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Promoting Conservation and Coexistence: The Case of Blackbucks (*Antilope cervicapra* L.) and the Bishnoi Community in Abohar, Punjab, India

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ABSTRACT

Abohar Wildlife Sanctuary (WLS) in Punjab, India, is a unique protected area with the blackbuck (*Antilope cervicapra* L.) as its flagship species. The history of blackbuck conservation is deeply intertwined with the culture and ethos of the local Bishnoi community. Most of the land in WLS is farmland owned by local people. When the area was declared a sanctuary in 2001, it contained many sand dunes with wild vegetation that served as habitats for wildlife. The local people's sustainable farming practices and their peaceful coexistence with blackbucks are now largely things of the past. Expansion of cultivated land has reduced the natural habitat of wild animals, a problem exacerbated by habitat fragmentation due to the fencing of crop fields. Hybrid cattle and stray dogs also pose threats to wildlife in the area. In this study, we explore ways to restore the coexistence between local communities and wildlife. We examine the underlying conflicts and potential strategies for reconciliation. Results show that local people in the case study area hold strong conservation values and are motivated by their cultural and religious beliefs to protect wildlife, but face increasing challenges in doing so. Our research indicates that these intrinsic motivations, when supported by extrinsic incentives such as compensation payments and other mechanisms like ecotourism or premium prices for wildlife-friendly certified products, could foster sustainable human–wildlife coexistence. Education may also be an important factor in encouraging acceptance of such extrinsic incentives.

1 | Introduction

Humanity faces the urgent task of addressing complex, interlinked environmental challenges, such as climate change and biodiversity loss, while simultaneously meeting the needs of a growing human population. The continued expansion of the human population has resulted in unsustainable exploitation of the Earth's natural resources and biodiversity (Rands et al. 2010;

Abbreviations: CES, Compensation for Ecosystem Services; IPBES, Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services; MA, Millennium Ecosystem Assessment; PA, protected area; PES, payment for ecosystem services; S. No, serial number.

Summary

Wildlife conservation has traditionally relied on declaring strict protected areas such as wildlife sanctuaries and national parks. In the past, the religious values of local communities also played a major role in protecting wildlife. This study focuses on a region in Punjab, India, where the blackbuck—a threatened species native to India—is deeply valued by the local Bishnoi community, who follow a religion called Bishnoism. The Bishnois are known for their deep-rooted conservation ethics and have even sacrificed their lives to protect trees and animals. Unlike most wildlife sanctuaries in India, which are on government-owned land, this area was declared a sanctuary even though all the land is privately owned. At the time, the area included many wild and uncultivated patches ideal for wildlife. However, irrigation infrastructure and a growing population with economic aspirations have since transformed much of this land into cultivated fields. As a result, wildlife now have limited space and face many challenges. Our study finds that local people are still willing to dedicate portions of their land to wildlife conservation if they are offered compensation or payments and if government-supported mechanisms such as ecotourism or wildlife-friendly certifications are put in place.

- **Practitioner Points**
  - Traditional conservation approaches such as command-and-control policies and intrinsic motivation are no longer sufficient given the decline of state-owned wild habitats and the increasing developmental pressures and livelihood challenges faced by rural communities, especially in the developing world.
  - New strategies are needed to supplement traditional conservation methods and counteract the erosion of intrinsic motivations. Extrinsic incentives such as payments/compensation and support mechanisms like ecotourism and wildlife-friendly certification can promote human–wildlife coexistence. Education may also help motivate local communities to adopt these newer strategies and accept extrinsic incentives.
  - State-owned protected areas alone are inadequate to meet global conservation targets. Conservation efforts must extend to privately owned land. Since wildlife conservation and habitat service provision are public goods, private landowners need government support through payments, compensation, or income from conservation-linked activities to maintain habitats on their land.

Dasgupta 2021). Increasing human use of natural resources has led to widespread degradation of wildlife habitats and, consequently, a rise in human–wildlife conflicts (Manral et al. 2016; Bajwa and Chauhan 2019). Food production is a major driver of terrestrial biodiversity loss (Dasgupta 2021). Habitat loss, land-use change, and agricultural expansion are key anthropogenic drivers of human-wildlife conflicts. Effectively managing such conflicts and promoting coexistence can support both conservation and inclusive development (Gross et al. 2021).

The ecosystem services concept (also described as nature's contribution to people's wellbeing) frames human dependence on nature. Ecosystem services underpin economies and contribute to human psychophysical wellbeing. Since the mid-20th century, the tension between the demand for provisioning services and that for regulating, maintenance, and cultural services has become increasingly acute. Both global ecosystem services reviews, that is, the Millennium Ecosystem Assessment (MA 2005) and the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES 2019), reported an increase in provisioning services but a decline in regulating and maintenance services (Dasgupta 2021).

