

Building evidence for conservation globally

Journal of Threatened Taxa



Open Access

10.11609/jott.2022.14.1.20311-20538

www.threatenedtaxa.org

26 January 2022 (Online & Print)

14(1): 20311-20538

ISSN 0974-7907 (Online)

ISSN 0974-7893 (Print)



ISSN 0974-7907 (Online); ISSN 0974-7893 (Print)

Publisher
Wildlife Information Liaison Development Society
www.wild.zooreach.org

Host
Zoo Outreach Organization
www.zooreach.org

No. 12, Thiruvannamalai Nagar, Saravanampatti - Kalapatti Road, Saravanampatti,
Coimbatore, Tamil Nadu 641035, India
Ph: +91 9385339863 | www.threatenedtaxa.org
Email: sanjay@threatenedtaxa.org

EDITORS

Founder & Chief Editor

Dr. Sanjay Molur

Wildlife Information Liaison Development (WILD) Society & Zoo Outreach Organization (ZOO),
12 Thiruvannamalai Nagar, Saravanampatti, Coimbatore, Tamil Nadu 641035, India

Deputy Chief Editor

Dr. Neelesh Dahanukar

Noida, Uttar Pradesh, India

Managing Editor

Mr. B. Ravichandran, WILD/ZOO, Coimbatore, India

Associate Editors

Dr. Mandar Paingankar, Government Science College Gadchiroli, Maharashtra 442605, India

Dr. Ulrike Streicher, Wildlife Veterinarian, Eugene, Oregon, USA

Ms. Priyanka Iyer, ZOO/WILD, Coimbatore, Tamil Nadu 641035, India

Dr. B.A. Daniel, ZOO/WILD, Coimbatore, Tamil Nadu 641035, India

Editorial Board

Dr. Russel Mittermeier

Executive Vice Chair, Conservation International, Arlington, Virginia 22202, USA

Prof. Mewa Singh Ph.D., FASC, FNA, FNASC, FNAPsy

Ramanna Fellow and Life-Long Distinguished Professor, Biopsychology Laboratory, and
Institute of Excellence, University of Mysore, Mysuru, Karnataka 570006, India; Honorary
Professor, Jawaharlal Nehru Centre for Advanced Scientific Research, Bangalore; and Adjunct
Professor, National Institute of Advanced Studies, Bangalore

Stephen D. Nash

Scientific Illustration, Conservation International, Dept. of Anatomical Sciences, Health Sciences
Center, T-8, Room 045, Stony Brook University, Stony Brook, NY 11794-8081, USA

Dr. Fred Pluthero

Toronto, Canada

Dr. Priya Davidar

Sigur Nature Trust, Chadapatti, Mavinhalla PO, Nilgiris, Tamil Nadu 643223, India

Dr. Martin Fisher

Senior Associate Professor, Battcock Centre for Experimental Astrophysics, Cavendish
Laboratory, JJ Thomson Avenue, Cambridge CB3 0HE, UK

Dr. John Fellowes

Honorary Assistant Professor, The Kadoorie Institute, 8/F, T.T. Tsui Building, The University of
Hong Kong, Pokfulam Road, Hong Kong

Prof. Dr. Mirco Solé

Universidade Estadual de Santa Cruz, Departamento de Ciências Biológicas, Vice-coordenador
do Programa de Pós-Graduação em Zoologia, Rodovia Ilhéus/Itabuna, Km 16 (45662-000)
Salobrinho, Ilhéus - Bahia - Brasil

Dr. Rajeev Raghavan

Professor of Taxonomy, Kerala University of Fisheries & Ocean Studies, Kochi, Kerala, India

English Editors

Mrs. Mira Bhojwani, Pune, India

Dr. Fred Pluthero, Toronto, Canada

Mr. P. Ilangoan, Chennai, India

Web Development

Mrs. Latha G. Ravikumar, ZOO/WILD, Coimbatore, India

Typesetting

Mr. Arul Jagadish, ZOO, Coimbatore, India

Mrs. Radhika, ZOO, Coimbatore, India

Mrs. Geetha, ZOO, Coimbatore India

Fundraising/Communications

Mrs. Payal B. Molur, Coimbatore, India

Subject Editors 2018–2020

Fungi

Dr. B. Shivaraju, Bengaluru, Karnataka, India

Dr. R.K. Verma, Tropical Forest Research Institute, Jabalpur, India

Dr. Vatsavaya S. Raju, Kakatiya University, Warangal, Andhra Pradesh, India

Dr. M. Krishnappa, Jnana Sahyadri, Kuvempu University, Shimoga, Karnataka, India

Dr. K.R. Sridhar, Mangalore University, Mangalagangothri, Mangalore, Karnataka, India

Dr. Gunjan Biswas, Vidyasagar University, Midnapore, West Bengal, India

Plants

Dr. G.P. Sinha, Botanical Survey of India, Allahabad, India

Dr. N.P. Balakrishnan, Ret. Joint Director, BSI, Coimbatore, India

Dr. Shonil Bhagwat, Open University and University of Oxford, UK

Prof. D.J. Bhat, Retd. Professor, Goa University, Goa, India

Dr. Ferdinando Boero, Università del Salento, Lecce, Italy

Dr. Dale R. Calder, Royal Ontario Museum, Toronto, Ontario, Canada

Dr. Cleofas Cervancia, Univ. of Philippines Los Baños College Laguna, Philippines

Dr. F.B. Vincent Florens, University of Mauritius, Mauritius

Dr. Merlin Franco, Curtin University, Malaysia

Dr. V. Irudayaraj, St. Xavier's College, Palayamkottai, Tamil Nadu, India

Dr. B.S. Kholia, Botanical Survey of India, Gangtok, Sikkim, India

Dr. Pankaj Kumar, Kadoorie Farm and Botanic Garden Corporation, Hong Kong S.A.R., China

Dr. V. Sampath Kumar, Botanical Survey of India, Howrah, West Bengal, India

Dr. A.J. Solomon Raju, Andhra University, Visakhapatnam, India

Dr. Vijayasankar Raman, University of Mississippi, USA

Dr. B. Ravi Prasad Rao, Sri Krishnadevaraya University, Anantpur, India

Dr. K. Ravikumar, FRLHT, Bengaluru, Karnataka, India

Dr. Aparna Watve, Pune, Maharashtra, India

Dr. Qiang Liu, Xishuangbanna Tropical Botanical Garden, Yunnan, China

Dr. Noor Azhar Mohamed Shazili, Universiti Malaysia Terengganu, Kuala Terengganu, Malaysia

Dr. M.K. Vasudeva Rao, Shiv Ranjani Housing Society, Pune, Maharashtra, India

Prof. A.J. Solomon Raju, Andhra University, Visakhapatnam, India

Dr. Mandar Datar, Agharkar Research Institute, Pune, Maharashtra, India

Dr. M.K. Janarthanam, Goa University, Goa, India

Dr. K. Karthigeyan, Botanical Survey of India, India

Dr. Errol Vela, University of Montpellier, Montpellier, France

Dr. P. Lakshminarasimhan, Botanical Survey of India, Howrah, India

Dr. Larry R. Noblick, Montgomery Botanical Center, Miami, USA

Dr. K. Haridasan, Pallavur, Palakkad District, Kerala, India

Dr. Analinda Manila-Fajard, University of the Philippines Los Banos, Laguna, Philippines

Dr. P.A. Sinu, Central University of Kerala, Kasaragod, Kerala, India

Dr. Afroz Alam, Banasthali Vidyapeeth (accredited A grade by NAAC), Rajasthan, India

Dr. K.P. Rajesh, Zamorin's Guruvayurappan College, GA College PO, Kozhikode, Kerala, India

Dr. David E. Boufford, Harvard University Herbaria, Cambridge, MA 02138-2020, USA

Dr. Ritesh Kumar Choudhary, Agharkar Research Institute, Pune, Maharashtra, India

Dr. Navendu Page, Wildlife Institute of India, Chandrabani, Dehradun, Uttarakhand, India

Invertebrates

Dr. R.K. Avasthi, Rohtak University, Haryana, India

Dr. D.B. Bastawade, Maharashtra, India

Dr. Partha Pratim Bhattacharjee, Tripura University, Suryamaninagar, India

Dr. Kailash Chandra, Zoological Survey of India, Jabalpur, Madhya Pradesh, India

Dr. Ansie Dippenaar-Schoeman, University of Pretoria, Queenswood, South Africa

Dr. Rory Dow, National Museum of natural History Naturalis, The Netherlands

Dr. Brian Fisher, California Academy of Sciences, USA

Dr. Richard Gallon, Llandudno, North Wales, LL30 1UP

Dr. Hemant V. Ghate, Modern College, Pune, India

Dr. M. Monwar Hossain, Jahangirnagar University, Dhaka, Bangladesh

Mr. Jatishwor Singh Irungbam, Biology Centre CAS, Branišovská, Czech Republic.

Dr. Ian J. Kitching, Natural History Museum, Cromwell Road, UK

Dr. George Mathew, Kerala Forest Research Institute, Peechi, India

For Focus, Scope, Aims, and Policies, visit https://threatenedtaxa.org/index.php/JoTT/aims_scope

For Article Submission Guidelines, visit <https://threatenedtaxa.org/index.php/JoTT/about/submissions>

For Policies against Scientific Misconduct, visit https://threatenedtaxa.org/index.php/JoTT/policies_various

continued on the back inside cover

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



Comparison of bird diversity in protected and non-protected wetlands of western lowland of Nepal

Jagan Nath Adhikari¹ , Janak Raj Khatiwada² , Dipendra Adhikari³ , Suman Sapkota⁴ ,
Bishnu Prasad Bhattarai⁵ , Deepak Rijal⁶ & Lila Nath Sharma⁷

^{1,5} Central Department of Zoology, Institute of Science and Technology, Tribhuvan University, Kathmandu, Nepal.

¹ Department of Zoology, Birendra Multiple Campus, Bharatpur, Chitwan, Nepal.

² Chengdu Institute of Biology, Chinese Academy of Sciences, Chengdu 610041, China.

³ Small Mammals Conservation and Research Foundation, PO Box 9092, Kathmandu, Nepal.

⁴ Friends of Nature (FON), Kathmandu, Nepal.

⁶ USAID Program for Aquatic Natural Resource Improvement, Paani Program, Baluwatar, Kathmandu, Nepal.

⁷ Forest Action Nepal, Bagdol Lalitpur, Nepal.

¹ jagan.adhikari@bimc.tu.edu.np (corresponding author), ² janakrajkhatiwada@gmail.com, ³ dipenadk2005@gmail.com, ⁴ suman.palpa99.ss@gmail.com, ⁵ bishnu.bhattarai@cdz.tu.edu.np, ⁶ deepak_rijal@dai.com, ⁷ lilanathsharma@gmail.com

Abstract: Protected areas are considered important for biodiversity conservation, however, studies have shown that habitats outside protected areas can also support high diversity and are important for biodiversity conservation. In this context, we compared the bird diversity between protected (Rani Taal in Shuklaphanta National Park) and non-protected (Sati Karnali Taal) wetlands in western Nepal. Bird surveys were conducted from February to August 2019, using open width point count method in 100 m intervals along transects. A total of 122 species belonging to 18 orders and 44 families were recorded from the protected wetland, and 107 species belonging to 16 orders and 41 families from the non-protected wetland area. Insectivores had high abundance in both wetlands (43% and 47% in protected and non-protected wetlands, respectively). Forest-dependent birds were more abundant in protected wetland compared to non-protected wetland. Our study showed that both protected and non-protected wetlands along with agricultural landscapes, support a richness of birds. Hence priority should be given to both wetlands for the conservation of birds.

Keywords: Aves, conservation, protected and non-protected areas, threatened birds.

Editor: Hem Sagar Baral, Charles Sturt University, Albury-Wodonga, Australia.

Date of publication: 26 January 2022 (online & print)

Citation: Adhikari, J.N., J.R. Khatiwada, D. Adhikari, S. Sapkota, B.P. Bhattarai, D. Rijal & L.N. Sharma (2022). Comparison of bird diversity in protected and non-protected wetlands of western lowland of Nepal. *Journal of Threatened Taxa* 14(1): 20371–20386. <https://doi.org/10.11609/jott.7452.14.1.20371-20386>

Copyright: © Adhikari et al. 2022. Creative Commons Attribution 4.0 International License. JoTT allows unrestricted use, reproduction, and distribution of this article in any medium by providing adequate credit to the author(s) and the source of publication.

Funding: This work was supported by USAID funded Paani Program (G-KAT-041) and ForestAction Nepal.

Competing interests: The authors declare no competing interests.

Author details & Author contributions: See end of this article.

Acknowledgements: Authors thank the Department of National Parks and Wildlife Conservation (DNPWC), Shuklaphanta National Park; Department of Forest and Division Forest Office Kailali for granting permission and support to conduct this research; USAID funded Paani Program for supporting this study (G-KAT-041); Forest Action Nepal for providing support, Sati Karnali Community Forest user groups, local communities of the Sati Karnali area for their support in the study area.



