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Journal of Threatened Taxa



Open Access

10.11609/jott.2024.16.10.25951-26062

www.threatenedtaxa.org

26 October 2024 (Online & Print)

16(10): 25951-26062

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

Srivari Illam, No. 61, Karthik Nagar, 10th Street, Saravanampatty, 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

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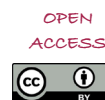
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Cover: A digital art of water birds of Noyyal River and its wetlands in Coimbatore District by Megha A. Kashyap.



Insights into human-wildlife interactions and community views on mangrove restoration in Kendrapada District, Odisha, India

Mohd Qayyum¹ , Vijai Dharmamony² , Muralidharan Manoharakrishnan³ , Sadhwi Sindura⁴ , Janmejey Sethy⁵ & Murali Krishna Chatakonda⁶

^{1,5,6} Amity Institute of Forestry and Wildlife, Amity University, Gautam Buddha Nagar, Sector 125, Noida, Uttar Pradesh 201301, India.

^{1,2,3,4} WWF-India, 172 B, Lodhi Estate, New Delhi 110003, India.

¹ mohd.qayyum2k@gmail.com, ² vijai@wwfindia.net, ³ murali@wwfindia.net, ⁴ sadhwi@wwfindia.net,

⁵ jsethy@amity.edu (corresponding author), ⁶ mkchatakonda@amity.edu

Abstract: This paper evaluates interactions between humans, Wild Boars, and crocodiles in mangrove ecosystems of the villages of Benakanda, Bhateni, and South Jambu in Mahakalapada Block in the Kendrapada District of the Indian state of Odisha, using questionnaire surveys. This is an area where mangrove restoration is currently in progress. Using a targeted sampling procedure, 280 respondents representing 14% of the population participated in the study. The results show that negative perceptions differ throughout villages, with a majority of respondents reporting interaction between humans and animals in Bhateni (91%) and South Jambu (98%). The most frequent animal reported to cause harm to crop and livelihoods is Wild Boar (44%). Communities understand the value of mangrove restoration despite facing obstacles brought on by interactions with wildlife. The vast majority of residents (87%) believe that restoration efforts were necessary, and many had taken part in these by themselves, or in conjunction with other communities.

Keywords: Crops, livelihoods, livestock, local communities, people perception, Saltwater Crocodile, Wild Boar.

Editor: L.A.K. Singh, Bhubaneswar, Odisha, India.

Date of publication: 26 October 2024 (online & print)

Citation: Qayyum, M., V. Dharmamony, M. Manoharakrishnan, S. Sindura, J. Sethy & M.K. Chatakonda (2024). Insights into human-wildlife interactions and community views on mangrove restoration in Kendrapada District, Odisha, India. *Journal of Threatened Taxa* 16(10): 25951–25961. <https://doi.org/10.11609/jott.9034.16.10.25951-25961>

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Competing interests: The authors declare no competing interests.

Funding: WWF India.



Author details: MOHD QAYYUM a forestry graduate with a professional degree and a passion for wildlife, works as a consultant with WWF India's TRAFFIC division, supporting workshops and training on illegal wildlife trafficking. Prior to this, he served as a project officer, having started as an intern, where he contributed to anti-poaching efforts, sniffer dog programs, and research on illegal wildlife trade. He now aims to leverage his skills in research, community conservation, and wildlife protection while preparing for his master's degree. VIJAI DHARMAMONY is an associate professor at the School for Sustainable Futures, Amrita University, Kerala. Prior to this, he served as the associate director at WWF-India, New Delhi, where he led the Marine Conservation programme and played a pivotal role in programme development, project management, and stakeholder engagement. Dharmamony earned his Ph.D. in Environmental Science from Hokkaido University, Japan. Following his Ph.D., he worked as a data scientist with the North Pacific Fisheries Commission, in Japan. Additionally, he served as a Development Officer at NCBS-TIFR, fostering and sustaining industry-academic relations and private partnerships. MURALIDHARAN MANOHARAKRISHNAN is the lead marine species at WWF-India. He is a member of the IUCN/SSC/Marine Turtle Specialist Group and has been involved in marine turtle research and conservation across India apart from other marine flagship species including sea snakes and sharks. He is interested in championing the cause of marine species and habitat recovery using a combination of research and models of community-based conservation. SADHWI SINDURA is the programme coordinator and the state lead in Odisha the Marine Programme of WWF-India. Her expertise lies in marine biodiversity conservation, stakeholder engagement, and participatory conservation models, she works closely with local communities, government agencies, and other stakeholders to promote sustainable natural resource management. JANMEJAY SETHY is associated with the Amity Institute of Forestry and Wildlife at Amity University. He is a member of the IUCN/SSC/BSG Sun Bear Specialist Group and IUCN/SSC/Pangolin Specialist Group. He is involved in the conservation and management of endangered species in the northeastern states of India. MURALI KRISHNA CHATAKONDA is associated with the Amity Institute of Forestry and Wildlife, Amity University. Currently, he is in a phase to expand his knowledge on small mammalian taxa from different regions of the eastern Himalaya and to look at the ecology and site-specific challenges that the species face. Also, he is more interested in building cross-country collaborations in this field and has recently initiated the same.