Changes in land use and agricultural management have reduced biodiversity and now threaten the survival of many species (Foley et al. 2005; Henle et al. 2008). Many traditional European habitats, such as hay meadows, moorlands, and lowland wet grasslands, have disappeared following the abandonment of traditional farming practices (Henle et al. 2008). Conflicts between agriculture and biodiversity conservation occur with agricultural intensification and the changing scale of operations (Henle et al. 2008). "Changing scale of operations" refers to the intensification of agriculture and the conversion of more land for cultivation, leading to a reduction in wilderness areas. For example, in the case study area, agriculture has shifted from rainfed, sustainable practices with ample fallow land for wildlife to intensive, irrigated agriculture with little to no fallow land remaining. In such contexts, maintaining biodiversity may require reintegrating traditional land-use and farming practices (Henle et al. 2008).

Managing endangered species on private lands presents significant challenges for policymakers and conservation managers in the 21st century (Peterson et al. 2004). In many countries, endangered species thrive on private lands. For instance, in the United States, more than 75% of endangered species are dependent on private lands, and there is a broad consensus that economic incentives, in addition to legal mechanisms, are necessary for effective conservation (Rodriguez et al. 2012). Engaging local stakeholders can present opportunities in conflict-prone settings, especially when these stakeholders attach cultural or symbolic value to the threatened species (Bernacchi et al. 2015).

Biodiversity conservation efforts should aim to maximise net local benefits, which may be achieved through strong community engagement and the provision of economic incentives. Conservation is more effective when costs are assessed, responsibilities clearly divided, and expected benefits made explicit (Badola et al. 2010). Active participation and long-term coexistence can be secured by addressing the needs and priorities of local people (Nepal and Weber 1995). Expanding the use of incentives and coordination mechanisms can help improve conservation outcomes on private land (Treakle et al. 2023).

Payment for ecosystem services (PES) is a widely used policy tool for conservation on private landholdings (Daniels et al. 2010). For example, the first PES scheme implemented in Costa Rica helped retain natural forest and improved tree cover in biological corridors (Morse et al. 2009). The principle underpinning PES is that ecosystems producing public goods services (e.g., biodiversity maintenance and water and climate regulation) are often located on private land. Therefore, the public (i.e., the users or beneficiaries of the ecosystem services) should compensate

landowners for the opportunity costs derived from implementing land-use or management practices that support the provision of these public goods (Dasgupta 2021).

Cultural and religious values have long contributed to biodiversity conservation, with religious beliefs and rituals often deeply intertwined with ecosystem stewardship (Negi 2005). Religion can preserve natural biodiversity by offering social and ethical models that encourage respectful relationships with nature (Bratton 1999). Religious taboos have helped prevent the hunting of threatened species (Colding and Folke 1997), and sacred status has been conferred upon many floral species in India. Sacred sites themselves frequently act as biodiversity sanctuaries (Negi 2005). Incorporating religious beliefs and values into conservation initiatives may be more effective in certain contexts than relying solely on scientific reasoning or economic incentives (Negi 2005).

Abohar Wildlife Sanctuary (WLS), the focus of our case study, is a unique protected area where the history of conservation is deeply rooted in the culture and ethos of the Bishnoi community. Most of the land within Abohar WLS is farmland owned by local people. When the area was declared a sanctuary in 2001, it contained many sand dunes with wild vegetation that served as habitat for blackbuck (*Antilope cervicapra* L.) and other wildlife species such as nilgai (*Boselaphus tragocamelus* Pall.) and golden jackal (*Canis aureus indicus* L.). These wild habitats are now declining due to the expansion of agriculture and horticulture. Consequently, populations of blackbucks and other wildlife species have drastically decreased within Abohar WLS and the surrounding community reserves (Bajwa and Chauhan 2019; records of the Department of Forests and Wildlife Preservation, Government of Punjab).

The blackbuck is an endangered wild species in India and is listed as a Schedule I species under the Wildlife Protection Act, 1972. It serves as a flagship species in our study area. Abohar WLS is the only landscape in the State of Punjab where blackbucks still occur in the wild. The local Bishnoi community holds strong religious reverence for the species. However, the peaceful coexistence that once characterized the relationship between the Bishnois and the blackbucks, along with their traditional sustainable farming practices, is now largely a thing of the past. Hence, there is an urgent need to identify novel approaches to restore human–wildlife coexistence and promote biodiversity conservation in the region.

