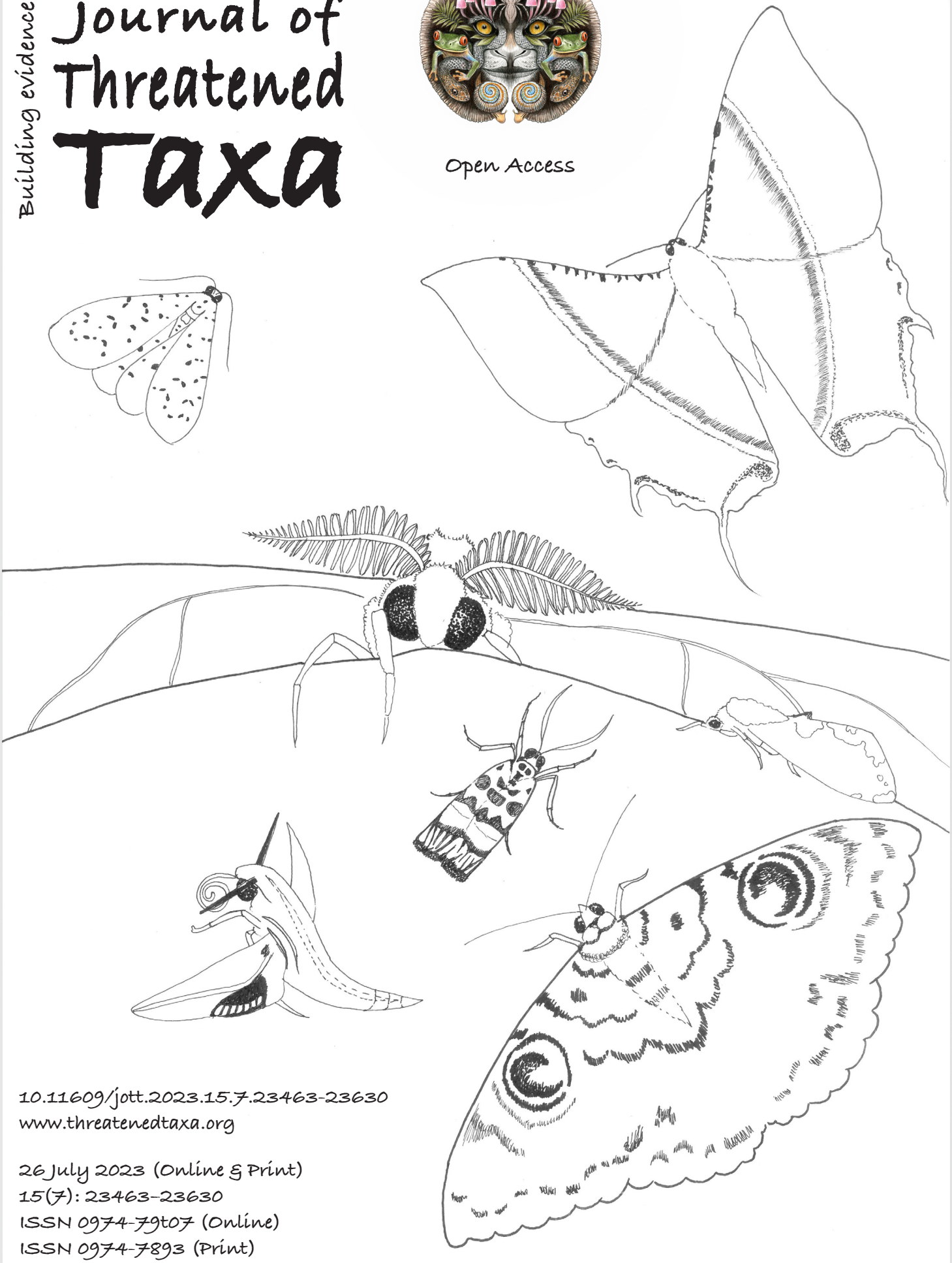
Building evidence for conservation globally

Journal of Threatened Taxa

Open Access



10.11609/jott.2023.15.7.23463-23630
www.threatenedtaxa.org

26 July 2023 (Online & Print)
15(7): 23463–23630
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

43/2 Varadarajulu Nagar, 5th Street West, Ganapathy, Coimbatore, Tamil Nadu 641006, India
Registered Office: 3A2 Varadarajulu Nagar, FCI Road, Ganapathy, Coimbatore, Tamil Nadu 641006, India
Ph: +91 9385339863 | www.threatenedtaxa.org
Email: sanjay@threatenedtaxa.org

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

Cover: Celebrating the unsung heroes—moths, our nocturnal pollinators. © Priyanka Iyer.

