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# Human-Leopard (*Panthera pardus fusca*) Co-Existence in Jhalana Forest Reserve, India

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**Abstract:** The intensity and frequency of human-animal conflicts has escalated in recent decades due to the exponential increase in the human population over the past century and the subsequent encroachment of human activities on wilderness areas. Jhalana Forest Reserve (JFR) presents the characteristics of island biogeography in the heart of Jaipur, which is a city of 3.1 million people. The leopard (*Panthera pardus fusca*) is the top predator in this newly declared sanctuary of 29 km<sup>2</sup>. We surveyed people in the 18 villages that engulf this sanctuary. We questioned the villagers' (n = 480) perceptions about conservation. As much as 93% (round figure) of the population has encountered leopards, and 83% were fully aware of its role in the ecosystem. In addition, 100% stressed the necessity of conservation to save the forests and 91% supported the efforts to a wall in the reserve in order to prevent human encroachment. Most of the population is Jains and Gujars, which are communities that believe in non-violence. We conclude that the villagers support conservation efforts. The authorities that manage JFR view the villagers favorably and, as stakeholders, are the basis for continued human-leopard coexistence.

**Keywords:** attitude; coexistence; human-wildlife interaction; Jhalana forest reserve; leopard; *Panthera pardus fusca*

## 1. Introduction & Literature Review

Although top predators are very charismatic animals in human perspective [1], they can also be identified as pests or vermin. In the past century, carnivore populations have suffered habitat loss and fragmentation, and reduced prey availability, which has resulted in elevated rates of conflicts with humans [2]. The intensity and frequency of human-animal conflicts has escalated mainly due to the exponential increase in the human population over the past century and the subsequent encroachment of human activities on wilderness areas [3–6].

Human-animal conflict is considered to have a social dimension and reflected conceptions of boundary crossing and human-animal conflict is often described in utilitarian or anthropocentric terms [7]. Others considered such conflicts to be the result of socio-economic and political landscapes, which have emerged because of competition for limited resources [8]. Humans and carnivores have similar needs i.e., protein-rich diet and large home ranges, drawing them into competition, which eventually leads to conflicts [2,9]. Additionally, since large predators require large areas with natural prey communities, they are prone to killing domestic livestock (Woodroffe 2000), which causes humans to retaliate in human-animal conflict [10].

Leopards (*Panthera pardus*) are the most widespread felid worldwide and are able to persist in a diverse range of habitats [11]. Their range is widely spread from Africa, across the Middle East to south-east Asia and Java, and northward to the Russian Far East [12]. They are found in a variety of habitats, from desert to high altitude mountains and rainforests [13]. However, over the past 100 years, it is estimated that the species has declined in its historical range due to habitat degradation and fragmentation, depletion of natural prey species, poorly managed harvests, illegal trade of leopard skins and bones, and human–leopard conflict [14–17]. Leopards are killed in the Limpopo Province (South Africa) because of the threats they pose to game and livestock [18]. In Blouberg, leopards accounted for 89% of the attacks on livestock [19] and 32% on game ranches in Botswana [20]. Similarly, habitat loss and conflict with humans threatens the similar-sized jaguar (*P. onca*) in Latin America [21]. However, predators are important because they are at the top of the food web and have a strong influence on ecosystem processes [22].

In India, the leopard (*P. pardus fusca*) is the most common carnivore involved in conflicts with humans [23]. Compared to other carnivores like the tiger (*P. tigris*) or the lion (*P. leo*), the leopard, due to its smaller body size, greater resilience, and adaptability, lives successfully in the proximity of humans [23,24]. People tolerate attacks on livestock to some extent, most likely due to the inherent attitude and religious beliefs [25], and compensation received from the Government in case of livestock depredation.

A major conservation concern in human-dominated landscapes worldwide is to facilitate human-carnivore co-existence [26–28]. During a systematic review of research trends of conflict between humans and big cats (*Panthera* spp.), data gaps were found in the socio-cultural context for conflicts [29]. Others contended that one can gain useful insights by understanding the dynamics of human-carnivore coexistence in landscapes in which they have a mutual history for an extended period [30].

One of the strategies suggested that, to prevent decline in carnivore populations, encouraging human-carnivore coexistence through conflict mitigation programs may help [26,28]. By being adaptive and by learning from past successes, it is possible to minimize conflicts between humans and predators [31]. However, in general, and in India in particular, there are very few studies where authorities have attempted to understand the attitudes of populations living in the immediate vicinity of a top predator [32].