INTRODUCTION

Protected area (PA) is a key strategy for in situ conservation of biodiversity. Evidence has shown PAs that are crucial in conserving forests, natural environments, biodiversity, and ecosystem services (Rodrigues et al. 2004; Dahal et al. 2014; Watson et al. 2016). In the past, PAs surged globally, and Nepal has also made notable progress in increasing PA coverage (UNEP-WCMC et al. 2018; DNPWC 2020). By the end of 2020 over 15% of the earth's terrestrial surface was covered by PAs (Terborgh et al. 2002; UNEP-WCMC et al. 2018). In spite of increase in PAs, their efficacy in protecting overall biodiversity is contested (Rodrigues et al. 2004; Chape et al. 2005). Several important species remain outside the jurisdiction of PAs (Chakravarty et al. 2012), and some geographical areas are under-represented (Shrestha et al. 2010), including some global biodiversity hotspots and agro-ecosystems that support rich biodiversity (Sharma & Vetaas 2015). Researchers have argued and demonstrated that areas outside formal PAs are worth conserving, as they provide alternative habitats and refuges for maintaining viable populations of residential and migratory bird species (Shrestha et al. 2010; Cox & Underwood 2011; Dudley et al. 2014; DNPWC 2020) and thus complement PAs in achieving biodiversity goals.

Freshwater ecosystems are among the most productive ecosystems, and they provide countless services to both the human and ecological communities (Dudgeon et al. 2006). Yet they remain vulnerable to various stresses and pressures (Geist 2011). Freshwater constitutes about 2.5% of the area of all water on Earth (Ostfeld et al. 2012) and approximately 5% (743,500 ha) in Nepal (Siwakoti & Karki 2009). In the global context, wetlands support more than 40% of the birds and 12% of other animals (Kumar 2005; Paracuellos 2006). More than 20% of threatened bird species, both migratory and resident, are supported by the wetlands of Asia (Paracuellos 2006; Grimmett et al. 2016a).

Birds are important indicators of the health of freshwater ecosystems (Zakaria & Rajpar 2010; Inskipp et al. 2017; Baral & Inskipp 2020; Brotherton et al. 2020). Past studies have highlighted that Nepal's freshwater diversity has been threatened by different factors, including construction of dams, point source and non-point source pollution, habitat encroachment by invasive species, overharvesting, and recent global environmental changes (Khatiwada et al. 2021).

Many wetlands outside protected areas are important for conserving biodiversity, but are not given due attention for conservation. Past studies of bird

species have been mostly concentrated in the protected areas and Ramsar sites. The difference in bird diversity between protected and non-protected areas is not well documented. In this study, we compared bird diversity between wetlands within a PA (Rani Taal in Shuklaphanta National Park) and outside it (Sati Karnali Taal), and asked following questions: (i) is there a difference in bird richness between protected and non-protected wetlands? (ii) is there a difference in conservation value for birds inside and outside protected area? (iii) do birds in protected and non-protected wetland differ in their feeding guilds? Understanding the distribution of bird diversity in and outside PAs can be useful to conservation managers and planners to formulate conservation strategies.

MATERIALS AND METHODS

Study area

This study was conducted in two wetlands, one in Shuklaphanta National Park (Rani Taal, hereafter referred to as protected and undisturbed wetland) and one in a nearby agricultural landscape (Sati Karnali Taal, hereafter non-protected and disturbed wetland), selected to compare bird diversity and distribution (Image 1). These wetlands share similar geography and climatic conditions, but differ in terms of management and disturbance (Table 1).

Bird survey

A bird survey was carried out following the "point count" method along transects near the bank of lake/wetland, following detailed instructions provided by Bibby et al. (2000) from February to September 2019 two times a day at 0600–1000 h and 1600–1800 h. A total of five transects were laid in each wetland and bird study was carried out during the winter and summer seasons. The length of the transect walks varied from 500 m to 1,000 m depending upon the shape of the wetland and forest patch. The points were fixed in every 100-m intervals along the transects, then the birds were scanned and counted with the aid of binoculars (Nikon 20 × 50 and Bushnell 10 × 40) within the 50 m circular radius.

Four observers scanned for birds in all directions for five minutes. The observed birds were counted and listed, and data from all observers were pooled for each transect. To ensure a comprehensive species list for each survey site, calls of birds were also recorded with a cell phone in MP3 format. All the observed species were

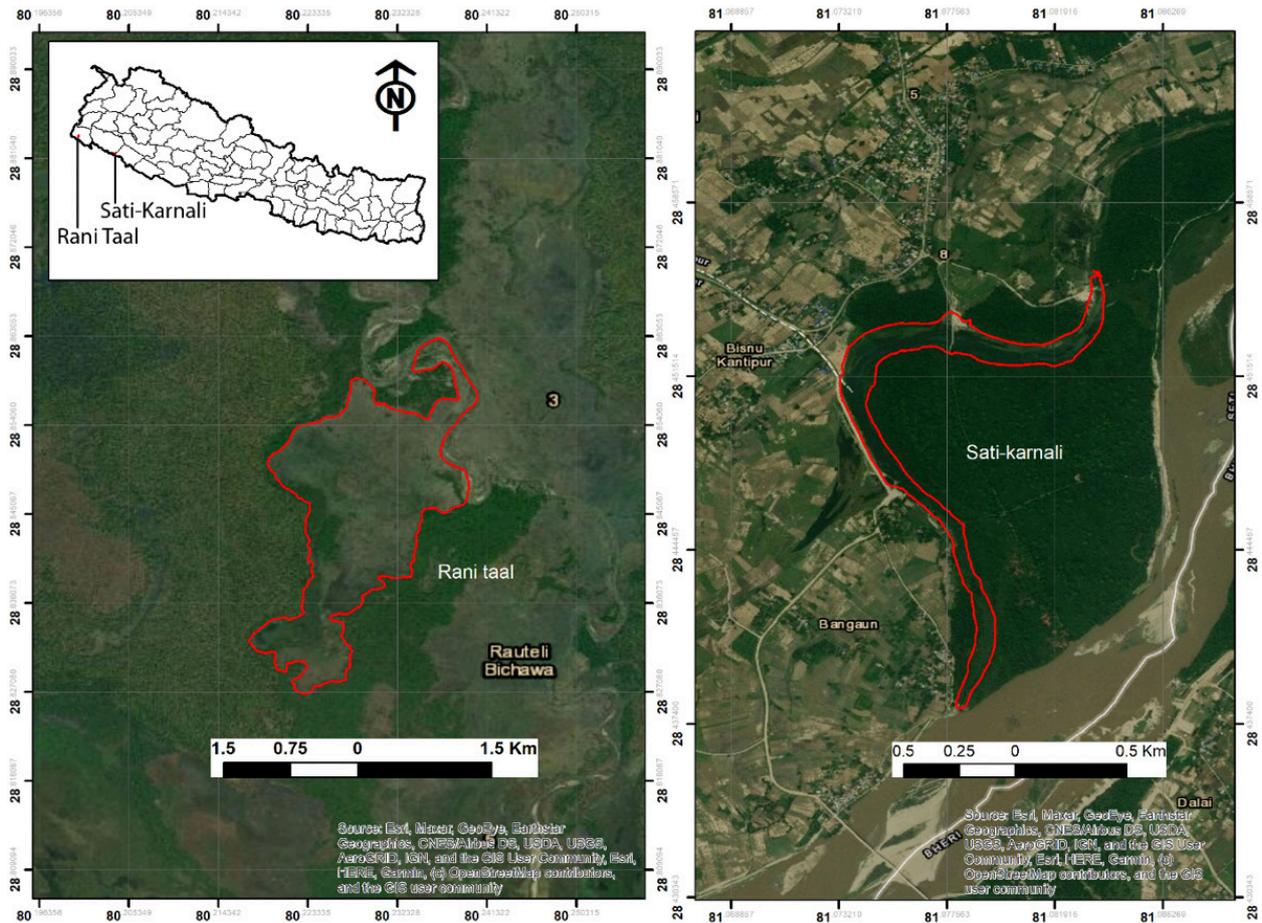


Figure 1. Map of the study area showing protected and non-protected wetlands.

recorded with abundance by visual and auditory aids, with habitat and environmental variables. Birds were identified using Grimm et al. (2016a,b). Calls were identified using the bird song database of Xeno-Canto (<https://www.xeno-canto.org/>). Foraging behavior was grouped into five different trophic structures based on the feeding habit of birds and availability of food resources in the study area (Zakaria & Rajpar 2010). These trophic structures are: insectivores, omnivores, piscivores, herbivores, and carnivores. We also carried out a questionnaire survey and literature review to record migratory and other rare bird species in the area.

Data analysis

We classified birds based on their feeding guilds, habitats and migratory behavior (BCN & DNPWC 2016; Grimm et al. 2016). We also categorized bird conservation status using IUCN Red List (<https://www.iucnredlist.org>). Species richness refers to the number of species, and abundance means the number of individuals of each species. We used two measures of

richness, one for transects and another for sites. We also calculated the diversity indices of birds in protected and non-protected sites.

Shannon Weiner diversity index (H) was used to determine species diversity in a community (Shannon 1948).

$$\text{Shannon index (H)} = \frac{1}{\sum_{i=1}^s p_i^2}$$

Where, p_i is the proportion (n/N) of individuals of one particular species found (n) divided by the total number of individuals found (N), \ln is the natural log, Σ is the sum of the calculations, and s is the number of species.

Simpson index was determined to measure community diversity in relation to habitats (Simpson 1949).

$$\text{Simpson index (D)} = - \sum_{i=1}^s p_i \ln p_i$$

Where p is the proportion (n/N) of individuals of one particular species found (n) divided by the total number of individuals found (N), Σ is the sum of the calculations, and s is the number of species.

Evenness (e) was used to determine distribution of

individuals of a species in a community.

$$\text{Evenness} = H'/H_{\text{max}}$$

Where H' is Shannon diversity index and H_{max} is the maximum possible value. E is constrained between 0 and 1.0. As with H' , evenness assumes that all species are represented within the sample.

Jacob's equitability (J) was used to measure the evenness with which individuals are divided among the taxa present. Equitability (J) = $H'/\ln S$

Where, H' = Shannon's index of diversity, S = number of taxa

Fisher's index describes mathematically the relation between the number of species and the number of individuals in those species (Fisher & Yates 1943). Fisher diversity index, defined implicitly by the formula.

$$S = a \times \ln \left(1 + \frac{n}{a} \right)$$

Where, S is number of taxa, n is number of individuals and a is the Fisher's alpha.

Differences in species richness and abundance between the protected and non-protected areas were tested using a student t test. Data were checked for normality before conducting the t test. All statistical analyses were carried out in R version. 3.6.1 (R Development Core Team 2019).

RESULTS

Diversity and distribution of birds in protected and non-protected wetlands

We recorded a total of 1,693 individuals (winter= 961; summer= 732) belonging to 122 species (winter= 118; summer= 104) from 18 orders and 44 families in the protected wetland, and 1,672 individuals (winter= 791; summer= 881) belonging to 107 species (winter= 94; summer= 86) from 16 orders and 41 families in non-protected wetland (Appendix 1). The most abundant species were from order Passeriformes (37%) followed by Coraciiformes (9.8%), Psittaciformes (7.2%), and Galliformes (6.3%) in the protected wetland whereas Passeriformes (43%) was the most abundant followed by Coraciiformes (11%), Pelecaniformes (6.9%), and Psittaciformes (6.8%) in the non-protected wetland.

In terms of cumulative abundance, Common Peafowl (4.9%) was the most abundant species in the protected wetland, followed by House Swift (4.7%), Blue-tailed Bee-eater (4.3%), and Wire-tailed Swallow (3.0%), whereas House Sparrow (4.2%) was the most abundant species followed by Cattle Egret (4.0%), Blue-tailed Bee-eater (3.5%), Lesser Whistling Duck (3.3%), and Slaty-headed

Parakeet (3.2%) in non-protected wetland (Appendix 1).

Overall, there was higher richness of birds in protected wetland ($n= 122$ compared to non-protected wetland ($n= 107$, $t= 8.623$, $p < 0.004$). Similarly, species richness was also higher in both summer ($t= 4.01$, $p= 0.004$) and winter ($t= 4.726$, $p= 0.001$) seasons (Figure 1) in protected wetland. However, there was no significant difference in species abundance between protected and non-protected wetlands ($t= 0.140$, $p= 0.870$). But the mean abundance of the birds was higher in summer season than winter in protected wetland (Figure 1).

The overall Shannon index of diversity (H), and Fisher alpha (α) in protected wetland was higher than from the non-protected wetland (Table 2). Similarly, the species diversity of protected wetland was more in winter season than summer. But there was no variation in species dominance index (D) during winter and summer seasons ($D= 0.019$, in winter and $D= 0.021$, in summer season) (Table 2). Similarly, the species diversity of birds in non-protected wetland was more winter ($H= 4.21$, $\alpha= 31.0$) than in summer ($H= 4.19$, $\alpha= 27.43$) (Table 2).

Categorization of birds according to habitat types

A total of 49 species of wetland dependent birds, followed by 43 species of forest, 17 species of open area birds, and 13 species of bush birds were recorded from protected wetland, whereas 41 species of wetland birds, 37 species of forest birds, 18 species of open area birds, and 11 species of bush dependent birds were recorded from human dominated non-protected lake (Figure 2).

Feeding guilds of birds

The proportion of insectivorous birds was higher in both wetlands (protected 43.5% and non-protected 47.41%) followed by omnivores, piscivores, herbivores, and carnivores, respectively (Figure 3).

Bird species with conservation concern

We recorded a globally Endangered species: Egyptian Vulture *Neophron percnopterus*; two Vulnerable species: Common Pochard *Aythya ferina* & Great Slaty Woodpecker *Mulleripicus pulverulentus*; and seven Near Threatened species: Grey-headed Fish Eagle *Ichthyophaga ichthyaetus*, Lesser Fish Eagle *Ichthyophaga humilis*, River Lapwing *Vanellus duvaucelii*, Red-headed Falcon *Falco chicquera*, Painted Stork *Mycteria leucocephala*, Asian Woollyneck *Ciconia episcopus*, & Oriental Darter *Anhinga melanogaster* in protected wetland. In non-protected wetland and its vicinity we reported three Vulnerable species: Common Pochard *Aythya ferina*, Great Slaty Woodpecker *Mulleripicus*

Table 1. Comparative information about the study area: Protected and non-protected wetlands of lowland Terai western Nepal.

