



Legacy of co-existence between rhino and people in a protected area in India



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ABSTRACT

Pobitora Wildlife Sanctuary in the Indian state of Assam has the highest density of the globally threatened greater one-horned rhino (*Rhinoceros unicornis*) in the world. The sanctuary constitutes an area of 38.81 km², which is relatively small for the rhino habitation. The contest for space and resources as a consequence, often triggers the megaherbivore's movement in the fringe areas of human settlements. Interestingly, the episodes of the human-rhino conflict are less contrary to the existing situation, which this paper aims to explore by understanding the community's perception towards wildlife, particularly the rhino. The five study villages and respondents were selected based on purposive sampling. The study highlights the role of attitudes, environmental ethics and, religious belief systems of the community while providing a space for co-existence for wildlife, which is a central issue today in conservation science and policy.

1. Introduction

There is no Protected Area (hereafter PA) for wildlife in the world devoid of human surroundings and dependency. In many parts of the developing world, wildlife inhabits landscapes outside PAs, where they come into conflict and competition for space and food resources with local communities (Madden, 2004). Encounters between humans and wildlife are more prominent now due to increased human populations and the resultant encroachment of anthropogenic activities on wilderness areas (Barua et al., 2013; Habib et al., 2015; Woodroffe, 2000). This proximity between people and wildlife often makes PAs vulnerable to anthropogenic pressures such as hunting, fishing, collecting Non-Timber Forest Produce (hereafter NTFP), deforestation, livestock grazing, and agricultural practices. The Human-Wildlife Interaction (hereafter HWI) are mostly viewed along a spectrum extending from negative to positive dynamics (Bhatia et al., 2021). This can manifest in visible and hidden forms of crop-raiding or destruction of stored food (Kolinski and Milich, 2021), property damage, livestock depredation and impacting psychosocial well-being, and food insecurity, attacks upon humans, disease transmission to livestock or humans (Ogra, 2008). Large body animals like Asian (*Elephas maximus*) and African (*Loxodonta africana*) elephants, hippopotamus (*Hippopotamus amphibius*), buffalo (*Bubalus*

sp.), lion (*Panthera leo*), leopard (*Panthera pardus*) and baboon (*Papio sp.*) are often identified as “problem” species or the greatest threat to farmers (Kaltenborn et al., 2003). Conservation organizations and the government often fund compensation packages to increase the tolerance levels among the affected people in the event of crop depredation, human casualty/death, property damage, or livestock depredation. However, bureaucratic inadequacies in disbursing timely and deserving compensation amounts have been a concern for the affected party (Maheshwari et al., 2014; Reddy and Yosef, 2016).

Amidst Human-Wildlife Conflict (hereafter HWC), there are instances of co-existence at fine spatial scales due to the proximity between human-dominated areas and wildlife habitats. For example, in Chitwan National Park of Nepal, tigers (*Panthera tigris*) spatially overlapped with people on foot and vehicles at a fine spatial scale. Tigers use the night to avoid anthropogenic activities associated with local resource collection (Carter et al., 2012). In peripheral areas of Dachigam National Park in India, Charoo et al. (2011) recorded a similar overlap in resource use by Asiatic black bears (*Ursus thibetanus*) and humans. However, adversity was recorded in response to bear attacks on humans and livestock and damage to crops by the retaliatory killing of bears. Some indigenous conflict mitigation methods used in the Dachigam Landscape include drumming empty metal containers, guard dogs, barbed

Abbreviations: PA, protected area; HWC, human-wildlife conflict; HWI, human-wildlife interaction; PWLS, pobitora wildlife sanctuary; KI, key informant; NTFP, non-timber forest produce; CTD, concurrent triangulation design; HRI, human-rhino interaction; HRC, human-rhino conflict.

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wire fencing, and scarecrows. Lamsal (2012) mentions various mitigation measures for the Human-Rhino Conflict (hereafter HRC) in Chitwan National Park, Nepal, in response to crop depredation and threatening human lives. They are fire sticks, acoustic deterrents, thronging dust and stone, electric fences, and adapting techniques like humans sinking into a water body and gathering tree support. Anwar et al. (2015) mention different deterrents to wildlife intrusions practiced in India. This includes acoustic deterrents (e.g., banging on metal, fire-crackers, thunder-fly ashes, fire-arms, recorded sounds); visual deterrents (brightly coloured cloths and plastic hung from a fence at the edge of fields and use of scarecrows); olfactory deterrents include extracted capsaicin resin from chilli peppers; taste deterrents (unpalatable lure crops); game proof fences and also, lethal control such as regulated hunting. Based on the nature and causes of HWC in Bale Mountains National Park of Southeast Ethiopia, Mekonen (2020) suggests some possibilities for peaceful co-existence between humans and wildlife. This could be through creating awareness among local communities by concerned stakeholders, identifying a clear border between the closure area and the land owned by local people, equal benefit sharing of the local communities, and reduction of human settlement encroachment into the national park range. Successful management of PA that is hemmed by villages is critical, especially when there is direct conflict with wildlife. Therefore, for sustainable and inclusive forest management to be achieved, considering local people's needs, aspirations and perception is paramount (Allendorf, 2010; Garekae et al., 2016). Mutanga et al. (2017) supports this argument because people's perceptions and attitudes towards conservation are directly proportionate to factors shaping the PA-people relationship. In a similar line, Ward (2022) discusses the factors that influence human behaviours in a conflict between yellow-shouldered amazon parrots (*Amazona barbadensis*) and residents in Bonaire. It states that a person's decision to perform a behaviour is controlled by their attitudes, subjective norms (influenced by social pressure and expectations to perform/not perform the target behaviour), and perceived control (how confident a person feels about performing the behavior). People construct meaning and act accordingly based on perceptions that arise through their experiences (Sodhi and Ehrlich, 2010). Banerjee et al. (2013) cite an example of a pro-conservation attitude and subjective norms regarding local people's (Maldhari community) attitudes toward Asiatic lions (*Panthera leo persica*) in the Gir National Park of India. Again, in understanding the local attitudes towards endangered aye-ayes (*Daubentonia madagascariensis*) in Madagascar.