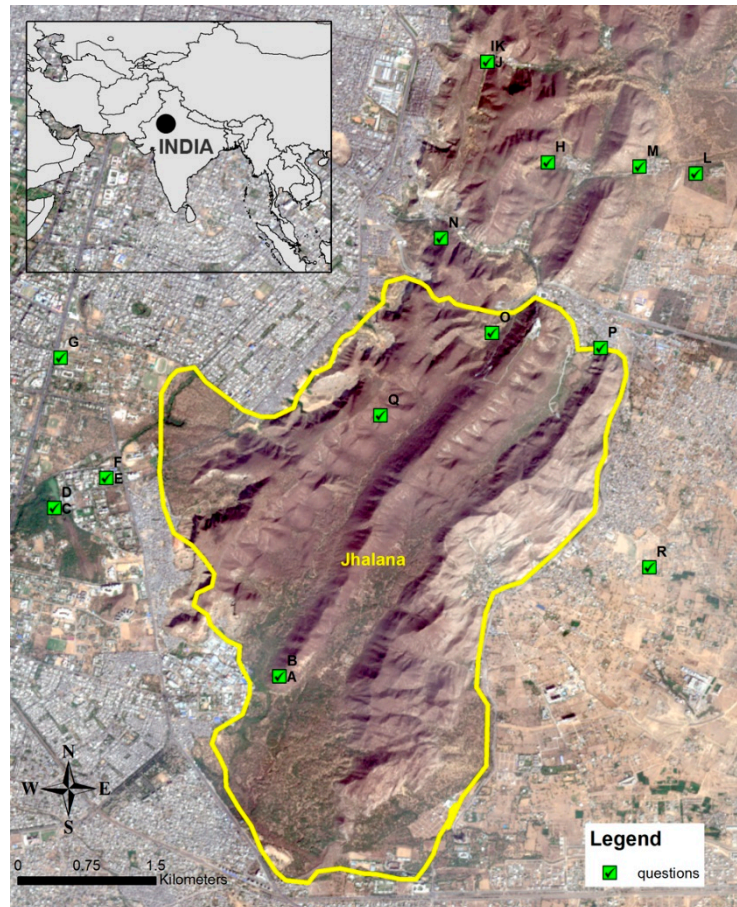
Considering the persistent human-leopard conflict in India, we questioned the attitudes of people who live in the immediate vicinity of a known leopard population. The study was conducted in and around the Jhalana Forest Reserve (JFR), which is a continuum of forest and human habitation, so the chances for encounters with leopards are exhausted. In addition, it is known that at least since the mid-18th century, a relatively large leopard population has coexisted with humans in the region. The human population around JFR has multiplied exponentially in the past few decades and urbanization has almost engulfed the entire reserve [33]. Considering the conclusions by researchers who have studied human tolerance toward predatory wildlife [34–38], we assumed that people would fear leopards [39].

### Research Question and Hypothesis

In order to understand the co-existence between leopards and humans we found at JFR, we questioned the reasons for its persistence and the related attitudes of the villagers and urban citizens who regularly came into contact with the leopards. We hypothesized that due to the relatively low level of education and poor financial status of the local residents, the responses would be of animosity and a negative attitude toward the conservation of this meso-predator. Our aim is to understand the local processes and to try and replicate this system of coexistence in other locations where there is human-wildlife conflict with leopards and other big cats.

## 2. Methods

We undertook a survey of 18 villages that surround the Jhalana Forest Reserve (JFR) to understand how encounters with leopards influence human attitudes (Figure 1).



**Figure 1.** Map of study area. The Jhalana Forest Reserve (JFR) border is delineated by the broad line, the locations of the villages sampled in the study are tick marked, and the city and human habitat that encircle JFR is evident outside the boundaries. Inset is a map of India showing the relative location of Jaipur.

### 2.1. Research Area

JFR was designated as a Reserved Forest on 21 November 1961 in accordance with the provisions of Rajasthan Forest Act 1953. However, only since it was declared a protected area in May 2017 was the villagers' access been greatly limited, especially for grazing livestock, and gathering firewood or fodder for cattle. During this period, access was not limited and locals have used it for parties and recreation purposes by the urban citizens, and for gathering grazing of livestock, fodder for cattle, and wood by the villagers.

JFR is situated on the southeastern borders of Jaipur, which is the capital of the state of Rajasthan, in North-west India. Its height from the Mean Sea Level is 516 m. It is categorized as a Northern Tropical Dry deciduous forest type, has a total area of 29 km<sup>2</sup>, and has no buffer or core areas. Tourists are allowed in jeep safaris on three routes in the reserve. The general slope of JFR and its surroundings is from North to South and then South to East. Nearly all the ephemeral streams flow southeast. Higher elevations in the North exist in the form of low, flat-topped hills and are deeply dissected and eroded.

The villagers are engaged in a variety of occupations such as construction laborers, painters, factory workers, safari guides, small restaurant and tea shop owners, and priests, while some are

students or housewives. Most of the population in the two villages of interest, Bhomiyaji and Kho Nagoriyan, are milkmen and herdsmen.

## 2.2. Data Collection

The questionnaire consisted of 10 questions (Table 1). Because of the inclusion of illiterate villagers in our study, the survey was constructed in a manner that required the participant to give clear answers. For these reasons, we preferred to offer them a choice of “Yes/No/No opinion” and, in this manner, prevented ambiguous answers.

**Table 1.** Questions related to encounters with leopards in the Jhalana Forest Reserve (India), posed to the villagers during the survey and their answers (n = 480).