Author contributions: Study conception and design: Vijai Dharmamony, Muralidharan Manoharakrishnan, Janmejey Sethy and Murali Krishna Chatakonda, Data collection: Mohd Qayyum and Sadhwi Sindura, Analysis and interpretation of results: Vijai Dharmamony, Muralidharan Manoharakrishnan, Janmejey Sethy and Mohd Qayyum Draft manuscript preparation: Muralidharan Manoharakrishnan, Janmejey Sethy, Mohd Qayyum and Murali Krishna Chatakonda. All authors reviewed the manuscript and approved the final version of the manuscript.

Acknowledgements: We would like to acknowledge the faculties of Amity Institute of Forestry and Wildlife, Amity University, Noida for their constant support. We thank WWF-India for providing the field logistic support and the Tech for Conservation (IGCMC) division for preparing the GIS maps. The successful completion of this study was possible due to the help of local communities of Bhitarkanika National Park, for this, we would like to give our special thanks to them.

INTRODUCTION

Mangrove forests are unique ecosystems in tropical and subtropical coastal regions that contain salt-tolerant trees, shrubs and other vegetation. They help maintain coastal biodiversity and contribute to the planet's overall health. Mangroves are found in 118 countries and are distributed across southern & southeastern Asia, Africa, America, and Oceania. In India, 4,660 km² of diverse mangrove forests make up 0.14% of the country's total land area (Ragavan et al. 2019; Bryan-Brown 2020). These forests are concentrated in river deltas, estuaries, and sheltered coastal areas, where freshwater and tidal inflow create ideal conditions for mangrove growth. The forests provide essential resources for neighbouring communities, including food, fuel, medicine, and other traditional goods.

Indian mangroves have experienced significant loss, with a declining trend since 1995 (Kathiresan 2018). Previously viewed as wastelands, they are now protected for their ecological and environmental value (Badola & Hussain 2005; Hussain & Badola 2010). The "Green India Mission" and the National Action Plan on Climate Change (2008) prioritized mangrove conservation and restoration (MoEF&CC 2009). Human-wildlife interactions (HWI) have been considered one of the most challenging issues of wildlife conservation in the world (Holmern et al. 2007; Acharya et al. 2017; Bhatia et al. 2020; Stoldt et al. 2020; Zhang et al. 2020; Halley et al. 2021). Negative interactions between humans and wildlife arise with human expansion and intrusion into natural habitats (Nyhus & Tilson 2004; Graham et al. 2005), from the implementation of nature protection measures, and the rise of wild animal populations (Fall & Jackson 1998; Palmeira et al. 2008). Globally, there seems to be a rise in conflicts between agricultural interests and the preservation of wildlife (Redpath et al. 2013; Madden & McQuinn 2014).

Human activities gradually destroy the natural habitat of wildlife, which increases human-wildlife interactions globally (Nyhus 2005; Agarwal et al. 2016; Digun-Aweto et al. 2022). Economic losses impact livelihoods, leading to poverty, food insecurity, and conflicts between farmers and environmentalists, potentially causing the retaliatory killing of wild species (Katel et al. 2014). Human-wildlife interaction in India is a pressing issue, as the growing human population and habitat encroachment increasingly lead to negative interactions between people and wildlife, jeopardizing both human livelihoods and animal conservation efforts. Balancing the needs of local communities and

the preservation of India's rich biodiversity is a complex challenge (Datta et al. 2012; Manral et al. 2016). In India, interactions between humans and wildlife, such as with the elephants and tigers, often result in crop damage, property destruction, and occasionally threats to human and animal lives, highlighting the challenges of coexistence and conservation efforts (Conover 2002; Decker et al. 2002; Madden 2004; Dickman 2010). When it comes to mangroves, the studies on human-tiger interactions and human-crocodile interactions are evident in their negativity and often appear in the literature (Vyas & Sengupta 2012; Khan et al. 2020; Dhar & Mandol 2023). Wild Boars can reside in a range of environments, including taigas, tropical forests, mountains, and marshes (Massei et al. 2011; Acevdo et al. 2014). Wild Boars threaten farmer livelihoods through crop depredation which is also aided by their rapid population growth, high fertility, and the absence of predators (Seward et al. 2004; Geisser & Reyer 2005; Liu et al. 2019; Csókás et al. 2020). The roles of natural ecosystems, such as mangroves, and hydrological variables, such as proximity to rivers, as well as various socio-economic factors determining economic well-being, are rarely taken into account (Das 2012). Bhitarkanika National Park is the second largest contiguous mangrove forest in India, with approximately 0.15 million mangrove-dependent populations residing in and around 307 villages within the protected area (Das et al 2022).

This study explores the relationship between mangrove conservation and wildlife interactions and the attitude of the community towards mangrove restoration in our study area, the Kendrapada District in Odisha State.

METHODS

STUDY AREA

The study was conducted in Kendrapara District of the coastal Indian state of Odisha which lies between 20.3333–20.6167 °N and 86.2333–87.0167 °E. Bhateni, Benakanda, and South Jambu are three villages in Kendrapara District where the questionnaire surveys were conducted. Nestled close together, the three villages present a unique region of river and mangrove access. South Jambu is directly connected to the Dabka River and surrounded by lush mangroves. Bhateni is mostly enclosed by mangroves, with only a small area open to the river. In contrast, Benakanda is more exposed to the mangrove area (Figure 1).