Using Abohar WLS and its surroundings as a case study, we aim to explore ways to support the sustainable coexistence of blackbucks and local people. Our objective is to identify policies and strategies that can help sustain wild blackbuck populations by maintaining suitable wildlife habitats. By "strategy," we refer to action plans developed by relevant stakeholders; by "policy," we mean a government guideline or scheme that can be used by stakeholders as part of a conservation strategy. We assess the willingness of local communities to allocate land for conservation and to adopt regenerative, wildlife-friendly agricultural practices. We also explore avenues to reconcile ecosystem conservation and restoration with local aspirations and expectations, paying particular attention to the role of opportunity costs and religious values in shaping pro-conservation attitudes.

We address the following research questions:

1. What are the perceptions of local people concerning the current challenges in biodiversity conservation and human–wildlife coexistence in Abohar?
2. What strategies may help resolve such challenges? What ecosystem services are provided by the wild habitats in the case area, as perceived by the local stakeholders?
3. What roles do cultural and religious values play in supporting or impeding such strategies? How do religion, education, and generational differences influence willingness to engage in conservation?

The conceptual framework for this study is described in Supporting Information S1: Annexure 1.

2 | Materials and Methods

2.1 | Case Study Area

The case study area comprises Abohar WLS, surrounding community reserves, and several villages in the vicinity of these protected areas. These villages do not have official protected status, but wild animals are nonetheless found there, as they provide comparable or better habitat conditions and lie within the same landscape. A detailed description of the case study area is given in Supporting Information S1: Annexure 2. This area is unique because land owned by local people has been designated as a protected area. The blackbuck, the state animal of Punjab and endemic to India, is found in the wild only in this region of Punjab. The Supporting Information also contains a video showing the wild habitats and blackbucks: Supporting information video. Blackbucks and wild habitats 2017 Video Naresh Mahajan.mp4

Village locations (where the study participants live) are shown in Supporting Information S1: Figure S1 (Map) in Supporting Information S1: Annexure 2. This map shows Fazilka and Muktsar districts of Punjab, as well as the boundaries of the WLS and community reserve areas.

2.2 | Data Collection

A mixed methods approach was used for data collection. Primary data collection was performed through semi-structured individual interviews, information from key informants, personal observation, and focus group discussions. Secondary data were obtained from statistics and records provided by the Department of Forests and Wildlife, Government of Punjab, and the Department of Animal Husbandry, Government of Punjab. Some of the data collected were quantitative, while others were qualitative.

Literature was reviewed to understand ecosystem services, methods for assessing them, the influence of cultural and spiritual values on biodiversity conservation, and innovative mechanisms, such as PES or Compensation for Ecosystem Services (CES), used to incentivize biodiversity conservation.

An interview questionnaire (Supporting Information S1: Annexure 3) was developed, pilot-tested, and adapted to meet the research requirements. A total of 87 semi-structured interviews were conducted across 24 villages from June 2021 to January 2022. Of these, 12 villages were located within Abohar WLS, 4 within a community reserve, and 8 outside protected areas.

34 interviews were conducted personally by the first author via Zoom. These interviews were recorded and transcribed. 53 interviews were conducted in person by an assistant (data collector), who recorded responses using Google Forms on a mobile phone. Interview participants were selected by convenience, based on availability and willingness to participate (convenience sampling). Before beginning, all participants were informed that Zoom interviews would be recorded and later transcribed for research purposes. They were also assured that responses would be anonymized and used solely for research purposes. Participants were asked open-ended questions regarding local challenges and potential solutions, eliciting spontaneous responses.

Zoom and in-person interviews were conducted in the local language (Punjabi) and later translated into English. Data from Zoom interviews were first transcribed into a Word document and then entered into an Excel spreadsheet. Data from in-person interviews, entered directly into Google Forms in Punjabi, were also translated and included in the same Excel file. The interviews provided insights into local views on conservation challenges and strategies, agricultural and livestock practices, ecotourism, and perspectives on PES/CES.

Respondents were also asked to list the ecosystem services they believe wild habitats provide (Shakya et al. 2021). Perceptions of ecosystem services and conservation were assessed through household surveys (Badola et al. 2010). Household survey methods also informed the potential design of conservation payment mechanisms (Zabel and Engel 2010). A description of the interview data is included in Supporting Information S1: Annexure 4.

A Zoom interview was also conducted with a Veterinary Department officer from the Government of Punjab, posted in Abohar, to better understand the issues and solutions regarding stray dogs and stray cattle. In addition, discussions were held with three key informants and protected area managers from the Department of Forest and Wildlife to understand problems and to collect secondary data on village common lands, habitat presence, and related topics.

Six focus group discussions were also conducted. Four were held with the local residents and two with protected area managers. Three in-person focus group discussions were held with local people to investigate the challenges faced in the area in 2019. These focus groups took place in public village settings to investigate local conservation challenges, highlighting a need to find solutions, which helped spark the idea for this study. An additional in-person focus group discussion was held in September 2022 with the local people of Abohar to discuss solutions to the identified problems. These discussions were conducted in the local language, and notes were taken directly in English.