ID Question	Question Description	Possible Answers			Rate Responses	Kruskall-Wallis	
		Yes	No	No Opinion		KW	p-Value
Q1	Are you aware of the leopards in the immediate vicinity?	480	0	0	100.00	1883.5	<2.2 x 10 <sup>-16</sup>
Q2	Have you ever encountered a leopard in real life? If so, what is the frequency?	446	34	0	100.00	1759.3	<2.2 x 10 <sup>-16</sup>
Q3	Do you know of a family member or fellow villager who has encountered a leopard? If so, to what frequency?	428	51	1	99.80	1699.3	<2.2 x 10 <sup>-16</sup>
Q4	Are you aware of property loss in a leopard(s) related incident? Any attack on humans or livestock?	363	116	1	99.80	1712.9	<2.2 x 10 <sup>-16</sup>
Q5	Have you suffered personal loss directly or indirectly related to a leopard(s)?	1	479	0	100.00	1877.6	<2.2 x 10 <sup>-16</sup>
Q6	Are you aware of any benefits from the continued existence of the leopard?	421	58	1	99.80	1679.5	<2.2 x 10 <sup>-16</sup>
Q7	Do you consider leopards essential in the evolving modern-day landscapes?	445	5	30	93.30	1754.7	<2.2 x 10 <sup>-16</sup>
Q8	Could you envision a future without leopards?	38	435	7	98.52	1721	<2.2 x 10 <sup>-16</sup>
Q9	Does the leopard play any role of importance in the environment?	417	1	62	85.17	1667.8	<2.2 x 10 <sup>-16</sup>
Q10	Do you see any importance in the effort to conserve the leopard and the forest it inhabits?	477	0	3	99.40	1871.7	<2.2 x 10 <sup>-16</sup>
First time	Unique experience with leopards	377	103	0	100.00	1565.4	<2.2 x 10 <sup>-16</sup>

We randomly sampled a minimum of 15 people in each of the 18 villages and neighborhoods. Each person was asked about what they thought on issues pertaining to the conservation of leopards in JFR, their day-to-day lives, and their opinions on the efforts taken by the forest department to conserve the habitat. Each person was required to give an affirmative or negative answer and to rank (from 1 to 5) how strongly they felt about the issue. All the surveys were conducted in his/her mother tongue: Marwadi/Hindi. We noted all additional comments, observations, and grievances if any comments were made by the participant. A team of five volunteers from local villages helped conduct the survey and communicated only in their local language [40]. The answers of each of the persons surveyed were written on a separate form. In rural India, this personal acquaintance and mutual trust is important since it encourages villagers to voice opinions frankly and without fear of their landowners or of political repercussions. The volunteers were born and brought up in the same villages and are well versed with human-leopard interactions since childhood. They could relate to the incidents and stories and their significance in rural life. They helped identify the truth in the information provided by the villagers. The authors and the volunteer team were welcomed at every village throughout the survey. All answers were translated into English and computerized.

## 2.3. Analyses

All analyses were performed using R software [41]. The relationship between the numbers of leopard encounters regarding distance from JFR to respondents' location was quantified by means of linear regression analysis (lm function). For graphic representation, we used a Pearson correlation test. In order to represent respondents' answers to the questionnaire (Table 1), we calculated the relative frequencies and percentages of answers using the function 'barplot' in R. The statistical significance



among the different type of answers ('yes,' 'no,' or 'no opinion') were determined by using the Kruskal Wallis chi squared test with the function 'kruskal.test' in R.

### 3. Results

The questionnaire of 10 questions (Table 1) with a choice of "Yes/No/No opinion" was answered by a minimum of 15 people in each of the 18 villages and neighborhoods.

After analyzing the answers, we consolidated the remarks of the villagers into six categories including five positive categories and one negative.

Positive:

1. Part of life for generations: All the participants were aware of the presence of leopards. It is common knowledge for them and their families who have lived with leopards for generations. The majority (93%,  $p < 0.05$ , Table 1) of the villagers had encountered a leopard at least once.
2. The leopard has a fundamental right to exist: Religious belief, principles of non-violence, living in harmony with nature, and respect for leopards have helped the species thrive despite growing urbanization and pressures on the leopard habitat.
3. No animosity: There have been no attacks on humans or any substantial loss of property because of leopards despite frequent encounters.
4. Commercial and environmental benefits: Most (87.5%,  $p < 0.05$ , Table 1) were aware of the commercial benefits from ecotourism. They are also aware of the indirect benefits derived from preserving a forest in the heart of a city.
5. Support Forest Department conservation efforts: The majority (90%,  $p < 0.05$ , Table 1) value the efforts and measures taken to conserve the habitat and protecting the leopard. There is no ill-will to the construction of the wall and fence enclosing the reserve.

Negative:

A small number (12%,  $p < 0.05$ , Table 1, Q6) of the villagers were indifferent to the existence of the leopards and the benefits they get from the JFR. An even smaller (2%) number of the villagers expressed a conditional accommodation for the continued existence of the leopards, so long as no human or property loss occurred as a result of the human-leopard interface.

