

STATUS OF MIGRATORY BIRDS AND KEY WILDLIFE IN BIKANER, RAJASTHAN

2020

Front Cover:
Demoiselle Crane: Dhritiman Mukherjee

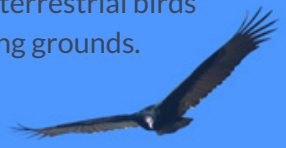
CONTENT

Griffon Vulture

BACKGROUND

The Indian subcontinent hosts a wide spectrum of migratory birds, particularly during winter. According to the State of Indian Birds (SOIB) report 2020, 280 species are long distance migrants with majority wintering in the country with its warm tropical climate and rich habitats immediately south of the Palearctic region. India lies along three major bird migratory flyways, identified by United Nation Environment Program's Convention on the Conservation of Migratory Species of Wild Animals: Central Asian Flyway (CAF), East Asian Australasian Flyway over parts of eastern India (EAAF), and Asian East African Flyway (EAF).

India is a signatory to the Convention of Migratory Species, which prescribes science-based conservation measures to ensure the survival of species as well as their habitats and to provide sustainable benefits to people. According to the Government of India's National Action Plan for Conservation of Migratory Birds in Central Asian Flyway (2018-2023), over 370 migratory bird species from three flyways visit the Indian subcontinent, among which 310 are wetland specialists while the rest are terrestrial. Long-term datasets show that CAF migratory terrestrial birds are declining rapidly. Species that breed on grasslands and agricultural areas, and those wintering in deserts of Thar and the Rann of Kutch are most affected. Changing land-use is the most important factor affecting terrestrial birds across breeding and non-breeding grounds.



For conservation of migratory birds in India, the National Action Plan proposes measures such as: a) assessing status and distribution of migratory birds in wetlands and terrestrial habitats, b) evaluation of threats and site specific recommendations to mitigate them, c) involving local communities in conservation activities including citizen science groups, d) sustainable management of habitats through capacity building and outreach. To further this initiative and develop conservation plans for local wildlife, the Hon'ble Minister of State for Heavy Industries & Public Enterprises and Parliamentary Affairs-GoI, on the request of local people, invited the Wildlife Institute of India (WII) through Ministry of Environment Forest and Climate Change (MoEFCC) to conduct a status survey on migratory birds and other key wildlife in Bikaner parliamentary constituency. This area situated in Thar Desert of western Rajasthan, warrants conservation interventions to arrest the decline of migratory birds, as highlighted in the National Action Plan (CAF National Action Plan 2018-India).

This is an interim report on the status of migratory bird species and other key wildlife of this region using existing information. We have used eBird data, wildlife surveys conducted by the WII and Rajasthan Forest Department in the southern part of this region during 2014-17, and other scientific sources to prepare this report. We propose survey in winter season (between November 2020 - February 2021), the period when many migratory species visit the area. These surveys will aim at assessing the status of migratory birds and other key wildlife so that priority areas and conservation actions can be identified. Special permissions would be required from Ministry of Home Affairs and Ministry of Defense to survey the international border and Indian Army's field firing range in Mahajan, spanning an area of ~ 1,300 sqkm that perhaps serves as viable wildlife habitat due to low human footprint.

STUDY AREA

Indian Gazelle

Bikaner Parliamentary Constituency

Bikaner Parliamentary Constituency is spread across an area of 32,528 km^2 and is situated in northwestern region of Rajasthan State (Figure 1). The area has 11 administrative units or Tehsils namely, Bikaner, Nokha, Lunkaransar, Khajuwala, Shri Dungargarh, Kolayat, Chhattargarh and Pugal (Bikaner District), Rawla Mandi, Gharsana and Anupgarh (Sri Ganganagar District). According to Census of India 2011, the human population in Bikaner District is 23,63,987 (density 78 km^{-2}), whereas the human population in Sri Ganganagar part of the constituency is 3,56,253 (density 155 km^{-2}).

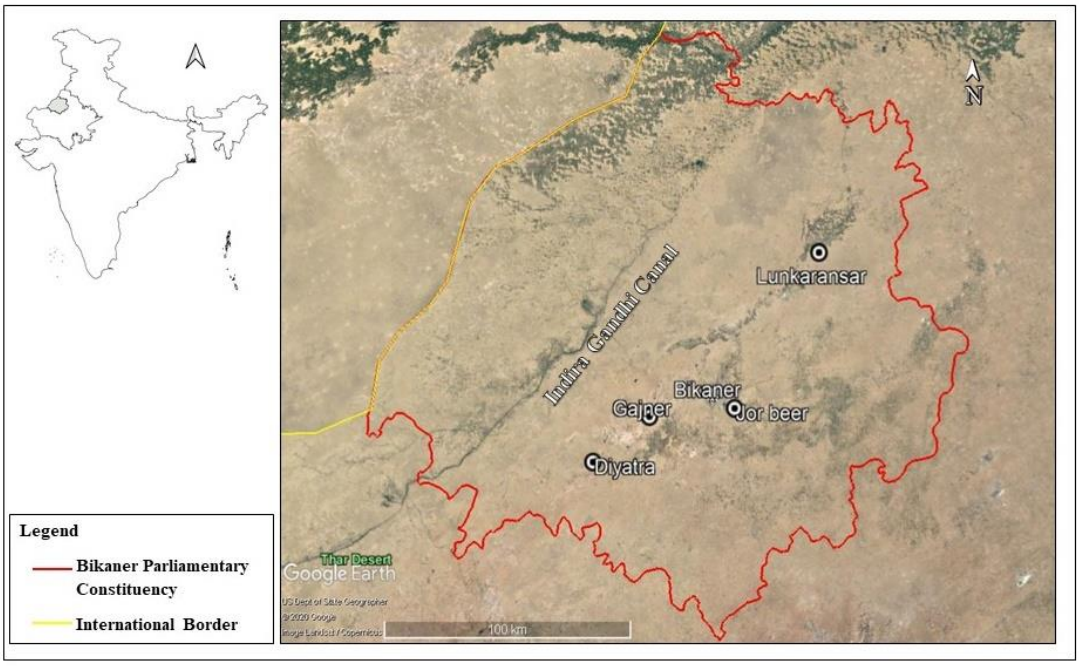


Figure 1. Map of the study area indicating important wildlife areas

Rain-fed and irrigated farming along with animal husbandry are the main livelihoods of people in this region. The Indira Gandhi Canal on the western side of the area with the main canal of length ~ 200 km running from North to South and its distribution system is the primary source of water for irrigation. The population of large livestock (cattle and buffalo) in Bikaner District is 14,02,980 (density 46 km^{-2}) and small stock- sheep and goat is 12,88,905 (density 43 km^{-2}). In Sri Ganganagar part of the constituency, large livestock population is 1,87,569 (density- 82 km^{-2}) and small stock population is 1,25,634 (density- 55 km^{-2}) according to Livestock census of India 2019.

The area falls in Desert Biogeographic Zone (Rodgers et al. 2002) with super-arid conditions and is part of the *Marusthali* region of the Great Indian Thar Desert (Sharma et al. 2013). Rainfall is scarce and erratic, at mean annual precipitation of 100-500 mm that decreases from east to west (Pandeya et al. 1977). The climate is characterized by very hot summer (temperature rising up to 50°C), and cold winter (temperature dropping below 0°C), and large diurnal temperature range (Sikka 1997). The topography of the area is mostly flat and the elevation ranges from 154- 429m

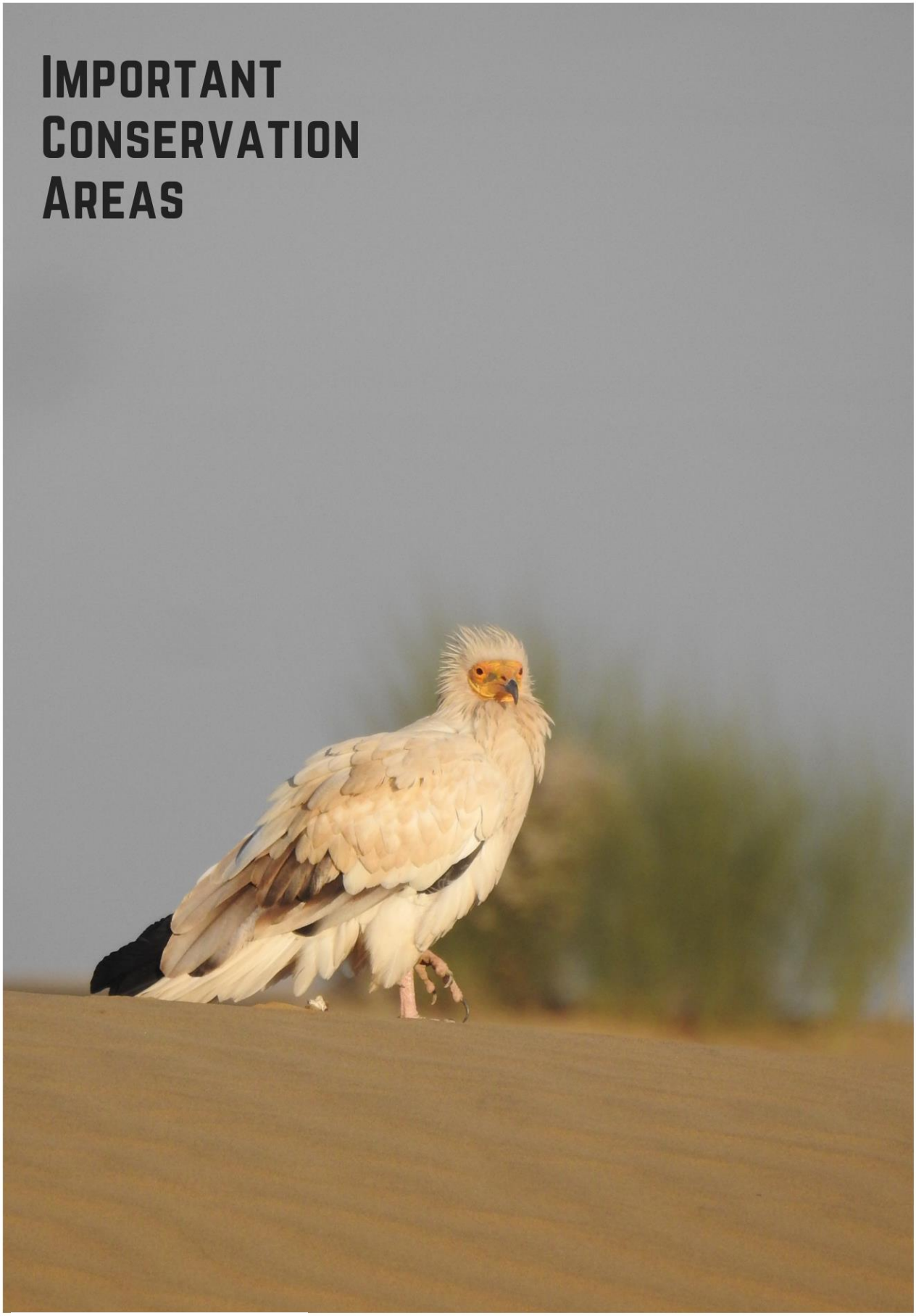
above msl (Sehgal 1962, 1962a). Broad topographical features are gravel plains, rocky hillocks, sand-soil mix, and sand dunes (Ramesh and Ishwar 2008).