Journal of Threatened Taxa | www.threatenedtaxa.org | 26 July 2023 | 15(7): 23514–23520

OPEN ACCESS

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

https://doi.org/10.11609/jott.8415.15.7.23514-23520

#8415 | Received 20 February 2023 | Final received 25 April 2023 | Finally accepted 16 July 2023

COMMUNICATION

An assessment of the diet of Brown Fish-Owl *Ketupa zeylonensis* (J.F. Gmelin, 1788) (Aves: Strigiformes: Strigidae) from two localities in the foothills of the Western Ghats of Goa, India

Stephen Jonah Dias [1] & **Atul Sinai Borker** [2]

[1,2] Planet Life Foundation, C8/G4, Maple Grove Apartments, Belloy, Nuvem, Salcete, Goa 403601, India
[2] Luta Innovation, 887/13, Kamat Nagar, Porvorim, Socorro, Bardez, Goa 403501, India
[1] stephendias46@gmail.com (corresponding author), [2] borker.atul@gmail.com

Abstract: The Brown Fish-Owl *Ketupa zeylonensis* is a large nocturnal bird of prey that has a vast distribution range. However, there is a significant literature gap on the ecology of this species in the Western Ghats ecoregion, particularly in regard to its food spectrum. In the present study, we assessed the diet composition of this species in the foothills of the Western Ghats of Goa, India. The diet was evaluated by analysing the undigested prey remains in regurgitated pellets obtained from the banks of forest streams and roosting sites. A total of 104 pellets were collected from two localities that exhibited similar landscape characteristics. Our analysis indicated that crabs contributed to a significant proportion of the diet of the species (75.47%), followed by amphibians (frogs, 8.02%), fishes (7.08%), reptiles (snakes, 2.83%), birds (2.36%), scorpions (1.89%), and insects (Odonata, 0.47%). Additionally, 1.89% (n = 4) of the prey items could not be identified due to their disintegrated nature. Furthermore, an assessment of Food Niche Breadth (FNB) indicated that *K. zeylonensis* exhibited a high degree of specialization in terms of its diet in the study areas.

Keywords: Diet analysis, feeding ecology, food niche breadth, food spectrum, forest streams, owl pellets, prey composition, relative frequency of occurrence.

Abbreviations: CITES—Convention on International Trade in Endangered Species of Wild Fauna and Flora | FNB—Food Niche Breadth | IUCN—International Union for Conservation of Nature | NP—National Park | RFO%—Relative Frequency of Occurrence | UNESCO—United Nations Educational, Scientific and Cultural Organization | WS—Wildlife Sanctuary.

Editor: Prachi Mehta, Wildlife Research and Conservation Society (WRCS), Pune, India. **Date of publication:** 26 July 2023 (online & print)

Citation: Dias, S.J. & A.S. Borker (2023). An assessment of the diet of Brown Fish-Owl *Ketupa zeylonensis* (J.F. Gmelin, 1788) (Aves: Strigiformes: Strigidae) from two localities in the foothills of the Western Ghats of Goa, India. *Journal of Threatened Taxa* 15(7): 23514–23520. https://doi.org/10.11609/jott.8415.15.7.23514-23520

Funding: No funding was acquired to carry out the study.

Competing interests: The authors declare no competing interests.

Author details: Stephen Jonah Dias holds a master's degree in wildlife biology and conservation. He served as research associate at Planet Life Foundation. He has previously worked on otters in human-dominated landscapes of Goa, India. Presently, he is working on several research projects pertaining to the ecology of mammals and birds in Goa. Atul Arun Sinai Borker has served as director of Planet Life Foundation. Currently, he is working on wildlife research and conservation projects in the Western Ghats.

Author contributions: SJD & ASB: Conceptualized the study and carried out the field work; SJD: Performed the data analysis; SJD & ASB: Prepared the draft of the manuscript.

Acknowledgements: We are grateful to the trustees of Planet Life Foundation and the staff of Nature's Nest Nature Resort for their support during the project. Our gratitude to the Goa State Biodiversity Board for granting the necessary approvals for the project. Special thanks to Swanand Patil of Arcane Conservancy for his assistance during the initial stages of the project and for providing us with the photograph of Brown Fish-Owl from his personal collection. We would also like to thank Rohan Gaonkar and Gautam Gad for extending their support. We are thankful to Sophia Dias, Anselia Da Costa, and Dr. Claret Shastry for proofreading the manuscript. Lastly, we would like to appreciate the efforts of the reviewers for their constructive comments and suggestions on the manuscript.

INTRODUCTION

Birds of prey occupy the apex position in food web assemblages. Therefore, they are considered to be important bioindicators of the environments in which they persist (González-Rubio et al. 2021). The taxonomic order Strigiformes is represented by 250 extant species of owls distributed across the world (Gill et al. 2023). This order is divided into two families: (i) Tytonidae, which includes barn owls, bay owls, and grass owls, and (ii) Strigidae, which includes true (or typical) owls (Sieradzki 2023). India is home to 32 species of owls, 13 of which are found in the state of Goa (Baidya & Bhagat 2018; BirdLife International 2020). The Brown Fish-Owl *Ketupa zeylonensis* is a nocturnal bird of prey that is distributed across southern and southeastern Asia with isolated populations occurring in Turkey and Iran, and vagrant populations occurring in Seychelles (Birdlife International 2016). It is a large bird (approx. 56 cm) having bright yellow eyes and outward-facing ear tufts. It exhibits rufous-brown upper parts with heavy streaking, and pale underparts with dark streaks (Ali 2002; Kazmierczak & Perlo 2012; Grewal et al. 2016). The species is classified as 'Least Concern' in the IUCN Red List of Threatened Species. Although global populations of this species have not been evaluated, it is suspected to be in decline due to habitat destruction (Birdlife International 2016). In addition, the species is listed under 'Schedule I' of the Indian Wild Life (Protection) Amendment Act, 2022 and under Appendix II of CITES (Ministry of Law and Justice 2022; CITES 2023). In India, this species faces threats from the illegal wildlife trade, persecution by fishermen, and its use in witchcraft (Ahmed 2010).