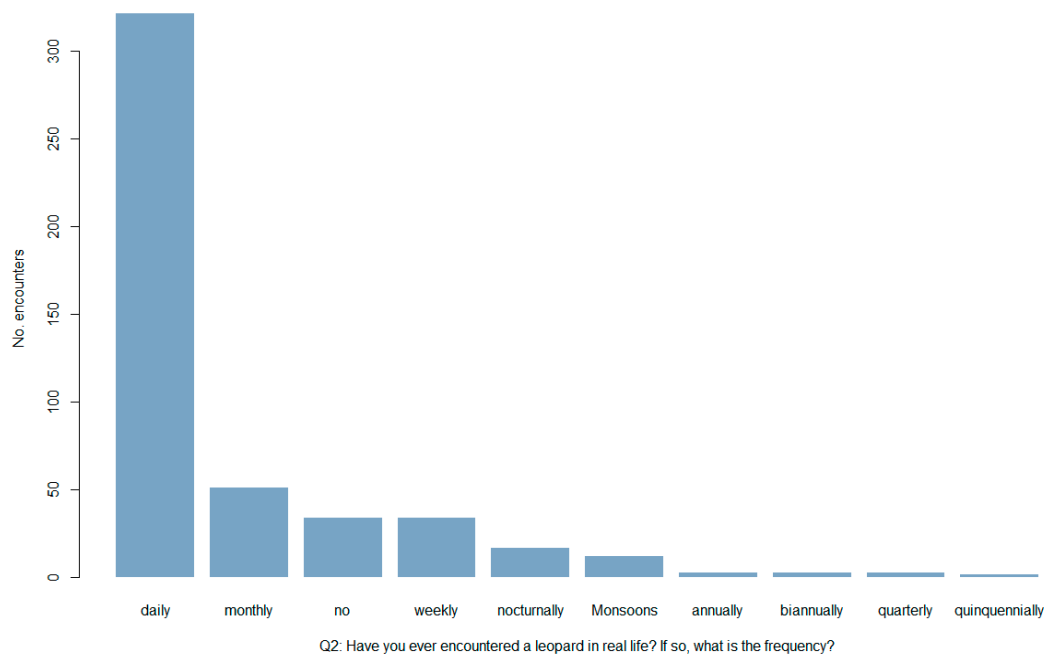
All of the villagers questioned were aware of the presence of the leopards in their vicinity (100%,  $p < 0.05$ , Table 1, Q1). Most of the people had encountered a leopard at least once (93%,  $p < 0.05$ , Table 1, Figure 2, Q2), of which 67% had encountered a leopard every day (Table 1, Figure 2).

**Table 2.** Results of linear regression analysis exploring the association between numbers of Leopard encounters and the distance of the village/residence to the Jhalana Forest Reserve.

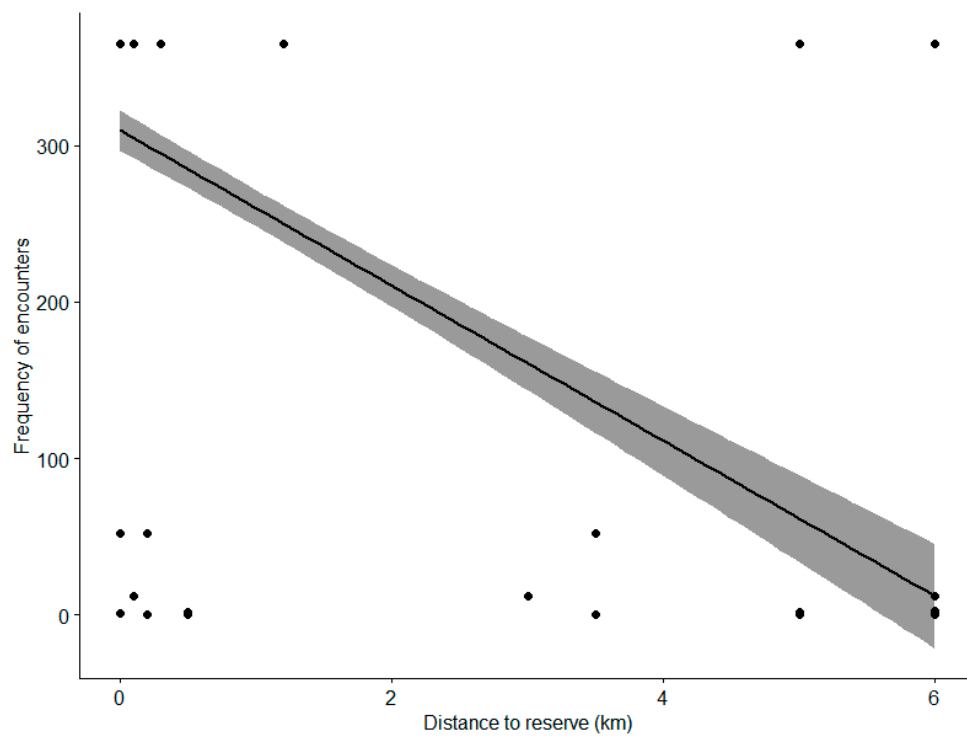
Variable	Estimate	SE	T	<i>p</i> -Value
Intercept	309.853	6.663	46.50	0.000
Distance to reserve	−49.647	3.172	−15.65	0.000

Villagers living closer to JFR have encountered leopards more frequently, as demonstrated by the negative and significant correlation between distance from reserve to responders' locations (Pearson correlation  $r = -0.58$ ,  $r^2 = 0.34$ ,  $P \leq 0.001$ , Table 2, Figure 3).