Parameters	Protected wetland	Non-protected wetland
Location	Inside Shuklaphanta National Park, Kanchanpur	Inside Sati Karnali Community Forest User Group, Tikapur, Kailali
Geographic location	N28.922883/ E80.176317	N28.453533/ E81.07378
Elevation	175 m	158 m
River basin	Mahakali	Karnali
Nature of lake	Oxbow	Oxbow
Area	369 hector	25 hector
Temperature	Average temperature 25.9 °C (14.3–32 °C, warmest month May and coldest month January)	Average temperature 24.6 °C (15.6–32 °C, warmest month May and coldest month January)
Rainfall	1,579 mm	1,757 mm
Feeder	Rainwater	Rani Kulo
Vegetation	Surrounded by dense Sal (<i>Shorea robusta</i>) forest. Associated tree species are Kusum (<i>Scheleira oleosa</i>), Saaj (<i>Terminalia alata</i>), Rohini (<i>Mallotus philipensis</i>), Jamun (<i>Syzygium cuminii</i>), Bhellar (<i>Trewia nudiflora</i>) Common shrub species: Rudilo (<i>Pogostemon bengalensis</i>), Asare (<i>Murraya koenighii</i>) and Bhati (<i>Clerodendrum viscosum</i>). The lake is surrounded by elephant grass (<i>Saccharum spontaneum</i>), Narenga (<i>Narenga porphyrocoma</i>) on south, west and east Khatiwada et al. (2019)	Surrounded by riverine type and dominated by Sissoo (<i>Dalbergia sissoo</i>), Simal (<i>Bombax ceiba</i>), Vellar (<i>Trewia nudiflora</i>) and Khayer (<i>Acacia catechu</i>). Sindhure (<i>Mallotus philipensis</i>) and Shirish (<i>Albizia chinensis</i>) Common shrub species: Asare (<i>Murraya koenighii</i>), Bhati (<i>Clerodendron viscosum</i>). This area is well known for rattan cane (<i>Calamus tenuis</i>). Khatiwada et al. (2019)
Disturbance	No human impact, Natural eutrophication and siltation is common. More than 80% of the total area of this lake is converted into grassland and marshy land	Anthropogenic activities such as fishing, collection of snails, other aquatic products, grazing are very common.
Management authority	Shuklaphanta National Park	Sati Karnali Community Forest User Group

Table 2. The diversity and dominance indices of birds in protected and non-protected wetlands.

	Winter		Summer		Total	
	Protected	Non-protected	Protected	Non-protected	Protected	Non-protected
Species richness	118	94	104	86	122	107
Dominance_D	0.019	0.03	0.021	0.03	0.019	0.018
Shannon_H	4.512	4.21	4.29	4.19	4.47	4.38
Evenness_e^H/S	0.68	0.69	0.69	0.67	0.66	0.672
Equitability_J	0.917	0.921	0.921	0.92	0.92	0.921
Fisher_alpha	37.21	31	34.51	27.43	31.54	27.31

pulverulentus, & Lesser Adjutant *Leptoptilos javanicus*; and six Near Threatened species: Grey-headed Fish-eagle *Ichthyophaga ichthyæetus*, River Lapwing *Vanellus duvaucelii*, Asian Woollyneck *Ciconia episcopus*, Painted Stork *Mycteria leucocephala*, Oriental Darter *Anhinga melanogaster*, and Alexandrine Parakeet *Psittacula eupatria* (Figure 4, Image 2).

DISCUSSION

The present study examined diversity of wetland-associated bird species from the lowlands of western Nepal. Our results indicate that bird community structure (i.e., species richness, abundance, composition) varied

notably between protected and non-protected wetland and associated areas. Nevertheless, wetlands outside the protected area system also support a large number of important birds.

Bird diversity in protected and non-protected areas

The wetlands in both protected and non-protected areas support a considerable bird diversity of different feeding guilds. Overall, higher bird diversity was found in protected areas, signifying the importance of these areas for species conservation. Similar results were reported by Dahal et al. (2014) from forests of lowland Nepal. Abundance of forest specialist bird species such as Lesser Yellownappe *Picus chlorolophus* and Common Peafowl *Pavo cristatus* was higher around the protected

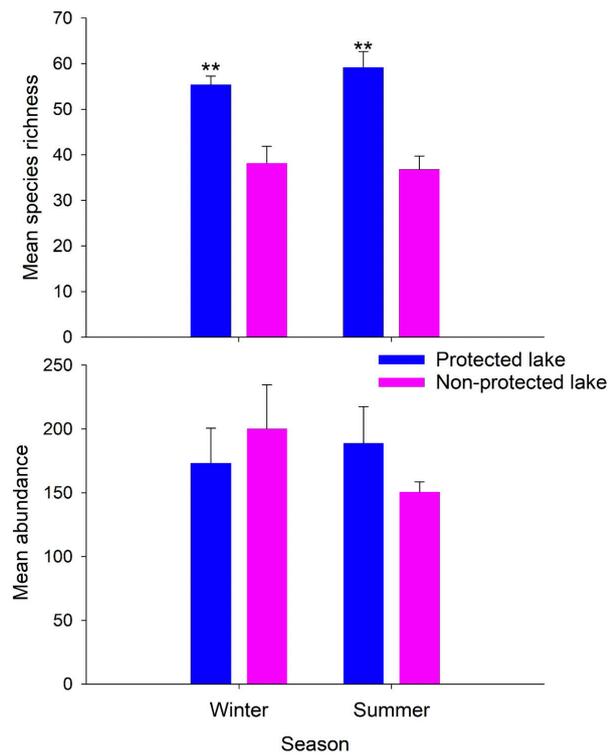


Figure 1. Mean richness and abundance of bird species on the protected and non-protected wetlands. The level of significance is from t-test (** <0.01).

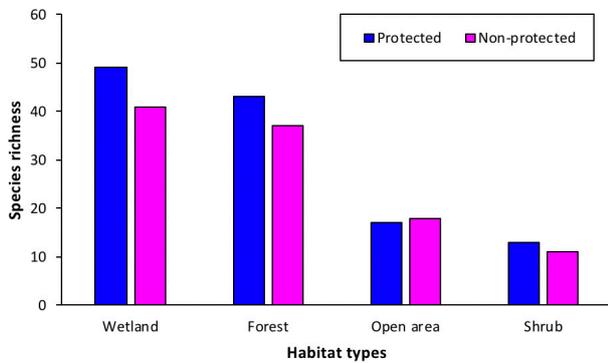


Figure 2. Habitat-wise species richness of birds.

wetland compared to non-protected wetland and surrounding areas (Appendix 1).

Our results showed an important dynamic in the wetlands in and outside the protected area. Increasing in richness in PA within the wetlands during summer, there is not distinct change in wetlands outside the PA (Figure 1). Slight increase of bird richness inside the PA might be because it provides a safe refuge for breeding birds and the disturbance is very low. Similarly, the higher abundance of the birds outside the PA during

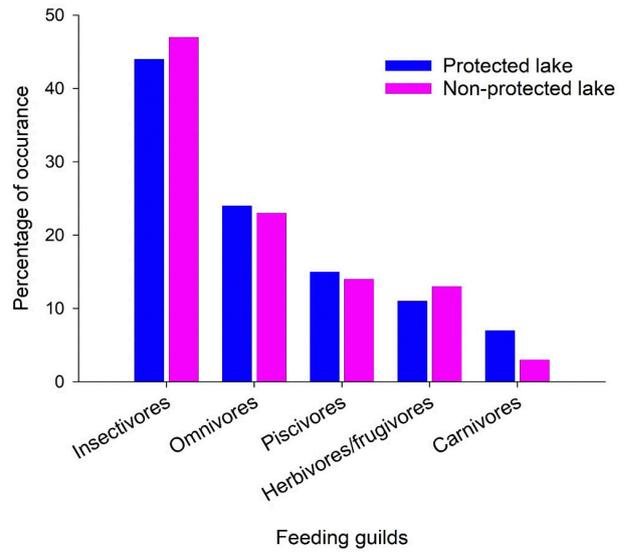


Figure 3. Percentage of bird species recorded for the different feeding guilds.

winter indicates that open and more disturbed nature of the wetlands are equally important to provide habitat for birds. Agriculture landscapes around the wetlands outside the protected area also provide bird feeding grounds. Abundance in wetlands outside PA decreases noticeably, indicating that winter migrants would have left and some resident species may also leave seeking safer habitat to breed. During March-June, water resources inside the PA become dry and the birds concentrate in this lake, hence it shows greater abundance during summer than in winter.

Our study reports higher species richness in wetland followed by forest birds (Figure 2). The species richness of birds is comparatively higher in and around the protected wetland. Lowland protected areas support old and mature forests and harbor the highest richness of forest specialist bird species (Dahal et al. 2014). Similarly, some of the wetland-dependent and associated bird species like Lesser Fish Eagle *Ichthyophaga humilis*, Osprey *Pandion haliaetus*, Mallard *Anas platyrhynchos*, Ruddy Shelduck *Tadorna ferruginea*, and Gadwall *Mareca strepera* were reported only from the protected wetland and associated areas. Higher richness of birds in protected wetland areas may be attributed to lower anthropogenic disturbance (Khatri et al. 2019; Lamsal et al. 2019), supporting birds that require undisturbed forests.

National Park are surrounded by Sal forest and grassland that support many globally threatened birds. Nepal's wetlands provide an important habitat for many wetland dependent and grassland birds including 15

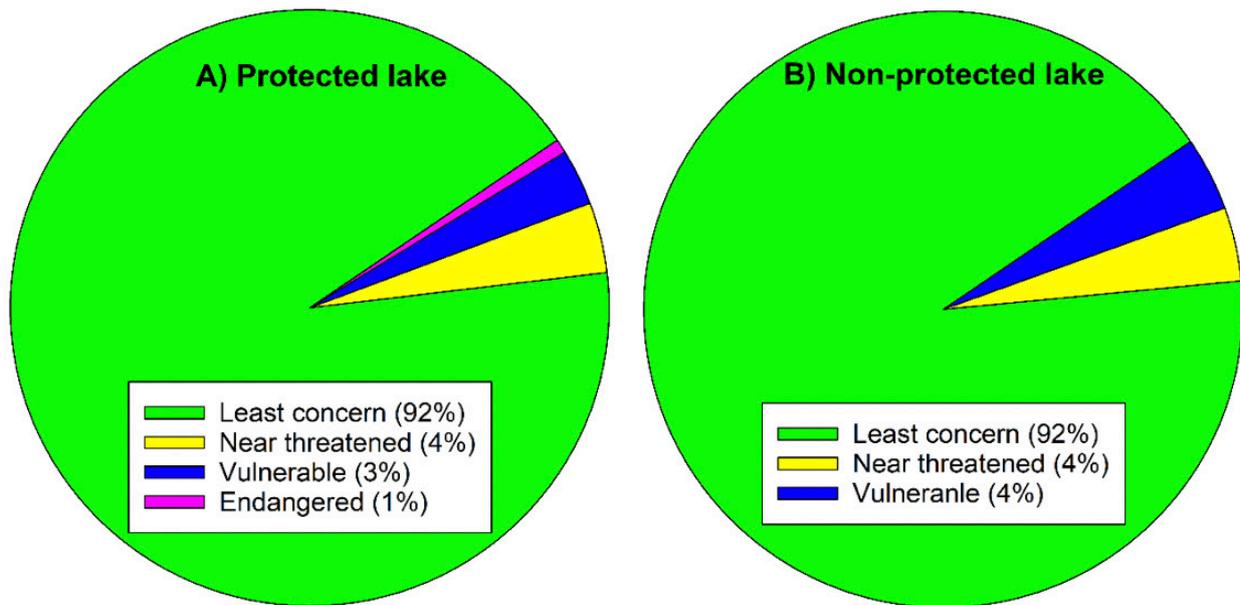


Figure 4. Pie chart showing the percentage of bird species according to IUCN Category.

globally threatened and 13 near threatened bird species (Baral & Inskipp 2009). During our study, we recorded one Endangered species of bird: Egyptian Vulture *Neophron percnopterus*, two globally Vulnerable birds: Great Slaty Woodpecker *Mulleripicus pulverulentus* Common Pochard *Aythya ferina* and five globally Near Threatened birds in and around the protected lake.

Habitat heterogeneity is greater inside the Shuklaphanta National Park in and around the protected wetland. Higher the habitat heterogeneity favours higher the species diversity (Tamme et al. 2010). Hence higher number of forest specific birds and wetland birds were recorded in the protected wetland. But the non-protected wetland is surrounded by small patch of forest and agriculture landscape. The exploitation of natural resources and impact of human pressure was more in non-protected wetland which may be a cause of lower abundance of forest and wetland specialist birds. Nevertheless, due to diverse habitats, agricultural landscape supported higher richness and abundance of open area birds. Elsen et al. (2017) reported that low intensity agriculture supports higher bird diversity during winter in Himalayan montane landscape.