The Brown Fish-Owl inhabits deciduous, semi-deciduous and evergreen woodland ecosystems and is found in close proximity to water bodies. Its diet is reported to constitute crabs, fish, frogs, reptiles, birds, mammals, and carrion (Ali 2002; Bindu & Balakrishnan 2015; Grewal et al. 2016).

Owls are highly specialized hunters that regurgitate undigested prey remains such as bones, feathers, hair, scales, and other exoskeletal structures of their prey in the form of compact pellets. The analysis of regurgitated pellets has proven to be a robust technique to assess the food spectrum of owls and understand the diversity and population structure of prey species (Meek et al. 2012; Andrade et al. 2016). In an Indian context, published literature on the diet composition of the Brown Fish-Owl is sparse. Vyas et al. (2013) reported the food spectrum of *K. zeylonensis* from Jambughoda WS in Gujarat. However, there is a significant literature gap in the diet composition of the species from the Western Ghats ecoregion, particularly in the context to the Indian state of Goa. This study was carried out to understand the diet composition of the species in two sites located in the foothills of the Western Ghats of Goa.

MATERIALS AND METHODS

Study Area

Goa is located on the western coast of India (15.492°N, 73.826°E) (Figure 1). The Western Ghats is a 1,600 km long mountain range that runs parallel to the western coast of the Indian peninsula and extends through the Indian states of Gujarat, Maharashtra, Goa, Karnataka, Tamil Nadu, and Kerala. These mountains are recognized as one of the world's eight 'hottest hotspots' for biological diversity and endemism (Molur et al. 2011; UNESCO 2023). In Goa, these mountains pass through the eastern regions of the state where a significant section of the range is protected through four protected areas: Mhadei WS, Bhagwan Mahavir WS & NP, Netravali WS, and Cotigao WS. The vegetation type of the Western Ghats of Goa is varied and includes tropical evergreen, semi-evergreen, and moist mixed deciduous forests (Goa Forest Department 2023). This study was conducted along forest streams that originate from the Western Ghats. The sections of the streams surveyed for this study were located outside the boundaries of protected areas. Study Area 1 was located near Mhadei WS and Study Area 2 was located near Bhagwan Mahavir WS & NP. The streams that were considered for the study were of the perennial and intermittent type. The general vegetation type of the study areas is dominated by tropical evergreen, semi-evergreen, and moist mixed deciduous forests. In addition, both study areas were located in close proximity to plantations and human settlements. The streams considered for this study are part of a larger catchment system that empties into the Mahadayi River of Goa (see Figure 1). The aerial distance between the two study areas was approximately 16.7 km.

Data Collection

This study was conducted from 20 October 2022 to 5 February 2023. Prior to this study, Brown Fish-Owl activity in Study Area 1 was established by conducting field surveys. In addition, the feeding and breeding activity of this species in Study Area 2 was recorded for over two years with the help of camera traps and