The vegetation is thorny Scrub, characterized by open woodlot dominated by *Prosopis cineraria*, *Salvadora persica* and exotic *Acacia tortilis* trees, scrubland dominated by *Capparis decidua*, *Zizyphus mauritiana*, *Salvadora oleoidis*, *Calligonum polygonoides*, *Leptadenia pyrotechnica*, *Aerva pseudotomentosa*, *Haloxylon salicornicum* and *Crotolaria bhuria* shrubs, and grasslands dominated by *Lasiurus sindicus* and *Dactyloctenium sindicum*.

Notable fauna include mammals like chinkara *Gazella bennettii*, blackbuck *Antelope cervicapra*, nilgai *Boselaphus tragocamelus* Indian fox *Vulpes bengalensis*, desert or white-footed fox *Vulpes vulpes pusilla*, Indian wolf *Canis lupus* pallipes, golden jackal *Canis aureus* and desert cat *Felis silvestris*, birds like demoiselle crane *Grus virgo*, Macqueen's bustard *Chlamydotis macqueenii*, cream-coloured courser *Cursorius cursor*, Stoliczka's or white-browed bushchat *Saxicola macrorhynchus*, sandgrouses *Pterocles* spp., larks, and several raptors including red-headed vulture *Sarcogyps calvus*, Himalayan griffon *Gyps himalayensis*, Eurasian griffon or griffon vulture *Gyps fulvus*, Indian vulture *Gyps indicus*, white-rumped vulture *Gyps bengalensis*, cinereous vulture *Aegypius monachus*, and Egyptian vulture *Neophron percnopterus*.

Historically, Critically Endangered Great Indian bustard *Ardeotis nigriceps*, the State bird of Rajasthan was present in the area but there have been no recent sightings (Rahmani et al. 2016). The total forest area in Bikaner district is 942 km^2 and other potential areas for wildlife such as permanent pasture and other grazing land, culturable waste land and fallow land together constitute an area of 10,000 km^2 (Census of India 2011). Three large water bodies in the area are situated in Gajner, Kolayat and Lunkansar (salt water lake) (Sehgal 1962).

Important Conservation Areas



Egyptian Vulture

Jorbeer Conservation Reserve situated in Bikaner District and spanning across an area of 56 km^2, ppis a cattle carcass dumping ground near Bikaner city. The area is famous for congregation of vultures, eagles and yellow-eyed pigeon during winter and is a designated Important Bird Area (IBA) Criteria: A1 (threatened species), A4i (1% of global population) (Rahmani et al. 2016). Notable avifauna found in this reserve include Critically Endangered- red-headed vulture, Indian vulture and white-rumped vulture; Endangered Egyptian vulture; Vulnerable- Pallas's fish eagle *Haliaeetus leucoryphus*, greater spotted eagle *Clanga clanga*, imperial eagle *Aquila heliacal*; Near threatened species- yellow-eyed pigeon *Columba eversmanni*, cinereous vulture, and Himalayan griffon.

Diyatra Area (50 km^2) situated in Bikaner District is a designated IBA**:** A1 (Threatened species). This grassland habitat was selected as IBA because of presence of Critically Endangered Great Indian bustard. This site was a former hunting reserve of erstwhile royalty of Bikaner, presently is in a state of neglect and flagged as a IBA in danger since it is in a state of neglect. Other important birds found in the area include Critically Endangered- Indian vulture and white-rumped vulture, Endangered Egyptian vulture, Vulnerable-Macqueen's bustard and Stoliczka's or white-browed bushchat, Near Threatened cinereous vulture, demoiselle crane and short-eared owl *Asio flammeus*. Critically Endangered Great Indian bustard was found in the area, but there have been no recent sightings (Rahmani et al. 2016).

Gajner Wildlife Sanctuary (area- 24 km^2) is a private Sanctuary situated in Bikaner District. This area was the former hunting ground for the erstwhile royalty of Bikaner. A wetland is present in the Sanctuary and hundreds of migratory water birds and sandgrouse spp. are found here during winter. The occasional presence of Great Indian bustard was also reported in the past. Blackbuck, which was introduced here by the erstwhile rulers of Bikaner during 1920's is present in and around the Sanctuary (Rahmani and Sankaran 1991) along with chinkara, Indian wolf and golden jackal. A few bird species found in the here are demoiselle crane, dalmatian pelican *Pelecanus crispus*, Eurasian coot *Fulica atra*, ruddy shelduck *Tadorna ferruginea*, and northern pintail *Tadorna ferruginea*.

Lunkaransar Salt Lake is situated in Lunkaransar Tehsil, Bikaner District and is an important area for migratory water birds. Notable species found here include greater flamingo *Phoenicopterus roseus*, northern shoveler *Spatula clypeata*, ruff *Philomachus pugnax*, white-tailed lapwing *Vanellus leucurus*, and red-necked phalarope *Phalaropus lobatus*.

Other important wildlife habitats are found in Bajju (210.00 km^2), Deshnok (25.17 km^2), Mukam (168.82 km^2), along the international border and Mahajan Field Firing Range (~ 1300 km^2).

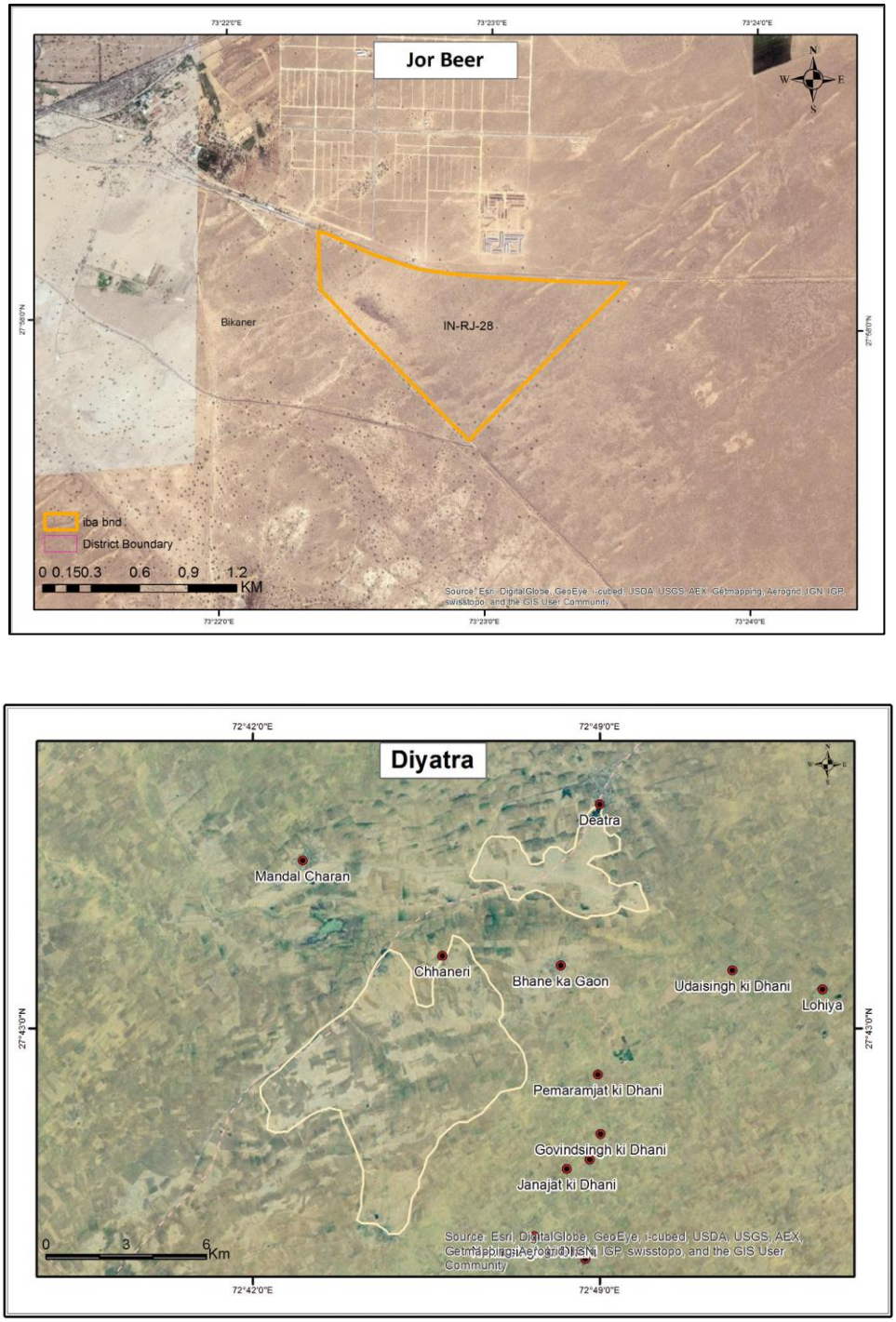


Figure 2. Important Bird Areas, Jorbeer Conservation Reserve (top) and Diyatra Area (bottom), situated in Bikaner District, Rajasthan. Source: Rahmani et al. 2016

METHODS

Stoliczka's (White-browed) Bushchat

For preliminary understanding of bird status, distribution and important conservation areas, we accessed data from eBird online platform (www.ebird.org), a citizen science initiative, where bird watchers around the world upload their bird observation lists. We also used the WII's survey data (2014 -2017) on great Indian bustard and associated wildlife. We included bird sighting lists of Bikaner region that were complete and between 2014–20, to understand their recent status and because the data availability is sparse before 2014. We removed unsure or ambiguous reporting of species (eg., species recorded as bird sp., *Aquilla* sp., *buteo/falco* sp. etc.). We used the GPS coordinates of unique bird lists to segregate them into 625 km^2 (25km× 25km) grid-cells that were overlaid on the 32,528 km^2 study area using program QGIS (Figure 3). We categorized the species as resident and migratory and assessed 1) the bird species pool in the study area along with their ecological and conservation status, 2) number of species detected in a grid-cell, or a crude metric of species richness, to identify bird hotspots and priority cells, 3) reporting frequency of each species computed as the proportion of complete lists that included the species for each grid-cell, averaged across cells (following SOIB 2020). This metric is a crude surrogate of species' abundance as more the number of a species in an area more likely is its detection during a search. We provide mean reporting frequency of all species and reporting frequency at the cell level for species of conservation/ cultural importance in Bikaner, based on IUCN Red List and SOIB 2020 conservation priority. Information of distribution range size and status of these important species at the country scale are also reported based on the State of India Birds 2020 report.