Two focus group discussions were conducted with protected area managers: one at the range level via Zoom in 2021, and the other in person at the state level in 2022. Zoom-based focus group discussions were conducted in the local language, recorded, and later transcribed into English. The in-person state-level discussion was conducted bilingually (English and Punjabi), with notes taken in English.

2.3 | Data Analysis

Qualitative interview data were analyzed using content analysis (Erlingsson and Brysiewicz 2017), and quantitative data were analyzed using descriptive statistics and logit regression models. Spontaneous qualitative responses to the open-ended questions were grouped into key thematic categories, following the method described in Erlingsson and Brysiewicz (2017).

Quantitative data analysis was conducted using logit models based on binary dependent variables approximating respondents' willingness to leave land fallow and willingness to sell land to the government if compensated. For a detailed explanation of the logit model, see Demaris (1992). Each model was run twice: once including all respondents and again including only those who provided complete responses to all questions.

One of our research objectives was to examine whether education is associated with greater willingness to leave land fallow. To this end, we created a binary variable coded as 1 if the respondent had completed college/university education or higher. While it would have been possible to construct multiple variables to represent different education levels, or to use a continuous variable for years of education, we chose a single binary variable distinguishing highly educated respondents from others. This approach was selected to increase the likelihood of detecting statistically significant associations between education and the outcome variables, given our sample size and the distribution of education levels.

3 | Results

The semi-structured interviews were conducted with 87 participants, comprising 80 males and seven females. The distribution of respondents residing within and outside the protected areas is shown in Supporting Information S1: Figure S2 (Annexure 2). Of the 87 respondents, 65 lived within protected areas (i.e., the sanctuary and community reserves), and 22 resided in nearby villages outside the protected areas.

Regarding education, seven interviewees reported having no formal education, 46 had completed middle school or high school, 29 had attended college or university, and five did not respond to this question about education. Not all the respondents answered every question.

Land ownership varied among participants: 64 owned land, six leased land for cultivation, and 17 did not possess any land. In total, 70 respondents were engaged in agriculture, while the

remaining individuals were labourers, government or private employees, self-employed, or involved in social work. Of the 87 respondents, 64 identified as Bishnois, while the remainder identified as Hindus, Sikhs, or reported no religious affiliation. Agriculture was the predominant occupation, and Bishnoism was the major religion among respondents in the study area.

3.1 | Current Challenges in Biodiversity Conservation and the Coexistence of Humans and Wild Animals

Local people's perceptions of the key challenges in the study area, based on the interview responses, are shown in Table 1. Responses were categorized through content analysis to highlight the primary concerns.

Quotes from the respondents describing these challenges are provided in Supporting Information S1: Annexure 5. Participants frequently expressed concern over the declining numbers of wildlife and the rising populations of stray dogs and stray cattle. Many expressed the need to protect wild animals and the sanctuary. These concerns were echoed in focus group discussions and by key informants from the Department of Forests and Wildlife.

Focus group participants often attributed the observed ecological changes to factors such as shifts in cropping patterns following the introduction of irrigation facilities, changing local attitudes, and human population growth. Secondary data and the literature review also support the finding that both wild habitats and blackbuck numbers have reduced drastically. Stray dogs and stray cattle were reported to pose serious threats to blackbuck and other wildlife. Further detail on these challenges is provided in Supporting Information S1: Annexure 6.

3.2 | Strategies for Sustainable Coexistence and Biodiversity Conservation

Local people's perceptions of biodiversity conservation strategies, based on the interviews, are summarised in Table 2.

Local people's willingness to provide land for habitat for conservation was also explored during the interviews.

The positive and statistically significant coefficients in Table 3a indicate that Bishnoi respondents and those with college/university education or higher are more likely to express willingness to leave their lands fallow if they receive compensation. Age and household size do not show a statistically significant association with willingness to leave land fallow.

A similar multivariate logit regression was conducted to assess willingness to sell land to the government for wildlife conservation. As shown in Table 3b, none of the predictors has a statistically significant association in this case. Supporting Information S1: Annexure 7.1 explains that only nonarable land or land unsuitable for cultivation is typically offered for sale, which may explain the lack of association with education, religion, or age.

Since the coefficients in Tables 3a and 3b cannot be directly interpreted in terms of effect size, we calculated the predicted probabilities of a respondent being willing to leave land fallow under different conditions, as illustrated in Figure 1. For a

TABLE 1 | Content analysis of local people's perceptions regarding biodiversity conservation and coexistence challenges.