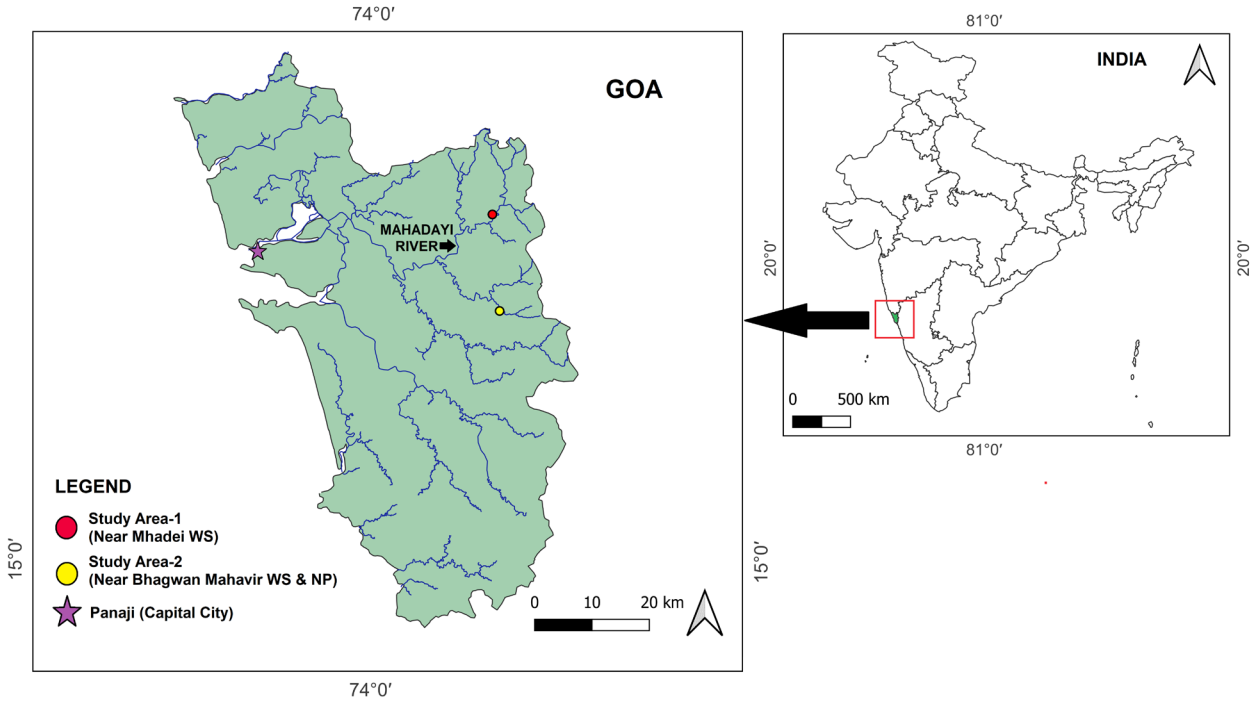


Figure 1. Map depicting the study areas. WS—Wildlife Sanctuary | NP—National Park.

direct observations respectively. This was part of a larger nocturnal wildlife monitoring effort by Planet Life Foundation, Belloy, Nuvem, Goa and Nature's Nest Nature Resort, Surla, Sancordem, Goa. Brown Fish-Owl pellets were collected from the study areas once a week. The pellets were usually found deposited along stream banks and in close proximity to roosting sites (Image 1). A total of four roosting sites were identified across our study areas based on repetitive pellet deposition observed during our surveys. The entire pellet was collected and temporarily stored in plastic zip-lock bags. Prior to analysis, we manually removed all conspicuous debris from the pellet by hand. Following this, the pellets were soaked in 70% ethyl alcohol for 24 h to kill all microorganisms. The pellets were then air-dried for 24 h to remove moisture. During analysis, the dry weight of each pellet was recorded using a weighing balance with 0.001 g accuracy. The prey items in the pellets were then sorted into eight categories: crabs, insects, scorpions, fishes, amphibians, reptiles, birds, and unidentified prey. These prey categories were established based on literature review and field observations. As we did not have access to reference specimens, the items in the pellets could not be identified at the species level. Identification of the prey items was carried out using reference books and taxonomic keys (Verma 2014; Ganguly et al. 2015; Saxena & Saxena 2019; Mehta et al. 2020; Mishra et al. 2021). As most of the items in the pellets were conspicuous, identification and sorting were possible by the naked eye. However, we used a compound microscope (ESAW SM-02, ESAW India, Ambala Cantt, Haryana, India) set at 10x magnification to identify the inconspicuous prey remains. Arthropods were identified primarily from structures such as mouthparts, chelipeds, pereiopods, abdomen, and carapace (in the case of crabs); wings (in the case of insects); pedipalps, cephalothorax shield, mesosoma, metasoma, walking legs, and telson (in the case of scorpions). Scorpion identification was also aided by shining an ultraviolet light at 395 nm and observing fluorescence (Gaffin et al. 2012) (Image 1). Chordates were identified from endoskeletal and exoskeletal structures such as bones and scales (in the case of fishes), bones and mouthparts (in the case of amphibians i.e., frogs), vertebrae, ribs, and skin (in the case of reptiles i.e., snakes), and bones and feathers (in the case of birds). The prey items that could not be identified were sorted into the 'unidentified' category. For each pellet, we estimated the number of individuals for each prey category (Table 1). The data for both study sites was pooled and subsequently analyzed.

Data Analysis

We estimated the Relative Frequency of Occurrence (RFO%) for each prey group by dividing the number of occurrences of each prey category by the total number

of occurrences of all prey categories multiplied by 100 (Mehta et al. 2020). To assess the diversity of prey in the owl diet, we estimated the Food Niche Breadth (FNB) by employing the standardized Levin's Index (B_A) formula (Levins 1968; Colwell & Futuyma 1971; Mehta et al. 2018) as follows:

$$B_A = \left(\frac{1}{\Sigma P_i^2} - 1\right) \times \frac{1}{n-1}$$

Where P_i is the proportion of i^{th} prey category and n is the number of prey categories recorded in the diet of the Brown Fish-Owl. This standardized index computes a value that can range from 0–1. Values closer to 0 indicate a specialist diet whereas values closer to 1 indicate a generalist diet (Mehta et al. 2018).