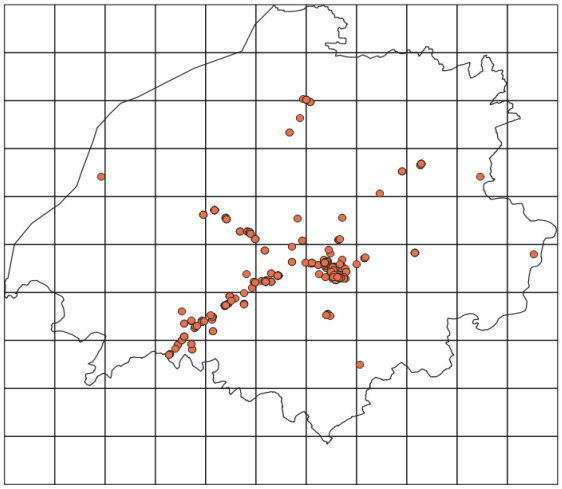


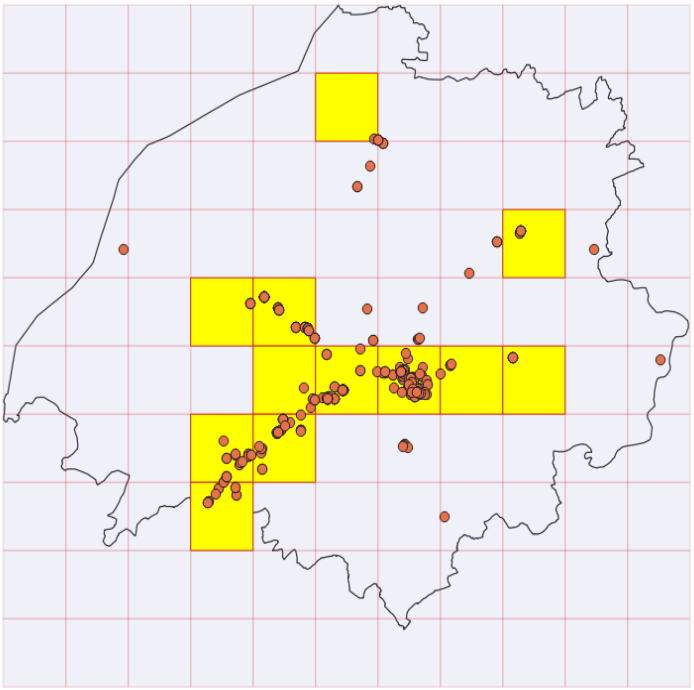
Figure 3: Grid- cells of 25 km squares overlaid on study area with locations of bird lists accessed from eBird database (2014–20)

Survey of potential great Indian bustard habitat in southern part of Bikaner District (Area-300 km^2) as part of the WII'S bustard recovery program was conducted using vehicle transects in a systematic sampling design during 2014-2017. Sampling was conducted in early morning (0600-1100) and late afternoon (1600-1900), when bird/animal activity was highest. Prior to surveys, team members were trained through workshops and field exercises on a standardized data collection protocol. Data on great Indian bustard, key associated species (desert fox, Indian fox, chinkara and nilgai), and biotic disturbance agents (feral dogs and livestock) were collected along the transect. As a preliminary estimate of animal population in Bikaner region, encounters rates (number of animals detected per km) were calculated for the above taxa. Past locations of great Indian bustard were collated from various sources to identify important habitats for this species.

RESULTS & DISCUSSION

Great Indian Bustard

Total 1158 bird lists were obtained from eBird data for the period 2014-2020 that reported 298 species in Bikaner region. Of these, 842 lists were complete with 291 species: 170 residents, 73 long distance migrants and 24 local migrants. These lists represented 12 grid-cells. Majority of lists were clustered in/around Jor beer Conservation area (63% lists in cell # 66) with 269 species, and Gajner wildlife Sanctuary and surroundings (13% in grid # 56) with 197 species. Collectively, these areas included >90% of the species found in the region. In Lunkanasar Salt Lake area, 86 species were reported (Figure 4).



Cell	Complete lists	Species reported
35	5	20
37	21	132
38	11	71
45	74	152
46	6	61
47	56	118
52	7	85
56	107	197
66	527	269
76	7	31
84	13	94
86	8	45

Figure 4. Cells with five or more eBbird (2014–20) lists (in yellow) included in the study

We identified 16 bird species for priority conservation measures in Bikaner region (Table 1). These species were considered important because of their IUCN Red List status, high regional conservation concern assigned to them in the State of Indian Birds 2020 report, and their ecological/ cultural values. Nine of these species are resident and seven long distance migrants.

The reporting frequency for species of conservation/ cultural importance at cell and regional levels in Bikaner is presented in Table 2. Great grey shrike (0.29 ± 0.10SE) had the maximum mean reporting frequency followed by Egyptian vulture (0.26 ± 0.08SE) and Steppe eagle (0.14 ± 0.05SE). Reporting frequencies of all bird species are available in Appendix 1. Distribution maps of these species, using reporting frequency at cell level, are presented in Figure 5.

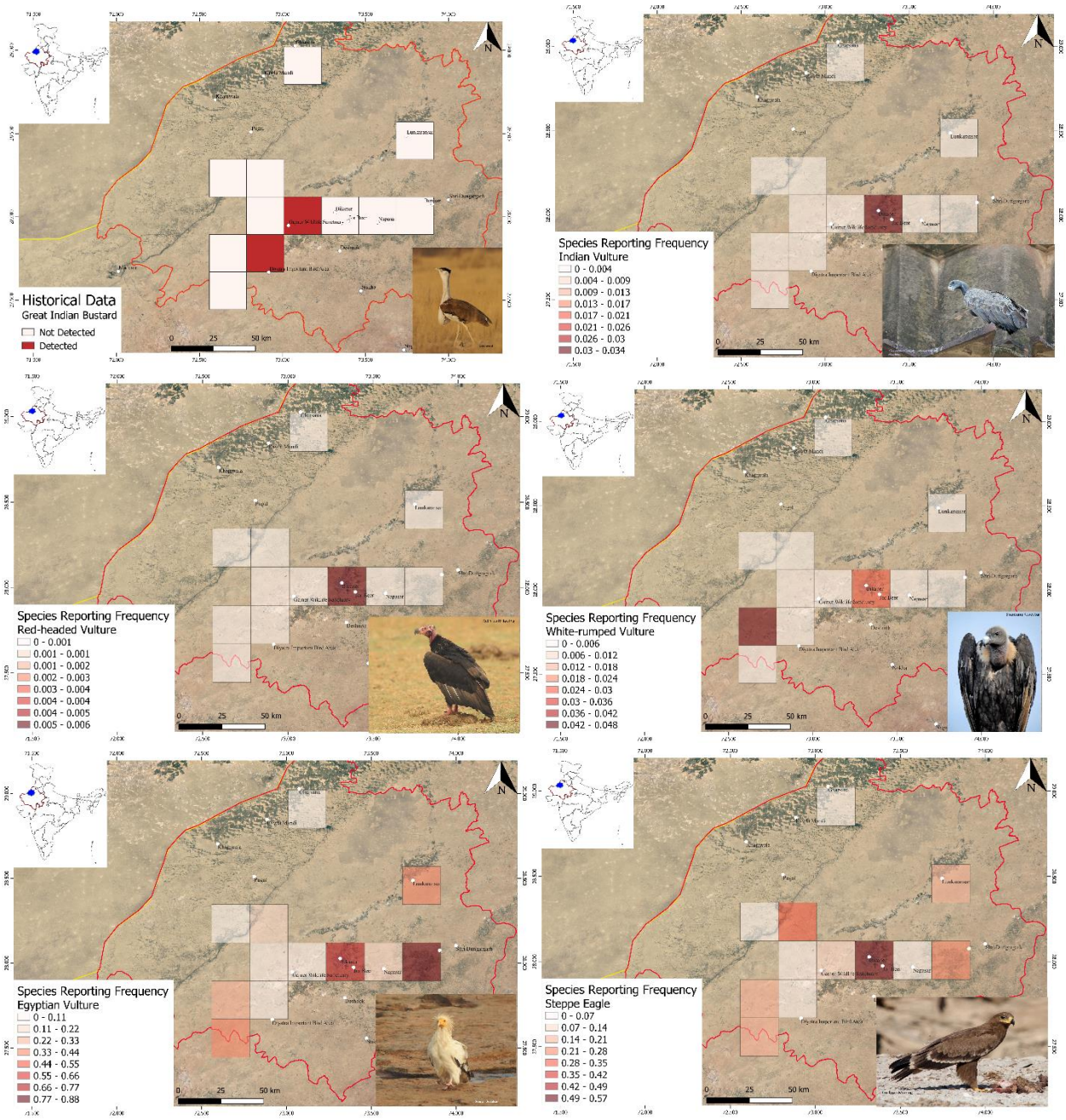
Table 1: Avifauna of conservation/ cultural importance in Bikaner region

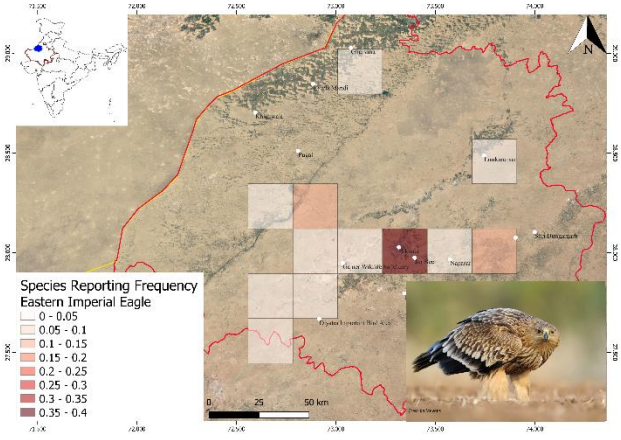
Species	Scientific name	IUCN status	WLPA Schedule	Resident/ Migratory
Great Indian bustard	*Ardeotis nigriceps*	Critically Endangered	I	Resident
Indian vulture	*Gyps indicus*	Critically Endangered	I	Resident
Red-headed vulture	*Sarcogyps calvus*	Critically Endangered	IV	Resident
White-rumped vulture	*Gyps bengalensis*	Critically Endangered	I	Resident
Egyptian vulture	*Neophron percnopterus*	Endangered	IV	Resident
Steppe eagle	*Aquila nipalensis*	Endangered	I	Migratory
Eastern imperial eagle	*Aquila heliaca*	Vulnerable	I	Migratory
Tawny eagle	*Aquila rapax*	Vulnerable	I	Migratory
Macqueen's bustard	*Chlamydotis macqueenii*	Vulnerable	I	Migratory
Stoliczka's bushchat	*Saxicola macrorhynchus*	Vulnerable	IV	Resident
Himalayan vulture	*Gyps himalayensis*	Near Threatened	IV	Resident
Cinereous vulture	*Aegypius monachus*	Near Threatened	IV	Migratory
Yellow-eyed pigeon	*Columba eversmanni*	Near Threatened	IV	Migratory
Demoiselle crane	*Grus virgo*	Least Concern	IV	Migratory
Rufous-fronted prinia	*Prinia buchanani*	Least Concern	IV	Resident
Great grey shrike	*Lanius excubitor*	Least Concern	IV	Resident

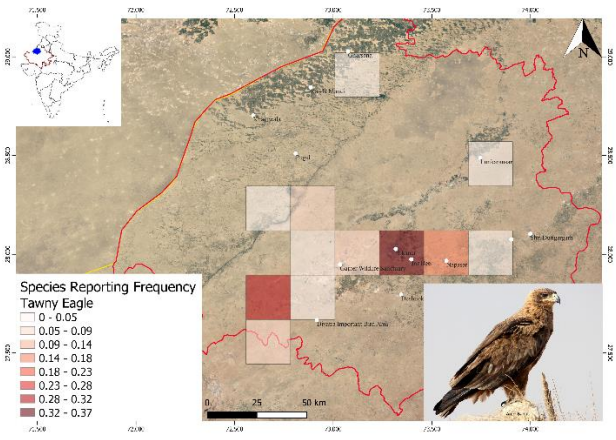
Table 2. Reporting frequency of important bird species in Bikaner. Source: eBird data (2014–20)