S. No	Response theme/categories	Percentage (No.) of responses[a]
1.	Need to conserve wild animals	51.4% (90)
2.	Need to control stray cattle and dogs	38.9% (68)
3.	Wild animals are decreasing in numbers	5.7% (10)
4.	Sanctuary needs to be preserved	4% (7)
	Total	100% (175)

[a]Respondents could provide multiple answers to this open-ended question (87 respondents in total).

TABLE 2 | Local people's perceptions regarding solutions to biodiversity conservation challenges.

S. No	Response themes/categories	Percentage (No.) of responses[a]
1.	Government should purchase lands for wild habitats	31.3% (36)
2.	Government should be more involved in wildlife conservation	28.7% (33)
3.	People can tolerate damage by wild animals	10.4% (12)
4.	Local people's participation is needed for conservation	9.6% (11)
5.	Village common lands can be used for wildlife conservation	9.6% (11)
6.	Religion/culture aids in conservation	6.1% (7)
7.	Organic farming is needed for wildlife conservation	3.5% (4)
8.	Poverty needs to be eradicated to help biodiversity conservation	0.9% (1)
	Total	100% (115)

[a]Respondents could indicate multiple responses (87 respondents in total).

TABLE 3a | Logit regression: Explained variable–willingness to leave land fallow (land sparing) if compensated.

	All respondents	Respondents who completed all questions
1 if Bishnoi	1.125**	2.086**
	(0.533)	(0.815)
1 if older than 55	−0.308	−0.287
	(0.565)	(0.872)
1 if graduate-level education or higher	0.491	2.987**
	(0.557)	(1.492)
1 if more than five household members	−0.221	−0.952
	(0.476)	(0.753)
Constant	−0.903	−0.969
	(0.591)	(0.935)
Observations	85	47
Pseudo R^2	0.0518	0.262
Loglikelihood	−55.72	−23.41
AIC	121.4	56.81
BIC	133.7	66.06

Note: Coefficients represent changes in log-odds for a one-unit increase in each predictor. Standard errors in parentheses.
*$p < 0.10$; **$p < 0.05$; ***$p < 0.001$.

TABLE 3b | Logit regression: Explained variable—willingness to sell land to the government for wildlife conservation.

	All respondents	Respondents who completed all questions
1 if Bishnoi	1.229	1.318
	(1.058)	(0.976)
1 if older than 55	−0.0559	−0.193
	(0.789)	(0.770)
1 if gradute-level education or higher	0.860	1.267
	(0.740)	(0.867)
1 if more than five household members	−0.520	−0.790
	(0.756)	(0.841)
Constant	−2.995**	−2.374**
	(1.026)	(0.955)
Observations	85	47
Pseudo R^2	0.0565	0.0979
Loglikelihood	−29.05	−20.71
AIC	68.10	51.41
BIC	80.31	60.66

Note: Coefficients represent changes in log-odds for a one-unit increase in each predictor. Standard errors in parentheses.
*$p < 0.10$; **$p < 0.05$; ***$p < 0.001$.

respondent who is a Bishnoi and has completed college/university education or higher, the probability of willingness is approximately 0.97. For a Bishnoi respondent without higher education, the probability falls to approximately 0.60. For a non-Bishnoi respondent with higher education, the predicted probability is 0.78. The lowest probability, 0.17, corresponds to non-Bishnoi respondents without a college/university education.

An important aspect to keep in mind when interpreting the results presented in Figure 1 is that education is strongly correlated with income, measured as yearly income from agricultural and other nonagricultural activities obtained by the household head. For instance, while the average income of respondents with college/university education is 2.13 million INR, respondents with lower education report an average income of 0.94 million INR. A t-test comparing these income groups yields a p-value of 0.0041, indicating a statistically significant difference. This suggests that income, rather than education per se, may be the true underlying factor influencing willingness to leave land fallow if compensated. However, when both education and income are included in the logit model, multicollinearity renders both coefficients insignificant. Thus, we retained the binary education variable, which demonstrated a stronger statistical association than income alone.

Overall, 92% of respondents expressed willingness to allow wild animals to graze in their fields, while 39% would require compensation to do so (land sharing).

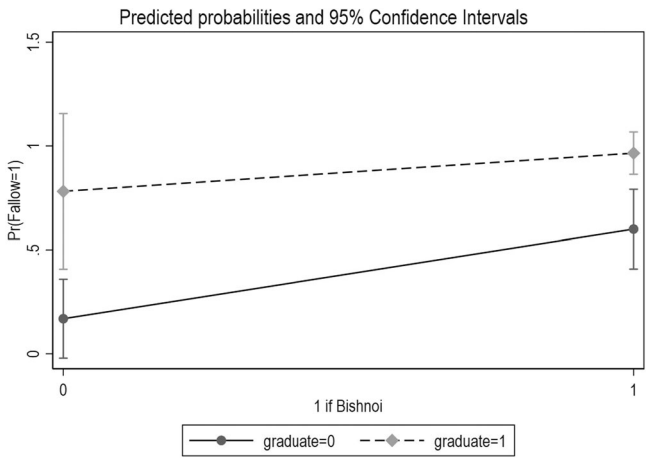

FIGURE 1 | Predicted probabilities of willingness to leave land fallow if compensated. Estimated using the parameters from Table 3a (respondents who completed all questions).