RESULTS

A total of 104 Brown Fish-Owl pellets were collected during the present study (50 pellets from Study Area 1 and 54 pellets from Study Area 2). The average dry weight of the pellets was estimated to be 4.053 g (SD = ± 2.627; Range = 0.590–12.953). The total number of prey individuals recorded was 212. The average number of prey individuals per pellet was estimated to be 2.029 (SD ± 1.074; Range = 1–5). The diet of the Brown Fish-Owl was dominated by crabs followed by amphibians (frogs), fishes, reptiles (snakes), birds, scorpions, and insects (Odonata). The unidentified prey individuals constituted a minor portion of the diet (n = 4, Table 2). Although we were unable to positively identify the type of prey items in the 'unidentified' category due to their disintegrated nature, we were able to identify the remnants as vertebrates. In such cases, all the unidentified remains having similar characteristics were assumed to originate from a single individual. The number of occurrences of prey categories was largely comparable across the two study areas. However, insects were only present in the pellets collected from Study Area 1 (Odonata, n = 1) and scorpions were only present in pellets collected from Study Area 2 (n = 4) (Figure 2). Lastly, the Food Niche Breadth (FNB) value was estimated to be 0.1, indicating that the Brown Fish-Owl exhibits a high degree of specialization in terms of its diet in the study areas. The diet composition of the species in the present study has been detailed in Table 2.

DISCUSSION

The Brown Fish-Owl is a nocturnal predator that is known to feed on a wide variety of prey, such as fish, frogs, crabs, small mammals, birds, and reptiles. It is also reported to occasionally feed on carrion (Ali 2002). Published literature on the diet composition of *K. zeylonensis* in India is sparse. A study conducted by Vyas et al. (2013) on the breeding behaviour of *K. zeylonensis* in Jambughoda WS and surrounding areas in Gujarat, India reported fishes, crabs, insects, and prawns in the pellets of the species. However, the authors identified

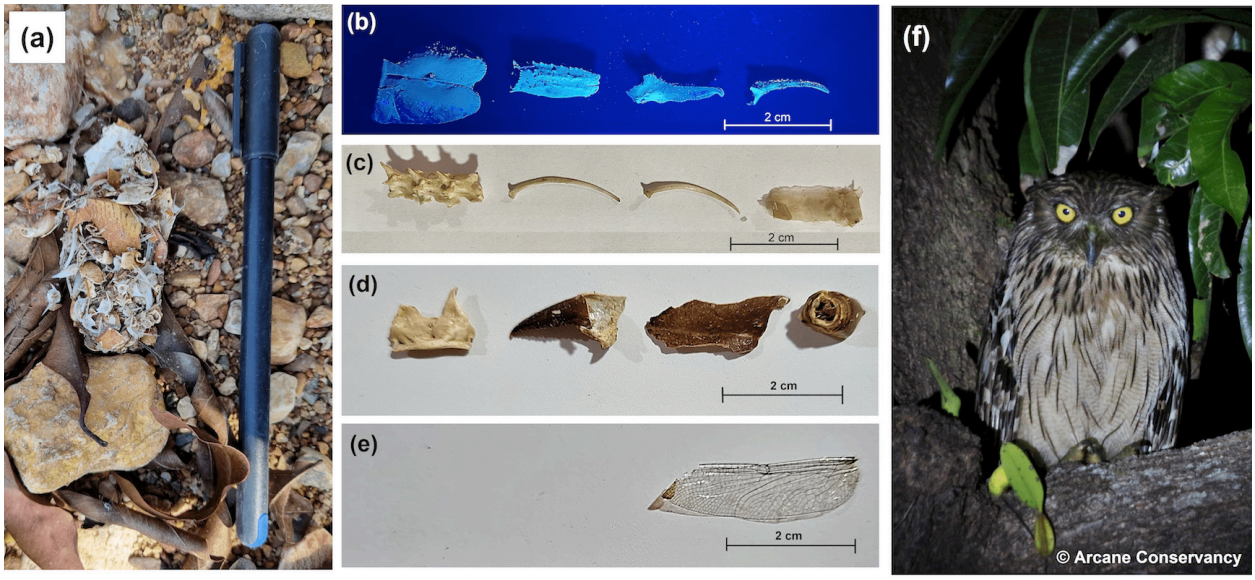


Image 1. Pellet analysis of Brown Fish-Owl *Ketupa zeylonensis*: a—A typical pellet deposited along a stream bank | b—Scorpion remains exhibiting fluorescence under ultraviolet light | c—Snake vertebral column, ribs, and skin | d—Crab remains | e—Insect remains (odonate wing) (© Stephen Jonah Dias & Atul Sinai Borker) | f—A Brown Fish-Owl on its perch in Study Area 2 (© Arcane Conservancy).