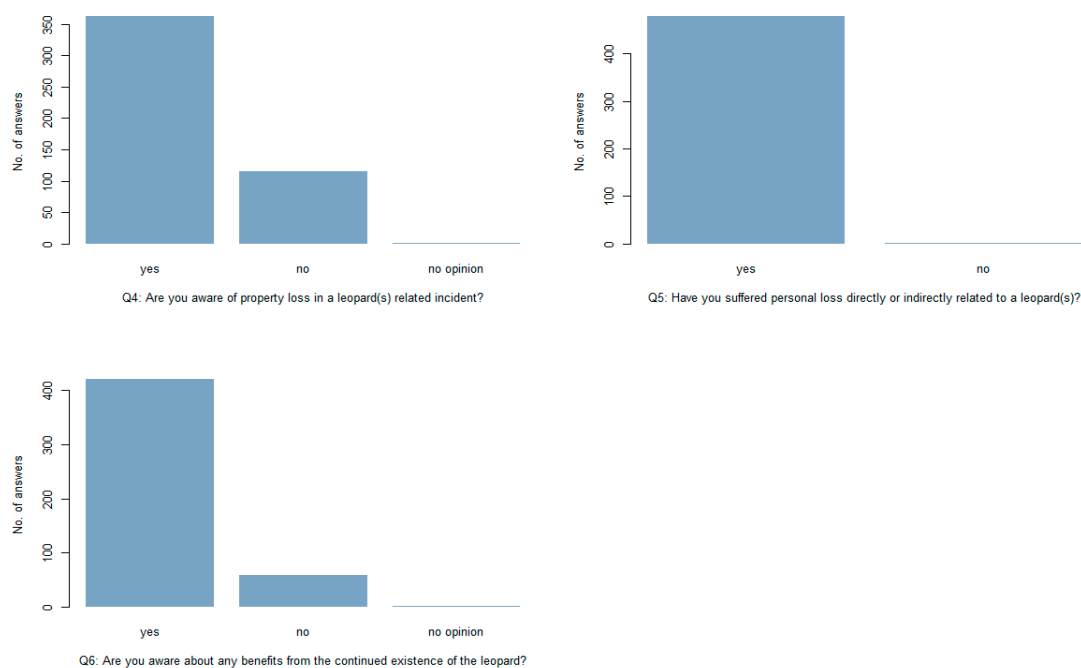
Most villagers also knew a person, usually a family member or neighbor, who had encountered a leopard (89%,  $p < 0.05$ , Table 1, Figure 4, Q3). Only 7% of the villagers had never encountered a leopard ( $p < 0.05$ , Table 1, Q2).



**Figure 2.** Frequency of encounters (Q2) with leopards, *Panthera pardus fusca*, by villagers (n = 480) surrounding Jhalana Forest Reserve according to the questionnaire (Table 2).



**Figure 3.** Correlation between the frequency of encounters between villagers and leopards (*Panthera pardus fusca*) and the distance (km) from the Jhalana Forest Reserve.



**Figure 4.** Frequency of answers ( $n = 480$ ) of living alongside leopards, *Panthera pardus fusca*, (Q4), awareness of property and personal loss (Q5), and the benefits from the persistence of the leopard (Q6).