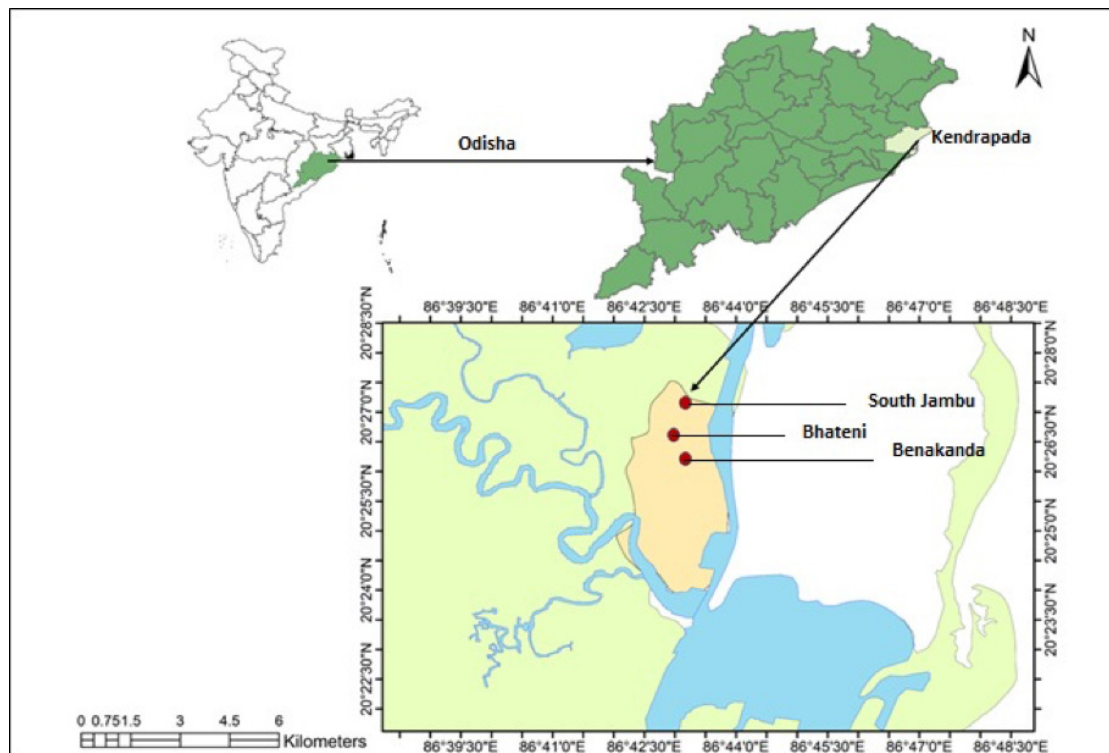


Figure 1. Map of the study area showing South Jambu, Benakanda and Bhateni.

In recent years, severe weather events such as cyclones and floods have increased in the Bhitarkanika landscape region (Kadaverugu et al. 2022). The two major river systems further make it vulnerable to cyclones, storm surges, and floods. The ingress of seawater is another threat that has also displaced many villages and threatened the livelihoods of the people in the landscape. The district has mangrove forests with varying widths of 100–10,000 m in places and narrow patches of *Casuarina* plantations near the sand dunes, but their presence is very limited (Das 2020).

Questionnaire survey

A survey was carried out in three villages where the mangrove restoration program by WWF India is in progress to gain further insight into the interactions between humans and wildlife in the mangrove forest as well as the opinions of the locals on the preservation of mangroves. In February and March of 2023, the survey was conducted over two months. Before the comprehensive questionnaire survey was carried out, interactive sessions and informal discussions were organised in the villages of Benakanda, Bhateni, and South Jambu. The questionnaire concerning the interaction between human-wildlife and mangrove restoration was developed after the pilot study (Appendix 1).

The interviews aimed to explore people's reliance on the mangrove ecosystem as a source of income as well as to understand the HWI in this region. All respondents freely participated in the questionnaire after providing informed verbal consent. For those participants who were less than 18 years of age, consent was taken from their parents/guardians before the commencement of the questionnaire. Prior to this, the study's purpose and their right to withdraw even in the middle of the interview, were clearly explained. This ensured ethical data collection through voluntary and informed participation. Open-ended questions were asked as they are more advantageous than closed-format questions when trying to understand the attitude of respondents (Newing 2010). We gathered information on which animals were most involved in the interaction (mostly negative) and whether these occurred seasonally. Additionally, we inquired about the types of crops that these animals feed on, the damages they cause, and whether the government provides any compensation or compassionate payment to address these negative interactions and pacify hostility.

We interviewed a total of 280 families, which represents 14% of the targeted population. These families included local representatives, leaders, fishermen, farmers, landowners, and daily wage labourers. The

purpose of the interviews was to determine the significance of mangroves in their lives, the occurrence of interactions between humans and wildlife, and the damages caused during these interactions. We worked with field staff from the forest and wildlife department of the state government, who acted as translators for the interviews conducted in Odia and Bengali. The data was analysed using Microsoft Excel.

RESULTS

The survey shows that 85% of the interviewed people reported experiencing HWI in the area.