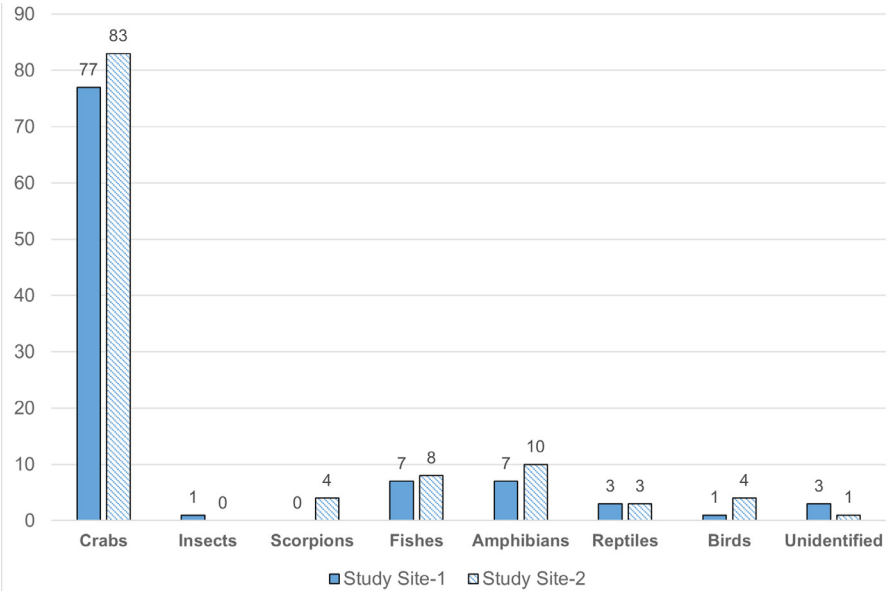


Figure 2. A comparison between prey categories recorded in the pellets of *Ketupa zeylonensis* in the study areas.

Table 1. Details of key body parts examined for the identification of the number of prey individuals in each pellet.

Prey Category	Key body parts used for assessing the number of individuals	Details of analysis
Crabs	Mouthparts, chelipeds, carapace, abdomen	The number of duplicates of exoskeletal structures (either whole parts or fragments) was used to estimate the number of individuals in each pellet.
Insects	Wings	
Scorpions	Pedipalps, cephalothorax shields, and telson	
Amphibians (Frogs)	Mouthparts, vertebrae (e.g., urostyle), pelvic girdle, humerus, radio-ulna, femur, tibio-fibula, and astragalus-calcaneum.	
Fishes	Parts of the axial skeleton (skull, vertebrae, and ribs), and scales.	Microscopic examinations of the morphological patterns on fish scales were conducted based on the principle that the patterns serve as useful taxonomic identifiers of fish species (Bräger & Moritz 2016). This was further supported by observations of the bones from the axial skeleton. As it was difficult to determine the number of individuals of the same species, all endoskeletal remains of similar size were assumed to be derived from a single individual unless morphological examinations of the scales indicated more than one species in the pellet.
Reptiles (Snakes)	Vertebrae, ribs, and skin	Identifying the number of individual snakes was straightforward in instances where the vertebral column was found to be relatively intact in the pellets. However, in instances where the vertebral column was found to be in a dismantled state, we used the general shape and size of the vertebrae and ribs to estimate the number of individuals. This was further supplemented by the remnants of snake skin present in the pellets.
Birds	Parts of the endoskeleton and feathers.	The number of duplicate endoskeletal remains was utilized to estimate the number of individuals. In cases where only feathers were present, feathers having similar morphological characteristics were assumed to originate from a single individual.

several other prey groups such as amphibians, reptiles, and birds from direct feeding observations and analysis of discarded prey items at the nests. This indicates that pellet analysis when supplemented with other observational protocols can significantly aid in the understanding of the food spectrum of the species. The diet composition of *K. zeylonensis* in Jambughoda WS was very similar to our observations in the Western Ghats of Goa with minor differences (Figure 3). In addition, the study in Jambughoda Wildlife Sanctuary was conducted during the pre-monsoon season (March–April) as compared to the present study that was conducted during the post-monsoon and winter seasons (October–February). Furthermore, fish owls are specialist birds of prey that have preferences for certain prey groups (Sieradzki 2023). Our data analysis supports this fact as the food niche breadth assessment indicated that *K. zeylonensis* is a specialist predator that feeds mainly on crabs whilst supplementing its diet with other invertebrate and vertebrate prey groups (Figure 2; Table 2).

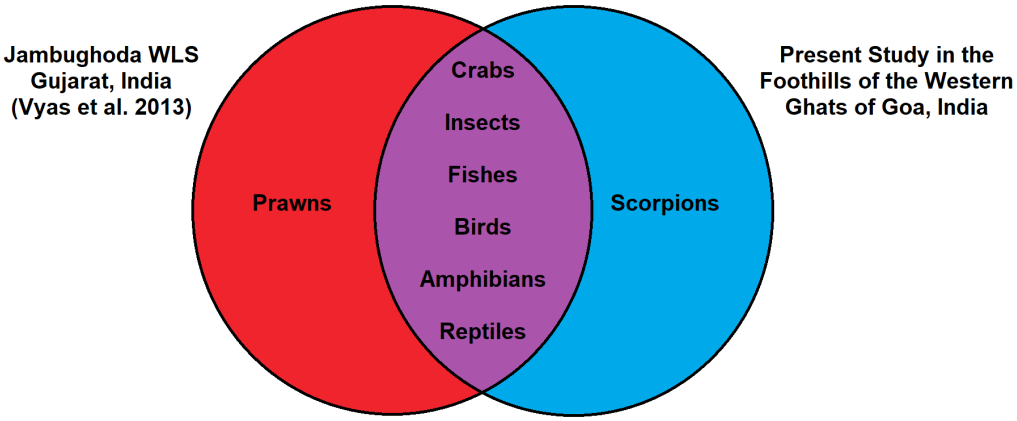


Figure 3. A comparative account of the diet of the Brown Fish-Owl *Ketupa zeylonensis* between Jambughoda Wildlife Sanctuary, Gujarat, and the present study conducted in the foothills of the Western Ghats of Goa, India