The wetland outside the protected area also supported considerable bird diversity. The birds reported here included several species listed as Vulnerable (VU) in IUCN Red List. Non-protected wetland and adjoining areas provide the suitable habitats for several vulnerable and near threatened bird species. During this study, we reported three Vulnerable and six Near Threatened

bird species. The adjoining area of this wetland is surrounded by paddy fields and swampy areas, which are the foraging ground to several species (de Silva et al. 2015; Adhikari et al. 2019). The tree species present in paddy field and adjoining community forest provide the nesting and foraging places for birds. The study on the responses of birds with tree species in agricultural landscape found larger population sizes of birds with low intensity farming as they share same land for foraging (Hulme et al. 2013). Hence, land sharing would result in better bird conservation outcomes (Hulme et al. 2013; Edwards et al. 2014; Schulte et al. 2016) but land sparing has greater potential biodiversity benefits for large mammals, cats and large birds than land sharing (Lamb et al. 2019; Finch et al. 2020). Several studies show that agricultural land is an important driver that effect the wild nature directly or indirectly which is very common in developing countries (Green et al. 2005; Haslem & Bennett 2008; Šálek et al. 2018; Chaudhary et al. 2020).

Difference in feeding guilds

The results showed that wetlands are suitable for avifauna as they offer shelter, food, suitable nesting, and roosting sites for different groups of birds (Giosa et al. 2018). The habitat preference of the bird could be due to the availability of food they feed on such as insects, fishes, frogs, lizards, mouse, grains, fruits, vegetable matter (Katuwal et al. 2016; Harisha & Hosetti 2018). We identified five different foraging guilds such as insectivores, omnivores, piscivores, herbivores, and

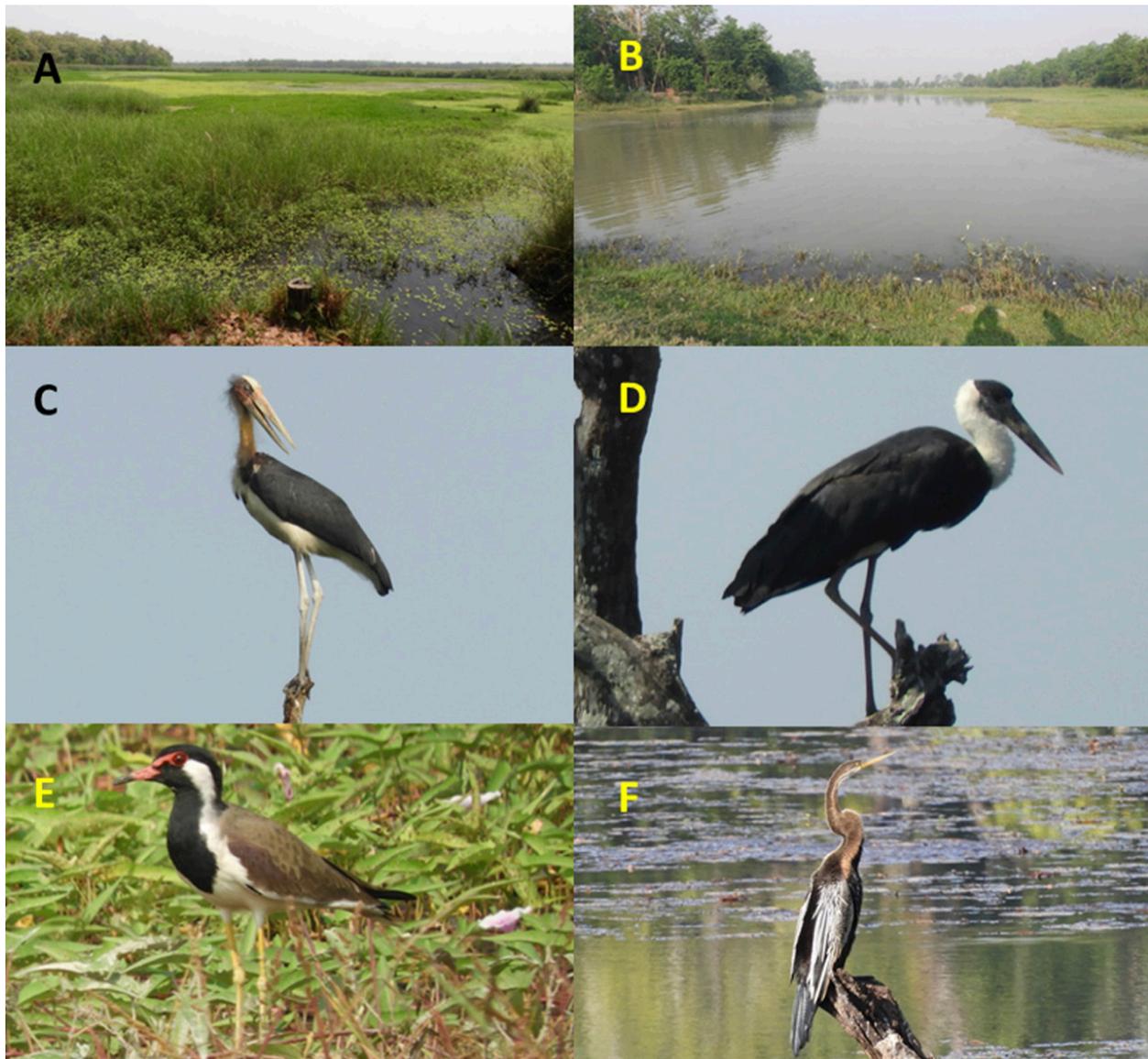


Image 2. A—protected wetland (Rani Taal) inside the Shuklaphanta National Park, western Nepal | B—non-protected wetland (Sati Karnali Taal) of Kailali district | C—Lesser Adjutant (*Leptoptilos javanicus*), globally Vulnerable, recorded from non-protected wetland | D—Asian Woolly-neck (*Ciconia episcopus*), globally Near threatened, recorded from both wetlands | E—Red-wattled Lapwing (*Vanellus indicus*), globally Least Concern, recorded from both wetlands | F—Oriental Darter (*Anhinga melanogaster*), globally near threatened recorded from both wetlands. © Jagan Nath Adhikari

carnivores of birds. Among them, insectivores were highly abundant in both wetland systems. Dahal et al. (2014) identified seven main foraging guilds of birds. Insectivores are the most dominant group of birds as compared to other birds in the globe (Zakaria & Rajpar 2010; Datta 2011; Dahal et al. 2014; Basnet et al. 2016; Adhikari et al. 2018a,b). The main reason for the selection of different habitats by birds could be the presence of different vegetation types. The vegetation surrounding the protected wetland was dense and relatively mature compared to non-protected wetland.

The agricultural fields around the non-protected wetland also supported more insectivore birds. Hence, both protected and non-protected wetlands are very important from conservation aspects of birds.

CONCLUSION

This study demonstrates that both protected and non-protected wetlands have comparable richness, though the composition of birds slightly differed.

Protected areas supported some forest and wetland specialist birds. The study reported the same common bird species on both protected and non-protected wetlands, hence, wetlands outside protected areas are also important for species conservation. This result suggests that the habitats outside protected areas also play an important complementary role to conservation of bird species which are worth conserving. Mosaics of habitat patches in low-intensity agricultural landscape favored considerable bird diversity which supports the idea that food production and biodiversity conservation can be reconciled in same landscape unit. Wetlands rich in biodiversity and sources of ecosystem goods and services are dwindling faster due to increased human activities related with agriculture, land use change and infrastructure development. We underscore call for action to extend program for the protection of ecosystem outside protected areas while emphasizing the management of protected areas for enhanced in situ conservation.

REFERENCES

- Adhikari, J.N., B.P. Bhattarai & D.N. Dhakal (2018a). Conservation value of Beeshazari Lake: an insight into diversity and abundance of wetland birds. *Our Nature* 16(1): 17–26. <https://doi.org/10.3126/on.v16i1.21563>
- Adhikari, J.N., B.P. Bhattarai & T.B. Thapa (2018b). Diversity and conservation threats of water birds in and around Barandabhar corridor forest, Chitwan, Nepal. *Journal of Natural History Museum* 30: 164–179. <https://doi.org/10.3126/jnhm.v30i0.27553>
- Adhikari, J.N., B.P. Bhattarai & T.B. Thapa (2019). Factors affecting diversity and distribution of threatened birds in Chitwan National Park, Nepal. *Journal of Threatened Taxa* 11(5): 13511–13522. <https://doi.org/10.11609/jott.4137.11.5.13511-13522>
- Baral, H.S. & C. Inskipp (2009). The birds of Suklaphanta Wildlife Reserve, Nepal. *Our Nature* 7(1): 56–81. <https://doi.org/10.3126/on.v7i1.2554>
- Baral, H.S. & C. Inskipp (2020). Birds of Nepal: Their Status and Conservation Especially with Regards to Watershed Perspectives, pp. 435–458. In: Regmi, G.R. & F. Huettmann (eds.). *Hindu Kush-Himalaya Watersheds Downhill: Landscape Ecology and Conservation Perspectives*. Springer. https://doi.org/10.1007/978-3-030-36275-1_22
- Basnet, T.B., M.B. Rokaya, B.P. Bhattarai & Z. Munzbergova (2016). Heterogeneous Landscapes on Steep Slopes at Low Altitudes as Hotspots of Bird Diversity in a Hilly Region of Nepal in the Central Himalayas. *PLoS ONE* 11(3): e0150498. <https://doi.org/10.1371/journal.pone.0150498>
- BCN & DNPWC (2016). *Birds of Nepal: An Official Checklist*. Bird Conservation Nepal (BCN) and Department of National Parks and Wildlife Conservation (DNPWC), Kathmandu, Nepal, 40 pp.
- Bibby, C.J., N.D. Burgess, D.A. Hill & S. Mustoe (2000). *Bird census techniques*. Academic Press, Elsevier, 302 pp.
- Brotherton, S., C.B. Joyce & J.P. Scharlemann (2020). Global offtake of wild animals from wetlands: critical issues for fish and birds. *Hydrobiologia* 847: 1631–1649. <https://doi.org/10.1007/s10750-020-04188-z>
- Chakravarty, S., S. Ghosh, C. Suresh, A. Dey & G. Shukla (2012). Deforestation: causes, effects and control strategies, pp. 1–26. In: Shukla, G. (eds.). *Global perspectives on sustainable forest management*. Intech Rijeka, Croatia, 315 pp.
- Chape, S., J. Harrison, M. Spalding & I. Lysenko (2005). Measuring the extent and effectiveness of protected areas as an indicator for meeting global biodiversity targets. *Philosophical Transactions of the Royal Society B: Biological Sciences* 360(1454): 443–455. <https://doi.org/10.1098/rstb.2004.1592>
- Chaudhary, S., Y. Wang, A.M. Dixit, N.R. Khanal, P. Xu, B. Fu, K. Yan, Q. Liu, Y. Lu & M. Li (2020). A synopsis of farmland abandonment and its driving factors in Nepal. *Land* 9(3): 1–24. <https://doi.org/10.3390/land9030084>
- Cox, R.L. & E.C. Underwood (2011). The importance of conserving biodiversity outside of protected areas in Mediterranean ecosystems. *PLoS ONE* 6(1): e14508. <https://doi.org/10.1371/journal.pone.0014508>
- Dahal, B.R., C.A. McAlpine & M. Maron (2014). Bird conservation values of off-reserve forests in lowland Nepal. *Forest Ecology and Management* 323: 28–38. <https://doi.org/10.1016/j.foreco.2014.03.033>
- Dahal, B.R., C.A. McAlpine & M. Maron (2015). Impacts of extractive forest uses on bird assemblages vary with landscape context in lowland Nepal. *Biological Conservation* 186: 167–175. <https://doi.org/10.1016/j.biocon.2015.03.014>
- Datta, T. (2011). Human interference and avifaunal diversity of two wetlands of Jalpaiguri, West Bengal, India. *Journal of Threatened Taxa* 3(12): 2253–2262. <https://doi.org/10.11609/JoTT.o2739.2253-62>
- de Silva, T.N., S. Fernando, H.B. de Silva & P. Tennakoon (2015). Lesser Adjutant *Leptoptilos javanicus* Horsfield, 1821 (Ciconiiformes: Ciconiidae) in the dry lowlands of Sri Lanka: distribution, ecology, and threats. *Journal of Threatened Taxa* 7(14): 8089–8095. <https://doi.org/10.11609/jott.2425.7.14.8089-8095>
- DNPWC (2020). *Protected areas of Nepal*. Department of National Parks and Wildlife Conservation (DNPWC) Nepal, Kathmandu, Nepal. Downloaded on 20 January 2020. <http://www.dnpwc.gov.np>
- Dudgeon, D., A.H. Arthington, M.O. Gessner, Z.I. Kawabata, D.J. Knowler, C. Lévêque, R.J. Naiman, A.-H. Prieur-Richard, D. Soto & M.L. Stiassny (2006). Freshwater biodiversity: importance, threats, status and conservation challenges. *Biological Reviews* 81(2): 163–182. <https://doi.org/10.1017/S1464793105006950>
- Dudley, N., C. Groves, K.H. Redford & S. Stolton (2014). Where now for protected areas? Setting the stage for the 2014 World Parks Congress. *Oryx* 48(4): 496–503. <https://doi.org/10.1017/S0030605314000519>
- Edwards, D.P., J.J. Gilroy, P. Woodcock, F.A. Edwards, T.H. Larsen, D.J. Andrews, M.A. Derhe, T.D. Docherty, W.W. Hsu, S.L. Mitchell, T. Ota, L.J. Williams, W.F. Laurance, K.C. Hamer & D.S. Wilcove (2014). Land-sharing versus land-sparing logging: reconciling timber extraction with biodiversity conservation. *Globe Change Biology* 20(1): 183–191. <https://doi.org/10.1111/gcb.12353>
- Elsen, P.R., R. Kalyanaraman, K. Ramesh & D.S. Wilcove (2017). The importance of agricultural lands for Himalayan birds in winter. *Conservation Biology* 31(2): 416–426. <https://doi.org/10.1111/cobi.12812>
- Finch, T., S. Gillings, D. Massimino, T. Brereton, J. Redhead, R. Pywell, R. Field, A. Balmford, R. Green & W. Peach (2020). Assessing the utility of land sharing and land sparing for birds, butterflies and ecosystem services in lowland England. Natural England Commissioned Report NECR280, 73 pp.
- Fisher, R.A. & F. Yates (1943). *Statistical Tables: For Biological, Agricultural and Medical Research*. Second edition. Oliver and Boyd Ltd, London, 105 pp.
- Geist, J. (2011). Integrative freshwater ecology and biodiversity conservation. *Ecological Indicators* 11(6): 1507–1516. <https://doi.org/10.1016/j.ecolind.2011.04.002>
- Green, R.E., S.J. Cornell, J.P. Scharlemann & A. Balmford (2005). Farming and the fate of wild nature. *Science* 307(5709): 550–555. <https://doi.org/10.1126/science.1106049>