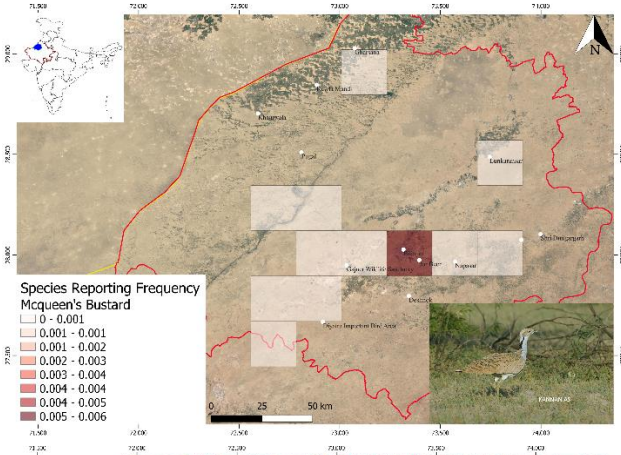
Species	Grid-cells												Mean (SE) reporting frequency
	35	37	38	45	46	47	52	56	66	76	84	86	
Great Indian bustard	Not reported in the list												-
Indian vulture	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.0028 (0.0028)
Red-headed vulture	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.0005 (0.0005)
White-rumped vulture	0	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.0062 (0.0044)
Egyptian vulture	0	0.29	0.36	0.12	0.00	0.09	0.00	0.09	0.73	0.14	0.38	0.88	0.2574 (0.0835)
Steppe eagle	0	0.19	0.18	0.30	0.00	0.00	0.00	0.09	0.57	0.00	0.15	0.25	0.1444 (0.0494)
Eastern imperial eagle	0	0.05	0.00	0.14	0.00	0.00	0.00	0.05	0.40	0.00	0.00	0.13	0.0629 (0.0338)
Tawny eagle	0	0.29	0.09	0.07	0.00	0.02	0.00	0.05	0.37	0.14	0.00	0.00	0.0850 (0.0355)
Macqueen's bustard	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.0005 (0.0005)
Stoliczka's bushchat	0	0.00	0.36	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.0327 (0.0302)
Himalayan griffon	0	0.05	0.00	0.03	0.00	0.00	0.00	0.01	0.25	0.00	0.00	0.13	0.0384 (0.0221)
Cinereous vulture	0	0.05	0.00	0.00	0.00	0.00	0.00	0.03	0.41	0.00	0.00	0.13	0.0506 (0.0340)
Yellow-eyed pigeon	0	0.00	0.00	0.09	0.00	0.00	0.00	0.13	0.39	0.00	0.08	0.13	0.0680 (0.0330)
Demoiselle crane	0	0.14	0.00	0.00	0.02	0.07	0.00	0.31	0.03	0.00	1.15	0.00	0.1439 (0.0955)
Rufous-fronted prinia	0	0.14	0.18	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.0310 (0.0183)
Great grey shrike	1	0.43	0.82	0.15	0.02	0.18	0.00	0.07	0.51	0.14	0.00	0.13	0.2874 (0.0961)

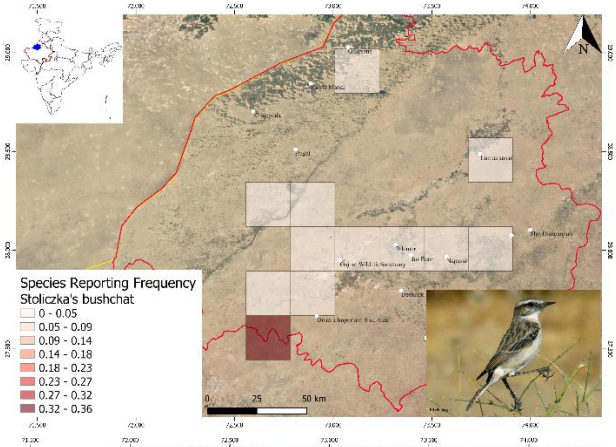
Figure 5. Distribution maps of important bird species, based on their reporting frequency across grid-cells in eBird data (2014–20). For Great Indian bustard historical locations of presence was used.

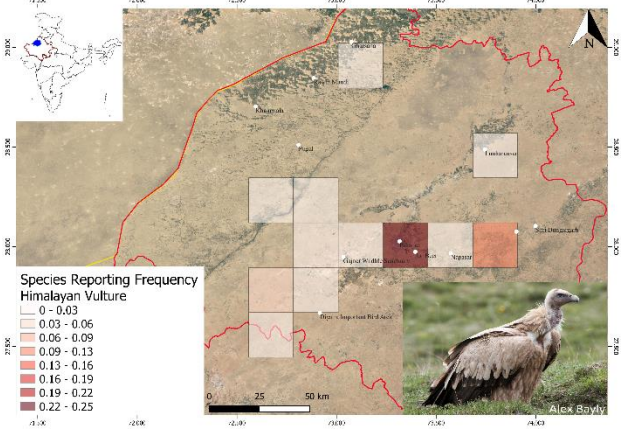


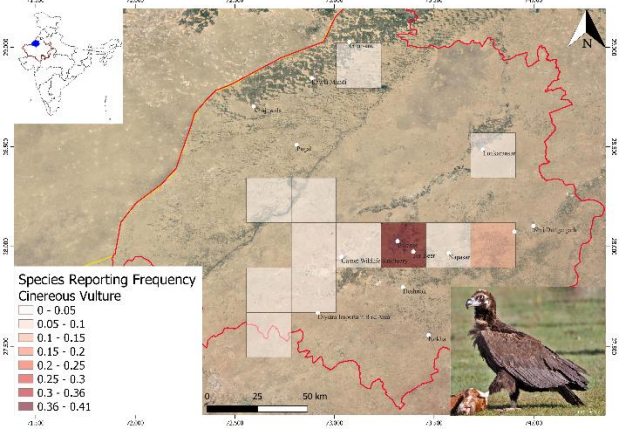

Species Reporting Frequency
Eastern Imperial Eagle
0 - 0.05
0.05 - 0.1
0.1 - 0.15
0.15 - 0.2
0.2 - 0.25
0.25 - 0.3
0.3 - 0.35
0.35 - 0.4
N
0 25 50 km

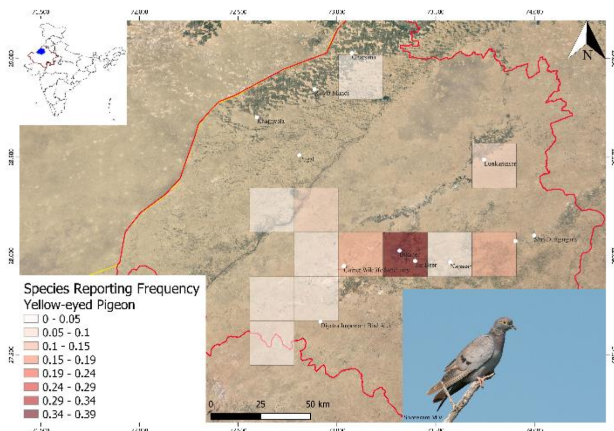

Species Reporting Frequency
Tawny Eagle
0 - 0.05
0.05 - 0.09
0.09 - 0.14
0.14 - 0.18
0.18 - 0.23
0.23 - 0.28
0.28 - 0.32
0.32 - 0.37
N
0 25 50 km

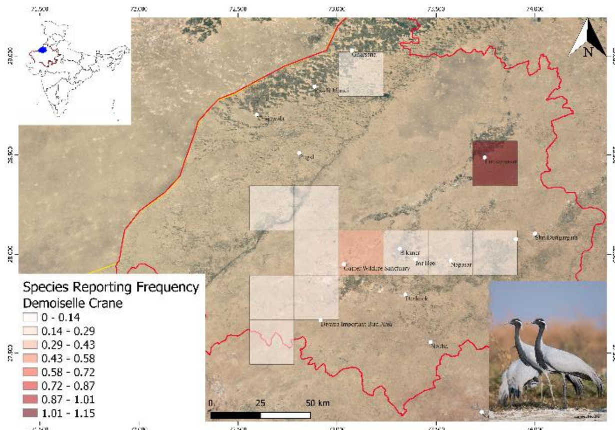

Species Reporting Frequency
Mcqueen's Bustard
0 - 0.001
0.001 - 0.001
0.001 - 0.002
0.002 - 0.003
0.003 - 0.004
0.004 - 0.004
0.004 - 0.005
0.005 - 0.006
N
0 25 50 km

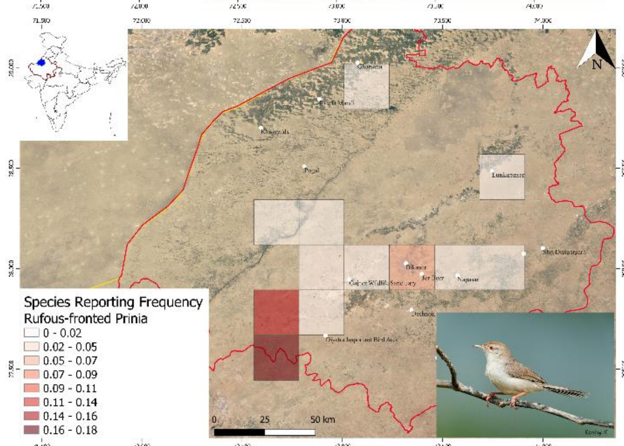

Species Reporting Frequency
Stoliczka's bushchat
0 - 0.05
0.05 - 0.09
0.09 - 0.14
0.14 - 0.18
0.18 - 0.23
0.23 - 0.27
0.27 - 0.32
0.32 - 0.36
N
0 25 50 km

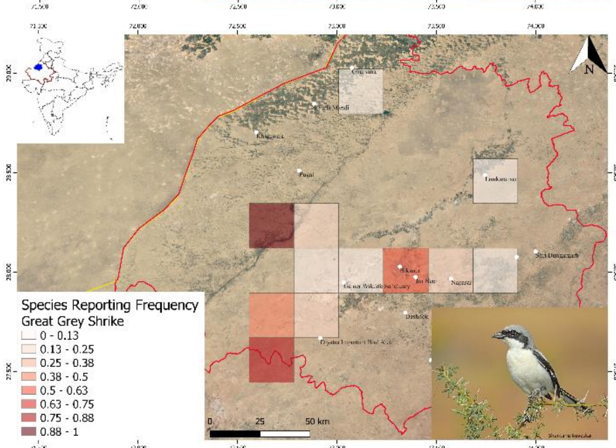

Species Reporting Frequency
Himalayan Vulture
0 - 0.03
0.03 - 0.06
0.06 - 0.09
0.09 - 0.13
0.13 - 0.16
0.16 - 0.19
0.19 - 0.22
0.22 - 0.25
N
0 25 50 km
Alex Bayly