Table 2. Diet composition of the Brown Fish-Owl *Ketupa zeylonensis* in the foothills of the Western Ghats of Goa.

Phylum	Prey category	n	RFO %	FNB
Arthropoda	Crabs	160	75.47	0.1
	Insects	1	0.47	
	Scorpions	4	1.89	
Chordata	Fishes	15	7.08	
	Amphibians	17	8.02	
	Reptiles	6	2.83	
	Birds	5	2.36	
	Unidentified	4	1.89	
Total		**212**	**100**	

n—Number of individuals in each prey category | RFO %—Relative frequency of occurrence | FNB—Food niche breadth.

Pellet analysis is considered to be a robust indicator of the food spectrum of owls. In addition, such analysis can shed light on the richness, evenness, and abundance of prey groups constituting owl diet in the foraging environments (Heisler et al. 2015; Andrade et al. 2016). The present study was conducted due to the gap in knowledge in regards to the diet composition of *K. zeylonensis* in the Western Ghats ecoregion, particularly in the state of Goa. However, it is imperative to note that pellet collection in the present study was conducted for a relatively short period of time (post-monsoon and winter seasons), and the diet composition of owls is reported to change based on seasonal variations in prey availability (Kafkaletou-Diez et al. 2008; Santhanakrishnan et al. 2010). This may be an important factor to consider in landscapes such as the Western Ghats that undergo changes in hydrology across seasons. Organisms in such aquatic ecosystems may exhibit population changes on a seasonal scale that may influence the diet composition of the Brown Fish-Owl. Therefore, further assessments are required to understand the trends in the diet composition of the species across a seasonal gradient in the Western Ghats landscape.

REFERENCES

Ahmed, A. (2010). Imperilled Custodians of the Night: A Study on Illegal Trade, Trapping, and Use of Owls in India. TRAFFIC India, New Delhi, 76 pp.

Ali, S. (2002). *The Book of Indian Birds.* Bombay Natural History Society, Mumbai, 326 pp.

Andrade, A., J.F. de Menezes & A. Monjeau (2016). Are owl pellets good estimators of prey abundance? *Journal of King Saud University- Science* 28(3): 239–244. https://doi.org/10.1016/j.jksus.2015.10.007

Baidya, P. & M. Bhagat (2018). A checklist of the birds of Goa. *Indian BIRDS* 14(1): 1–31.

Bindu, T.N. & P. Balakrishnan (2015). Observations on the breeding of the Brown Fish-Owl *Ketupa zeylonensis* in Kerala, Southern India. *Journal of the Bombay Natural History Society* 112(2): 97–98. https://doi.org/10.17087/jbnhs/2015/v112i2/104938

BirdLife International (2016). *Ketupa zeylonensis*. In: The IUCN Red List of Threatened Species 2016: e.T22689012A90010491. https://doi.org/10.2305/IUCN.UK.2016-3.RLTS.T22689012A90010491.en. Accessed 8 February 2023.

BirdLife International (2020). Country Profile: India. http://www.birdlife.org/datazone/country/india. Electronic version accessed 8 February 2023.

Bräger, Z. & T. Moritz (2016). A scale atlas for common Mediterranean teleost fishes. *Vertebrate Zoology* 66(3): 275–386. https://doi.org/10.25225/fozo.v66.i3.a1

CITES (2023). Appendices I, II and III. In: Convention on International Trade in Endangered Species of Wild Fauna and Flora. https://cites.org/sites/default/files/eng/app/2023/E-Appendices-2023-02-23.pdf. Accessed 28 March 2023.

Colwell, R.K. & D.J. Futuyma (1971). On the measurement of niche breadth and overlap. *Ecology* 52(4): 567–576. https://doi.org/10.2307/1934144

Gaffin, D.D., L.A. Bumm, M.S. Taylor, N.V. Popokina & S. Mann (2012). Scorpion fluorescence and reaction to light. *Animal Behaviour* 83(2): 429–436. https://doi.org/10.1016/j.anbehav.2011.11.01412

Ganguly, B.B., A.K. Sinha, S. Adhikari & B.C.B. Goswami (2015). *Biology of Animals, 4th edition, Vol. 1.* New Central Book Agency (P) Ltd., Kolkata, 1293 pp.

Gill, F., P. Rasmussen & D. Donsker (2023). IOC World Bird list (v 13.1). IOC World Bird List. https://doi.org/10.14344/ioc.ml.13.1. Electronic version accessed 28 March 2023.