Our study observed different gender distribution patterns in the three villages. In Benakanda, approximately 65.56% of the respondents were men. Similarly, in Bhateni, around 62.23% of the respondents were male, and 36.67% were female. In South Jambu, over 67% of the population was male, while females accounted for roughly 32% (Figure 2).

Age classification of the informants

The percentage of respondents was categorised by their generational group—Younger Generation (15–30 years), Mid Generation (31–60 years), and Old Generation (61–90 years)—across the three villages. This data helps in understanding the demographic distribution across these villages. This group constitutes the largest percentage of respondents in each village. South Jambu has the highest proportion at approximately 70%, followed by Benakanda (65%), and Bhateni (60%). The percentage of the younger generation is fairly consistent across the three villages, with each village having around 20% of its respondents in this category (Figure 3).

Species associated with human-wildlife interaction (Overall account)

Wild Boars were reported to account for the majority (43.6%) of interaction cases (where the crop is damaged), followed by jackals (21.3%), Saltwater Crocodiles (12.8%) (poultry and livestock lifting), and the remaining (22.3%) were comprised of wild cats, Spotted Deer, langurs, snakes, and birds. In Benakanda the maximum cases were observed with Wild Boars (49.39%), followed by Rhesus Macaques (22.22%), and crocodiles (12.36%), while jackals and wild cats accounted for less (4.94%) of interactions (Figure 4). Whereas in South Jambu it was maximum with Wild Boars (51.85%), followed by jackals (16.05%), Rhesus Macaques (14.20%), and crocodiles (10.49%). In Bhateni, the maximum number

of cases were of jackals (38.56%), followed by Wild Boars (24.84%), wild cats (16.99%), and crocodiles (13.08%). Based on the respondents we observed varying human-wildlife interactions in different areas of the study site (Image 1,2).

Seasonal variation

The majority of interactions were reported during the cropping season, which runs from June to December. The areas with the highest reported interactions were Benakanda (71.11%), followed by Bhateni (61.2%), and South Jambu (59%). Wild Boars are the main cause of damage to paddy and tuber crops during this time, and they also pose a risk of injuries to humans (Figure 5). This issue is particularly prominent in South Jambu and Benakanda. In contrast, the risk of interactions remains consistent throughout Bhateni, as a large area of the village borders the mangrove forest. During the non-cropping season, the highest number of cases were reported in South Jambu (41%), followed by Bhateni (38.8%), and Benakanda (28.89%) (Figure 5).

Damage caused

The percentage of crop damage is highest in South Jambu at 48.0%, followed by Benakanda at 28% and Bhateni at 24%. In Benakanda, 36% of the population suffered injuries. In Bhateni, 53% of the cattle have been lost, which is higher compared to the other two villages (Figure 6). The “No loss” category represents the proportion of the population or property that has not suffered any loss. In South Jambu, 16% of the population or property hasn’t experienced any loss due to human-wildlife interactions. These give insights into the impact of certain factors on each village’s agriculture, population, and livestock. It helps in understanding the vulnerability and resilience of each community in the face of these challenges.

Human-wildlife interactions were claimed by the villagers for crop damage, livestock losses, and injuries. The most agricultural damage was observed in South Jambu, the area closest to the mangroves. The greatest number of livestock losses (cattle and goat) were reported in Bhateni, a region with vast fields that are home to Jackals and wild cats. Most injuries were reported in South Jambu and Benakanda (Image 2).

Mangrove restoration

In both the individual and community categories, Bhateni and Benakanda show higher percentages of restoration compared to South Jambu. South Jambu has the highest percentage in the “Restoring with

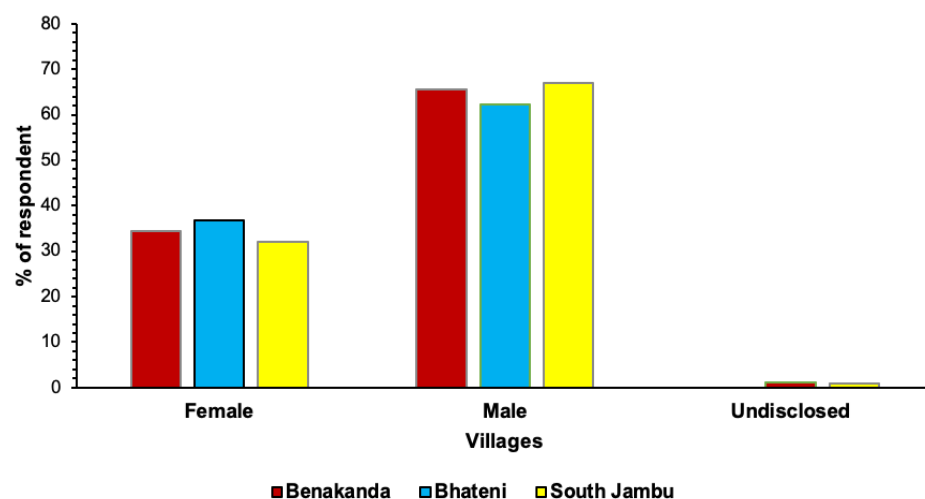


Figure 2. Gender-wise respondents in different villages.