- Grimmett, R., C. Inskipp & T. Inskipp (2016a). *Birds of the Indian Subcontinent: India, Pakistan, Sri Lanka, Nepal, Bhutan, Bangladesh and the Maldives*. Bloomsbury Publishing, 448 pp.
- Grimmett, R., C. Inskipp, T. Inskipp & H.S. Baral (2016b). *Birds of Nepal: Revised Edition*. Bloomsbury Publishing, India, 386 pp.
- Harisha, M.N. & B.B. Hosetti (2018). Status and conservation issues of wetland birds in Komaranahalli lake, Davanagere district, Karnataka, India. *Journal of Threatened Taxa* 10(2): 11290–11294. <http://doi.org/10.11609/jott.2809.10.2.11290-11294>
- Haslem, A. & A.F. Bennett (2008). Birds in agricultural mosaics: the influence of landscape pattern and countryside heterogeneity. *Ecological Applications* 18(1): 185–196. <https://doi.org/10.1890/07-0692.1>
- Hulme, M.F., J.A. Vickery, R.E. Green, B. Phalan, D.E. Chamberlain, D.E. Pomeroy, D. Nalwanga, D. Mushabe, R. Katebaka & S. Bolwig (2013). Conserving the birds of Uganda's banana-coffee arc: land sparing and land sharing compared. *PLoS ONE* 8(2): e54597. <https://doi.org/10.1371/journal.pone.0054597>
- Inskipp, C., H.S. Baral, T. Inskipp, A.P. Khatiwada, M.P. Khatiwada, L.P. Poudyal & R. Amin (2017). Nepal's National Red List of birds. *Journal of Threatened Taxa* 9(1): 9700–9722. <https://doi.org/10.11609/jott.2855.9.1.9700-9722>
- Katuwal, H.B., K. Basnet, B. Khanal, S. Devkota, S.K. Rai, J.P. Gajurel, C. Scheidegger & M.P. Nobis (2016). Seasonal Changes in Bird Species and Feeding Guilds along Elevational Gradients of the Central Himalayas, Nepal. *PLoS ONE* 11(7): e0158362. <https://doi.org/10.1371/journal.pone.0158362>
- Khatiwada, J.R., J.N. Adhikari, D. Adhikari, S. Sapkota, S.R. Ghimire, P.B. Budha & L.N. Sharma (2019). Assessment and conservation status of aquatic biodiversity in lower Karnali and Mahakali River basin. Forest Action Nepal, USAID Pani Program, 116 pp.
- Khatiwada, J. R., J.N., Adhikari, D., Rijal & L.N. Sharma (2021). Freshwater biodiversity in western Nepal: A review. *Nepalese Journal of Zoology* 5(1): 34–46. <https://doi.org/10.3126/njz.v5i1.38290>
- Khatri, N.D., B. Neupane, Y.P. Timilsina & S. Ghimire (2019). Assessment of Avifaunal diversity and threats to them in Phewa wetland, Nepal. *Forestry: Journal of Institute of Forestry, Nepal* 16: 31–47. <https://doi.org/10.3126/forestry.v16i0.28352>
- Kumar, A. (2005). *Handbook on Indian wetland birds and their conservation*. Zoological Survey of India, Dehradun, India, 472 pp.
- Lamb, A., T. Finch, J.W. Pearce-Higgins, M. Ausden, A. Balmford, C. Feniuk, G. Hirons, D. Massimino & R.E. Green (2019). The consequences of land sparing for birds in the United Kingdom. *Journal of Applied Ecology* 56(8): 1870–1881. <https://doi.org/10.1111/1365-2664.13362>
- Lamsal, P., K. Atreya, M.K. Ghosh & K.P. Pant (2019). Effects of population, land cover change, and climatic variability on wetland resource degradation in a Ramsar listed Ghodaghodi Lake Complex, Nepal. *Environmental Monitoring and Assessment* 191(7): 1–16. <https://doi.org/10.1007/s10661-019-7514-0>
- Ostfeld, A., S. Barchiesi, M. Bonte, C.R. Collier, K. Cross, G. Darch, T.A. Farrell, M. Smith, A. Vicory & M. Weyand (2012). Climate change impacts on river basin and freshwater ecosystems: some observations on challenges and emerging solutions. *Journal of Water and Climate Change* 3(3): 171–184. <https://doi.org/10.2166/wcc.2012.006>
- Paracuellos, M. (2006). Relationships of songbird occupation with habitat configuration and bird abundance in patchy reed beds. *ARDEA* 94(1): 87–98.
- R Development Core Team (2019). *A Language and Environment for Statistical Computing*. R Foundation for Statistical Computing, Vienna, Austria.
- Rodrigues, A.S., H.R. Akcakaya, S.J. Andelman, M.I. Bakarr, L. Boitani, T.M. Brooks, J.S. Chanson, L.D. Fishpool, G.A. Da Fonseca & K.J. Gaston (2004). Global gap analysis: priority regions for expanding the global protected-area network. *BioScience* 54(12): 1092–1100. [https://doi.org/10.1641/0006-3568\(2004\)054\[1092:GGAPRF\]2.0.CO;2](https://doi.org/10.1641/0006-3568(2004)054[1092:GGAPRF]2.0.CO;2)
- Šálek, M., M. Bažant & M. Žmihorski (2018). Active farmsteads are year-round strongholds for farmland birds. *Journal of Applied Ecology* 55(4): 1908–1918. <https://doi.org/10.1111/1365-2664.13093>
- Schulte, L.A., A.L. MacDonald, J.B. Niemi & M.J. Helmers (2016). Prairie strips as a mechanism to promote land sharing by birds in industrial agricultural landscapes. *Agriculture, Ecosystems and Environment* 220: 55–63. <https://doi.org/10.1016/j.agee.2016.01.007>
- Shannon, C.E. (1948). *Mathematical Theory of Communication*. *The Bell System Technical Journal* 27(3): 379–424. <https://doi.org/10.1002/j.1538-7305.1948.tb01338.x>
- Sharma, L.N. & O.R. Vetaas (2015). Does agroforestry conserve trees? A comparison of tree species diversity between farmland and forest in mid-hills of central Himalaya. *Biodiversity Conservation* 24(8): 2047–2061. <https://doi.org/10.1007/s10531-015-0927-3>
- Shrestha, U.B., S. Shrestha, P. Chaudhary & R.P. Chaudhary (2010). How representative is the protected areas system of Nepal? *Mountain Research and Development* 30(3): 282–294. <https://doi.org/10.1659/MRD-JOURNAL-D-10-00019.1>
- Simpson, E.H. (1949). Measurement of diversity. *Nature* 163(4148): 688–688. <https://doi.org/10.1038/163688a0>
- Siwakoti, M. & J.B. Karki (2009). Conservation status of Ramsar sites of Nepal Terai: an overview. *Botanica Orientalis: Journal of Plant Science* 6: 76–84. <https://doi.org/10.3126/botor.v6i0.2914>
- Tamme, R., I. Hiiesalu, L. Laanisto, R. Szava-Kovats & M. Pärtel (2010). Environmental heterogeneity, species diversity and co-existence at different spatial scales. *Journal of Vegetation Science* 21(4): 796–801. <https://doi.org/10.1111/j.1654-1103.2010.01185.x>
- Terborgh, J., C. van Schaik, L. Davenport & M. Rao (2002). *Making Parks Work: Strategies for Preserving Tropical Nature*. Island Press, 511 pp.
- UNEP-WCMC, IUCN & NGS (2018). *Protected Planet Report 2018*. UNEP-WCMC, IUCN and NGS, Cambridge UK; Gland, Switzerland; and Washington, D.C., USA, 70 pp.
- Watson, J.E., E.S. Darling, O. Venter, M. Maron, J. Walston, H.P. Possingham, N. Dudley, M. Hockings, M. Barnes & T.M. Brooks (2016). Bolder science needed now for protected areas. *Conservation Biology* 30(2): 243–248. <https://doi.org/10.1111/cobi.12645>
- Zakaria, M. & M.N. Rajpar (2010). Bird species composition and feeding guilds based on point count and mist netting methods at the Paya Indah Wetland Reserve, Peninsular Malaysia. *Tropical Life Sciences Research* 21(2): 7–26.

Appendix 1. Bird species with their abundance observed in protected and non-protected wetlands in Winter and Summer. Relative abundance (RA) refers total percentage contribution of each species to the total sample. 0 indicated the species were not recorded during field study, here, EN= Endangered, VU= Vulnerable, NT= Near threatened and LC= Least Concern.

	Order/Family/ Common name	Zoological name	RA in Winter		RA in Summer		Total RA (%)		IUCN category
			Protected	Non-protected	Protected	Non-protected	Protected	Non-protected	
Order ACCIPITRIFORMES									
Family Accipitridae									
1	Black Kite	<i>Milvus migrans</i> (Boddaert, 1783)	0.004	0.5	0.007	0.554	0.524	0.53	LC
2	Crested Serpent-eagle	<i>Spilornis cheela</i> (Latham, 1790)	0.002	0.125	0.001	0.111	0.175	0.117	LC
3	Grey-headed Fish-eagle	<i>Ichthyophaga ichthyaetus</i> (Horsfield, 1821)	0.002	0.503	0.001	0.443	0.175	0.47	NT
4	Lesser Fish-eagle	<i>Ichthyophaga humilis</i> (Müller & Schlegel, 1841)	0.604	0	0.005	0	0.466	0	NT
5	Egyptian Vulture	<i>Neophron percnopterus</i> (Linnaeus, 1758)	0.001	0	0.001	0	0.117	0	EN
Family Pandionidae									
6	Osprey	<i>Pandion haliaetus</i> (Linnaeus, 1758)	0.002	0	0.003	0	0.233	0	LC
Order ANSERIFORMES									
Family Anatidae									
7	Bar-headed Goose	<i>Anser indicus</i> (Latham, 1790)	0.005	0	0	0	0.291	0	LC
8	Common Pochard	<i>Aythya ferina</i> (Linnaeus, 1758)	1.915	1.509	0	0	0.874	0.707	LC
9	Common Shelduck	<i>Tadorna tadorna</i> (Linnaeus, 1758)	1.017	1.509	0	0	0.932	0.7	LC
10	Common Teal	<i>Anas crecca</i> Linnaeus, 1758	0.004	0.628	0	0	0.233	0.294	LC
11	Gadwall	<i>Mareca strepera</i> (Linnaeus, 1758)	0.004	0	0	0	0.233	0	LC
12	Lesser Whistling-duck	<i>Dendrocygna javanica</i> (Horsfield, 1821)	0.91	6.92	0	0	0.583	3.241	LC
13	Mallard	<i>Anas platyrhynchos</i> Linnaeus, 1758	0.002	0	0	0	0.117	0	LC
14	Ruddy Shelduck	<i>Tadorna ferruginea</i> (Pallas, 1764)	0.002	0	0	0	0.117	0	LC
Order BUCEROTIFORMES									
Family Bucerotidae									
15	Indian Grey Hornbill	<i>Ocyrceros birostris</i> (Scopoli, 1786)	0.002	0	0.003	0.111	0.233	0.05	LC
Family Upupidae									
16	Common Hoopoe	<i>Upupa epops</i> Linnaeus, 1758	0.006	0.25	0.008	0.222	0.699	0.235	LC
Order CAPRIMULGIFORMES									
Family Apodidae									
17	House Swift	<i>Apus nipalensis</i> (Hodgson, 1836)	2.052	2.77	3.04	2.328	4.662	2.533	LC
Order CHARADRIIFORMES									
Family Charadriidae									
18	Grey-headed Lapwing	<i>Vanellus cinereus</i> (Blyth, 1842)	0.004	0.251	0.005	0	0.466	0.118	LC
19	Red-wattled Lapwing	<i>Vanellus indicus</i> (Boddaert, 1783)	0.004	0.503	0.007	0.665	0.524	0.589	LC
20	River Lapwing	<i>Vanellus duvaucelii</i> (Lesson, 1826)	0.004	0.628	0.004	0.665	0.408	0.648	NT
21	Yellow-wattled Lapwing	<i>Vanellus malabaricus</i> (Boddaert, 1783)	0.004	1.006	0.005	1.219	0.466	1.119	LC
Family Jacanidae									
22	Bronze-winged Jacana	<i>Metopidius indicus</i> (Latham, 1790)	0.81	0.628	1.019	0.332	1.399	0.471	LC