Goa Forest Department (2023). Forest and Tree Cover. https://forest.goa.gov.in/node/896. Electronic version accessed 1 February 2023

González-Rubio, S., A. Ballesteros-Gómez, A.G. Asimakopoulos & V.L.B. Jaspers (2021). A review on contaminants of emerging concern in European raptors (2002–2020). *Science of The Total Environment* 760: 143337. https://doi.org/10.1016/j.scitotenv.2020.143337

Grewal, B., S. Sen, S. Singh, N. Devasar & G. Bhatia (2016). *A Pictorial Field Guide to Birds of India, Pakistan, Nepal, Bhutan, Sri Lanka and Bangladesh.* Om Books International, Noida, 791 pp.

Heisler, L.M., C.M. Somers & R.G. Poulin (2015). Owl Pellets: A more effective alternative to conventional trapping for broad-scale studies of Small Mammal Communities. *Methods in Ecology and Evolution* 7(1): 96–103. https://doi.org/10.1111/2041-210x.12454

Kafkaletou-Diez A., E.P. Tsachalidis & K. Poirazidis (2008). Seasonal variation in the diet of the Long-eared Owl *(Asio otus)* in a northeastern agricultural area of Greece. *Journal of Biological Research-Thessalonik* 10: 181–189.

Kazmierczak, K. & B. Perlo (2012). *Birds of India, Sri Lanka, Pakistan, Nepal, Bhutan, Bangladesh, and the Maldives.* Christopher Helm, London, 352 pp.

Levins, R. (1968). *Evolution in changing environments: Some theoretical explorations.* Princeton University Press, Princeton, 132 pp.

Meek, W.R., P.J. Burman, T.H. Sparks, M. Nowakowski & N.J. Burman (2012). The use of Barn Owl *Tyto alba* pellets to assess population change in small mammals. *Bird Study* 59(2): 166–174. https://doi.org/10.1080/00063657.2012.656076

Mehta, P., J. Kulkarni, S. Talmale & R. Chandarana (2018). Diets of sympatric Forest Owlets, Spotted Owlets, and Jungle Owlets in East Kalibhit forests, Madhya Pradesh, India. *Journal of Raptor Research* 52(3): 338–348. https://doi.org/10.3356/jrr-17-00002.1

Mehta, P., S. Talmale, V. Kulkarni & J. Kulkarni (2020). *All About Owl Diet: A Technical Manual for Identification of Prey Remains from Owl Pellets in Central India.* Raptor Research and Conservation Foundation, Mumbai, and Wildlife Research and Conservation Society, Pune, 216 pp.

Ministry of Law and Justice (2022). The Wild Life (Protection) Amendment Act, 2022. https://egazette.nic.in/WriteReadData/2022/241252.pdf. Electronic version accessed 28 March 2023.

Mishra, T., D. Mishra & S. Srivastav (2021). *Comparative Anatomy of Vertebrates.* Mahaveer Publications, Dibrugarh, 291 pp.

Molur, S., D. Allen & K. Smith (2011). Chapter 1. Background, pp. 12. In: Molur, S., K.G. Smith, B.A. Daniel & W.R.T. Darwall (eds.). *The Status And Distribution of Freshwater Biodiversity In The Western Ghats, India.* IUCN, UK and Switzerland, 116 pp.

Santhanakrishnan R., A.H.M.S. Ali & U. Anbarasan (2010). Diet Variations of the Barn Owl *Tyto alba* (Scopoli, 1769) in Madurai District, Tamil Nadu, Southern India. *Podoces* 5(2): 95–103.

Saxena, R.K. & S. Saxena (2019). *Comparative Anatomy of Vertebrates.* Viva Books Private Limited, New Delhi, 667 pp.

Sieradzki, A. (2023). Designed for Darkness: The Unique Physiology and Anatomy of Owls, pp. 24. In: Mikkola, H.J. (ed.). *Owls - Clever Survivors.* Intech Open, London, 174 pp.

UNESCO (2023). Western Ghats. https://whc.unesco.org/en/list/1342/. Electronic version accessed 17 January 2023.

Verma, P.S. (2014). *A Manual of Practical Zoology: Chordates.* S. Chand & Company Pvt. Ltd., New Delhi, 515 pp.

Vyas, R., K. Upadhayay, M.R. Patel, R.D. Bhatt & P. Patel (2013). Notes on the breeding of the Brown Fish Owl *Ketupa zeylonensis*. *Indian BIRDS* 8(6): 147–51.

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,
43/2 Varadarajulu Nagar, 5th Street West, Ganapathy, Coimbatore,
Tamil Nadu 641006, India
ravi@threatenedtaxa.org

Journal of Threatened Taxa

www.threatenedtaxa.org

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

July 2023 | Vol. 15 | No. 7 | Pages: 23463–23630
Date of Publication: 26 July 2023 (Online & Print)
DOI: 10.11609/jott.2023.15.7.23463-23630

Publisher & Host

WILD ZOOREACH
Threatened Taxa