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PEOPLE'S KNOWLEDGE AND ITS IMPLICATIONS FOR WILLINGNESS TO CONSERVE THE SUNDA PANGOLIN IN INDONESIA: AN ETHNOZOOLOGICAL STUDY

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Abstract

The conservation of Sunda Pangolins (Manis javanica), classified as critically endangered, depends on community involvement, not just law enforcement and ex situ captive breeding. Local knowledge, shaped by cultural characteristics, is crucial for integrating community conservation perspectives with socioeconomic values and existing protection policies. However, research on this approach is limited. This study presents the level of community knowledge related to ecological, socio-economic, and conservation policy aspects and its implications for the willingness to conserve Sunda pangolins. Data were collected from Jambi Province, Indonesia, a region that has been a focal point of media attention regarding the illegal pangolin trade since the 1990s. Jambi Province is also strategically located as a major entry point for the maritime distribution of various goods, which now includes pangolin smuggling. Virtual ethnography techniques, in-depth interviews, and Orange Data Mining 3.36.1 analysis revealed community knowledge levels. Ecological knowledge is at a medium-to-high level, with pangolins recognized as both pest controllers and economic commodities. However, community awareness of local conservation policies is limited and primarily based on oral information. Correlation analyses indicate that higher levels of knowledge correlate with greater conservation efforts. This finding offers opportunities for designing inclusive community-based conservation strategies. Ethnozoological approaches should be considered to foster effective protection policies for endangered species that align with local values and needs.

***Keywords**: Community-based conservation; Local ecological knowledge; Conservation policy; Illegal trade; Manis javanica.*

Introduction

Biodiversity loss is one of the most pressing challenges of our time, caused by habitat destruction, climate change, and the illegal wildlife trade. Pangolins (8 species in total) are the mammals most threatened by these pressures in the last two decades, as they have become a major target in the illegal trade. One of Southeast Asia's native mammal species, the Sunda Pangolin (*Manis javanica* Desmaret 1822), was hunted more intensively before 2000 than any other pangolin species [1] traded to China [2]. The Sunda Pangolin is critically endangered according

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to the IUCN Red List [3]. This species is also listed in Appendix I of CITES, subject to full restrictions on international trade.

Pangolins are natural entities that make important ecological, social, and economic contributions to ecosystems. These nocturnal mammals' activities as predators of ants and termites in soil and decaying wood support soil loosening, energy, and material recycling [4], [5], [6]. Beyond their ecological role, pangolins also have social and cultural significance, reflecting the close relationship between biodiversity and the cultural values of local communities. In numerous indigenous traditions, pangolins are regarded as protective symbols, incorporated into rituals, or even regarded as symbols of local wisdom rooted in human harmony with nature [7]-[13]. From an economic perspective, pangolins play a role in various traditional practices, such as serving as ingredients in medicines and natural biopesticides [14], [15], [16]. Additionally, they function as a source of income for specific communities [17].

Indonesia occupies a pivotal role in the global pangolin trade, functioning as both a source country—where the Sunda pangolin primarily inhabits—and a transit country [18]. Efforts to halt the decline of Sunda pangolin populations in Indonesia are being implemented through law enforcement and ex-situ conservation. However, these efforts are insufficient to address the issue adequately due to a lack of emphasis on this species. For instance, law enforcement initiatives targeting perpetrators of the Sunda pangolin illegal trade still rely on programs established for other species, such as the Sumatran tiger [19]. Furthermore, the illicit pangolin trade has been linked to global organized crime networks [20], which complicates the enforcement of legal measures. With regard to ex-situ conservation, endeavors to augment captive populations for the purposes of rearing and breeding are often accompanied by substantial financial expenditures, despite the implementation of effective feeding and housing management strategies [21], [22], [23], [24]. Captive breeding success remains low, and reports are scant [25] due to the reproduction factors [26], [27] and high cage mortality due to infection [28], [29]. Successful breeding of Sunda pangolins to the third generation has only been reported in China [30]. This species is particularly sensitive due to its low resistance to pathogens [31].

Biocultural approaches are gaining increasing attention to meet the current challenges for sustainability [32]. In the context of conservation, biocultural approaches have been demonstrated to achieve effective and equitable conservation outcomes while addressing the erosion of both cultural and biological diversity [33]. Achieving management and conservation of Sunda pangolins necessitates a strategic approach that incorporates a people's knowledge-based element. This component is a fundamental component of the biocultural diversity framework, as it is frequently grounded in local cultural perspectives. People's perspectives, particularly those preserved and transmitted through local and traditional means as knowledge by experts (often termed ethnobiology or ethnoecology), are increasingly recognized for their role in fostering diverse perceptions that can influence and guide human understanding and appreciation for conserving wild species towards greater sustainability [34], [35]. The ecological knowledge of local traditional landscape users, which may differ from that of conservationists, influences preferences in species protection and is often the basis for communities supporting or rejecting conservation efforts [36], [37]. Positive attitudes can promote protection, while negative perceptions or lack of understanding can increase the risk of overexploitation [37], especially when integration process documentation is fragmented and scarce [38] if there is no meaningful cross-cultural discussion [39]. Therefore, communities with local perspectives on pangolin conservation must be directed not to jeopardize the targeted species [40]. Local knowledge can bridge modern conservation policies and traditional wisdom, creating stronger synergies in species protection among stakeholders [41].