	Order/Family/ Common name	Zoological name	RA in Winter		RA in Summer		Total RA(%)		IUCN category
			Protected	Non- protected	Protected	Non- protected	Protected	Non- protected	
Family Scolopacidae									
23	Common Sandpiper	<i>Actitis hypoleucos</i> Linnaeus, 1758	0.004	0	0.003	0	0.35	0	LC
24	Green Sandpiper	<i>Tringa ochropus</i> Linnaeus, 1758	0.012	0.503	0.007	0.554	0.991	0.53	LC
25	Marsh Sandpiper	<i>Tringa stagnatilis</i> (Bechstein, 1803)	0.004	0.503	0.003	0.443	0.35	0.471	LC
26	Wood Sandpiper	<i>Tringa glareola</i> Linnaeus, 1758	0.002	0	0	0	0.117	0	LC
Order CICONIIFORMES									
Family Ciconiidae									
27	Asian Openbill	<i>Anastomus oscitans</i> (Boddaert, 1783)	0.71	1.509	0.009	1.77	0.991	1.649	LC
28	Asian Woollyneck	<i>Ciconia episcopus</i> (Boddaert, 1783)	0.002	0.125	0.003	0.886	0.233	0.53	NT
29	Black Stork	<i>Ciconia nigra</i> (Linnaeus, 1758)	0.002	0	0.003	0	0.233	0	LC
30	Lesser Adjutant	<i>Leptoptilos javanicus</i> (Horsfield, 1821)	0	0.252	0	0	0	0.117	VU
31	Painted Stork	<i>Mycteria leucocephala</i> (Pennant, 1769)	0.002	0.252	0	0	0.117	0.117	NT
Order COLUMBIFORMES									
Family Columbidae									
32	Grey-capped Emerald Dove	<i>Chalcophaps indica</i> (Linnaeus, 1758)	0.008	1.006	1.011	0.997	0.932	1.001	LC
33	Oriental Turtle-dove	<i>Streptopelia orientalis</i> (Latham, 1790)	0.004	0.503	0.005	0.443	0.466	0.47	LC
34	Red Turtle-dove	<i>Streptopelia tranquebarica</i> (Hermann, 1804)	0.004	0.503	0.005	0.554	0.466	0.53	LC
35	Rock Dove	<i>Columba livia</i> Gmelin, 1789	0.005	0	0.004	0	0.466	0	LC
36	Western Spotted Dove	<i>Spilopelia suratensis</i> (Gmelin, 1789)	0.019	0.628	0.008	4.212	1.399	2.53	LC
Order CORACIIFORMES									
Family Alcedinidae									
37	Common Kingfisher	<i>Alcedo atthis</i> (Linnaeus, 1758)	0.005	0.628	0.007	0.554	0.583	0.589	LC
38	Pied Kingfisher	<i>Ceryle rudis</i> (Linnaeus, 1758)	0	0.252	0.001	0	0.058	0.117	LC
39	Stork-billed Kingfisher	<i>Pelargopsis capensis</i> (Linnaeus, 1766)	0.002	0	0	0	0.117	0	LC
40	White-breasted Kingfisher	<i>Halcyon smyrnensis</i> (Linnaeus, 1758)	0.07	0.88	0.012	2.1	0.932	1.532	LC
Family Coraciidae									
41	Indian Roller	<i>Coracias benghalensis</i> (Linnaeus, 1758)	0.05	0.628	0.007	0.554	0.583	0.589	LC
Family Meropidae									
42	Asian Green Bee-eater	<i>Merops orientalis</i> Latham, 1802	1.018	2.138	2.013	2.106	1.573	2.121	LC
43	Blue-tailed Bee-eater	<i>Merops philippinus</i> Linnaeus, 1766	2.038	3.899	3.048	3.215	4.254	3.535	LC
44	Chestnut-headed Bee-eater	<i>Merops leschenaulti</i> Vieillot, 1817	0.004	0.503	0.005	0.222	0.466	0.353	LC
Order CUCULIFORMES									
Family Cuculidae									
45	Banded Bay Cuckoo	<i>Cacomantis sonneratii</i> (Latham, 1790)	0.002	0.252	0.003	0.222	0.233	0.23	LC
46	Common Hawk-cuckoo	<i>Hierococcyx varius</i> (Vahl, 1797)	0.002	0.252	0.003	0.222	0.233	0.23	LC
47	Greater Coucal	<i>Centropus sinensis</i> (Stephens, 1815)	0.002	0.252	0.003	0.222	0.233	0.23	LC
48	Indian Cuckoo	<i>Cuculus micropterus</i> Gould, 1837	0.003	0.377	0.004	0	0.35	0.176	LC

	Order/Family/ Common name	Zoological name	RA in Winter		RA in Summer		Total RA (%)		IUCN category
			Protected	Non-protected	Protected	Non-protected	Protected	Non-protected	
49	Lesser Coucal	<i>Centropus bengalensis</i> (Gmelin, 1788)	0.008	1.006	0.009	0.776	0.874	0.88	LC
50	Western Koel	<i>Eudynamis scolopaceus</i> (Linnaeus, 1758)	0.002	0	0.003	0	0.233	0	LC
Order FALCONIFORMES									
Family Falconidae									
51	Red-headed Falcon	<i>Falco chicquera</i> Daudin, 1800	0.002	0	0.003	0	0.233	0	NT
Order GALLIFORMES									
Family Phasianidae									
52	Black Francolin	<i>Francolinus francolinus</i> (Linnaeus, 1766)	0.004	0.252	0.003	0.221	0.35	0.23	LC
53	Common Peafowl	<i>Pavo cristatus</i> Linnaeus, 1758	3.052	2.767	4.047	2.328	4.953	2.53	LC
54	Common Quail	<i>Coturnix coturnix</i> (Linnaeus, 1758)	0.004	0	0.008	0	0.583	0	LC
55	Red Junglefowl	<i>Gallus gallus</i> (Linnaeus, 1758)	0.804	0.503	0.005	0.443	0.466	0.471	LC
56	Common Coot	<i>Fulica atra</i> Linnaeus, 1758	0.01	0	0	0.554	0.583	0.294	LC
Order GRUIFORMES									
Family Rallidae									
57	Ruddy-breasted Crane	<i>Zapornia fusca</i> (Linnaeus, 1766)	0.015	0	0.017	0	1.632	0	LC
58	Watercock	<i>Gallicrex cinerea</i> (Gmelin, 1789)	0.01	1.258	0.004	0	0.758	0.58	LC
59	White-breasted Waterhen	<i>Amaurornis phoenicurus</i> (Pennant, 1769)	0.003	0.377	0	0	0.175	0.17	LC
Order PASSERIFORMES									
Family Alaudidae									
60	Rufous-winged Lark	<i>Mirafra assamica</i> Horsfield, 1840	0.715	1.88	2.017	1.33	1.632	1.591	LC
61	Sand Lark	<i>Alaudala raytal</i> (Blyth, 1844)	0.002	0.25	0	0.221	0.117	0.23	LC
Family Campephagidae									
62	Scarlet Minivet	<i>Pericrocotus flammeus</i> (Forster, 1781)	0.006	0.754	0.009	0.665	0.758	0.7	LC
Family Cisticolidae									
63	Jungle Prinia	<i>Prinia sylvatica</i> Jerdon, 1840	0.005	0.628	0.005	0	0.524	0.294	LC
64	Zitting Cisticola	<i>Cisticola juncidis</i> (Rafinesque, 1810)	0.004	0.503	0.004	0.443	0.408	0.471	LC
Family Corvidae									
65	Grey Treepie	<i>Dendrocitta formosae</i> Swinhoe, 1863	0.002	0	0.003	0	0.233	0	LC
66	House Crow	<i>Corvus splendens</i> Vieillot, 1817	0.915	1.88	1.012	2.439	1.399	2.18	LC
67	Large-billed Crow	<i>Corvus macrorhynchos</i> Wagler, 1827	0.004	0.503	0.008	1.441	0.583	1	LC
68	Red-billed Blue Magpie	<i>Urocissa erythroryncha</i> (Boddaert, 1783)	0.002	0.25	0.003	0.221	0.233	0.235	LC
69	Rufous Treepie	<i>Dendrocitta vagabunda</i> (Latham, 1790)	0.004	0.503	0.004	0.554	0.408	0.53	LC
Family Dicruridae									
70	Ashy Drongo	<i>Dicrurus leucophaeus</i> Vieillot, 1817	0.005	0.628	0.007	0.55	0.583	0.58	LC
71	Black Drongo	<i>Dicrurus macrocercus</i> Vieillot, 1817	1.015	1.88	2.017	1.88	1.632	1.885	LC
72	Greater Racquet-tailed Drongo	<i>Dicrurus paradiseus</i> (Linnaeus, 1766)	0.004	0.503	0.003	0.44	0.35	0.47	LC
73	Lesser Racquet-tailed Drongo	<i>Dicrurus remifer</i> (Temminck, 1823)	0.002	0.252	0.003	0.221	0.233	0.23	LC

	Order/Family/ Common name	Zoological name	RA in Winter		RA in Summer		Total RA (%)		IUCN category
			Protected	Non-protected	Protected	Non-protected	Protected	Non-protected	
74	White-bellied Drongo	<i>Dicrurus caeruleus</i> (Linnaeus, 1758)	0	0	0	0.332	0	0.176	LC
Family Estrildidae									
75	Scaly-breasted Munia	<i>Lonchura punctulata</i> (Linnaeus, 1758)	0.005	0.628	0.007	0.554	0.583	0.589	LC
Family Hirundinidae									
76	Barn Swallow	<i>Hirundo rustica</i> Linnaeus, 1758	1.023	2.642	2.028	2.771	2.506	2.71	LC
77	Wire-tailed Swallow	<i>Hirundo smithii</i> Leach, 1818	2.026	3.144	3.036	2.771	3.03	2.946	LC
Family Laniidae									
78	Grey-backed Shrike	<i>Lanius tephronotus</i> (Vigors, 1831)	0	0	0.33	0.001	0.176	0.058	LC
Family Leiotrichidae									
79	Common Babbler	<i>Argya caudata</i> (Dumont, 1823)	0.004	0.503	0.005	0.665	0.466	0.589	LC
80	Jungle Babbler	<i>Turdoides striata</i> (Dumont, 1823)	1.014	1.761	2.016	1.33	1.515	1.53	LC
81	Large Grey Babbler	<i>Argya malcolmi</i> (Sykes, 1832)	0	0	0.005	0	0.233	0	LC
Family Monarchidae									
82	Black-naped Monarch	<i>Hypothymis azurea</i> (Boddaert, 1783)	0.905	0.628	0.807	0.554	0.583	0.589	LC
83	White Wagtail	<i>Motacilla alba</i> Linnaeus, 1758	0	0	0	1.108	0	0.589	LC
84	White-browed Wagtail	<i>Motacilla maderaspatensis</i> Gmelin, 1789	0.004	0.503	0.005	0.554	0.466	0.53	LC
Family Muscipidae									
85	Black Redstart	<i>Phoenicurus ochruros</i> (Gmelin, 1774)	0	0.629	0	0	0	0.294	LC
86	Common Stonechat	<i>Saxicola torquatus</i> (Linnaeus, 1766)	1.017	1.761	1.015	1.108	1.573	1.41	LC
87	Grey Bushchat	<i>Saxicola ferreus</i> Gray, 1846	0.002	0.251	0.003	0.221	0.233	0.23	LC
88	Indian Robin	<i>Saxicoloides fulicatus</i> (Linnaeus, 1766)	0.002	0.251	0.003	0.221	0.233	0.23	LC
89	Oriental Magpie-robin	<i>Copsychus saularis</i> (Linnaeus, 1758)	1.017	1.257	0.915	1.219	1.573	1.237	LC
90	Pied Bushchat	<i>Saxicola caprata</i> (Linnaeus, 1766)	0	0	0	0.332	0	0.176	LC
91	White-capped Water-redstart	<i>Phoenicurus leucocephalus</i> (Vigors, 1831)	0.005	0.628	0.001	0.554	0.35	0.589	LC
92	White-tailed Stonechat	<i>Saxicola leucurus</i> (Blyth, 1847)	0.004	0.503	0	0.443	0.233	0.471	LC
Family Oriolidae									
93	Black-hooded Oriole	<i>Oriolus xanthornus</i> (Linnaeus, 1758)	0.004	0.503	0.004	1.33	0.408	0.942	LC
Family Passeridae									
94	Chestnut-shouldered Bush-sparrow	<i>Gymnoris xanthocollis</i> (Burton, 1838)	1.015	1.257	1.615	1.662	1.515	1.473	LC
95	House Sparrow	<i>Passer domesticus</i> (Linnaeus, 1758)	1.026	3.144	2.028	5.21	2.681	4.242	LC
Family Ploceidae									
96	Baya Weaver	<i>Ploceus philippinus</i> (Linnaeus, 1766)	0.01	1.257	0.016	0.776	1.282	1	LC
Family Pycnonotidae									
97	Black Bulbul	<i>Hypsipetes leucocephalus</i> (Gmelin, 1789)	1.01	1.257	2.015	1.108	1.224	1.17	LC
98	Red-vented Bulbul	<i>Pycnonotus cafer</i> (Linnaeus, 1766)	0.006	0	0.008	0.665	0.699	0.35	LC
99	Red-whiskered Bulbul	<i>Pycnonotus jocosus</i> (Linnaeus, 1758)	1.017	2.012	1.019	1.995	1.748	2	LC