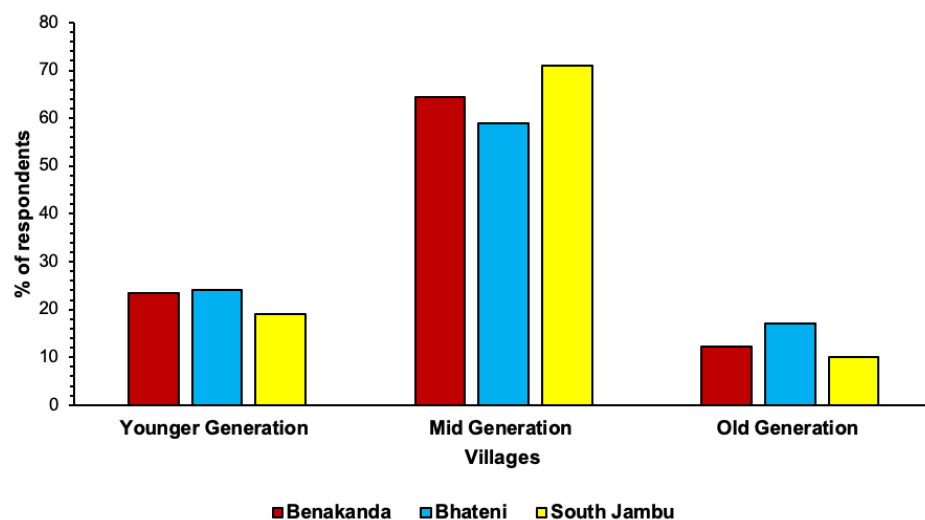


Figure 3. Age-wise respondents in different villages.

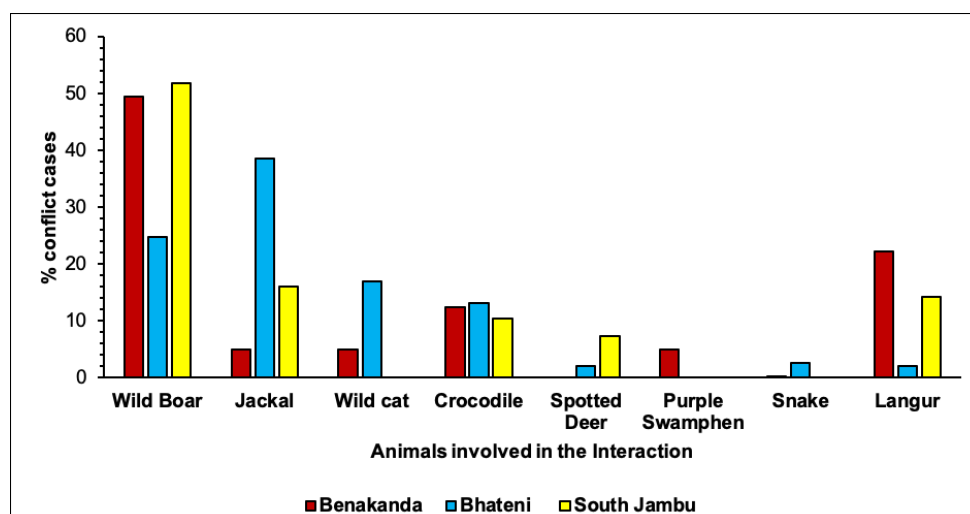


Figure 4. Different animals cause interactions in the respective villages.

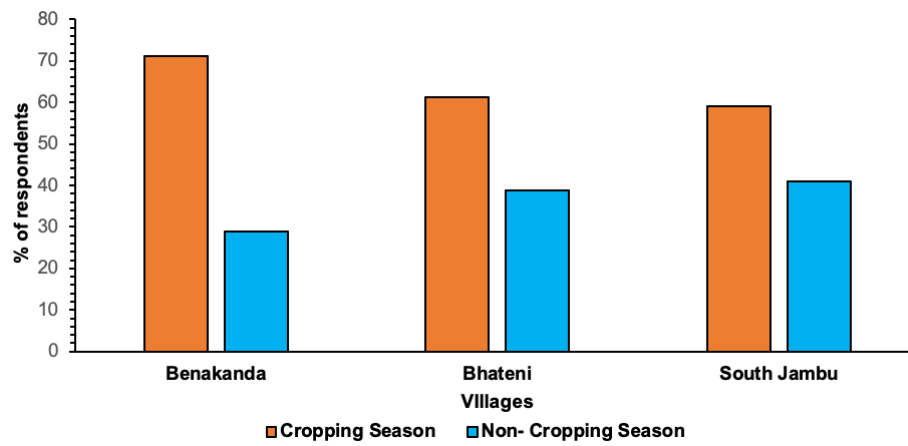


Figure 5. Season-wise human-wildlife interaction in the study area.