The proposed conservation strategies are outlined in Supporting Information S1: Annexure 7. Opportunity costs associated with conservation on privately owned agricultural land and village common lands were evaluated using interview data (Supporting Information S1: Annexure 7). Definitions and implications of land sharing and land sparing in relation to ecosystem services

are provided in Supporting Information S1: Annexure 8. A detailed discussion on designing PES strategies is presented in Supporting Information S1: Annexure 9, along with examples of successful PES schemes from other regions (Supporting Information S1: Annexure 11).

A first key step in developing a PES model or agreement is identifying viable ecosystem service prospects (Forest Trends, Katoomba Group and UNEP 2008). Respondents' perceptions of ecosystem services provided by natural or wild habitats are shown in Figure 2. The majority recognised habitat services (62 responses), followed by regulating services (14 responses), and provisioning services (five responses). Three respondents did not believe natural habitats offered any ecosystem services. Notably, only one respondent identified cultural services associated with these habitats. However, when asked whether natural habitats are necessary for humans, 66 answered "yes" and 14 responded "no."

3.3 | Role of Cultural and Religious Values in Conservation and Coexistence

The Bishnoi community has a long-standing tradition of allowing wild animals to roam freely in their fields (see Supporting Information S1: Annexure 10). As shown in Table 4, when respondents involved in agriculture were asked whether they would permit wild animals to graze in their fields, 92% answered "yes." When asked whether they would require compensation for this, 61% responded "no." The majority of interview respondents in this study were members of the Bishnoi community.

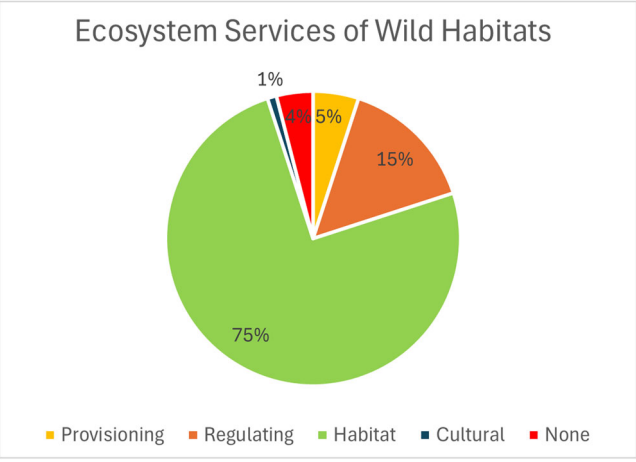

FIGURE 2 | Local people's perceptions of the ecosystem services provided by wild habitats in Abohar.

4 | Discussion

4.1 | Current Challenges for Biodiversity Conservation and for the Coexistence of Humans and Wild Animals

The challenges identified during the interviews and focus group discussions, such as decreasing wild habitats and wildlife populations, and increasing cultivation and stray cattle and dogs, closely align with findings of the reviewed literature. A detailed analysis is provided in Supporting Information S1: Annexure 6.

When Abohar WLS was established in 1975, there was extensive wild habitat (sand dunes) suitable for blackbucks and other wildlife. Since then, these habitats have been drastically reduced (Bajwa and Chauhan 2019). Populations of stray cattle and stray dogs have increased, further negatively affecting wildlife populations and biodiversity conservation (Khan et al. 2019; Kalpana 2020; Habib Bilal et al. 2023). Shifts in cropping patterns and farming practices have also contributed to declines in wildlife populations and hindered biodiversity conservation efforts (Kalpana 2020).

The sanctuary was originally classified as a *birani*, or sandy land, with minimal agriculture. After the construction of the Rajasthan and Bikaner Canals, the area now receives ample water for cultivation (Pathak 2009). Human–wildlife conflicts have intensified due to habitat reduction and land-use changes (Bajwa and Chauhan 2019). Additional pressures include an increasing human population, subdivision of land holdings due to increases in family size, and the conversion of crop fields to orchards (Pathak 2009).

Traditional command-and-control mechanisms, such as the designation of protected areas, are no longer sufficient as standalone policy strategies for wildlife conservation in Abohar WLS, especially since local people retain nearly all land rights except for hunting (Kalpana 2020). Consequently, there is no effective means to control habitat destruction from land-use changes. Voluntary participation by local communities is needed to maintain and restore habitats, necessitating the development of novel motivational approaches.