	Order/Family/ Common name	Zoological name	RA in Winter		RA in Summer		Total RA(%)		IUCN category
			Protected	Non- protected	Protected	Non- protected	Protected	Non- protected	
Family Scotocercidae									
100	Pale-footed Bush-warbler	<i>Hemitesia pallidipes</i> (Blanford, 1872)	0.002	0.251	0.003	0.221	0.233	0.235	LC
Family Sturnidae									
101	Asian-pied Starling	<i>Gracupica contra</i> (Linnaeus, 1758)	0	0	0	0.886	0	0.471	LC
102	Common Myna	<i>Acridotheres tristis</i> (Linnaeus, 1766)	1.015	1.886	2.019	1.99	1.69	1.944	LC
103	Jungle Myna	<i>Acridotheres fuscus</i> (Wagler, 1827)	1.012	1.509	1.015	2.1	1.34	1.826	LC
Family: Zosteropidae									
104	Indian White-eye	<i>Zosterops palpebrosus</i> (Temminck, 1824)	0.002	0.251	0.003	0.221	0.233	0.235	LC
Order PELECANIFORMES									
Family Ardeidae									
105	Cattle Egret	<i>Bubulcus ibis</i> (Linnaeus, 1758)	0.805	0.628	0.005	7.649	0.524	4.36	LC
106	Great White Egret	<i>Ardea alba</i> Linnaeus, 1758	0.006	0	0.007	0	0.641	0	LC
107	Grey Heron	<i>Ardea cinerea</i> Linnaeus, 1758	0.004	0.503	0.005	0.443	0.466	0.471	LC
108	Indian Pond Heron	<i>Ardeola grayii</i> (Sykes, 1832)	0	0	0.04	0.332	1.748	0.176	LC
109	Intermediate Egret	<i>Ardea intermedia</i> Wagler, 1829	0.003	0.628	0.004	0.554	0.35	0.589	LC
110	Little Egret	<i>Egretta garzetta</i> (Linnaeus, 1766)	0.004	0.503	0.005	0.997	0.466	0.766	LC
111	Purple Heron	<i>Ardea purpurea</i> Linnaeus, 1766	0.004	0	0.005	0.443	0.466	0.235	LC
Family Threskiornithidae									
112	Red-naped Ibis	<i>Pseudibis papillosa</i> (Temminck, 1824)	0.004	0.503	0.005	0.11	0.466	0.294	LC
Order PICIFORMES									
Family Megalaimidae									
113	Brown-headed Barbet	<i>Psilopogon zeylanicus</i> (Gmelin, 1788)	0.002	0.251	0.003	0.221	0.233	0.235	LC
114	Coppersmith Barbet	<i>Psilopogon haemacephalus</i> (Müller, 1776)	0.005	0.628	0.005	0.55	0.524	0.589	LC
Family Picidae									
115	Brown-capped Pygmy Woodpecker	<i>Picooides nanus</i> (Vigors, 1832)	0	1.509	0	1.77	0	1.649	LC
116	Great Slaty Woodpecker	<i>Mulleripicus pulverulentus</i> (Temminck, 1826)	0.002	0.251	0.003	0	0.233	0.117	VU
117	Indian Pygmy Woodpecker	<i>Picooides nanus</i> (Vigors, 1832)	1.012	0.503	1.012	0	1.224	0.235	LC
118	Lesser Yellownape	<i>Picus chlorolophus</i> Vieillot, 1818	0.004	0	0.005	0	0.466	0	LC
119	Greater Flameback	<i>Chrysocolaptes guttaeristatus</i> (Tickell, 1833)	0.808	0.503	0.78	0.44	0.816	0.471	LC
120	Yellow-crowned Woodpecker	<i>Leiopicus maharattensis</i> (Latham, 1801)	0.005	0.628	0.004	0.554	0.466	0.589	LC
Order PSITTACIFORMES									
Family Psittacidae									
121	Plum-headed Parakeet	<i>Psittacula cyanocephala</i> (Linnaeus, 1766)	2.021	1.257	2.025	0.997	2.273	1.119	LC
122	Alexandrine Parakeet	<i>Psittacula eupatria</i> (Linnaeus, 1766)	2.019	1.257	0	0.886	1.049	1.06	NT
123	Rose-ringed Parakeet	<i>Psittacula krameri</i> (Scopoli, 1769)	1.01	1.509	2.016	1.33	1.282	1.414	LC
124	Slaty-headed Parakeet	<i>Psittacula himalayana</i> (Lesson, 1832)	3.031	4.02	2.02	2.439	2.622	3.18	LC

	Order/Family/ Common name	Zoological name	RA in Winter		RA in Summer		Total RA (%)		IUCN category
			Protected	Non-protected	Protected	Non-protected	Protected	Non-protected	
Order STRIGIFORMES									
Family Strigidae									
125	Jungle Owlet	<i>Glaucidium radiatum</i> (Tickell, 1833)	0.001	0	0.001	0	0.117	0	LC
126	Spotted Owlet	<i>Athene brama</i> (Temminck, 1821)	0.001	0	0.001	0	0.117	0	LC
Order SULIFORMES									
Family Anhingidae									
127	Oriental Darter	<i>Anhinga melanogaster</i> Pennant, 1769	0.002	0.125	0	0	0.117	0.058	NT
Family Phalacrocoracidae									
128	Great Cormorant	<i>Phalacrocorax carbo</i> (Linnaeus, 1758)	0.01	0.503	0	0.443	0.583	0.47	LC
129	Little Cormorant	<i>Microcarbo niger</i> (Vieillot, 1817)	1.017	1.006	1.019	0.997	1.748	1	LC

Authors details: JAGAN NATH ADHIKARI has a keen interest in the ecology, behavior and conservation of birds, large mammals and herpetofauna. Jagan has authored or co-authored more than ten peer-reviewed papers on birds, mammals, and human-wildlife interactions and three textbooks of zoology for undergraduate level. JANAK RAJ KHATIWADA, PhD is a wildlife biologist with extensive field experience in Himalayan region. He has authored or co-authored more than 15 peer-reviewed papers on taxonomy, thermal ecology, composition, distribution, and conservation status of the herpetofauna of different parts of Nepal, India and China. To date, he has described four new species of amphibians for science from Nepal and India. DIPENDRA ADHIKARI is a wildlife biologist with field experience in lowland to highland of Nepal. His research interests include diversity and distribution patterns of small mammals, birds and photographic capture recapture of megafauna such as tigers, elephants. SUMAN SAPKOTA's research interests include ecology of frogs, bioacoustics, endemic and threatened frogs and effect of climate change on frogs. He has been involved in different researches related to herpetofauna and presented his work in different national and international conferences. He is currently working as Conservation Officer in Friends of Nature (FON), Nepal. BISHNU PRASAD BHATTARAI, PhD is a conservation biologist His research interests include the conservation of large carnivores, their habitats, and prey, biogeography of Himalayan flora and fauna (e.g., birds, mammals, herpetofauna, and orchids), forest and wildlife habitat management. DEEPAK RIJAL, PhD is nationally reputed scholar of biodiversity. Over 30 years Deepak with specialist expertise in ecological adaptation has been actively involved in research and conservation of agriculture, forest, and freshwater resources. He has been a prolific writer and has been the lead and co-author for knowledge products published nationally and internationally. Deepak as a Board Chair of the nationally reputed research and development non-government organization consistently provides strategic direction that contributes to knowledge and benefit to various end-users in Nepal and abroad. LILA NATH SHARMA, PhD is a researcher at ForestAction Nepal. He is an ecologist and undertakes action research related to biodiversity conservation, forest restoration, and invasive species management.

Author's contributions: JNA designed the study, carried out the fieldwork, analysed the data and prepare draft, JRK designed the study, analysed the data and revised the draft, DA carried out the fieldwork and revised the final draft, SS carried out the fieldwork and revised the final draft, BPB prepared map and revised the final draft, DR revised the final draft, LNS designed the study, helped in fieldwork, analysed and helped for the preparation of manuscript and revised the draft.



Dr. John Noyes, Natural History Museum, London, UK
Dr. Albert G. Orr, Griffith University, Nathan, Australia
Dr. Sameer Padhye, Katholieke Universiteit Leuven, Belgium
Dr. Nancy van der Poorten, Toronto, Canada
Dr. Kareen Schnabel, NIWA, Wellington, New Zealand
Dr. R.M. Sharma, (Retd.) Scientist, Zoological Survey of India, Pune, India
Dr. Manju Siliwal, WILD, Coimbatore, Tamil Nadu, India
Dr. G.P. Sinha, Botanical Survey of India, Allahabad, India
Dr. K.A. Subramanian, Zoological Survey of India, New Alipore, Kolkata, India
Dr. P.M. Sureshan, Zoological Survey of India, Kozhikode, Kerala, India
Dr. R. Varatharajan, Manipur University, Imphal, Manipur, India
Dr. Eduard Vives, Museu de Ciències Naturals de Barcelona, Terrassa, Spain
Dr. James Young, Hong Kong Lepidopterists' Society, Hong Kong
Dr. R. Sundararaj, Institute of Wood Science & Technology, Bengaluru, India
Dr. M. Nithyanandan, Environmental Department, La Ala Al Kuwait Real Estate. Co. K.S.C., Kuwait
Dr. Himender Bharti, Punjabi University, Punjab, India
Mr. Purnendu Roy, London, UK
Dr. Saito Motoki, The Butterfly Society of Japan, Tokyo, Japan
Dr. Sanjay Sondhi, TITLI TRUST, Kalpvriksh, Dehradun, India
Dr. Nguyen Thi Phuong Lien, Vietnam Academy of Science and Technology, Hanoi, Vietnam
Dr. Nitin Kulkarni, Tropical Research Institute, Jabalpur, India
Dr. Robin Wen Jiang Ngiam, National Parks Board, Singapore
Dr. Lionel Monod, Natural History Museum of Geneva, Genève, Switzerland.
Dr. Asheesh Shivam, Nehru Gram Bharti University, Allahabad, India
Dr. Rosana Moreira da Rocha, Universidade Federal do Paraná, Curitiba, Brasil
Dr. Kurt R. Arnold, North Dakota State University, Saxony, Germany
Dr. James M. Carpenter, American Museum of Natural History, New York, USA
Dr. David M. Claborn, Missouri State University, Springfield, USA
Dr. Kareen Schnabel, Marine Biologist, Wellington, New Zealand
Dr. Amazonas Chagas Júnior, Universidade Federal de Mato Grosso, Cuiabá, Brasil
Mr. Monsoon Jyoti Gogoi, Assam University, Silchar, Assam, India
Dr. Heo Chong Chin, Universiti Teknologi MARA (UiTM), Selangor, Malaysia
Dr. R.J. Shiel, University of Adelaide, SA 5005, Australia
Dr. Siddharth Kulkarni, The George Washington University, Washington, USA
Dr. Priyadarsanan Dharma Rajan, ATREE, Bengaluru, India
Dr. Phil Alderslade, CSIRO Marine And Atmospheric Research, Hobart, Australia
Dr. John E.N. Veron, Coral Reef Research, Townsville, Australia
Dr. Daniel Whitmore, State Museum of Natural History Stuttgart, Rosenstein, Germany.
Dr. Yu-Feng Hsu, National Taiwan Normal University, Taipei City, Taiwan
Dr. Keith V. Wolfe, Antioch, California, USA
Dr. Siddharth Kulkarni, The Hormiga Lab, The George Washington University, Washington, D.C., USA
Dr. Tomas Ditrich, Faculty of Education, University of South Bohemia in Ceske Budejovice, Czech Republic
Dr. Mihaly Foldvari, Natural History Museum, University of Oslo, Norway
Dr. V.P. Uniyal, Wildlife Institute of India, Dehradun, Uttarakhand 248001, India
Dr. John T.D. Caleb, Zoological Survey of India, Kolkata, West Bengal, India
Dr. Priyadarsanan Dharma Rajan, Ashoka Trust for Research in Ecology and the Environment (ATREE), Royal Enclave, Bangalore, Karnataka, India

Fishes

Dr. Neelesh Dahanukar, IISER, Pune, Maharashtra, India
Dr. Topiltzin Contreras MacBeath, Universidad Autónoma del estado de Morelos, México
Dr. Heok Hee Ng, National University of Singapore, Science Drive, Singapore
Dr. Rajeev Raghavan, St. Albert's College, Kochi, Kerala, India
Dr. Robert D. Sluka, Chiltern Gateway Project, A Rocha UK, Southall, Middlesex, UK
Dr. E. Vivekanandan, Central Marine Fisheries Research Institute, Chennai, India
Dr. Davor Zanella, University of Zagreb, Zagreb, Croatia
Dr. A. Biju Kumar, University of Kerala, Thiruvananthapuram, Kerala, India
Dr. Akhilesh K.V., ICAR-Central Marine Fisheries Research Institute, Mumbai Research Centre, Mumbai, Maharashtra, India
Dr. J.A. Johnson, Wildlife Institute of India, Dehradun, Uttarakhand, India

Amphibians

Dr. Sushil K. Dutta, Indian Institute of Science, Bengaluru, Karnataka, India
Dr. Annemarie Ohler, Muséum national d'Histoire naturelle, Paris, France

Reptiles

Dr. Gernot Vogel, Heidelberg, Germany
Dr. Raju Vyas, Vadodara, Gujarat, India
Dr. Pritpal S. Soorae, Environment Agency, Abu Dhabi, UAE.
Prof. Dr. Wayne J. Fuller, Near East University, Mersin, Turkey
Prof. Chandrashekhar U. Rivonker, Goa University, Taleigao Plateau, Goa, India
Dr. S.R. Ganesh, Chennai Snake Park, Chennai, Tamil Nadu, India
Dr. Himansu Sekhar Das, Terrestrial & Marine Biodiversity, Abu Dhabi, UAE