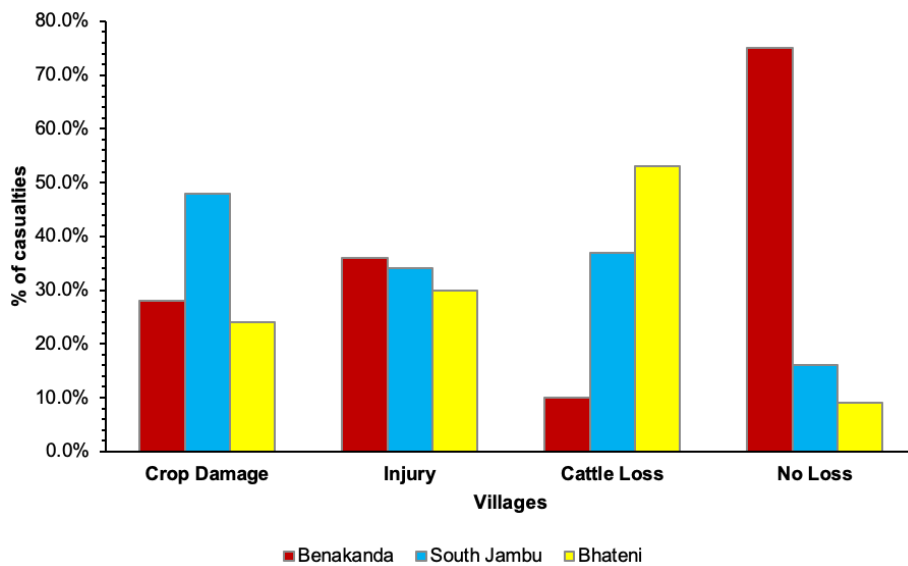


Figure 6. Human-wildlife interaction patterns in different villages.

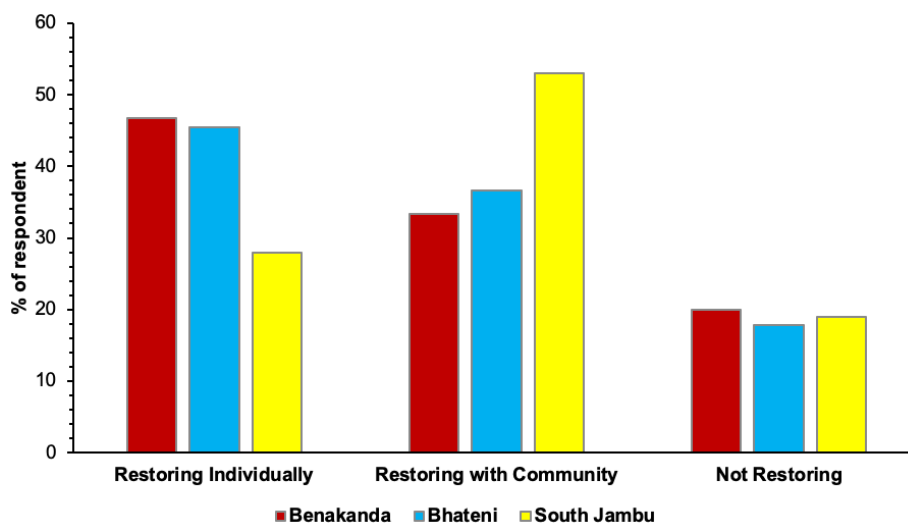


Figure 7. Restoration perception of local communities in different villages.

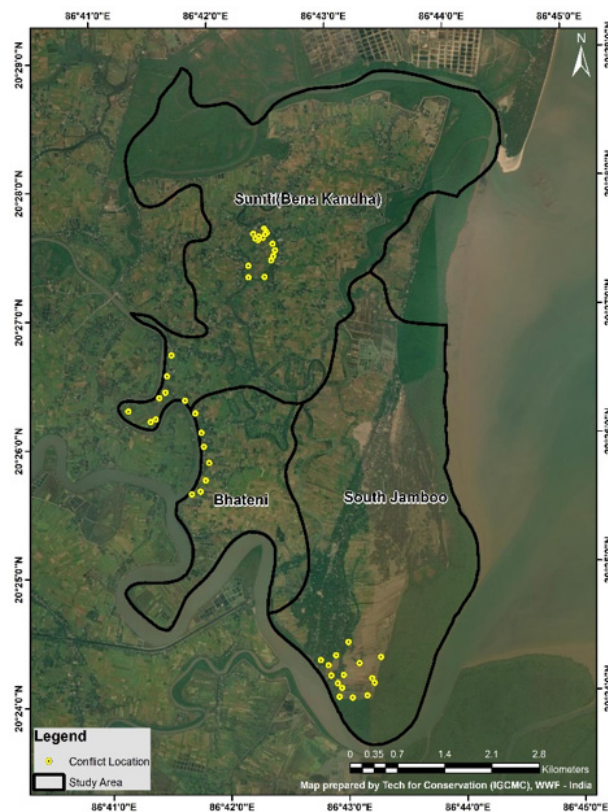


Image 1. Human-wildlife interaction locations.

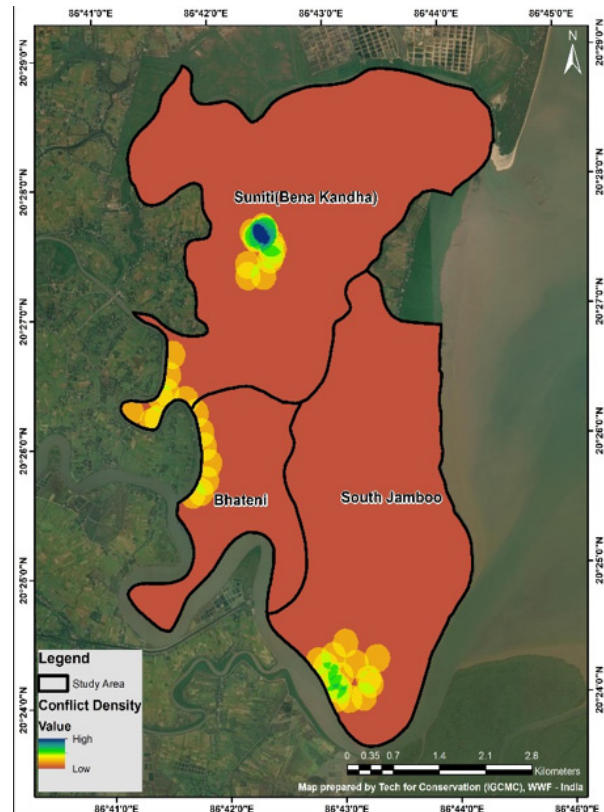


Image 2. Human-wildlife interaction density.