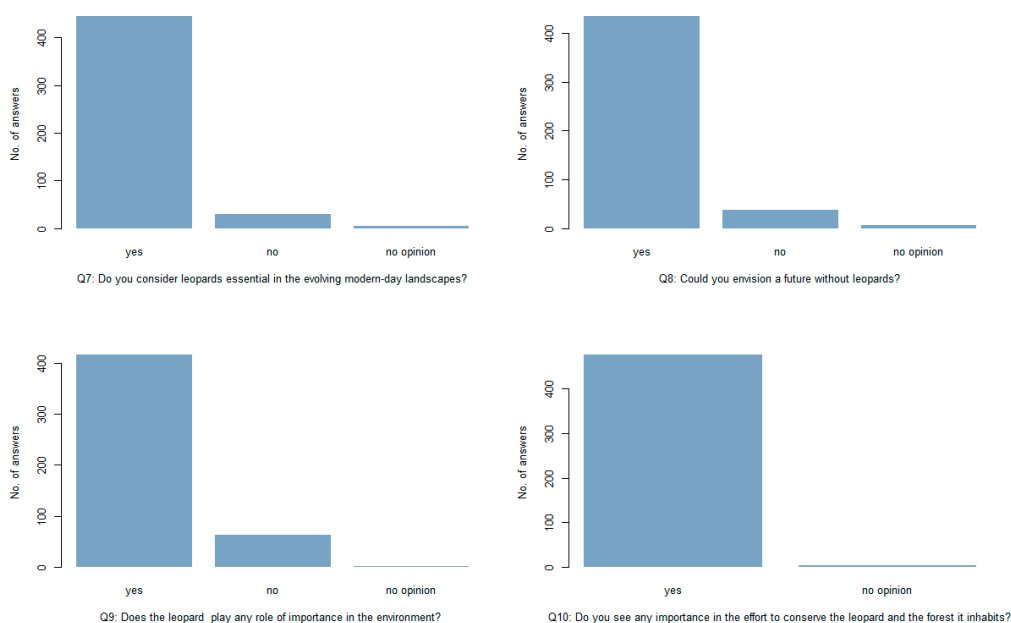
We found that most of the population living in the surrounding villages is illiterate or poorly educated (68%, Table 3). Most villagers are engaged in professions mainly related to an urban lifestyle. Most (84%, Table 3) are dailywage workers in factories, at construction sites, or the plumbing and painting industry in Jaipur. Hence, these villages offer no incentive for the leopards in terms of prey. The exceptions are the two villages of Bhomiyaji and Kho Nagoriyan, which are to the northwest of JFR, where there are milkmen and herdsmen grazing cattle and goats in and around the forest reserve. However, only one person was reported as losing goats to a leopard. One of the reasons, as observed by the villagers, is that the leopards' prey mostly on stray dogs, cats, and domestic pigs in the vicinity.

The majority of the villagers surveyed were aware of the benefits from the continued existence of leopards (88%,  $p < 0.05$ , Table 1, Figure 4, Q6). Most of the people thought the leopard and its persistence in the near future should be ensured in order to preserve the forest's biodiversity (92%,  $p < 0.05$ , Table 1, Figure 5, Q9). A few of the villagers did not perceive any benefits from the existence of the leopard (12%,  $n = 58$ ).

They displayed their knowledge about the leopard's role in the food web and acknowledged that a healthy population of leopards' benefits society in general. The majority of villagers supported the efforts and measures taken by the forest department in conservation of the JFR (90%,  $p < 0.05$ , Table 1, Q 10).

**Table 3.** Percentage of social characteristics of respondents (n = 480) for the following variables: Population size (big: >50,000 habitat, medium: >10,000 habitat, small: <2000 habitat). Sex. Age. Level education (school class/standard- STD) and academic degree (MA) and Professional sector.

Categories	Percentage (%)
Population Size	
Small	37.7
Medium	52.5
Big	5.63
Undefined	4.17
Sex	
Female	20.42
Male	79.58
Age	
<18 years old	15.21
18 to 60 years old	63.96
>60 years old	6.88
Undefined	13.96
Level Education	
Uneducated	21.67
Up to 6th STD	32.5
>6th STD to 12th STD	34.58
>MA	7.71
Undefined	3.54
Professional Sector	
Agriculture	2.71
Commerce	4.58
Construction	5.00
Education	8.96
Government	0.21
Industry	5.63
Services	5.42
Religion	3.96
Undefined	63.54



**Figure 5.** Frequency of villagers’ answers (n = 480) of the necessity of leopards in the modern-day landscape (Q7), visualize a future without leopards (Q8), envision the continued role of leopards in the environment (Q9), and the importance of efforts undertaken to conserve the leopard and its habitat (Q10).



#### 4. Discussion

Rapid industrialization, mining activities to the west, new neighborhoods on the east, a variety of religions practiced by the people, a mix of traditional and modern professions, medium to uneducated and low-to-medium income working class, two national highways on the northern border, about 50,000 villagers, and >3 million city-dwellers surround the Jhalana Forest Reserve. A healthy population of ca. 25 individual leopards, their frequent encounters with humans on the fringes of the reserve and in town/villages, makes JFR an ideal case study of a terrestrial habitat with island biogeographic characteristics (Figure 1).

We questioned the apparent coexistence at Jhalana and hypothesized that the villagers, due to their relatively low level of education, poor financial status, and occasional property loss, will have feelings of animosity and, hence, expected a negative response toward the conservation of this meso-predator. However, responses of the residents and the villagers did not substantiate our hypotheses. Their attitudes toward the leopards of Jhalana were surprisingly positive considering that predators are feared for threatening livestock and human lives [42,43]. It was found that public attitudes toward carnivores are typically positive in areas where they have coexisted for an extended period [44]. This is true for our study wherein the villagers have lived on the fringes of the Jhalana forest for generations and have always shared natural resources with leopards and other wildlife. They and their families encounter leopards on a regular basis and do not consider the leopards as a threat. This is similar to the Batoro and Banyoro tribes in Uganda who continue to hunt and collect food, firewood, and medicinal plants in spite of sharing the habitat with large carnivore species [44–46].