Randimbiharirina et al. (2021) examine the intertwined connection between folklore and narrative. The mythology about vampirism has relayed negative attitudes towards bat (Prokop et al., 2009) and the residual fear and antagonism only get robust over time (Dickman, 2010). Despite livestock lifting, human death, and physical loss, the Maldhari community in Gir does not foster a hostile attitude toward lions. The religious sentiments and ecological benefits of pastoralists living in lion habitats, and strict legal protection regimes are all needed to continue the co-existence. However, suppose PA authorities fail to work with local people to address such conflict adequately. In that case, the conflict intensifies, becoming not only a conflict between humans and animals but also with the PA management (Sedhain and Adhikary, 2016).

People's attitude towards wildlife to some extent is influenced by their 'views of nature' which is determined by a person's environmental ethics navigated through utilization and preservation of natural resources (Kaltenborn et al., 2003). Some environmental worldviews are Anthropocentric, focusing primarily on the needs and wants of people; others are Biocentric, focusing on the entire biosphere and that all life deserves equal moral consideration (Miller & Spoolman, 2010). For example, Bulte (2005) mentions that in the Netherlands, Dutch people were willing to pay more to conserve the common seal (*Phoca vitulina*) because their decline was presented as a man-made problem rather than a natural cause such as a virus. Just as human's perceptions and behaviours are driven in response to HWC, Whittaker & Knight (1998) out-

line three wildlife responses to humans. Firstly, an animal can find human-provided stimuli reinforcing, leading to "attraction". Example include Clark's nutcrackers (*Nuayraga columbiana*) that fly to picnickers for handouts. Secondly, aversive leads to "avoidance". Example include, deer (*Odocoileus* spp.) can learn to avoid touching an electrified fence. Thirdly, neutral leads to "habituation". An apt example is crow (*Corvus* spp.) ignoring a scarecrow.

While we try to unfold the various nuances of people's interaction with rhino, it is vital to understand the role and utility of rhino in particular and other wild animals in general. Documenting the perception towards the latter is necessary to understand if the same attitude and belief applies to other resident animals or is unique to the focal species of the study. Therefore, it is necessary to use social sciences concepts in wildlife decision-making concerning issues of HWC, wildlife disease management, regulating tourism activities and environmental sustainability (Manfredo and Vaske, 2014); on the trajectory of considerable knowledge about wildlife populations and ecological dynamics.

The local communities on the fringes of Pobitora Wildlife Sanctuary (hereafter PWLS) in the north-eastern state of Assam in India live near one of the most popular flagship species on land, the greater one-horned rhinoceros (*Rhinoceros unicornis*). It is a Schedule I animal under the Wildlife Protection Act of India (1972) and vulnerable species in the IUCN Red List of threatened species. PWLS constitutes a small area of 38.81 km² (Bhatta and Saikia, 2011). As per the latest census of 2022, it harbours 107 Indian rhinos (Sentinel Digital Desk, 2022). With a unit density of rhino in PWLS of 4.62 per km², it has the highest ecological density of the species in the world (Konwar et al., 2009). Most importantly, the rhino-bearing capacity of PWLS has already exceeded as the small 16 km² area of the de facto sanctuary cannot support the growing number of rhinos. It is a natural phenomenon that an average of 20–30 rhinos stray out of PWLS every night, mainly to graze, migrate and mate. Generally, the migration is mainly from November until early March (Talukdar, 2002). This dry season coincides with the cultivation of mustard crops, paddy, and green leafy vegetables in a crop field and kitchen garden. Also, during the flood, rhinos do move out of the sanctuary to take shelter in the foothills of Burhamayong hills. There is no published literature to ascertain that there are resident rhinos outside the PWLS. Borgohain et al. (2014) point out that the movement of stray rhino into civil areas leads to crop depredation. Bhatta (2011) argues that it has developed a negative Human-Rhino Interaction (hereafter HRI) in Pobitora Landscape based on tangible loss from crop damage, human death, and property damage. Despite close encounters with humans, rhinos had survived in PWLS before the 1970s since it was a grazing reserve (Konwar et al., 2009). However, there are very few studies that explore local people's conservation attitude and how subjective norms influence behaviour towards rhino (it could be through retaliatory killing, trapping, demanding compensation to providing safe passage for rhino movement and developing co-existence mindset). For instance, Boeyens and Van der Ryst (2014) and Kaltenborn et al. (2003) explored the ethnohistorical and cultural significance of rhinos and HWI around Serengeti National Park in the African region, respectively. This paper presents a novel viewpoint on the capacity and mechanisms adopted by the local people to exist with rhino in such proximity. The study explores how people interpret rhino's behavioural responses based on its movement in human-dominated areas. First, we explored the community's perception of sharing space and resources with the rhino. Second, we comprehend the beliefs and ethics attached to the rhino.

2. Methods

The study is underpinned by the Grounded Theory that begins with documenting individuals' observations (respondent's responses) rather than hypotheses (Babbie, 2013). This way, it helped us develop a framework of HRI that explains the driving factors of the prevailing relationship with the megaherbivore. The study did not typically assume there is

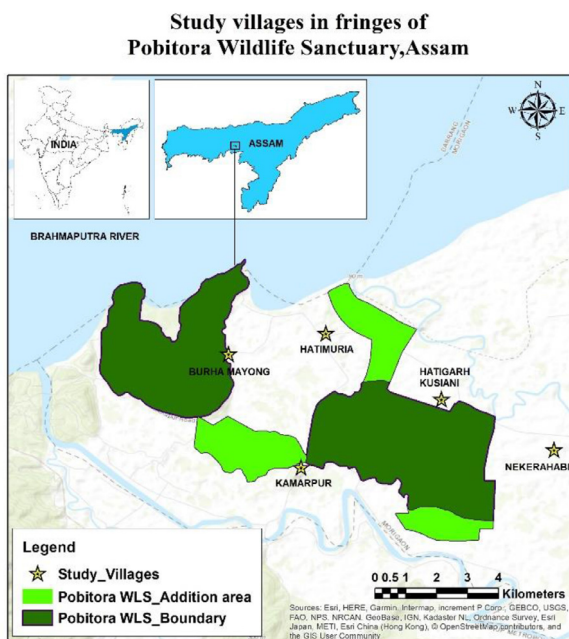


Fig. 1. Study villages in fringes of PWLS, Assam.

only conflict but attempts to unfold the perception and beliefs regarding rhino and how these are shaping the current relationship.