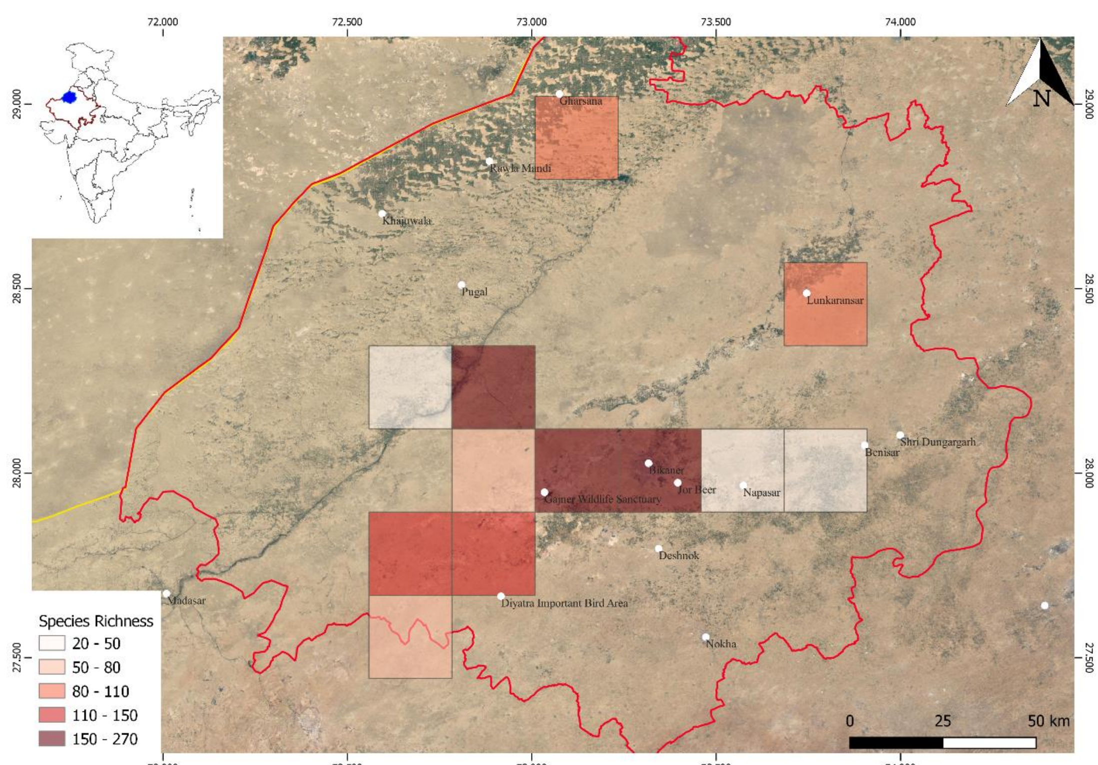

Species Reporting Frequency
Cinereous Vulture
0 - 0.05
0.05 - 0.1
0.1 - 0.15
0.15 - 0.2
0.2 - 0.25
0.25 - 0.3
0.3 - 0.36
0.36 - 0.41
N
0 25 50 km


Species Reporting Frequency
Yellow-eyed Pigeon
0 - 0.05
0.05 - 0.1
0.1 - 0.15
0.15 - 0.19
0.19 - 0.24
0.24 - 0.29
0.29 - 0.34
0.34 - 0.39
0
25
50 km
N


Species Reporting Frequency
Demoiselle Crane
0 - 0.14
0.14 - 0.29
0.29 - 0.43
0.43 - 0.58
0.58 - 0.72
0.72 - 0.87
0.87 - 1.01
1.01 - 1.15
0
25
50 km
N


Species Reporting Frequency
Rufous-fronted Prinia
0 - 0.02
0.02 - 0.05
0.05 - 0.07
0.07 - 0.09
0.09 - 0.11
0.11 - 0.14
0.14 - 0.16
0.16 - 0.18
0
25
50 km
N


Species Reporting Frequency
Great Grey Shrike
0 - 0.13
0.13 - 0.25
0.25 - 0.38
0.38 - 0.5
0.5 - 0.63
0.63 - 0.75
0.75 - 0.88
0.88 - 1
0
25
50 km
N


72.000
72.500
73.000
73.500
74.000
29.000
28.500
28.000
27.500
N
Gharsana
Rawla Mandi
Khajuwala
Pugal
Lunkaransar
Shri Dungargarh
Benisar
Bikaner
Jor Beer
Napasar
Gajner Wildlife Sanctuary
Deshnok
Diyatra Important Bird Area
Madasar
Nokha
Species Richness
20 - 50
50 - 80
80 - 110
110 - 150
150 - 270
0
25
50 km

The current status and distribution range size of these important species at the country scale were obtained from Status of India Birds 2020 report (Table 3). Yellow-eyed pigeon with 6,734.92 (95% CI-988) km^2 had the least distribution range size at the country scale followed by great Indian bustard with 23,148.77 (95% CI-1,163) km^2 and great grey shrike with 42,582.65 (95% CI-684) km^2. Three of these species *viz.* Great Indian bustard, Indian vulture and rufous-fronted prinia are endemic to the Indian subcontinent and four species are highly threatened including the first two endemics, red-headed vulture and white-rumped vulture.

Great Indian bustard was not reported in the lists accessed from eBird database. Historical locations of GIB obtained as part of the WII's bustard recovery program were collated and plotted for the study area (Figure 6). Great Indian bustard presence was reported from six areas in the past *viz.* Diyatra, Gajner, Kolayat, Jhaju and Nokha and possibly still harbor scattered potential bustard habitats which could be revived with effective conservation management.

Table 3. Country scale status and distribution range size of avifauna of conservation/ cultural importance in Bikaner region. Source: SOIB 2020 report

Species	Current status	Distribution range size	
		Mean	95% CI
Great Indian bustard	Data Deficient	23148.77	1163
Indian vulture	Strong Decline	244856.90	701
Red-headed vulture	Strong Decline	244856.90	676
White-rumped vulture	Strong Decline	243879.10	765
Egyptian vulture	Strong Decline	623957.20	764
Steppe eagle	Uncertain	334531.50	692
Eastern imperial eagle	Uncertain	87487.02	764
Tawny eagle	Strong Decline	397137	924
Macqueen's bustard	NA	NA	NA
Stoliczka's bushchat	Data Deficient	52820.42	773
Himalayan vulture	Uncertain	122365.70	741
Cinereous vulture	Moderate Decline	60030.17	906
Yellow-eyed pigeon	Data Deficient	6734.92	988
Demoiselle crane	Uncertain	147106.20	817
Rufous-fronted prinia	Strong Decline	345094.70	1045
Great grey shrike	Moderate Decline	42582.65	684

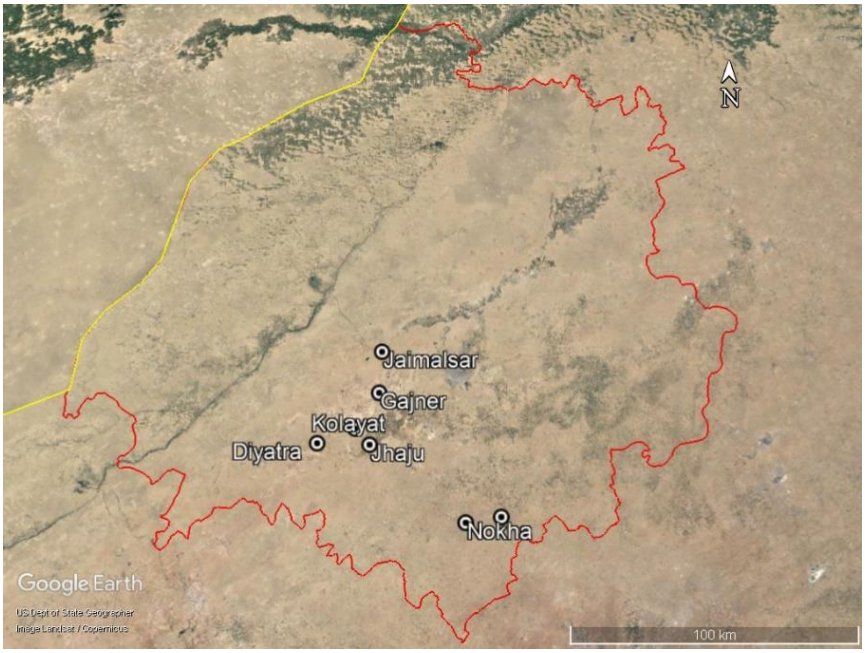


Figure 6. Past locations (village names) of great Indian bustard in Bikaner region

During the surveys conducted from 2014-17 by the WII bustard recovery program team in partnership with Rajasthan Forest Department, a total of 180 km were sampled in the southern part of the study area (300 km^2). Encounter rates of key species are presented in table 4.

Table 4: Encounter rate of animals sighted during surveys (2014-17) conducted by Wildlife Institute of India and Rajasthan Forest Department in the southern part of Bikaner region

Species	Encounter rate (Individuals per km)				
	2014	2015	2016	2017	All years
Chinkara	5.78	5.95	0.34	2.06	3.40
Desert fox	0.06	0.16	0.00	0.05	0.07
Nilgai	0.17	0.00	0.00	0.00	0.03
Dog	0.25	0.00	0.24	0.13	0.15
Cattle	3.33	2.73	2.13	0.88	2.09
Sheep & Goat	22.53	1.59	7.34	8.04	9.22

WAY FORWARD

Mcqueen’s Bustard

Survey will be conducted in Bikaner Parliamentary Constituency during the winter season from November 2020-February 2021 to assess the status of migratory birds and other major wildlife in a systematic sampling design. Habitat information including anthropogenic activities will be recorded. Additionally, brief questionnaire regarding wildlife will be conducted in the grid cells. Surveys inside Protected Areas/ Important Bird Areas/Potential wildlife areas will be carried out using more rigorous methods.

Based on the status assessment, priority areas and conservation action plans will be identified for key wildlife species.

Permissions are required for conducting the survey that may need facilitation from higher authorities.

Activity/Area	**Permitting Authority**
Survey of the entire study area	a) State Biodiversity Board, Rajasthan b) District Collectors of Bikaner District and Sri Ganganagar District
Survey in forest areas other than Protected Area/ Conservation Reserve	Principal Chief Conservator of Forests/ Head of Forest Force, Rajasthan Forest Department
Survey in Protected Area/ Conservation Reserve	Chief Wildlife Warden, Rajasthan Forest Department
Survey for Endangered species	Chief Wildlife Warden, Rajasthan Forest Department
Gajner Wildlife Sanctuary	Erstwhile royal family of Bikaner (Land owner)
Survey near International border	Ministry of Home Affairs, GoI
Survey in Mahajan Field Firing Range	Ministry of Defence, GoI

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Appendix 1

The mean reporting frequency for 291 bird species present in 12 grid-cells (size- 25km × 25km each) in Bikaner region. (CR- Critically Endangered, EN- Endangered, VU- Vulnerable, NT- Near Threatened, LC- Least concerned, WLPA- Wildlife Protection Act 1972)

Taxonomic group	S.No.	Common Name	Scientific Name	IUCN Status	WLPA Schedule	Resident/ Migratory	Mean (SE) Reporting Frequency
Waterfowls	1	Bar-headed Goose	*Anser indicus*	LC	IV	Migratory-Local	0.0343 (0.0229)
	2	Common Pochard	*Aythya ferina*	VU	IV	Migratory-Long-Distance	0.0803 (0.0364)
	3	Common Shelduck	*Tadorna tadorna*	LC	IV	Migratory	0.0034 (0.0034)
	4	Cotton Pygmy-Goose	*Nettapus coromandelianus*	LC	IV	Resident	0.0128 (0.0077)
	5	Eurasian Wigeon	*Mareca penelope*	LC	IV	Migratory-Long-Distance	0.0768 (0.0368)
	6	Ferruginous Duck	*Aythya nyroca*	NT	IV	Migratory-Long-Distance	0.0335 (0.0172)
	7	Gadwall	*Mareca strepera*	LC	IV	Migratory-Long-Distance	0.2329 (0.0791)
	8	Garganey	*Spatula querquedula*	LC	IV	Migratory-Long-Distance	0.0531 (0.0319)
	9	Green-winged Teal	*Anas crecca*	LC	IV	Migratory-Long-Distance	0.2247 (0.0883)
	10	Greylag Goose	*Anser anser*	LC	IV	Migratory-Long-Distance	0.0006 (0.0006)
	11	Indian Spot-billed Duck	*Anas poecilorhyncha*	LC	IV	Resident	0.0409 (0.0247)
	12	Knob-billed Duck	*Sarkidiornis melanotos*	LC	IV	Resident	0.002 (0.0015)
	13	Lesser Whistling-Duck	*Dendrocygna javanica*	LC	IV	Resident	0.0313 (0.0151)
	14	Mallard	*Anas platyrhynchos*	LC	IV	Migratory-Long-Distance	0.102 (0.0437)
	15	Northern Pintail	*Anas acuta*	LC	IV	Migratory-Long-Distance	0.1319 (0.0606)
	16	Northern Shoveler	*Spatula clypeata*	LC	IV	Migratory-Long-Distance	0.2575 (0.1054)
	17	Red-crested Pochard	*Netta rufina*	LC	IV	Migratory-Long-Distance	0.0208 (0.0109)