We suspect that the major reason for this lack of animosity stems from the religious background of the residents. Jainism, which is a prominent religion in Rajasthan, preaches coexistence and non-violence towards all living beings, no matter how insignificant they may seem to be. This is embedded in the psychology of the people regardless of education or economic status. This is underwritten by villagers who have created artificial waterholes at the temples and within the boundaries of the villages. In addition to the leopards, we have observed birds, bats, and langur monkeys (*Semnopithecus dussumieri*, considered pests in neighboring urban landscapes) using these waterholes especially during the dry seasons. Furthermore, most of the population is traditionally vegetarian. Though the population has a low income, poaching is not encouraged by the village elders. They also do not retaliate toward the leopards due to their practice of coexistence with all living organisms. This is similar to the Harare region of Eastern Ethiopia, where the locals think of spotted hyenas (*Crocuta crocuta*) as beneficial to the local human population because of their predisposition to kill and consume unseen spirits [47]. In a study of the attitudes of villagers toward Bengal Tigers, researchers found that the villagers' religious beliefs can be used as a tool to motivate them to help in conservation efforts of large predators and their related habitats [32].

Researchers have concluded that various socio-economic factors, including relative wealth, levels of education, the extent to which people derive monetary or other benefit from wildlife, and the magnitude of wildlife-associated costs influence the extent to which people tolerate wildlife damage [48,49]. The human population surrounding JFR has a very low income, low education levels (96% have not finished school), and the average income of 88% of the participants is less than \$200 per month. People in the villages of Bhomiyaji and Kho Nagoriyan still practice traditional livelihoods of goat herders or cattle milkmen and are among the poorest in our study. They are in direct contact with the reserve and its wildlife, especially the leopards. Despite frequent encounters, it is noteworthy that there has been no fatal attack on humans to date. Only one person reported a personal loss of property (goat) attributed to leopards. We think that, in spite of the religious convictions and the low intensity of livestock predation, the main reason the villagers have no animosity toward the leopards is the absence of fatal human attacks and substantial property loss [10]. Others also found that acceptance of large carnivores by local people often depended on the degree of predation on their livestock [50,51].

The villagers were aware and conscious about conservation issues. This is mainly due to their exposure through modern technology, social media (Facebook, WhatsApp, television), to the efforts

taken by the forest department and conservationists to preserve the habitat, flora, and fauna of similar reserves in and around JFR. They are proud that theirs is the only leopard sanctuary in India and are keen to conserve this forest for future generations. Even though they are not involved directly, or do not fully understand, the meaning of global conservation efforts to preserve natural habitats and biodiversity in general, and apex predator populations, they do understand the intricacies of environmental services and future planning. This is a point that one needs to build upon and to involve these stakeholders in conservation of JFR. It has been shown that, once the local population of predators is lost, the reintroduced populations will never have the same relationship with the locals [40]. We think that these reintroductions will invariably result in conflicts and will possibly take several generations on both sides until equilibrium of coexistence can be reached.

Furthermore, in a tropical country like India where temperatures soar to 46°C, the villagers realize the importance of JFR as a forest that acts as a sink for the heat of the city of Jaipur. They have observed that JFR is considerably cooler than the rest of the city. They stressed the necessity of preserving the habitat as a free ecosystem service for the benefit of the other 3 million residents of the urban areas.

Another important factor to be considered is ecotourism and other direct and indirect benefits that villagers derive from the leopards of Jhalana. The state of Rajasthan is an important tourism hub of India and ecotourism plays an important role in this sector [52]. JFR is in proximity of two major national parks known as Ranthambore and Sariska Tiger Reserves. Ecotourism creates jobs and much-needed income for the local people of Jaipur. Most (87.5%) of the villagers were aware of the benefits from ecotourism and of the indirect benefits gained from the existence of the leopard. Some expressed their discontent about the inequality in the opportunities the ecotourism sector had to offer. However, they did not oppose the growth of ecotourism in and around JFR *per se*. Some of the villagers are safari guides in JFR, or drivers of tourist cabs, whose livelihood is dependent on this industry. It is of interest to note that the villagers were keen toward preserving the vegetation in and around JFR. They considered the leopards as a boon for the forest since it prevented wood cutters and loggers exploiting the natural resources for commercial gains.