2.1. Study area

We selected the five study villages using the purposive sampling method based on their geographical direction from PWLS (North, South, East, West) (Fig. 1) and their proximity to the PWLS edge: near (<1 km), medium (1–2 km) and far (> 2 km). Considering the representation of diverse (in terms of mother tongue, religion and ethnicity) ethnic groups in the population, the respondents were selected based on purposive sampling. The sample size represented the ethnic groups disproportionately because the objective is to interpret a collective perception and not to gauge the variation in perception among ethnicities. So, we determined the community as a single entity. The sample size of 180 respondents represented 20% of households in each study village (Table 1). All respondents are above 18 years.

2.2. Data collection and analysis

The study adopted Concurrent Triangulation Design Model (hereafter CTD) as a systematic framework for approaching mixed methods design. Here qualitative and quantitative strands are mixed concurrently in three possible interface points as data collection, data analysis, and interpretation (Creswell, 2003). The word “triangulation” is used since two or more methods used to cross-validate, corroborate, or merge findings within the study. We merged the two sets of data (numerical and texts) during the interpretation and discussion phase

using basic arithmetical functions in MS Excel and manually coding qualitative data. Similar to the livestock and crop depredation study at Bhadra Tiger Reserve in Southern India by Madhusudan (2003), the current study used the survey method to conduct face-to-face interviews using a semi-structured questionnaire comprising both open and close-ended questions. It allowed all respondents to fully explore perceptions, attitude, and relationship with rhino. Field observation was done to substantiate respondents’ responses to the people-rhino-PA interface. This observation was done in the early morning and evening because, from the author’s personal observation prior to data collection phase, during this time, the visibility of rhino from human-dominated areas is clearer. Therefore, these particular time of the day makes local people consciously stroll on the street to enjoy the scenic beauty of PWLS and rhinos grazing. In addition to observation, Fentaw and Duba (2017) supported the study on HWC among pastoral communities in Ethiopia through Key informant (hereafter KI) interviews. KI interviews were administered with open-ended questions. We strategically selected KIs with a depth of knowledge about a specific topic. E.g., a forest department staff who is a fringe dweller of PWLS has many years of experience in dealing with HRI, 40th traditional king of Mayong (PWLS is located in the Mayong revenue circle of Morigaon District in Assam) who is well versed with the history and origin of PWLS, owner of a local resort famously known for rendering voluntary services to the forest department during floods and a higher secondary level school teacher in Mayong who takes a deep interest in issues related to wildlife conservation.

There were close-ended questions that had numerical answers (e.g., comparative rank ordering), and others produced binary responses. Even in close-ended questions, we needed qualitative data analysis to understand the comments respondents left alongside binary/numerical responses. We noted these comments as field notes and transcribed them into the textual data. We then manually coded qualitative data to find significant themes. Most of the analysis was done through deductive coding, where we started with a pre-defined set of codes. E.g., Space, Conflict, Tolerance, Perception, etc. Open ended question on the evolution of attitude towards rhino was analyzed using inductive coding where codes arose directly from survey responses, e.g., Religion, God, etc. In both cases, we have done narrative and thematic analysis. The narrative analysis for KI’s data and transcribed textual data consisted of three processes basically; (1) obtaining a general sense of the information (2) creating categories. For e.g., KIs commented on situation during flood, history of the existence of rhino and dynamics of HRI (3) interpreting the data and fitting their quotes into the relevant section.

Some striking and relevant statements across the interviews were interpreted as quotes in the final text. We did not seek permission for recording the interview using voice recorder technology. We obtained verbal informed consent from each respondent only after explaining the research objectives and assuring that information would be used only for research, and data presentation in aggregate analyses, protecting each participant’s identity.

We evaluated the general socio-economic context of the respondents by asking about their age, gender, level of education, source of income, and land use pattern. The survey instrument evaluated three distinct aspects related to interaction with rhinos (Table 2): (1) Space of encounter with rhinos (2) Perception based on rhinos-land-livestock

Table 1 Villages-wise population and sample size.

S.no	Village	Approximate distance from PWLS edge	Communities*	Total household	Surveyed household
1	Hatigarh Kusiani	<1 km	Bengali-speaking Muslim, Assamese-speaking Hindu, Kachari	79	16
2	Hatimuria	1–2 km	Assamese-speaking Hindu	130	26
3	Burhamayong	>2 km	Karbi, Bengali-speaking Hindu, Koch	150	30
4	Kamarpur	<1 km	Bengali-speaking Hindu, Koch, Kalita	235	47
5	Nekerahabi	1–2 km	Bengali-speaking Muslim	303	61

*Communities are listed (termed) as per mentioned in the village headman’s document.

Table 2
Questions for evaluating perceptions based on HRI.

Human-rhino interface	Aspects evaluated	Questions
Space of encounter between human and rhino	Location where rhino is mostly sighted outside PA Season when rhino is mostly sighted outside PA Time when rhino is mostly sighted outside PA Dynamics of HRI during the flood?	Where have you sighted rhino? The names of the most commonly sighted locations were given as options: agriculture field, residence compound, water body, common area (e.g., street, open fields, etc.) During which season do you sight rhino: Winter (December–February), Pre-monsoon (March–May), Monsoon (June–September), and Retreating-monsoon (October–November)? During which time rhino is mostly sighted (early morning, noon, afternoon, evening, night)? How is the situation of HRI different during flood?
Perception of rhino-land-livestock interaction	Acceptability and un-acceptability of occurrence of competition for space and resources between rhino- livestock and rhino-human	Do you agree/disagree/uncertain about the following type of interaction? We then reclassified the answers into five more different categories: <ul style="list-style-type: none"> • Rhino and livestock compete over forage • Rhino avoids area where livestock grazes • Agriculture reduces place rhino uses for shelter • Rhino destroys crop • Rhino transmits disease to the livestock
Negative interaction with rhino	Propensity of developing hostile attitude towards rhino gauged by assigning ranks to pre-determined six types of HRC	Out of six attributes, what rank do you assign to crop depredation? Simultaneously, we asked to rank five more attributes: <ul style="list-style-type: none"> • Rhino scaring people while working in crop field • Rhino attacking livestock • Rhino disturbs and scare people during night • Rhino attacking local people • Rhino transmitting disease to livestock
Views on problem animal Conservation of rhino	Assigning connotation as a problem animal Opinion on the increase in rhino population	Do you perceive Asiatic water buffalo and wild pigs as problem animal? If yes, why? Do you think a dramatic increase in the rhino population is viable for PWLS?