	18	Ruddy Shelduck	*Tadorna ferruginea*	LC	IV	Migratory-Local	0.0165 (0.0127)
	19	Tufted Duck	*Aythya fuligula*	LC	IV	Migratory-Long-Distance	0.041 (0.0244)
Grouse, Quail, and Allies	20	Black Francolin	*Francolinus francolinus*	LC	IV	Resident	0.0089 (0.0062)
	21	Common Quail	*Coturnix coturnix*	LC	IV	Migratory	0.0003 (0.0003)
	22	Grey Francolin	*Francolinus pondicerianus*	LC	IV	Resident	0.3826 (0.093)
	23	Indian Peafowl	*Pavo cristatus*	LC	I	Resident	0.1896 (0.074)
Flamingos	24	Greater Flamingo	*Phoenicopterus roseus*	LC	IV	Resident	0.0624 (0.045)
Grebes	25	Eared Grebe	*Podiceps nigricollis*	LC	IV	Migratory	0.0002 (0.0002)
	26	Little Grebe	*Tachybaptus ruficollis*	LC	IV	Resident	0.2657 (0.0844)
Pigeons and Doves	27	Eurasian Collared Dove	*Streptopelia decaocto*	LC	IV	Resident	0.7336 (0.1201)
	28	Laughing Dove	*Streptopelia senegalensis*	LC	IV	Resident	0.2747 (0.0784)
	29	Oriental Turtle-Dove	*Streptopelia orientalis*	LC	IV	Resident	0.0009 (0.0008)
	30	Red Collared Dove	*Streptopelia tranquebarica*	LC	IV	Resident	0.0385 (0.0162)
	31	Rock Pigeon	*Columba livia*	LC	IV	Resident	0.5774 (0.0909)
	32	Spotted Dove	*Streptopelia chinensis*	LC	IV	Resident	0.0234 (0.0129)
	33	Yellow-eyed Pigeon	*Columba eversmanni*	VU	IV	Migratory-Long-Distance	0.068 (0.033)
	34	Yellow-footed Green-Pigeon	*Treron phoenicopterus*	LC	IV	Resident	0.0626 (0.0373)
Sandgrouse	35	Black-bellied Sandgrouse	*Pterocles orientalis*	LC	IV	Migratory	0.0115 (0.0082)
	36	Chestnut-bellied Sandgrouse	*Pterocles exustus*	LC	IV	Resident	0.1394 (0.0556)
	37	Painted Sandgrouse	*Pterocles indicus*	LC	IV	Resident	0.0002 (0.0002)
	38	Spotted Sandgrouse	*Pterocles senegallus*	LC	IV	Migratory	0.0115 (0.0082)
Bustards	39	Macqueen's Bustard	*Chlamydotis macqueenii*	VU	I	Migratory	0.0005 (0.0005)

Cuckoos	40	Asian Koel	*Eudynamys scolopaceus*	LC	IV	Resident	0.0372 (0.0179)
	41	Common Hawk-Cuckoo	*Hierococcyx varius*	LC	IV	Resident	0.0013 (0.0013)
	42	Greater Coucal	*Centropus sinensis*	LC	IV	Resident	0.0571 (0.0263)
	43	Pied Cuckoo	*Clamator jacobinus*	LC	IV	Resident	0.0202 (0.0158)
	44	Sirkeer Malkoha	*Taccocua leschenaultii*	LC	IV	Resident	0.0002 (0.0002)
Swifts	45	Little Swift	*Apus affinis*	LC	IV	Resident	0.036 (0.0169)
Rails, Gallinules, and Allies	46	Common Moorhen	*Gallinula chloropus*	LC	IV	Resident	0.1904 (0.0831)
	47	Eurasian Coot	*Fulica atra*	LC	IV	Resident	0.2229 (0.0725)
	48	Gray-headed Swamphen	*Porphyrio poliocephalus*	LC	IV	Resident	0.0003 (0.0003)
	49	White-breasted Waterhen	*Amaurornis phoenicurus*	LC	IV	Resident	0.062 (0.0318)
Cranes	50	Common Crane	*Grus grus*	LC	IV	Migratory-Long-Distance	0.044 (0.0312)
	51	Demoiselle Crane	Grus virgo	LC	IV	Migratory-Long-Distance	0.1439 (0.0955)
Shorebirds	52	Black-tailed Godwit	*Limosa limosa*	NT	IV	Migratory-Long-Distance	0.0581 (0.0387)
	53	Black-winged Stilt	*Himantopus himantopus*	LC	IV	Resident	0.353 (0.1098)
	54	Bronze-winged Jacana	*Metopidius indicus*	LC	IV	Resident	0.0002 (0.0002)
	55	Common Greenshank	*Tringa nebularia*	LC	IV	Migratory-Long-Distance	0.0534 (0.0254)
	56	Common Redshank	*Tringa totanus*	LC	IV	Migratory-Long-Distance	0.1084 (0.0494)
	57	Common Sandpiper	*Actitis hypoleucos*	LC	IV	Migratory-Long-Distance	0.1857 (0.0634)
	58	Common Snipe	*Gallinago gallinago*	LC	IV	Migratory-Long-Distance	0.0581 (0.0362)
	59	Cream-colored Courser	*Cursorius cursor*	NT		Migratory	0.0026 (0.0018)
	60	Curlew Sandpiper	*Calidris ferruginea*	NT	IV	Migratory-Long-Distance	0.0011 (0.0008)
	61	Eurasian Curlew	*Numenius arquata*	NT	IV	Migratory-Long-Distance	0.0501 (0.0474)

	62	Greater Painted-Snipe	*Rostratula benghalensis*	LC	IV	Resident	0.0066 (0.0059)
	63	Green Sandpiper	*Tringa ochropus*	LC	IV	Migratory-Long-Distance	0.1303 (0.041)
	64	Indian Courser	*Cursorius coromandelicus*	LC	IV	Resident	0.0465 (0.0241)
	65	Indian Thick-knee	*Burhinus indicus*	LC	IV	Resident	0.0038 (0.003)
	66	Kentish Plover	*Charadrius alexandrinus*	LC	IV	Resident	0.0991 (0.0618)
	67	Lesser Sand-Plover	*Charadrius mongolus*	LC	IV	Migratory-Local	0.0133 (0.0128)
	68	Little Ringed Plover	*Charadrius dubius*	LC	IV	Resident	0.1773 (0.0792)
	69	Little Stint	*Calidris minuta*	LC	IV	Migratory-Long-Distance	0.0608 (0.0506)
	70	Marsh Sandpiper	*Tringa stagnatilis*	LC	IV	Migratory-Long-Distance	0.0705 (0.0705)
	71	Oriental Pratincole	*Glareola maldivarum*	LC	IV	Resident	0.0005 (0.0005)
	72	Pheasant-tailed Jacana	*Hydrophasianus chirurgus*	LC	IV	Resident	0.011 (0.0079)
	73	Pied Avocet	*Recurvirostra avosetta*	LC	IV	Migratory-Long-Distance	0.129 (0.1147)
	74	Red-necked Phalarope	*Phalaropus lobatus*	LC		Migratory	0.0064 (0.0064)
	75	Red-wattled Lapwing	*Vanellus indicus*	LC	IV	Resident	0.5498 (0.1058)
	76	Ruff	*Calidris pugnax*	LC	IV	Migratory-Long-Distance	0.1457 (0.1047)
	77	Small Pratincole	*Glareola lactea*	LC	IV	Resident	0.0013 (0.0009)
	78	Spotted Redshank	*Tringa erythropus*	LC	IV	Migratory-Long-Distance	0.0361 (0.0161)
	79	Temminck's Stint	*Calidris temminckii*	LC	IV	Migratory-Long-Distance	0.0715 (0.0445)
	80	Terek Sandpiper	*Xenus cinereus*	LC	IV	Migratory-Long-Distance	0.0064 (0.0064)
	81	White-tailed Lapwing	*Vanellus leucurus*	LC	IV	Migratory-Long-Distance	0.1166 (0.0896)
	82	Wood Sandpiper	*Tringa glareola*	LC	IV	Migratory-Long-Distance	0.0922 (0.056)

	83	Yellow-wattled Lapwing	*Vanellus malabaricus*	LC	IV	Resident	0.0008 (0.0008)
Gulls, Terns, and Skimmers	84	Black-headed Gull	*Chroicocephalus ridibundus*	LC	IV	Migratory-Long-Distance	0.0043 (0.0034)
	85	Brown-headed Gull	*Chroicocephalus brunnicephalus*	LC	IV	Migratory-Local	0.0019 (0.0016)
	86	Gull-billed Tern	*Gelochelidon nilotica*	LC	IV	Migratory-Local	0.0238 (0.0238)
	87	Lesser Black-backed Gull	*Larus fuscus*	LC	IV	Migratory-Long-Distance	0.0003 (0.0003)
	88	Pallas's Gull	*Ichthyaetus ichthyaetus*	LC	IV	Migratory-Long-Distance	0.0233 (0.0148)
	89	River Tern	*Sterna aurantia*	NT	IV	Resident	0.0932 (0.0425)
	90	Whiskered Tern	*Chlidonias hybrida*	LC	IV	Resident	0.0155 (0.012)
Storks	91	Asian Openbill	*Anastomus oscitans*	LC	IV	Resident	0.0625 (0.0304)
	92	Black Stork	*Ciconia nigra*	LC	IV	Migratory-Long-Distance	0.0056 (0.0056)
	93	Black-necked Stork	*Ephippiorhynchus asiaticus*	NT	IV	Resident	0.0056 (0.0056)
	94	Painted Stork	*Mycteria leucocephala*	NT	IV	Resident	0.123 (0.0769)
	95	Woolly-necked Stork	*Ciconia episcopus*	VU	IV	Resident	0.0539 (0.035)
Cormorants and Anhingas	96	Great Cormorant	*Phalacrocorax carbo*	LC	IV	Resident	0.0318 (0.0193)
	97	Indian Cormorant	*Phalacrocorax fuscicollis*	LC	IV	Resident	0.0603 (0.0277)
	98	Little Cormorant	*Microcarbo niger*	LC	IV	Resident	0.1854 (0.0769)
	99	Oriental Darter	*Anhinga melanogaster*	NT	IV	Resident	0.0287 (0.0147)
	100	Great White Pelican	*Pelecanus onocrotalus*	LC	IV	Migratory-Long-Distance	0.0016 (0.0016)
Pelicans	101	Dalmatian Pelican	*Pelecanus crispus*	NT	IV	Migratory-Long-Distance	0.0154 (0.0123)
Herons, Ibis, and Allies	102	Black Bittern	*Ixobrychus flavicollis*	LC	IV	Resident	0.0002 (0.0002)
	103	Black-crowned Night-Heron	*Nycticorax nycticorax*	LC	IV	Resident	0.0273 (0.0162)
	104	Black-headed Ibis	*Threskiornis melanocephalus*	NT	IV	Resident	0.0473 (0.0187)