Community” category, indicating that community efforts are more prevalent there compared to individual initiatives. Bhateni and Benakanda seem to have a more balanced approach to individual and community-based restoration than South Jambu. For individual restoration, the percentages are Benakanda (46.67%), Bhateni (45.5%), and South Jambu (28%). In South Jambu, 53% of the community supports the restoration of mangroves. In Bhateni and Benakanda, the percentages are 36.66% and 33.33%, respectively. The majority of villagers agree that mangrove restoration is essential. However, while some prefer to work alone, others prefer to involve the community in the restoration work. Some remaining residents have shown no interest in restoring mangroves due to fears of potential HWI (Figure 7).

Awareness of Government schemes

Knowledge and awareness of government schemes related to HWI and compensation or compassionate grants provided in case of injury or damage were also assessed. The majority of respondents (92%) were unaware of any government schemes in their area, while only a small percentage (1.2%) had little knowledge, and a few (6.8%) had no idea about any government

schemes (Figure 8).

DISCUSSION

This study provides information on human-wildlife interactions in the study area involving primarily crocodiles, wild cats, and Wild Boar. A majority of those interviewed emphasized the importance of human-boar interactions. Our research evaluated instances of interactions between humans and wildlife species such as Wild Boars in the mangrove ecosystem. These interactions likely arose due to habitat loss, competition for resources, and potential threats to livelihoods. This negative interaction is consistent with global observations (Mathur et al. 2015), which attest to the widespread appreciation of Wild Boar crop predators (Tisdell 1980; Bengsen et al. 2014). This negative interaction reflects their behavioural plasticity and increasing dependency on agricultural produce (Herrero et al. 2003).

Wild Boars were reported as being responsible for negative interactions in all villages. These interactions occur mostly during the cropping season when the boars feed on paddy fields and tuber crops during the

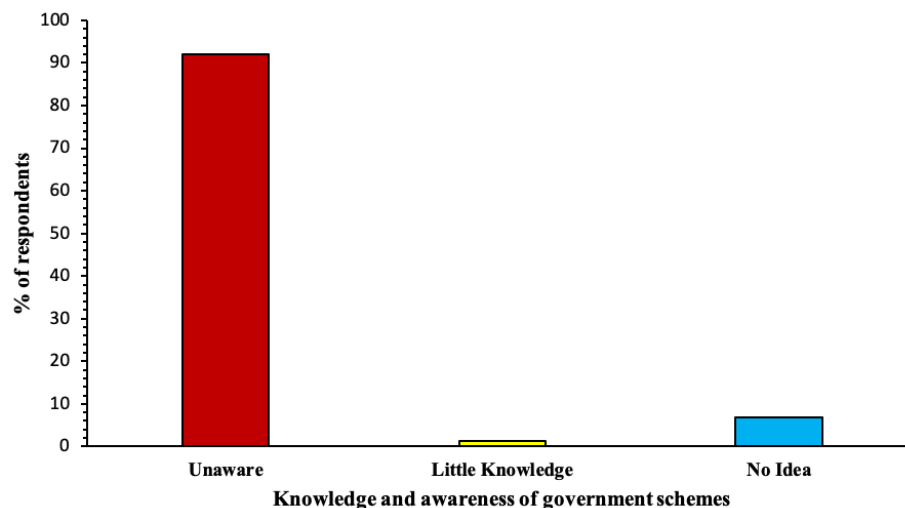


Figure 8. Knowledge and awareness of government schemes for human-wildlife interaction.

off-season. They are reported to come in large groups at night to eat the crops, and sometimes even sleep in the agricultural fields. When the farmers check on their crops, the boars cause injuries to anyone in their path while trying to escape from the farmers. Fencing done by the government, and the lack of fencing in some areas, increase the chances for animals to cause harm. Additionally, venturing into the forest in search of fodder and firewood puts people at risk of encountering animals. Unlike the majority of other wildlife, rising anthropogenic pressure has offered Wild Boars opportunities to expand their populations. Accordingly, the circumstances for interactions also increased in human-wildlife interface areas (Milda et al. 2023).

Wild Boars threaten farmers' livelihoods through crop depredation, which is aided by rapid boar population growth, high fecundity, and the absence of predators (Seward et al. 2004; Geisser & Reyer 2005; Liu et al. 2019; Csókás et al. 2020). Their entry into homes can be dangerous and has resulted in injuries and even loss of life. To protect themselves, farmers resort to various measures, such as building fences around their fields and homes. However, these measures are not always effective in stopping Wild Boars.