interaction (3) Propensity of developing HRC. These parameters were influenced by Kaltenborn et al. (2003) study on HWI around Serengeti National Park, Tanzania. As mentioned in Chawla and Sondhi (2011), we used comparative scaling techniques such as rank order scaling to identify the propensity of tolerance toward HRC. We have classified the rank into two categories, the meaning of each rank has been explained prior to the respondent. We asked the respondents to rank the most perceived severe problem (attribute) with rhino as 1st. Here, in category one (Rank 1st to 3rd) - depicts repeated occurrence of the event has high propensity to induce hostile attitude towards rhino. The intensity of hostile attitude decreases with each rank. Therefore, the second category of rank (4th to 6th) means the occurrence of this event will bring fewer hostile feelings. Instead, the community has learned to cope with these problems. An attribute with 6th rank is a least severe problem to evoke a hostile attitude. The lowest and highest rank depends on the number of attributes. We calculated the rank score for each attribute in the following manner:

$$\begin{aligned} \text{E.g. : Cropdepredation : } & (\text{no.ofrespondents} * 1^{\text{st}}\text{rank}) \\ & + (\text{no.ofrespondents} * 2^{\text{nd}}\text{rank}) \dots \\ & + (\text{no.ofrespondents} * 6^{\text{th}}\text{rank}) = \text{rankscore} \end{aligned}$$

To calculate the summary rank ordering, the attribute with the highest rank score, is assigned the lowest rank (6th), and attribute with lowest rank score is assigned highest rank (1st), which can evoke hostile attitude if it occurs repeatedly.

To trace the roots of perception towards rhino in the backdrop of a person's "views of nature", we asked two close-ended questions having two response options as Agree and Disagree: "Do you think that natural resources are finite and should be judiciously utilized and preserved?" and "Do you think all living organisms (flora and fauna) should be given their own space and freedom to exist independently?". These two questions are necessary to understand local people's viewpoint on protecting PA resources, habitat, and corridor of wild animals that will directly impact the rhinos' survival. Similarly, close-ended questions were framed for understanding people's interaction with PWLS, the prime habitat

of rhino: "Do you receive ecosystem services from PWLS?"; we then reclassified the answers into six categories "livestock grazing", "firewood", "NTFP", "fish", "regulating and provisioning services" and "status of the local market". These six categories were answered through binary responses, "Yes and No" with a scope of providing qualitative remarks. The importance of protecting rhino was assessed by asking a close-ended question: "Is rhino a vulnerable species?". To explore the cultural sanctions towards rhino we posed two open-ended questions: "How do you describe rhino's existence attached to religion?" and "How do you trace rhino's presence in culture and folklore?". Very generic questions were asked to KI such as, "Narrate the evolution of current attitude towards the rhino", and "How do you describe the presence of rhino and human in such a proximity?".

3. Results

3.1. Demographic details of respondents (n = 180)

The fringe communities are primarily dependent on an agriculture-based economy. The respondent's age ranges from 20 to 95. Male respondents constitute 51%, and females as 49%. Most respondents (58%) have attained elementary education (Grade I to VIII), and 12% have not acquired formal education. Less than 25% of respondents have attained secondary to higher secondary education (Grade IX to XII), graduation, and post-graduation. The average annual family income is $\$1652.96 \pm \268.54 . Land use consists of cash crop cultivation (average land size ranges from 0.26 to 0.53 hectares), kitchen gardening, fishery, shelter for domestic livestock, and residential area. Paddy is the main cash crop and also their staple food. Most households (82%) grow solely winter paddy along with monsoon paddy (4%) and occasionally mustard greens and black gram. The study followed Borthakur (1986) in describing the seasons as winter from December–February, pre-monsoon from March to May, monsoon from June to September, and retreating-monsoon from October to November. Only 8% of the respondents cultivate all these types of crops.

3.2. Ecosystem services and PWLS

Most respondents (93%) depend on PWLS and its borderlands for grazing livestock. Regarding the cooking arrangement, the majority of respondents, i.e., 67%, solely depend on firewood; the rest use liquefied petroleum gas and firewood as cooking energy. Provisioning services like the collection of NTFP vary along with the distance from the sanctuary. All respondents (100%) from Burha Mayong and Nekearahabi are found to collect more variety of NTFPs such as *Colocasia esculenta*, *Ziziphus jujube*, *Tamarindus indica*, *Terminalia chebula*, *Saccharum spontaneum*, *Diplazium esculentum*, *Ipomea reptans*, and other locally available resources. According to respondents, the practice of extracting traditional house construction materials that are also meant to be natural fodder for rhino like *Arundo donax*, *Phramites karka*, *Saccharum ravennae* and *Vetiveria zizanioides* has reduced tremendously (also during personal field observation no such extraction was recorded).

Fishing is prevalent (in ponds like Bengdubi, Goranga, and Kanjuli) for self-subsistence. All respondents (100%) acknowledge receiving regulating and provisioning services like a pleasant environment, less warm and humid summer, and fresh air to inhale. Significantly, 90% of respondents opine the up-gradation of the local market due to the incoming of tourists.

3.3. Identifying the 'Space' of encounter with rhino

All respondents (100%) had encountered rhino outside the PWLS. The study showed that 97% of respondents had sighted rhinos in the agricultural field. The seasonal crop calendar shows that from December to June, human-dominated landscapes are filled with crops in their sowing, transplanting, and harvesting stage. It is mainly during this period when rhino strays out from PWLS in search of food. A popular saying prevails in the villages, and we quote in the words of a KI, "A rhino can only satisfy its appetite when it eats crops from seven paddy fields in one single night". Sighting happens in the early morning between 4 am-6 am and night time after 7:30 pm. According to a resident of Hatigarh Kusiani, rhino chooses these 'particular' times to avoid the human rush of the day. After the night-long incursion into the paddy fields, it starts its returning journey at around 4 am. Seedling of the winter paddy and mustard greens are recorded to be the most preferred crop of the rhinos followed by black gram which is only recorded to cultivate in Hatimuria. The rhino is also sighted in the front yard and backyard of the house. Most respondents i.e., 41%, have sighted rhinos during the winter season, 10% in the monsoon season, and 13% in the summer or pre-monsoon season. Occurring twice a month, this 64% of respondents see rhino in the residential compound during evening and night.