4.2 | Strategies and Policies to Promote the Sustainable Coexistence of Local People and Wildlife

The current policy framework in Abohar follows a traditional command-and-control model, which is proving inadequate, even where intrinsic motivations exist due to religious values. PES offer a promising alternative in contexts where opportunity

TABLE 4 | Local people's willingness to allow wild animals to graze in crop fields (land sharing).

S. No	Question	Percentage and (number of responses)	
		Yes	No
1.	Would you allow wild animals to graze in your field?	92.3% (60)	7.7% (5)
2.	Do you require compensation to allow wild animals to graze in your field?	39.3% (22)	60.7% (34)

costs are lower (Wunder 2006; Clements and Milner-Gulland 2015). However, in the case of Abohar, the opportunity costs of conservation are high (see Supporting Information S1: Annexure 8), and willingness to pay has not been fully revealed. Nonetheless, complementary strategies or policy tools are needed to augment the effectiveness of existing policy strategies (i.e., protected areas).

PES schemes can provide potential opportunities where society has failed to secure ecosystem services through command-and-control measures (Wunder 2006). They can complement traditional mechanisms and may be particularly relevant in areas like Abohar, where habitat services are threatened but potentially tradeable through PES (Clements and Milner-Gulland 2015). Examples of successful PES schemes in other contexts are presented in Supporting Information S1: Annexure 11.

Direct conservation strategies, such as land purchase or compensation for habitat provision, can be effective. Given the difficulties associated with land purchase in the case study area, as explained in Supporting Information S1: Annexure 8, compensation-based mechanisms appear more feasible. As an example, the European Union's Common Agricultural Policy compensates farmers for income losses incurred by adopting environmentally friendly farming practices, with the dual goal of producing food and maintaining biodiverse, culturally significant landscapes (Henle et al. 2008). Similar strategies could be explored in Abohar to support sustainable farming methods.

Previous research in the area indicates that interest in conservation seems to be higher in the older generation, who are more tolerant of the damage caused by ungulates (Pathak 2009). While our results do not show age-related differences in willingness to leave land fallow, education level and religious/cultural affiliation do show statistical significance. Specifically, Bishnois with graduate-level education are most likely to leave land fallow if compensated. This finding suggests the value of targeting educated members of the Bishnois community for conservation initiatives.

Both external (e.g., monetary) and internal (e.g., cultural or spiritual) motivations play key roles in wildlife conservation (Laney and Moses 2021). Our results support the potential of PES or CES-like schemes to motivate wildlife-friendly practices in agricultural and horticultural landscapes within the protected area. Designing PES policy mechanisms to engage educated Bishnois may help secure remaining wild habitats and associated ecosystem services. Overall, the results presented in Section 3.2 highlight that local communities realize the value of natural habitats and may be receptive to compensation-based approaches.

4.3 | Role of Cultural and Religious Values in Conservation and Coexistence

Religious values appear to influence the acceptance of wild animals in agricultural fields in the case study area, helping to normalise rather than problematise their presence. Such values may have contributed to past coexistence (Bajwa and Chauhan 2019; Bishnoi 2020). However, the current context has shifted, likely due to the increasing human population and rising aspirations. Additionally, religious sentiments against slaughtering animals have contributed to an increase in stray cattle populations (Habib et al. 2023).

Our findings suggest that strong cultural and religious values are positively associated with the willingness of local people to share and spare their agricultural land for wildlife. The majority of the interview respondents were Bishnois, and 61% of them expressed willingness to allow blackbucks to graze in their agricultural fields without expecting compensation. We interpret this as an outcome of the cultural and religious reverence that the Bishnoi community holds for wild animals, particularly blackbucks. Further elaboration of this role is provided in Supporting Information S1: Annexure 10.

However, religious values in the case study area can influence conservation negatively. For instance, the proliferation of stray cattle and stray dogs may partly stem from religious beliefs that prohibit culling. Thus, religious values can act as a double-edged sword, both supporting and simultaneously hampering conservation. A comparable example is found among the Wedjah people in Liberia, who protect chimpanzees due to spiritual beliefs but also feed them, a practice that inadvertently encourages disease transmission and crop raiding (Infield et al. 2018).

In summary, religious and cultural values, and related practices and beliefs, present both opportunities and obstacles for conservation. Understanding and integrating local belief systems is crucial for designing effective conservation strategies—a principle known as the cultural values approach (Infield et al. 2018). PES programmes are likely to be more sustainable when they align with and reinforce such intrinsic motivations (Clements et al. 2010).