In previous seasons, farmers have also focused more on growing flowers than vegetables. A study conducted by Chauhan et al. (2009) advised changing crop patterns near forests by planting different income-generating crops instead of highly vulnerable crops. To resolve the interactions between people and Wild Boars, they experimented with traditional methods, such as using human hair to deter Wild Boars. However, this proved ineffective after a few days as the Wild Boars became

accustomed. Similar techniques were observed by Rao et al. (2008) who found that many farmers in the Telangana State were using such farming strategies and development pathways of small-holder farming systems namely, (i) crop without livestock (CWL), (ii) crop with small ruminants (CSR), and (iii) crop with dairy (CD), in the context of climate change to reduce the damage caused by Wild Boars by 40–50 %. This study revealed that while many strategies have been attempted to address the interactions, they do not last long as they become ineffective after a few days.

The impact of Wild Boars on the livelihoods of people in rural areas is evident also in a study conducted in China, where on average, each household experienced a loss of 10,480 RMB (the Chinese renminbi) per year (Wang et al. 2023). While Wild Boars have been destroying crops and causing physical harm, jackals and wild cats have been causing a loss to cattle and poultry, despite fencing. Khan et al. (2020) report the long tradition of crocodile-human interactions. Crocodiles are associated with deities in several local communities across the nation. However, Project Crocodile's restoration attempts have been thwarted by increasing human encroachment and intolerance of crocodiles, mostly resulting in a reduction in crocodile habitat (Das & Jana 2018). This has led to a decline in the amount of available habitat for crocodiles leading to conflicts (Khan et al. 2020). This study did not report saltwater crocodiles causing any casualty of life in the region. However, the fishermen and villagers living near the forest often mentioned that they must be careful all the time because of the crocodile presence in the area and their entry into the fishponds, cattle sheds, and poultry, preying on fish and livestock like hens,

ducks, and rarely cattle. Fencing around their houses and ponds has given them a positive result.

It was observed that the local community holds mangroves with great reverence as they consider the mangrove trees as sacred trees. Furthermore, they are appreciative of the benefits of fodder, fuelwood, fruits and fish provided by the mangrove habitats. The community is closely connected to the mangroves and actively participates in their restoration by planting more trees in the vicinity of their homes and within the community. This has resulted in a low rate of exploitation in the area. The community receives various services from the mangroves such as firewood, crabs, and fishes (provisioning services), climate change regulation (regulating services), and protection from soil erosion (supporting services). Villagers lack the information on schemes available to them when damage is caused due to HWI. This knowledge gap hinders their ability to seek government assistance. However, there's a positive side: the majority of villagers recognize the importance of mangroves and are enthusiastic about their restoration. With proper guidance from the government or NGOs, they can play a crucial role in protecting these vital ecosystems, rather than contributing to their destruction. WWF-India has also initiated a conservation initiative on a plot of land in collaboration with the community, where they have established a nursery (employing local people) and are raising mangrove species to restore 22 ha of lost mangroves in community land alongside the Gobari River, spread across the three selected villages. On average, these resources contribute to over 14.5% of households' total income, with this proportion rising to over 30% for poorer households living near the forests (Badola & Hussain 2003). Given that these households typically have lower levels of education, employment, and income, their reliance on the mangrove resources is even greater.

Thus, the current study provides necessary base information for planning future restoration programs and investigating aspects that might cause hindrances.

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Appendix 1. Questionnaire survey format for human-wildlife interaction.**CONTACT DETAILS****Name:****Age:****Address:****Education:****Gender:****Members:**

Sno	Questions
1.	What are ecosystem services that mangrove provides?
2.	Does the mangrove ecosystem provide a source of fresh water to you?
3.	Is there any noticeable change in the quality of water during the hightide and low tide?
4.	Do the mangroves have any cultural importance/ Values/ Purpose due to its natural character and traditional uses?
5.	Are there any traditional practices done by the community to conserve/protect the mangroves?
6.	Is mangrove ecosystem can provide sufficient income to support the family
7.	Does the community invite other parties to plant mangroves around the coastal area?
8.	Which animal appears the most often in Human-Wildlife interaction? What do you do to mitigate it?
9.	Do they have any particular season?
10.	Are there any particular crops they feed on?
11.	Types of Damages caused by them? (Economic Damage, Loss of Life, Injury)
12.	Does the government provide any compensation policy to mitigate the Human-Wildlife interaction?
13.	How can you describe your relationship with the animal?

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, Kalpavriksh, 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
Dr. R. Ravinesh, Gujarat Institute of Desert Ecology, Gujarat, 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 Dubai, 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
Mr. H. Byju, Coimbatore, Tamil Nadu, India
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. P.A. Azeez, Coimbatore, Tamil Nadu, India

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
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Print copies of the Journal are available at cost. Write to:
The Managing Editor, JoTT,
c/o Wildlife Information Liaison Development Society,
3A2 Varadarajulu Nagar, FCI Road, Ganapathy, Coimbatore,
Tamil Nadu 641006, India
ravi@threatenedtaxa.org & ravi@zooreach.org

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



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

October 2024 | Vol. 16 | No. 10 | Pages: 25951–26062

Date of Publication: 26 October 2024 (Online & Print)

DOI: 10.11609/jott.2024.16.10.25951-26062

www.threatenedtaxa.org

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