Kitchen Garden is a part of a residential compound, which means it is a very personal space. The attention-grabbing finding is that rhino was found to be strolling in the kitchen garden to consume tender parts of specific plants like ridge gourd, sponge gourd, tomato, eggplant, betel leaf, sugar cane, and jujube. Despite this intrusion, respondents showed no negative behaviour. The respondents have deliberately interpreted that rhino indicates its presence beforehand and never enters forcefully. According to a respondent of Burha Mayong, "A rhino never enters a residence compound without giving some sort of signal. Either it will make some peculiar sound or bang on the boundary wall (made of bamboo). Meanwhile, if someone chases the rhino away, it never enters forcefully". Mostly during February and March, 49% of the respondents sighted rhino wallowing in several water bodies. According to 66% of people of Nekearahabi, Haahsora pond is the hotspot for a rhino to wallow all-round the year. A respondent from the same village narrates the sighting experience, "It is a refreshing moment for us to see a rhino wallowing in the muddy areas. Rhino has never bothered us; rather, it remains busy in preventing its body from several pests". Less than half of respondents, i.e., 38%, have sighted rhino in the public street and open fields. The people of Hatigarh Kusiani have the highest encounter on the road that bypasses the Pokoria pond and PWLS. According to the community, sighting mainly occurs

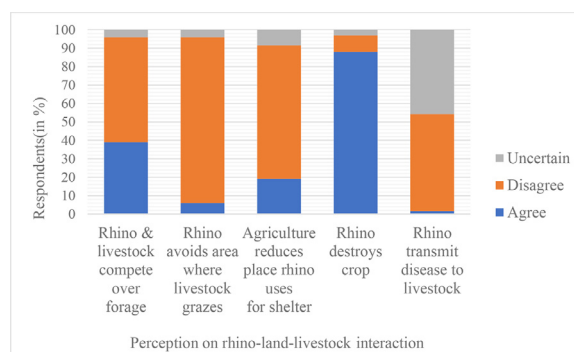


Fig. 2. Perception of rhino-land-livestock interaction.

in the winter season when the rhino is on its way to crop fields during the evening time. Despite Burha Mayong being a remote village from the PWLS (>2km), 77% of the respondents have sighted it. According a respondent from the same village, "A rhino comes so far because it loves to explore and eat a variety of crops grown in Burha Mayong". However, 17% of the respondents opine that rhino sighting in these above spaces has decreased in the last 5-10 years.

Illumination of streets, increase in household population, construction of concrete bridges at Kamarpur and Bordia, and renovation of roads with increased heights prevent the rhino movement outside PWLS. It is also an outcome of increased guard platforms on the paddy fields and the forest department's enhancement of strict vigilance and patrolling. Most respondents opined that a decrease in the sighting of rhino in human-dominated areas is a positive change. A KI confidently quotes, "Not every passer-by is a local villager who will not harm the stray rhino, and so the forest department does a good job by sending the rhinos back to PWLS".

3.4. Perception based on rhino-land-livestock interaction

The Fig. 2 shows the community's perception based on the visual, tactile, verbal, and auditory contact with the rhino in the form of agreement and disagreement.

3.4.1. Rhino and livestock compete over forage

Many respondents (57%) do not think that rhino and livestock compete over forage. Their justification to this denial is that neither rhino population has ceased to increase even in this small area of PWLS due to lack of fodder nor any case has been recorded where any rhino died out of starvation. Hence, the respondents could not record any indication of fodder competition. As quoted by a respondent of Nekearahabi, "If the grass would have diminished then either rhino would have disappeared long back, or you could see a lean and thin rhino, which is not seen in PWLS".

3.4.2. Rhino avoids area where livestock grazes

Though 90% of the respondents are aware that rhino and cattle graze together inside PWLS, less than 2% of respondents agree on the possibility of disease transfer between the two different species (Fig. 2). Most respondents are either uncertain (46%) or disagree (53%) because cattle are vaccinated after a certain period, and there is no particular case of disease outbreak.

Majority of the respondents (72%) opined that there could never be a lack of space for the rhino because a rhino has expanded its habitat (which includes the areas discussed in Section 3.3.). A small portion of respondents, i.e., 19%, believed that land-use activities have increased, turning the PA borderlands into agriculture or roads. Nevertheless, at the same time, 72% of people feel that the expansion of human activities like agriculture, concrete roads, and regulated tourism are necessary for a better standard of living.

Table 3
Comparative rank ordering.

Attribute	Rank						Rank score#
	1 st	2 nd	3 rd	4 th	5 th	6 th	
Crop depredation	5*1	1*2	31*3	44*4	92*5	7*6	778(6th)
Scares people in crop field	4*1	33*2	74*3	40*4	20*5	9*6	606(4th)
Attacked livestock	5*1	125*2	37*3	10*4	3*5	0*6	421(2nd)
Disturb and scares people during night	5*1	66*2	67*3	35*4	4*5	3*6	516(3rd)
Attacked local people	172*1	5*2	2*3	1*4	0*5	0*6	192 (1st)
Transmit disease to livestock	7*1	3*2	74*3	55*4	36*5	5*6	665(5th)

As explained in Section 2.2., the attribute with the highest rank score is assigned the lowest rank (i.e., 6th), and the attribute with the lowest rank score is given the highest rank (i.e., 1st).

3.4.3. Rhino destroys crops

Majority of the respondents (88 %) accepted that rhino destroys their crops. An average of 0.13 hectares is being depredated in a year by rhino and other animals like Asiatic water buffalo (*Bubalus arnee*) and wild pig (*Sus scrofa*). An approximate economic loss of a minimum of \$38.4 has been recorded from crop depredation. Since most above-mentioned respondents grow paddy, they have calculated the monetary loss based on the cost incurred to cultivate paddy in 0.13 hectares. If the yield is good, then generally, nine quintal paddy is produced from 0.13 hectares (the price of one quintal paddy is \$11.5). The respondents have calculated the minimum price of each material since it is subject to change. Therefore, nine quintal paddy fetches an amount of \$115.3. The investment cost in 0.13 hectares is \$76.8, 4.6% of the average annual family income. It includes mechanical ploughing: \$12.7, 10kg seedling and labor charge of transplantation of seedlings: \$10.2, manure: \$6.3, pesticide: \$5.1, labor charge for harvesting: \$11.4, water: \$15.3, harvest with thresher machine: \$7.6 and drying of rice and transportation to selling place: \$6.3. Hence, every year, crop depredation of 0.13 hectares debar the local people from contributing an additional 2.3% to their annual family income by curbing the profit of \$38.4.