Birds

Dr. Hem Sagar Baral, Charles Sturt University, NSW Australia
Dr. Chris Bowden, Royal Society for the Protection of Birds, Sandy, UK
Dr. Priya Davidar, Pondicherry University, Kalapet, Puducherry, India
Dr. J.W. Duckworth, IUCN SSC, Bath, UK
Dr. Rajah Jayapal, SACON, Coimbatore, Tamil Nadu, India
Dr. Rajiv S. Kalsi, M.L.N. College, Yamuna Nagar, Haryana, India
Dr. V. Santharam, Rishi Valley Education Centre, Chittoor Dt., Andhra Pradesh, India
Dr. S. Balachandran, Bombay Natural History Society, Mumbai, India
Mr. J. Praveen, Bengaluru, India
Dr. C. Srinivasulu, Osmania University, Hyderabad, India
Dr. K.S. Gopi Sundar, International Crane Foundation, Baraboo, USA
Dr. Gombobaatar Sunde, Professor of Ornithology, Ulaanbaatar, Mongolia
Prof. Reuven Yosef, International Birding & Research Centre, Eilat, Israel
Dr. Taej Mundkur, Wetlands International, Wageningen, The Netherlands
Dr. Carol Inskipp, Bishop Auckland Co., Durham, UK
Dr. Tim Inskipp, Bishop Auckland Co., Durham, UK
Dr. V. Gokula, National College, Tiruchirappalli, Tamil Nadu, India
Dr. Arkady Lelej, Russian Academy of Sciences, Vladivostok, Russia
Dr. Simon Dowell, Science Director, Chester Zoo, UK
Dr. Mário Gabriel Santiago dos Santos, Universidade de Trás-os-Montes e Alto Douro, Quinta de Prados, Vila Real, Portugal
Dr. Grant Connette, Smithsonian Institution, Royal, VA, USA
Dr. M. Zafar-ul Islam, Prince Saud Al Faisal Wildlife Research Center, Taif, Saudi Arabia

Mammals

Dr. Giovanni Amori, CNR - Institute of Ecosystem Studies, Rome, Italy
Dr. Anwaruddin Chowdhury, Guwahati, India
Dr. David Mallon, Zoological Society of London, UK
Dr. Shomita Mukherjee, SACON, Coimbatore, Tamil Nadu, India
Dr. Angie Appel, Wild Cat Network, Germany
Dr. P.O. Nameer, Kerala Agricultural University, Thrissur, Kerala, India
Dr. Ian Redmond, UNEP Convention on Migratory Species, Lansdown, UK
Dr. Heidi S. Riddle, Riddle's Elephant and Wildlife Sanctuary, Arkansas, USA
Dr. Karin Schwartz, George Mason University, Fairfax, Virginia.
Dr. Lala A.K. Singh, Bhubaneswar, Orissa, India
Dr. Mewa Singh, Mysore University, Mysore, India
Dr. Paul Racey, University of Exeter, Devon, UK
Dr. Honnavalli N. Kumara, SACON, Anaikatty P.O., Coimbatore, Tamil Nadu, India
Dr. Nishith Dharaiya, HNG University, Patan, Gujarat, India
Dr. Spartaco Gippoliti, Socio Onorario Società Italiana per la Storia della Fauna "Giuseppe Altobello", Rome, Italy
Dr. Justus Joshua, Green Future Foundation, Tiruchirappalli, Tamil Nadu, India
Dr. H. Raghuram, The American College, Madurai, Tamil Nadu, India
Dr. Paul Bates, Harison Institute, Kent, UK
Dr. Jim Sanderson, Small Wild Cat Conservation Foundation, Hartford, USA
Dr. Dan Challender, University of Kent, Canterbury, UK
Dr. David Mallon, Manchester Metropolitan University, Derbyshire, UK
Dr. Brian L. Cypher, California State University-Stanislaus, Bakersfield, CA
Dr. S.S. Talmale, Zoological Survey of India, Pune, Maharashtra, India
Prof. Karan Bahadur Shah, Budhanilankantha Municipality, Kathmandu, Nepal
Dr. Susan Cheyne, Borneo Nature Foundation International, Palangkaraja, Indonesia
Dr. Hemanta Kafley, Wildlife Sciences, Tarleton State University, Texas, USA

Other Disciplines

Dr. Aniruddha Belsare, Columbia MO 65203, USA (Veterinary)
Dr. Mandar S. Paingankar, University of Pune, Pune, Maharashtra, India (Molecular)
Dr. Jack Tordoff, Critical Ecosystem Partnership Fund, Arlington, USA (Communities)
Dr. Ulrike Streicher, University of Oregon, Eugene, USA (Veterinary)
Dr. Hari Balasubramanian, EcoAdvisors, Nova Scotia, Canada (Communities)
Dr. Rayanna Hellem Santos Bezerra, Universidade Federal de Sergipe, São Cristóvão, Brazil
Dr. Jamie R. Wood, Landcare Research, Canterbury, New Zealand
Dr. Wendy Collinson-Jonker, Endangered Wildlife Trust, Gauteng, South Africa
Dr. Rajeshkumar G. Jani, Anand Agricultural University, Anand, Gujarat, India
Dr. O.N. Tiwari, Senior Scientist, ICAR-Indian Agricultural Research Institute (IARI), New Delhi, India
Dr. L.D. Singla, Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana, India
Dr. Rupika S. Rajakaruna, University of Peradeniya, Peradeniya, Sri Lanka
Dr. Bahar Baviskar, Wild-CER, Nagpur, Maharashtra 440013, India

Reviewers 2018–2020

Due to pausity of space, the list of reviewers for 2018–2020 is available online.

The opinions expressed by the authors do not reflect the views of the Journal of Threatened Taxa, Wildlife Information Liaison Development Society, Zoo Outreach Organization, or any of the partners. The journal, the publisher, the host, and the partners are not responsible for the accuracy of the political boundaries shown in the maps by the authors.

Journal of Threatened Taxa is indexed/abstracted in Bibliography of Systematic Mycology, Biological Abstracts, BIOSIS Previews, CAB Abstracts, EBSCO, Google Scholar, Index Copernicus, Index Fungorum, JournalSeek, National Academy of Agricultural Sciences, NewJour, OCLC WorldCat, SCOPUS, Stanford University Libraries, Virtual Library of Biology, Zoological Records.

NAAS rating (India) 5.64

Print copies of the Journal are available at cost. Write to:
The Managing Editor, JoTT,
c/o Wildlife Information Liaison Development Society,
No. 12, Thiruvannamalai Nagar, Saravanampatti - Kalapatti Road,
Saravanampatti, Coimbatore, Tamil Nadu 641035, India
ravi@threatenedtaxa.org



OPEN ACCESS



The Journal of Threatened Taxa (JoTT) is dedicated to building evidence for conservation globally by publishing peer-reviewed articles online every month at a reasonably rapid rate at www.threatenedtaxa.org. All articles published in JoTT are registered under [Creative Commons Attribution 4.0 International License](https://creativecommons.org/licenses/by/4.0/) unless otherwise mentioned. JoTT allows unrestricted use, reproduction, and distribution of articles in any medium by providing adequate credit to the author(s) and the source of publication.

ISSN 0974-7907 (Online) | ISSN 0974-7893 (Print)

January 2022 | Vol. 14 | No. 1 | Pages: 20311–20538

Date of Publication: 26 January 2022 (Online & Print)

DOI: 10.11609/jott.2022.14.1.20311-20538

www.threatenedtaxa.org

Articles

Estimating the completeness of orchid checklists and atlases: a case study from southern Italy

– Antonio Croce, Pp. 20311–20322

A floristic survey across three coniferous forests of Kashmir Himalaya, India – a checklist

– Ashaq Ahmad Dar, Akhtar Hussain Malik & Narayanaswamy Parthasarathy, Pp. 20323–20345

Associations of butterflies across different forest types in Uttarakhand, western Himalaya, India: implications for conservation planning

– Arun Pratap Singh, Pp. 20346–20370

Comparison of bird diversity in protected and non-protected wetlands of western lowland of Nepal

– Jagan Nath Adhikari, Janak Raj Khatiwada, Dipendra Adhikari, Suman Sapkota, Bishnu Prasad Bhattarai, Deepak Rijal & Lila Nath Sharma, Pp. 20371–20386

Local hunting practices and perceptions regarding the distribution and ecological role of the Large Flying Fox (Chiroptera: Pteropodidae: *Pteropus vampyrus*) in western Sarawak, Malaysian Borneo

– Jayasilan Mohd-Azlan, Joon Yee Yong, Nabila Norshuhadah Mohd Hazzrol, Philoveny Pengiran, Arianti Atong & Sheema Abdul Aziz, Pp. 20387–20399

Communications

Macrolichens of Mathikettan Shola National Park, Western Ghats: a preliminary investigation with some new records

– Aswathi Anilkumar, Stephen Sequeira, Arun Christy & S.M. Arsha, Pp. 20400–20405

New distribution record of globally threatened Ocean Turf Grass *Halophila beccarii* Ascherson, 1871 from the North Andaman Islands highlights the importance of seagrass exploratory surveys

– Swapnali Gole, Prasad Gaidhani, Srabani Bose, Anant Pande, Jeyaraj Antony Johnson & Kuppasamy Sivakumar, Pp. 20406–20412

An inventory of new orchid (Orchidaceae) records from Kozhikode, Kerala, India

– M. Sulaiman, C. Murugan & M.U. Sharief, Pp. 20413–20425

Abundance and spatial distribution analyses of *Stemonoporus moonii* Thwaites (Dipterocarpaceae) - a critically endangered species endemic to Sri Lanka

– K.A.M.R.P. Atapattu, H.D.D.C.K. Perera, H.S. Kathiriarachchi & A.R. Gunawardena, Pp. 20426–20432

Plant diversity of Point Calimere Wildlife Sanctuary and fodder species grazed by the Blackbuck *Antelope cervicapra* L.

– Ashutosh Kumar Upadhyay, A. Andrew Emmanuel, Ansa Sarah Varghese & D. Narasimhan, Pp. 20433–20443

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

– L.A.K. Singh, R.K. Sharma & Udayan Rao Pawar, Pp. 20444–20460

Nesting success of Sharpe's Longclaw (*Macronyx sharpei* Jackson, 1904) around the grasslands of lake Ol'bolossat Nyandarua, Kenya

– Hamisi Ann Risper, Charles M. Warui & Peter Njoroge, Pp. 20461–20468

Population, distribution and diet composition of Smooth-coated Otter *Lutrogale perspicillata* Geoffroy, 1826 in Hosur and Dharmapuri Forest Divisions, India

– Nagarajan Baskaran, Raman Sivaraj Sundarraj & Raveendranathanpillai Sanil, Pp. 20469–20477

Utilization of home garden crops by primates and current status of human-primate interface at Galigamuwa Divisional Secretariat Division in Kegalle District, Sri Lanka

– Charmalie Anuradhi Dona Nahallage, Dahanakge Ayesha Madushani Dasanayake, Dilan Thisaru Hewamanna & Dissanayakalage Tharaka Harshani Ananda, Pp. 20478–20487

Revival of Eastern Swamp Deer *Rucervus duvaucelii ranjitsinhi* (Groves, 1982) in Manas National Park of Assam, India

– Nazrul Islam, Aftab Ahmed, Rathin Barman, Sanatan Deka, Bhaskar Choudhury, Prasanta Kumar Saikia & Jyotishman Deka, Pp. 20488–20493

Trypanosoma evansi infection in a captive Indian Wolf *Canis lupus pallipes* – molecular diagnosis and therapy

– Manojita Dash, Sarat Kumar Sahu, Santosh Kumar Gupta, Niranjana Sahoo & Debarat Mohapatra, Pp. 20494–20499

View Point

COVID-19 and civil unrest undoing steady gains in karst conservation and herpetological research in Myanmar, and an impediment to progress

– Evan S.H. Quah, Lee L. Grismer, Perry L. Wood, Jr., Aung Lin & Myint Kyaw Thura, Pp. 20500–20502

Short Communications

Morphological characterization and mt DNA barcode of a tiger moth species, *Asota ficus* (Fabricius, 1775) (Lepidoptera: Noctuoidea: Erebiidae: Aganainae) from India

– Aparna Sureshchandra Kalawate, K.P. Dinesh & A. Shabnam, Pp. 20503–20510

Distribution of Smooth-coated Otters *Lutrogale perspicillata* (Mammalia: Carnivora: Mustelidae): in Ratnagiri, Maharashtra, India

– Swanand Patil & Kranti Yardi, Pp. 20511–20516

Wildlife at the crossroads: wild animal road kills due to vehicular collision on a mountainous highway in northwestern Himalayan region

– Muzaffar A. Kichloo, Asha Sohil & Neeraj Sharma, Pp. 20517–20522

Notes

Robiquetia gracilis (Lindl.) Garay—a new record to the flora of Anamalai Hills, Tamil Nadu, India

– B. Subbaiyan, V. Ganesan, P.R. Nimal Kumar & S. Thangaraj Panneerselvam, Pp. 20523–20525

Ipomoea laxiflora H.J. Chowdhery & Debta (Convolvulaceae): new records for the Western Ghats and semiarid regions

– Sachin M. Patil, Ajit M. Vasava, Vinay M. Raole & Kishore S. Rajput, Pp. 20526–20529

Counting the cost: high demand puts *Bunium persicum* (Boiss.) B.Fedtsch. in jeopardy

– Monika Sharma, Manisha Mathela, Rupali Sharma, Himanshu Bargali, Gurinderjit S. Goraya & Amit Kumar, Pp. 20530–20533

First record of Parasitic Jaeger *Stercorarius parasiticus* (Aves: Charadriiformes: Stercorariidae) from inland freshwater Inle Lake, Myanmar

– Sai Sein Lin Oo, Myint Kyaw, L.C.K. Yun, Min Zaw Tun, Yar Zar Lay Naung, Soe Naing Aye & Swen C. Renner, Pp. 20534–20536

Book Review

Capparis of India

– V. Sampath Kumar, Pp. 20537–20538

Publisher & Host