	105	Cattle Egret	*Bubulcus ibis*	LC	IV	Resident	0.2965 (0.1041)
	106	Eurasian Spoonbill	*Platalea leucorodia*	LC	I	Resident	0.1735 (0.0672)
	107	Glossy Ibis	*Plegadis falcinellus*	LC	IV	Resident	0.0144 (0.0118)
	108	Great Egret	*Ardea alba*	LC	IV	Resident	0.0942 (0.0523)
	109	Grey Heron	*Ardea cinerea*	LC	IV	Resident	0.2002 (0.0809)
	110	Indian Pond-Heron	*Ardeola grayii*	LC	IV	Resident	0.1862 (0.0617)
	111	Intermediate Egret	*Ardea intermedia*	LC	IV	Resident	0.1746 (0.0844)
	112	Little Egret	*Egretta garzetta*	LC	IV	Resident	0.1459 (0.0601)
	113	Purple Heron	*Ardea purpurea*	LC	IV	Resident	0.0101 (0.0068)
	114	Red-naped Ibis	*Pseudibis papillosa*	LC	IV	Resident	0.2546 (0.0632)
	115	Striated Heron	*Butorides striata*	LC	IV	Resident	0.002 (0.0018)
	116	Western Reef-Heron	*Egretta gularis*	LC	IV	Resident	0.0238 (0.0238)
Vultures, Hawks, and Allies	117	Black Kite	*Milvus migrans*	LC	I	Resident	0.1236 (0.0654)
	118	Black-winged Kite	*Elanus caeruleus*	LC	I	Resident	0.1561 (0.0831)
	119	Bonelli's Eagle	*Aquila fasciata*	LC	I	Resident	0.0059 (0.0036)
	120	Booted Eagle	*Hieraaetus pennatus*	LC	I	Migratory-Long-Distance	0.0184 (0.0114)
	121	Brahminy Kite	*Haliastur indus*	LC	I	Resident	0.0008 (0.0008)
	122	Changeable Hawk-Eagle	*Nisaetus cirrhatus*	LC	I	Resident	0.0002 (0.0002)
	123	Cinereous Vulture	*Aegypius monachus*	NT	IV	Migratory-Long-Distance	0.0506 (0.034)
	124	Common Buzzard	*Buteo buteo*	LC	I	Migratory-Long-Distance	0.0031 (0.0024)
	125	Crested Serpent-Eagle	*Spilornis cheela*	LC	I	Resident	0.0002 (0.0002)
	126	Eastern Imperial Eagle	*Aquila heliaca*	VU	I	Migratory-Long-Distance	0.0629 (0.0338)

	127	Egyptian Vulture	*Neophron percnopterus*	EN	IV	Resident	0.2574 (0.0835)
	128	Eurasian Marsh-Harrier	*Circus aeruginosus*	LC	I	Migratory-Long-Distance	0.0779 (0.0474)
	129	Eurasian Sparrowhawk	*Accipiter nisus*	LC	I	Resident	0.0257 (0.0157)
	130	Greater Spotted Eagle	*Clanga clanga*	VU	I	Migratory-Long-Distance	0.0552 (0.0262)
	131	Griffon Vulture	*Gyps fulvus*	LC	IV	Migratory-Long-Distance	0.1978 (0.0981)
	132	Hen Harrier	*Circus cyaneus*	LC	I	Migratory	0.0016 (0.0016)
	133	Himalayan Vulture	*Gyps himalayensis*	NT	IV	Resident	0.0384 (0.0221)
	134	Indian Spotted Eagle	*Clanga hastata*	VU	I	Resident	0.0084 (0.0046)
	135	Indian Vulture	*Gyps indicus*	CR	I	Resident	0.0028 (0.0028)
	136	Long-legged Buzzard	*Buteo rufinus*	LC	I	Migratory-Long-Distance	0.2022 (0.0877)
	137	Montagu's Harrier	*Circus pygargus*	LC	I	Migratory-Long-Distance	0.0228 (0.0156)
	138	Oriental Honey-buzzard	*Pernis ptilorhynchus*	LC	I	Resident	0.0295 (0.0195)
	139	Osprey	*Pandion haliaetus*	LC	I	Migratory-Long-Distance	0.0543 (0.0363)
	140	Pallas's Fish-Eagle	*Haliaeetus leucoryphus*	EN	I	Resident	0.0003 (0.0003)
	141	Pallid Harrier	*Circus macrourus*	NT	I	Migratory-Long-Distance	0.0038 (0.0038)
	142	Red-headed Vulture	*Sarcogyps calvus*	CR	IV	Resident	0.0005 (0.0005)
	143	Shikra	*Accipiter badius*	LC	I	Resident	0.2222 (0.0811)
	144	Short-toed Snake-Eagle	*Circaetus gallicus*	LC	I	Resident	0.0178 (0.0086)
	145	Steppe Eagle	*Aquila nipalensis*	EN	I	Migratory-Long-Distance	0.1444 (0.0494)
	146	Tawny Eagle	*Aquila rapax*	VU	I	Resident	0.085 (0.0355)
	147	White-eyed Buzzard	*Butastur teesa*	LC	I	Resident	0.153 (0.0637)
	148	White-rumped Vulture	*Gyps bengalensis*	CR	I	Resident	0.0062 (0.0044)

	149	White-tailed Eagle	*Haliaeetus albicilla*	LC	I	Migratory	0.0008 (0.0008)
Owls	150	Barn Owl	*Tyto alba*	LC	IV	Resident	0.0002 (0.0002)
	151	Indian Scops-Owl	*Otus bakkamoena*	LC	IV	Resident	0.0016 (0.0016)
	152	Short-eared Owl	*Asio flammeus*	LC	IV	Migratory-Long-Distance	0.0026 (0.0018)
	153	Spotted Owlet	*Athene brama*	LC	IV	Resident	0.0739 (0.0277)
Hoopoes	154	Common Hoopoe	*Upupa epops*	LC	IV	Resident	0.1315 (0.035)
Kingfishers	155	Common Kingfisher	*Alcedo atthis*	LC	IV	Resident	0.054 (0.0271)
	156	Pied Kingfisher	*Ceryle rudis*	LC	IV	Resident	0.0375 (0.0263)
	157	White-throated Kingfisher	*Halcyon smyrnensis*	LC	IV	Resident	0.2797 (0.0669)
Bee-eaters, Rollers, and Allies	158	Blue-cheeked Bee-eater	*Merops persicus*	LC	IV	Migratory-Long-Distance	0.0752 (0.027)
	159	Blue-tailed Bee-eater	*Merops philippinus*	LC	IV	Resident	0.0002 (0.0002)
	160	European Roller	*Coracias garrulus*	LC	IV	Migratory-Long-Distance	0.0376 (0.0168)
	161	Green Bee-eater	*Merops orientalis*	LC	IV	Resident	0.2206 (0.061)
	162	Indian Roller	*Coracias benghalensis*	LC	IV	Resident	0.3323 (0.1075)
Barbets and Toucans	163	Coppersmith Barbet	*Psilopogon haemacephalus*	LC	IV	Resident	0.0009 (0.0009)
Woodpeckers	164	Black-rumped Flameback	*Dinopium benghalense*	LC	IV	Resident	0.0198 (0.0118)
	165	Eurasian Wryneck	*Jynx torquilla*	LC	IV	Migratory-Long-Distance	0.0204 (0.0129)
	166	Yellow-crowned Woodpecker	*Leiopicus mahrattensis*	LC	IV	Resident	0.0008 (0.0008)
Falcons and Caracaras	167	Common Kestrel	*Falco tinnunculus*	LC	IV	Resident	0.2068 (0.0832)
	168	Eurasian Hobby	*Falco subbuteo*	LC	IV	Migratory-Local	0.0008 (0.0008)
	169	Laggar Falcon	*Falco jugger*	NT	I	Resident	0.2133 (0.0812)
	170	Lesser Kestrel	*Falco naumanni*	LC	IV	Migratory	0.0002 (0.0002)

	171	Peregrine Falcon	*Falco peregrinus*	LC	I	Resident	0.0143 (0.0118)
	172	Red-necked Falcon	*Falco chicquera*	NT	I	Resident	0.0035 (0.0035)
Parrots, Parakeets, and Allies	173	Alexandrine Parakeet	*Psittacula eupatria*	NT	IV	Resident	0.0017 (0.0017)
	174	Plum-headed Parakeet	*Psittacula cyanocephala*	LC	IV	Resident	0.0002 (0.0002)
	175	Rose-ringed Parakeet	*Psittacula krameri*	LC	IV	Resident	0.3474 (0.102)
Cuckooshrikes	176	Black-headed Cuckooshrike	*Lalage melanoptera*	LC	IV	Migratory-Local	0.0003 (0.0003)
	177	Small Minivet	*Pericrocotus cinnamomeus*	LC	IV	Resident	0.0107 (0.0104)
Old World Orioles	178	Indian Golden Oriole	*Oriolus kundoo*	LC	IV	Migratory-Local	0.0023 (0.0016)
Vangas, Helmetshrikes, and Allies	179	Common Woodshrike	*Tephrodornis pondicerianus*	LC	IV	Resident	0.0824 (0.053)
Fantails	180	White-browed Fantail	*Rhipidura aureola*	LC	IV	Resident	0.0877 (0.0412)
Drongos	181	Ashy Drongo	*Dicrurus leucophaeus*	LC	IV	Migratory-Local	0.0019 (0.0016)
	182	Black Drongo	*Dicrurus macrocercus*	LC	IV	Resident	0.4172 (0.0929)
	183	White-bellied Drongo	*Dicrurus caerulescens*	LC	IV	Resident	0.0003 (0.0003)
Shrikes	184	Bay-backed Shrike	*Lanius vittatus*	LC	IV	Resident	0.0711 (0.0275)
	185	Great Grey Shrike	*Lanius excubitor*	LC	IV	Resident	0.2874 (0.0961)
	186	Isabelline Shrike	*Lanius isabellinus*	LC	IV	Migratory-Long-Distance	0.0485 (0.0182)
	187	Long-tailed Shrike	*Lanius schach*	LC	IV	Resident	0.0306 (0.0132)
	188	Red-tailed Shrike	*Lanius phoenicuroides*	LC		Migratory	0.0003 (0.0003)
Jays, Magpies, Crows, and Ravens	189	Common Raven	*Corvus corax*	LC	IV	Resident	0.0263 (0.016)
	190	House Crow	*Corvus splendens*	LC	V	Resident	0.7095 (0.1044)
	191	Large-billed Crow	*Corvus macrorhynchos*	LC	IV	Resident	0.0148 (0.0107)