3.5. Propensity of tolerating negative HRI

Most respondents (70%) accept that they face specific problems with the rhino. Compared across the 180 respondents facing negative HRI in five study villages, respondents from Nekerahabi are the highest (84%) to have reported such incidences. This is regarding livestock depredation, crop loss, and scaring people at night and while working in crop fields (Table 3). The village is adjacent to the PA, or we can say that a part of Nekerahabi even has its front yard as PWLS. Using rank order scaling technique mentioned in Chawla and Sondhi (2011) (detailed explanation in Section 2.2.), we have gauged the propensity of tolerating HRC.

3.5.1. Attacked local people

There has been only one rhino-induced human death among the five study villages. However, 99% of respondents opine repeated occurrence (3-5 annual deaths) will have the highest propensity to inculcate a hostile feeling towards the rhino. Community repercussions might include lethal measures like throwing fireballs, trapping the animal, carrying harmful equipment while working in the paddy fields, or strolling at night. Nevertheless, if we talk about the present scenario, a person whose significant family member was killed by the rhino in the 1970's quotes, "None can be blamed, both my family member and the rhino had unexpected encounter; while my family member was working in the agricultural field. It ended up in a panic situation whereby maybe both of them felt intimidated, and rhino was bound to attack as a defense mechanism. However, otherwise, rhino has always been a harmless animal".

3.5.2. Attacked livestock

There is no instance of cattle death/attack induced by rhino yet in the study villages. The majority of respondents, i.e., 93%, argue that

if it starts occurring at a regular interval (every month), their lenient attitude towards the rhino might change since livestock is their primary asset.

3.5.3. Disturb and scares people during the night

With only 15% of respondents experiencing this phenomenon, it has been ranked in the 3rd position, which means that its visible occurrence will trigger intolerance. A respondent from Hatigarh Kusiani quotes, "Many a time we encounter rhino in the evening while we are riding our cycles. But it has never attacked us. It is a divine animal that can read our intention. It is always advisable to leave one way open for the rhino to move out. Surrounding from all the sides is not an intelligent option".

3.5.4. Scares people in crop field

A significant percentage of respondents, i.e., 84%, have not experienced getting scared by rhino in the agricultural field. A respondent of Hatigarh Kusiani, who has shared this situation quotes, "A rhino never comes in the paddy field intending to disturb or harm people. Having a strong-smelling sense, it arrives whereby it gets the smell of its preferred crops. It was December (2015), when I was in the field and a rhino suddenly appeared at a close range. So, I climbed the nearest tree".

3.5.5. Transmit disease to livestock

To date, there has been no recorded livestock death in PWLS due to disease transmitted from the rhino. The community is quite reluctant to assume it in terms of the problem.

3.5.6. Crop depredation

Even though 88% (see Section 3.4.3.) of people have adhered that rhino is damaging their crop, they have considered it the slightest problem with high tolerance. The local communities consider it a good sign when rhino eats the ripe winter paddy's upper portion during the harvest. It indicates that the growth will be more luxurious in the next year. However, if the rhino walks over the paddy seedling, it leads to a huge loss since the heavy footsteps of the rhino squash/suppress growth in that particular patch. Again, some also believe that the seedling eaten by the rhino grows well in its matured stage. As quoted by a respondent from Hatigarh Kusiani, "Rhino never comes intending to ravage the crops. It is the heavy footsteps of the rhino that destroys it. Though rhino comes to eat a lot many crops but gets satisfied with the minimum". Only 4% of the respondents are found to be using robust fencing (with concrete materials like cement or barbed wire) because it requires a considerable amount of money. Crop guarding platforms, scarecrows, and acoustic deterrents (drumming empty metal containers) made from local materials are widely used by 87% of respondents as a coping and adapting measure. Also, 79% of respondents choose to inform the forest department. However, none was found to be using lethal measures except in an extreme situation where the herd of Asiatic water buffalo or any rhino portrays unruly behaviour. Then, in such cases, they pelt stones and use fire torches. According to the community, the forest department

should devise a robust compensation mechanism for crop loss. It is interesting to note here that despite crop depredation not being perceived as a significant problem by the community, the demand for compensation mechanism adheres to continue tolerance towards rhino and other wild animals. A quote by a respondent from Nekeerahabi supports this argument: “*Crop damage is a common phenomenon. Our forefathers and today we, are accepting this as costs of living near a PA. This is because, at the same time we believe that animals do not know to differentiate between boundaries. We cannot deny that future is unseen and human behaviour gets easily triggered. The way we have assigned rhino with cultural and religious connotations, our future generation might not. Therefore, devising compensation packages is both a pro-and re-active measure to maintain tolerance towards animals*”.

3.6. Interaction during flood

Rhino has been sighted in Burha Mayong, taking shelter in the foothills of the hillock. A respondent hailing from Burha Mayong recalls an incident in the 1960s where they offered milk to a lone rhino calf submerging in the water. Immediately they informed the forest department. KIs from the forest department and local resorts validated the above discussion. They mentioned local youths rendering voluntary services during the flood time by extending helping hands in constructing a few highlands for the wildlife, gathering grasses for rhino inside PWLS, and aiding the forest guards on duty.

3.6.1. Evolution and sustaining of attitude towards rhino and other wildlife

To understand the community’s perception of rhino, exploring their “views of nature” is necessary. More than 50% of the respondents agree that natural resources are finite and should be judiciously utilized and preserved. A significant percentage of respondents (97%) adhere to the fact that inhabitants of nature: plants and animals, should be given their own space and freedom to exist independently. The congruence is established by a resident of Burha Mayong who quotes, “*For protecting the rhino, we should consider protecting its habitat that contains its food and corridors*”. Along a line, two respondents from the same village suggested that the government should use a “helicopter” to sprinkle black gram seeds in the boundary of PWLS. So that the Rhino can satisfy its appetite by staying inside its home range, reducing threats of poaching and annual crop loss.

All the respondents want rhino to be conserved for the future generation, but 60% of them consider that a dramatic replete in rhino population is problematic considering the disproportionate land-rhino ratio. This would instead create chaos and conflict since both species will not be able to accommodate each other in terms of space. A respondent from Hatigarh Kusiani states that, “*Human behaviour is always subjected to change. Our respect and love towards rhino are indeed unparallel with any other, animal but that does not mean that we will want the rhino population to exceed the natural capacity of PWLS. Over-increasing rhino population will bring frequent encounters and instances of competition for food and space. This might not be accepted wholeheartedly by every individual*”.