4.4 | Limitations and Future Research

This study focuses on a single case study area, and there may be concerns regarding the representativeness of the data, as convenience sampling was used. The number of interviewees was also limited, which we addressed by conducting additional focus group discussions to gather a broader range of perspectives. These discussions, with larger groups, enabled deeper insight into community-level perceptions.

Some potential biases may arise from the mixed methods of data collection: some interviews were conducted in person by a research assistant, while others were conducted by the first author via Zoom. However, the author's direct experience with the Zoom interviews helped in interpreting and validating the research assistant's data. In cases where clarification was needed, the original respondents were contacted by telephone.

Further research is needed to devise viable PES/CES schemes, including an in-depth analysis of the views of relevant stakeholders such as government departments (Agriculture, Horticulture, Forests and Wildlife, Animal Husbandry) and local communities. Additionally, opportunities to adapt existing government programmes into PES/CES frameworks should be

explored as a means of generating sustainable funding. International donors have, at least partly, funded conservation in cash or kind for individual owners and communities in previous schemes implemented elsewhere (Milne and Niesten 2009).

Future studies should examine willingness to pay for conservation values/ecosystem services using a wide range of respondent groups, including citizens, and public and private organizations, within India and globally. While this study assessed willingness to accept compensation, effective PES design also requires understanding willingness to pay–an important next step. Comparative research across other regions, both nationally and internationally, would be valuable to verify and extend the findings of this study, and also to explore options for effective funding of PES/CES schemes.

5 | Conclusion

This case study highlights a unique context in which protected areas exist on private and community lands, and where the local people hold intrinsic cultural and religious motivations for biodiversity conservation. The residents of the region are predominantly Bishnois, a community known for its deep ecological ethos. Previous studies show that members of this community have even sacrificed their own lives to safeguard trees and wildlife (Bishnoi 2020). However, our study reveals that intrinsic motivations and protected status alone are no longer sufficient to address contemporary conservation challenges. The findings underscore the need for additional external support mechanisms, including compensation and incentive-based schemes, to complement both legal and cultural frameworks for conservation.

We found that local landowners are generally willing to accept compensation to uphold wild habitats, with those holding graduate-level education or higher, and members of the Bishoi community, being the most likely to participate in land sparing initiatives. We also investigated the opportunity costs associated with conservation, which are substantial. If willingness to pay can be established and suitable funding sources identified, PES/CES mechanisms could effectively complement existing strategies to support biodiversity conservation. Additionally, wildlife-friendly certifications and ecotourism development may help sustain long-term motivation for conservation, particularly when integrated with PES schemes.

Author Contributions

Geethanjali Mariaselvam: conceptualization, methodology, writing – original draft. **Ritva Toivonen:** supervision, writing – review and editing. **Dalia Damato:** supervision, writing – review and editing. **John Sumelius:** supervision, writing – review and editing. **Anil Bhardwaj:** conceptualization, writing – review and editing. **Adan Martinez Cruz:** formal analysis, writing – review and editing.

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Ethics Statement

Interview participants were informed that their personal data would be kept private and safe and only their opinions and other information (qualitative and quantitative) would be analysed and used for research purposes. The data set is currently not anonymized, and hence it has not been stored onto any data sharing portal. If any researcher is interested in viewing or using the data for research purposes, it can be shared after anonymization.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions. The data is not anonymised yet. On request from potential future researchers, it will be supplied after anonymisation.

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Note: References marked with an asterisk (*) are cited in Supporting Information.

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Supporting Information

Additional supporting information can be found online in the Supporting Information section.
Annexure 1: Conceptual background. **Annexure 2:** Description of the case study area. **Annexure 3:** Questionnaire for house hold surveys. **Annexure 4:** Description of the data collected through semi-structured interviews with local people. **Annexure 5:** Responses of local people regarding the challenges in the case study area. **Annexure 6:** Description of the challenges in the case study area. **Annexure 7:** Proposed strategies for conservation. **Annexure 8:** Concepts of land sharing and land sparing. **Annexure 9:** Creating PES/CES schemes in the case study area. **Annexure 10:** Religious values of bishnois towards conservation. **Annexure 11:** Examples of payments/compensations for conservation. **Figure S1:** Map of the case study area. **Figure S2:** Location of respondents. **Figure S3:** Blackbuck mortality. **Figure S4:** Nilgai (blue bull) mortality. **Figure S5:** The fate of unproductive cattle (bulls and non-milking cows). **Figure S6:** Crops cultivated in the case study area. **Figure S7:** Fencing types used by farmers to protect crop fields. **Table S1:** Ecosystem services perceived by the local people. **Table S2:** Content analysis of people's responses about following Guru Jambeshwar's teachings. Black bucks and wild habitats 2017 Video Naresh Mahajan.