	192	Rufous Treepie	*Dendrocitta vagabunda*	LC	IV	Resident	0.091 (0.034)
Fairy Flycatchers	193	Grey-headed Canary-flycatcher	*Culicicapa ceylonensis*	LC	IV	Migratory-Local	0.0072 (0.007)
Tits, Chickadees, and Titmice	194	Cinereous Tit	*Parus cinereus*	LC	IV	Resident	0.0122 (0.0119)
Larks	195	Ashy-crowned Sparrow-Lark	*Eremopterix griseus*	LC	IV	Resident	0.0819 (0.0405)
	196	Bimaculated Lark	*Melanocorypha bimaculata*	LC	IV	Migratory	0.0885 (0.05)
	197	Black-crowned Sparrow-Lark	*Eremopterix nigriceps*	LC	IV	Resident	0.0839 (0.0305)
	198	Crested Lark	*Galerida cristata*	LC	IV	Resident	0.1038 (0.0528)
	199	Greater Short-toed Lark	*Calandrella brachydactyla*	LC	IV	Migratory-Long-Distance	0.1099 (0.0497)
	200	Indian Bushlark	*Mirafra erythroptera*	LC	IV	Resident	0.0141 (0.0128)
	201	Oriental Skylark	*Alauda gulgula*	LC	IV	Resident	0.0009 (0.0009)
	202	Rufous-tailed Lark	*Ammomanes phoenicura*	LC	IV	Resident	0.0848 (0.0361)
	203	Singing Bushlark	*Mirafra cantillans*	LC	IV	Resident	0.0048 (0.004)
Cisticolas and Allies	204	Ashy Prinia	*Prinia socialis*	LC	IV	Resident	0.0027 (0.0027)
	205	Common Tailorbird	*Orthotomus sutorius*	LC	IV	Resident	0.0039 (0.0027)
	206	Graceful Prinia	*Prinia gracilis*	LC	IV	Resident	0.1687 (0.0625)
	207	Grey-breasted Prinia	*Prinia hodgsonii*	LC	IV	Resident	0.0003 (0.0003)
	208	Jungle Prinia	*Prinia sylvatica*	LC	IV	Resident	0.0009 (0.0009)
	209	Plain Prinia	*Prinia inornata*	LC	IV	Resident	0.0151 (0.0105)
	210	Rufous-fronted Prinia	*Prinia buchanani*	LC	IV	Resident	0.031 (0.0183)
	211	Zitting Cisticola	*Cisticola juncidis*	LC	IV	Resident	0.0143 (0.0119)
Reed Warblers and Allies	212	Blyth's Reed Warbler	*Acrocephalus dumetorum*	LC	IV	Migratory-Long-Distance	0.0024 (0.0022)
	213	Clamorous Reed Warbler	*Acrocephalus stentoreus*	LC	IV	Resident	0.0006 (0.0006)

	214	Paddyfield Warbler	*Acrocephalus agricola*	LC	IV	Migratory-Long-Distance	0.0002 (0.0002)
	215	Sykes's Warbler	*Iduna rama*	LC	IV	Migratory-Long-Distance	0.021 (0.0128)
Martins and Swallows	216	Barn Swallow	*Hirundo rustica*	LC	IV	Migratory-Local	0.0146 (0.0078)
	217	Dusky Crag-Martin	*Ptyonoprogne concolor*	LC	IV	Resident	0.0056 (0.0038)
	218	Grey-throated Martin	*Riparia chinensis*	LC	IV	Resident	0.0773 (0.039)
	219	Pale Sand Martin	*Riparia diluta*	LC		Resident	0.05 (0.0311)
	220	Red-rumped Swallow	*Cecropis daurica*	LC	IV	Resident	0.0005 (0.0005)
	221	Streak-throated Swallow	*Petrochelidon fluvicola*	LC	IV	Resident	0.0035 (0.0019)
	222	Wire-tailed Swallow	*Hirundo smithii*	LC	IV	Resident	0.0273 (0.0131)
Bulbuls	223	Red-vented Bulbul	*Pycnonotus cafer*	LC	IV	Resident	0.2765 (0.0734)
	224	White-eared Bulbul	*Pycnonotus leucotis*	LC	IV	Resident	0.4217 (0.0984)
Leaf Warblers	225	Brooks's Leaf Warbler	*Phylloscopus subviridis*	LC	IV	Migratory-Long-Distance	0.0016 (0.0016)
	226	Common Chiffchaff	*Phylloscopus collybita*	LC	IV	Migratory-Long-Distance	0.1151 (0.0521)
	227	Greenish Warbler	*Phylloscopus trochiloides*	LC	IV	Migratory-Local	0.0002 (0.0002)
	228	Hume's Leaf Warbler	*Phylloscopus humei*	LC	IV	Migratory-Local	0.0169 (0.0132)
	229	Plain Leaf Warbler	*Phylloscopus neglectus*	LC	IV	Migratory	0.0076 (0.0057)
	230	Sulphur-bellied Warbler	*Phylloscopus griseolus*	LC	IV	Migratory-Local	0.0002 (0.0002)
Sylviid Warblers	231	Asian Desert Warbler	*Sylvia nana*	LC	IV	Migratory	0.0337 (0.0133)
	232	Eastern Orphean Warbler	*Sylvia crassirostris*	LC	IV	Migratory-Long-Distance	0.0003 (0.0003)
	233	Lesser Whitethroat	*Sylvia curruca*	LC	IV	Migratory-Long-Distance	0.263 (0.0835)
Parrotbills, Wrentit, and Allies	234	Yellow-eyed Babbler	*Chrysomma sinense*	LC	IV	Resident	0.0016 (0.0011)
White-eyes, Yuhinas, and Allies	235	Indian White-eye	*Zosterops palpebrosus*	LC	IV	Resident	0.0008 (0.0008)

Laughingthrushes and Allies	236	Common Babbler	*Turdoides caudata*	LC	IV	Resident	0.4784 (0.096)
	237	Jungle Babbler	*Turdoides striata*	LC	IV	Resident	0.1515 (0.0496)
	238	Large Gray Babbler	*Turdoides malcolmi*	LC	IV	Resident	0.0377 (0.0189)
	239	Striated Babbler	*Turdoides earlei*	LC	IV	Resident	0.0359 (0.0257)
Treecreepers	240	Indian Spotted Creeper	*Salpornis spilonota*	LC	IV	Resident	0.0016 (0.0016)
Starlings and Mynas	241	Asian Pied Starling	*Gracupica contra*	LC	IV	Resident	0.0204 (0.0101)
	242	Bank Myna	*Acridotheres ginginianus*	LC	IV	Resident	0.1497 (0.0704)
	243	Brahminy Starling	*Sturnia pagodarum*	LC	IV	Resident	0.06 (0.0248)
	244	Chestnut-tailed Starling	*Sturnia malabarica*	LC	IV	Resident	0.0003 (0.0003)
	245	Common Myna	*Acridotheres tristis*	LC	IV	Resident	0.1655 (0.0431)
	246	European Starling	*Sturnus vulgaris*	LC	IV	Migratory-Local	0.1052 (0.0441)
	247	Rosy Starling	*Pastor roseus*	LC	IV	Migratory-Long-Distance	0.1618 (0.0653)
Thrushes	248	Black-throated Thrush	*Turdus atrogularis*	LC	IV	Migratory	0.0002 (0.0002)
Old World Flycatchers	249	Black Redstart	*Phoenicurus ochruros*	LC	IV	Migratory-Local	0.2685 (0.0832)
	250	Bluethroat	*Luscinia svecica*	LC	IV	Migratory-Local	0.0133 (0.0071)
	251	Brown Rock Chat	*Oenanthe fusca*	LC	IV	Resident	0.0222 (0.0154)
	252	Desert Wheatear	*Oenanthe deserti*	LC	IV	Migratory-Local	0.1361 (0.0316)
	253	Finsch's Wheatear	*Oenanthe finschii*	LC		Migratory	0.0008 (0.0008)
	254	Indian Robin	Saxicoloides fulicatus	LC	IV	Resident	0.1416 (0.0663)
	255	Isabelline Wheatear	*Oenanthe isabellina*	LC	IV	Migratory-Long-Distance	0.209 (0.0933)
	256	Oriental Magpie-Robin	*Copsychus saularis*	LC	IV	Resident	0.0086 (0.006)
	257	Persian Wheatear	*Oenanthe chrysopygia*	LC		Migratory	0.0003 (0.0003)

	258	Pied Bushchat	*Saxicola caprata*	LC	IV	Resident	0.0407 (0.0129)
	259	Red-breasted Flycatcher	*Ficedula parva*	LC	IV	Migratory-Long-Distance	0.0643 (0.0514)
	260	Rufous-tailed Scrub-Robin	*Cercotrichas galactotes*	LC	IV	Migratory	0.0002 (0.0002)
	261	Siberian Stonechat	*Saxicola maurus*	LC	IV	Migratory-Local	0.1071 (0.0826)
	262	Spotted Flycatcher	*Muscicapa striata*	LC	IV	Migratory	0.0024 (0.0022)
	263	Stoliczka's Bushchat	*Saxicola macrorhynchus*	VU	IV	Resident	0.0327 (0.0302)
	264	Taiga Flycatcher	*Ficedula albicilla*	LC	IV	Migratory-Long-Distance	0.0025 (0.0023)
	265	Variable Wheatear	*Oenanthe picata*	LC	IV	Migratory-Long-Distance	0.3574 (0.0896)
Sunbirds and Spiderhunters	266	Purple Sunbird	*Cinnyris asiaticus*	LC	IV	Resident	0.1922 (0.0619)
Weavers and Allies	267	Baya Weaver	*Ploceus philippinus*	LC	IV	Resident	0.0303 (0.0204)
Estrildids	268	Black-breasted Weaver	*Ploceus benghalensis*	LC	IV	Resident	0.0003 (0.0003)
	269	Indian Silverbill	*Euodice malabarica*	LC	IV	Resident	0.1549 (0.0494)
	270	Red Avadavat	*Amandava amandava*	LC	IV	Resident	0.0005 (0.0005)
	271	Scaly-breasted Munia	*Lonchura punctulata*	LC	IV	Resident	0.0003 (0.0003)
Old World Sparrows	272	House Sparrow	*Passer domesticus*	LC	IV	Resident	0.5485 (0.0931)
	273	Sind Sparrow	*Passer pyrrhonotus*	LC	IV	Resident	0.0328 (0.0235)
	274	Spanish Sparrow	*Passer hispaniolensis*	LC	IV	Migratory	0.0141 (0.0112)
	275	Yellow-throated Sparrow	*Gymnoris xanthocollis*	LC	IV	Resident	0.0242 (0.011)
Wagtails and Pipits	276	American Pipit	*Anthus rubescens*	LC	IV	Migratory	0.0357 (0.0357)
	277	Citrine Wagtail	*Motacilla citreola*	LC	IV	Migratory-Local	0.0366 (0.0167)
	278	Grey Wagtail	*Motacilla cinerea*	LC	IV	Migratory-Local	0.0165 (0.0119)

	279	Long-billed Pipit	*Anthus similis*	LC	IV	Resident	0.0024 (0.0024)
	280	Olive-backed Pipit	*Anthus hodgsoni*	LC	IV	Migratory-Local	0.0041 (0.004)
	281	Paddyfield Pipit	*Anthus rufulus*	LC	IV	Resident	0.0476 (0.024)
	282	Tawny Pipit	*Anthus campestris*	LC	IV	Migratory-Long-Distance	0.2069 (0.0809)
	283	Tree Pipit	*Anthus trivialis*	LC	IV	Migratory-Local	0.0361 (0.0236)
	284	Water Pipit	*Anthus spinoletta*	LC	IV	Migratory	0.0124 (0.0083)
	285	Western Yellow Wagtail	*Motacilla flava*	LC	IV	Migratory-Long-Distance	0.0374 (0.0146)
	286	White Wagtail	*Motacilla alba*	LC	IV	Migratory-Long-Distance	0.2734 (0.0827)
	287	White-browed Wagtail	*Motacilla maderaspatensis*	LC	IV	Resident	0.1265 (0.059)
Finches, Euphonias, and Allies	288	Common Rosefinch	*Carpodacus erythrinus*	LC	IV	Migratory-Local	0.0002 (0.0002)
Old World Buntings	289	Grey-necked Bunting	*Emberiza buchanani*	LC	IV	Migratory-Long-Distance	0.0002 (0.0002)
	290	Red-headed Bunting	*Emberiza bruniceps*	LC	IV	Migratory-Long-Distance	0.0082 (0.0075)
	291	Striolated Bunting	*Emberiza striolata*	LC	IV	Resident	0.0003 (0.0003)

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BUSTARD RECOVERY PROGRAM

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Wildlife Institute of India

Government of Rajasthan
FOREST DEPARTMENT