A significant portion of respondents, i.e., 46%, perceive Asiatic water buffalo as a ‘problem animal’, and 10% identified the wild pig as one. According to the community, these two animals show no mercy while raiding crops. The buffalo eats the crops from its root, while the wild pig uproots the entire plant, thus leaving no scope for regeneration. The justification for this upheaval result of only 3% of respondents considering rhino as a ‘Problem Animal’ despite annual crop damage is rooted in a cultural and religious context. The local people light earthen lamps with clarified butter and incense stick in the twilight and bows seven times before the rhino’s footsteps in the crop field. According to a respondent of Hatigarh Kusiani, “*Rhino is a considerate animal. It accepts genuine prayer and the same rhino will never raid the same patch of land. It is a sensitive and intelligent being; if you scold rhino, it will never listen to*

your request and might again damage the crops”. The community also considers rhino a predictable animal, unlike buffalo, pigs and snakes who has a history of chasing/attacking people without any provocation.

3.6.2. Rhino horn and Hindu deity

There is a widespread belief among the local people that the rhino was a vehicle of Lord Krishna. Once Lord Krishna was busy with some work and his vehicle (rhino) behaved disobediently by wallowing in the mud. Lord Krishna called the rhino several times to be in his designated position. Still, to the denial, Lord Krishna got infuriated that he threw his footwear (*Xorom* in local Assamese language) on the frontal view of the rhino. Hence, local people believe that the footwear of Lord Krishna which got attached as a horn on the rhino.

Again, in the local Assamese language, the community refers horn of any animal as ‘*Xing*’. It is only the horn of the rhino that is called “*Khorgo*”. A respondent from Kamarpur quotes, “*Khorgo is the same word which is also used for the ‘weapon’ that we see in the hand of Hindu Goddess Maa Durga*”. In Hindu mythology, just as Maa Durga uses her ‘*khorgo*’ to kill evil people, similarly a rhino will only use its ‘*khorgo*’ to attack the disturbing ones”. This narrative indicates that community has sanctioned a religious connotation to rhino which is not equated to any other animal with “horn” or “antler”.

This community belief can also be linked to fewer poaching cases in PWLS, unlike other rhino-bearing areas in Assam and Africa. In PWLS, the last reported case was in 2014 ([Sentinel Digital Desk, 2022](#)). Be it the poaching of rhino for its horn occurs inside the PA or outside the PA, a poacher has to come across civil areas. The low number of poaching cases in PWLS is also one of the effects of this culturally rooted positive perception and alertness of local communities.

3.6.3. Rhino skin

The community believes the layered skin on the rhino is due to the amalgamation of various animal flesh like deer, elephants, lions and tigers. According to one of the KIs, God created rhino at the end of the creation of all animals. The narrative itself places rhino in a unique and special position outstanding other wild animals by orating that rhino carries the accumulated strength and vigour of all animals.

3.7. Role and utility of the rhino

The community considers rhino part of their identity, culture, and environment. A respondent from Hatigarh Kusiani states, “*Rhino is an intangible property that has been given to us by our forefathers. We feel rhino to be a part of our tradition and lifestyle. There is no difference between a cow and a rhino except for the former remaining in a cowshed at home and rhino in a forest*”. A respondent from Burha Mayong mockingly calls their three-year-old niece a ‘*Goror puwali*’ (local Assamese term for rhino calf) for bearing a plump figure like a rhino calf. Also, a person who eats and sleeps too much is called a rhino in her village. Some of these popular narratives related to rhino find their place in day to day lives of the people. From the ecosystem services and well-being perspective, the rhino provides the villagers with recreational services. Most respondents opined that it is a relaxing moment in the evening hours to stand near the Garanga pond (en route Kamarpur) and enjoy several rhino grazing. This way, it is also like a community monitoring mechanism to check on the healthy presence of rhinos and, simultaneously, appease the local people’s eyes. A respondent from Kamarpur quotes, “*After remaining busy in the household chores for the entire day, strolling with neighbours and watching the rhinos grazing give an unexplainable peace of mind*” (a similar expression was recorded as direct field observation in late afternoon hours).

It is a positive sign that 65% of respondents know that the Indian rhino is a vulnerable species. They are also aware that Assam has the strongest hold on the greater one-horned rhino and that it is the state animal of Assam. This in-depth knowledge is also an impetus for the community to preserve this megaherbivore as a future resource of the

PWLS. To believe that the community has a deep attachment with the rhinos, the rhino translocation process under Indian Rhino Vision 2020 is a testimony. Two rhinos were translocated from PWLS to Manas National Park, Assam, India. Mainly it was the youths who got saddened and irked because they consider these rhinos to be a part of their identity. They opined that the government should have consulted with the local villagers. A youth from Hatigarh Kusiani quotes, “*Rhino is a faunal species belonging to the dinosaurs’ times (Jurassic times), the existence of which will always continue to inspire and amaze all of us*”. Henceforth, the community’s collective consciousness creates a positive relationship with the rhinos.

4. Discussion

In the current study, fringe villagers surrounding the PWLS have experienced rhino visits at least once in their lifetime. Madden (2004) rightly pointed out that wherever humans and wildlife have known to have existed within the same area, ‘competition’ and ‘conflict’ for ‘space and resources’ will be common. The findings recorded rhino to be involved in crop depredation. Now, it is unlikely that conflict can ever be eradicated; but as Dickman (2010) states it is necessary to understand the risk, as well as the reactions to it, since they are heavily influenced by socio-cultural perceptions. Interestingly even though agriculture is the main source of livelihood and 88% have accepted that rhino destroys their crops, only 3% perceive it as a problem animal. It is a term which is used ‘negatively’ when the intrusion of the animal in the human property is not liked and where an ad-hoc response might shape the situation antagonistically. Defying Dickman (2010) statement on higher resentment towards the wildlife when imposed by the state, our study recorded that rhino though is a wild animal meant to reside within the boundaries of a government notified PA, it does not fall under the same scanner of resentment despite the conflict. Though rhino is not a domestic animal, the community shares a certain emotion of belongingness and attachment with its whole existence. The current study states that rhino is ‘habituated’ to the human settlement and vice versa. Rhino strolling in public streets and common areas in the evening and leaving as a response to several locally made acoustic deterrents (as mentioned in Sections 3.3 and 3.5.6.) and people’s awareness of time and areas of rhino movement and negligible cases of human causality is a testimony to it.