In other parts of India, the situation can be quite different. Although eco-tourism is recognized as an important factor to be considered for most protected areas (PA), the social responsibility and connection of ecotourism operations to local stakeholders is not as clear and is taken for granted for nature conservation. The directives of the tourism industry should be to share the benefits with the local stakeholders and the community living around the PA, which contributes to conservation and encourages their continued participation [53]. In the absence of local involvement in tourism and development, benefits are unequally distributed, as the Indian wildlife tourism industry is mostly controlled by state and private agencies [54]. At the Corbett Tiger Reserve, it was found that the benefits need to be amassed by local communities to balance the distribution of benefits and costs, and not by outsiders, as is the case at present [55,56]. There is a need for increasing education and awareness toward conservation in India in spite of the high potential for growth of the ecotourism industry and support for conservation among tourists [57]. In the case of JFR, the principle tourism activity is limited to safari jeeps that take tourists on designated routes. Locals own these jeeps and operate the safaris independently. The communities benefit since the owners are locals who employ other locals as drivers. Despite limited opportunities, the economic benefits are directly passed on to the villagers and local stakeholders who benefit from the tourism industry. Tourists stay at various hotels in Jaipur city, eat and shop in town, and create an income and job opportunities for locals. There are no resorts owned and operated by remote companies or non-locals, as is the case with other national parks in India [53,56,58]. As such, unlike most other Indian PAs, stakeholders at JFR are involved in day-to-day operations, benefit directly from the revenue generated, and contribute to the conservation of JFR with a better understanding of the benefits. They voice their concerns from time to time, so that the Rajasthan Forest Department involves the safari owners in implementing their policies toward ecotourism activities. This approximates the concept of sustainable development,

which promotes community participation and calls for the protection and improvement of the quality of life for communities influenced by tourism development [59].

However, additional factors must be considered when encouraging ecotourism by disturbing the forest environment with the introduction of new tracks and the laying of infrastructure. In a study of the variation in cub recruitment for cheetahs (*Acinonyx jubatus*) in relation to habitat and the abundance of tourists, the researcher concluded that female cheetahs that were exposed to high tourist abundance raised significantly fewer cubs than in low tourism areas [60]. He strongly recommended that tourist quotas should be put in place in high visitation areas along with strict wildlife viewing guidelines, such as number of vehicles, tourist behavior, time spent, and distance to a sighting, should be enforced. This is critical for species persistence and subsuming these findings could aid conservation efforts for species that are increasingly under threat. A similar study should be implemented in JFR in order to elucidate the effects of human activities on leopard reproduction.

One must consider that the villagers have been reaping direct and indirect benefits from the existence of the forest long before it was declared a reserve. Having enjoyed the environmental benefits, villagers are aware of other life-cycle gains derived from the forest. They are further convinced that the forest cover is protected from indiscriminate, illegal, and commercial exploitation because of the existence of the leopard. They are aware that urban residents fear the leopards, and other wildlife, which indirectly helps in the conservation of the habitat. The villagers appreciate and support efforts taken by the Rajasthan Forest Department (RFD) in preventing illegal recreational activities and other harmful practices of the locals. They believe that the measures adopted by the RFD, like construction of the wall around JFR, will help preserve and protect the forest cover from felonious and harmful practices. They are aware that the wall will not hinder, affect, or prohibit movement of leopards in and around JFR to nearby villages or urban areas of Jaipur city, but will certainly reduce the exploitation of natural resources for commercial benefits by human residents. It is noteworthy that not a single person opposed or had a negative opinion about RFD, its conservation efforts, or methods adopted in the management of JFR. However, we believe that local villagers should be offered additional job opportunities with the RFD and should be actively included in the daily reserve operations in order to ensure their goodwill and the success of the conservation program.

## 5. Conclusions, Contributions, Implications, and Future Research Directions

In conclusion, our study was undertaken because we considered people living in the fringe villages of JFR to be stakeholders and wished to verify their attitudes toward leopards and their conservation considering the recent declaration of the area as a forest reserve. Our findings substantiate others who consider the support of local stakeholders to be a very important component in the success of an enhanced and comprehensive conservation strategy [52]. In our study, villagers displayed great awareness toward the importance of conservation of the top predator despite their lack of formal education, poor economic conditions, and occasional monetary and property losses. Additionally, most were glad to know that their opinion mattered, that they were considered to be stakeholders, and they were invited to participate in the conservation master plan of JFR. The encounter rate suggests that the activity of the leopards, assuming encounters as a proxy of the animal's activities, is contained within the borders, or close to the core area of JFR.

The conclusions are similar to the findings of other researchers who also found that intolerance for large carnivores arises primarily from possible threats to livelihoods [38]. However, although others have stated that villagers in Asia consider the top predators to be their enemies [39], we found that villagers living in the proximity of leopards for generations respected, loved, worshipped, and considered the free roaming leopard population as a part of their daily life. They could not imagine a future without the leopards of JFR and were assertive in their pro-conservation efforts. They appreciated efforts taken by the RFD and their significance to conserve both habitat and leopards for future generations. It is of the utmost importance to value these villagers as important stakeholders and to encourage them by ensuring that they are made aware of the possibilities of bettering their lives

by including their participation in eco-tourist related activities, and involving them directly in the monitoring and conservation efforts in JFR. Their goodwill and cooperation with the RFD will create a sustainable role model of conservation and co-existence with an apex predator.

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## Abbreviations

**Abbreviated abstract:** Jhalana Forest Reserve (JFR) has the characteristics of island biogeography in the heart of Jaipur, a city of 3.1 million people. The leopard (*Panthera pardus fusca*) is the top predator and we conclude that the positive attitude toward the villagers as stakeholders is the basis for continued human-leopard coexistence.

JFR Jhalana Forest Reserve

RFD Rajasthan Forest Department

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