One of this study’s primary implications is a contribution to the knowledge base of the human-wildlife interface. Despite the conflict elements discussed above, local people’s culturally rooted perception, values, ideology, and particularly “views of nature” have created co-existence between wild and anthropogenic space. **The community has put an inherent value to not only rhino but also to buffalo and wild pig. Despite the crop depredation and fear from animal attack, the study recorded no hostile action towards the wild animals. Showing inclination towards biocentric approach, the community has understood that proximity with PWLS will naturally expose them to share space and resources with wild animals.** As today there are multi-stakeholders planning and intervention to conserve the rhino, this people-centric ethos will build on further studies in conservation science. Indeed, the way people have accepted rhino’s presence is not from a modern science perspective in specific ways. Firstly, there is a belief that the crop raided by the rhino will grow luxurious in the following year. This can be understood from a different prism of analysis where the association of rhinos being in the muddy (crop) fields has been linked with Hindu Lord Krishna, and this connection has given them a perception of the rhinos as a ‘religious’ approach. Though this linkage has not been explained in any scriptures or folklore, subconsciously this is the story of the community today. Secondly, rhino’s intrusion in the kitchen garden is also gauged through a moderate lens where the rhino trespassing the boundary wall is seen as seeking permission. In a study in the Jalpaiguri district of West Bengal in India, Kshetry et al. (2021) recorded a similar role of cultural reverence and deep religious belief toward ele-

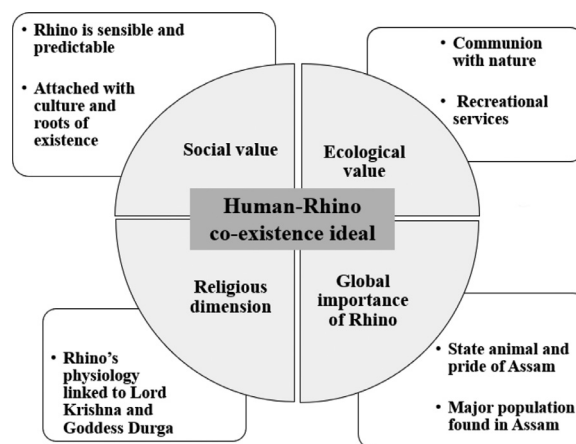


Fig. 3. Human-Rhino ‘Co-existence Ideal’ around PWLS.

phants in enabling the acceptance of crop losses. The community believes the elephant is the protector of the forest and everything within it. It is revered as *Mahakal* (*Maha*: great, *kal*: doom) in the local language and thus, not worshipping this elephant god will bring forth great doom. The community opines not claiming financial compensation for a crop loss by *Mahakal* would come out as a reward in the form of an increase in crop yield. This multifaceted belief could be one of many local socio-economic factors that can be considered when designing HWC management plans (including ex-gratia schemes) to gather conservation support for damage-causing animals.

It is important to mention that the community has ranked ‘Rhino attacking villagers’ in the 1st place in terms of propensity to develop a hostile attitude (as mentioned in Table 3). On this basis, our findings do not conform to Sodhi and Ehrlich (2010). When it comes to giving connotations to a certain thing, people construct meaning based on their own experiences. However, in the current study, though only one person has experienced rhino-induced death, the community will not justify it anyway when the question of human life comes into play. This indicates that in the future, strategic training and awareness campaigns will be necessary on dos and don’ts near PWLS edge, corridors, and crop fields during specific rhino movement time. As shown in Section 3.2., NTFP collection in the form of firewood from PWLS and its borderlands is still prevalent. To avert any sudden negative HRI during resource collection, energy efficient and cost-effective alternative cooking medium can be devised. Again, in light of ‘Rhino harming/attacking/killing cattle’ it would trigger negative perception towards the rhinos. However, the community does not perceive any threat or competition from rhino, which is why they allow livestock to graze. To maintain this positive HRI, techniques like stall feeding or regulated grazing need to be implemented in the future.

The community has not assigned higher value to buffalo and wild pigs than rhino. They opine that these animals tend to chase and attack people and damage the crop much ruder manner. It is true Dickman (2010) have noted that all wildlife species possess values assigned by society. Likewise, the response to conflict also depends on the animal’s roles in folklore. The below Fig. 3 results as a culmination of the four determining factors to the current type of positive HRI in Pobitora Landscape. It is open to further research and contestation, considering the fast rate of globalization, the present covid era where human, social and financial capital might be at stake, and other inevitable societal changes.

However, the community does not treat rhino as a deity, unlike cows, snakes, and primates in India. Our study concurs with Marten (2001), who opines that co-adaptation between humans and environment is constantly evolving with a situation that various institutions support to make a rational choice. We noticed the percolation of positive

perception in both the micro-level institution (family) to macro institution (political, economic, and cultural). The central and state government and the general public of Assam have played a significant role in spreading awareness and penetrating the importance of rhino in social spheres. Rhino has been put as the logo of the Assam State Transport Corporation, Mascot in the National Games (known as *Rongmon* in local Assamese language), held at the Indian city of Guwahati in 2007, and several state-level cultural events and other infrastructure manufacturing companies.

5. Conclusion

Owing to the large population of Indian rhinos in a small area of 38.81 km², it is common for them to stray outside PWLS in search of space and resources. Religious connotations and popular beliefs at different gradations allow the community not to imbibe hostility towards rhino even while raiding crops. **However, for the scientific community working on HWI, it will be interesting to see a systematic vigour in the claim that seedling eaten by the rhino grows well in its matured stage or ripen paddy consumed by rhino is an indicator that paddy will have luxurious growth in the following year.** Here, the pro-conservation attitude of local people determines their pro-conservation behaviour. As we conclude to define the prevailing HRI in the fringes of PWLS, our findings have confirmed the prevalence of HWC based on the economic and physiological impact on the community (see Sections 3.4.3. and 3.5.). Despite this, the community does not harbour negative perceptions. However, 'Direct threatening to Human *'life'* by rhino' has been identified as the key deterrent to this positive perception. The study suggests conservation-based awareness programs at both the school and village level, reduction of NTFP dependency, and regulated livestock grazing as critical precautionary interventions to maintain this positive HRI in the future.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper. Manisha Ashraf reports administrative support and writing assistance were provided by Tata Institute of Social Sciences - Guwahati Campus and WWF-India.

Data Availability

The data that has been used is confidential.

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