However, there is an emerging gap in many of Indonesia's existing Sunda pangolin conservation efforts. The aspect of public knowledge and the extent of the diversity of knowledge about pangolins has not been studied much, despite its role as a foothold for estimating whether there is a potential willingness to conserve this species. This aspect is an important note from

IUCN that the pangolin range states will further assess [3] to estimate future collaboration by aligning values and priorities between economic and conservation needs [37], [42], [43]. During a law enforcement situation that sometimes even ignores the importance of local communities as key stakeholders in conservation [44], people's knowledge and its implication towards willingness to conserve Sunda pangolins needs to be studied.

This study definitively explores the level of community knowledge on ecological, social, economic, and policy aspects of Sunda pangolin conservation. It also determines how this knowledge influences community willingness to conserve the Sunda pangolin. This research contributes to designing community-based conservation interventions compatible with local values. Furthermore, understanding the perspectives and aspirations of local communities regarding pangolin conservation in Indonesia is crucial in the fight against illegal trade. This approach is relevant for conserving the Sunda pangolin and potentially applicable to other species facing similar threats.

Materials and methods

Study site

The research was conducted in Jambi Province (Fig. 1), one of the provinces on the island of Sumatra, Indonesia, which is the habitat of pangolins. The region has been the focal point of media attention regarding the illegal pangolin trade since the 1990s. The position of Jambi Province is also strategic as the main entry point for the maritime distribution of various goods – which now includes pangolin smuggling [45], [46]. The region has also experienced significant land cover changes due to forest fires, land conversion, and other human activities, leading to declining watershed quality and reduced mammalian habitat capacity. The degradation of forest areas into plantations, agricultural land, and other uses has made Jambi province vulnerable to flooding, erosion, drought, deterioration of water quality, and estuarine sedimentation [47], [48]. This is also an important basis for why research is conducted here.

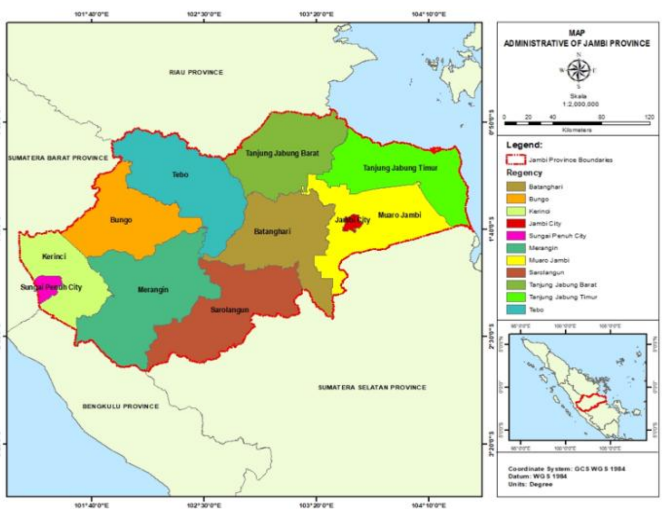

Fig. 1. Map of research location

Data collection

This study was conducted from late 2019 to February 2020 using a local ecological knowledge approach, part of an ethnographic research method recognized by numerous previous scientific publications [29], [49], [50]. This study employs a virtual ethnographic (VE) interview technique [51], [52] through the distribution of online forms starting from social media networks. VE interviews were selected for their ability to reach a broad audience across various regions and time zones [53], particularly given the ongoing COVID-19 pandemic. The data sources consisted of randomly selected individuals living in the study area who were willing to complete the questionnaire.

The questionnaire contains questions about four main aspects in a combination of open and closed questions. The four aspects that became the variables of this study were people's knowledge about a) the physical and ecological characteristics of pangolins, b) socio-economic and cultural benefits, c) compliance with protection regulations, and d) the urgency of protecting the species in terms of local and national policies. Although the data have been collected over a long period of time, especially for socially related research that can be outdated due to the dynamics that occur, until now, there has not been much research on people's perspectives on Sunda pangolins from Sumatra, Indonesia, and the results have not been published scientifically. Additionally, studies on perspectives, local knowledge, and the like for biodiversity conservation are essential for sustainable conservation policy considerations [54], [55]. The questionnaire is attached as a vital supplement to this paper.

In addition to the VE interviews, in-depth interviews were conducted with key individuals, particularly poachers. Understanding their perspectives on the value, ecology, and utility of pangolins, as well as their hunting objectives, motivations, and specific techniques, is essential for considering future conservation possibilities. Gaining insight into the needs and behaviors of the species from the viewpoint of those directly involved is crucial for developing effective management strategies [56]. Unfortunately, poachers targeting Sunda pangolins are challenging to locate, so snowball sampling techniques were employed to identify and recruit these individuals while maintaining ethical integrity through informed consent. The process for locating poachers was distinct from the VE interviews. Additionally, various methods have been employed to collect data in research aimed at conserving biocultural diversity through community engagement [57].

The study successfully interviewed a total of 55 people, consisting of 53 random respondents who completed the VE questionnaire and the remaining two people who were poachers who had hunted Sunda pangolins. Of the 51 random participants in the VE interviews, 48.3% were female, and 51.7% were male. All poachers who were interviewed in-depth were male.

Data analysis

Data were analyzed quantitatively based on responses from the data sources. Some qualitative data were transformed into quantitative data using coding, specifically ordinal types such as gender, tribe, willingness to conserve, and knowledge level of national policies. Other variables related to community knowledge regarding the Sunda Pangolin’s ecological, social, economic, and conservation policy aspects were expressed as weighted numerical data. Weighting was applied to the answers of each variable, adjusted into low (score 1), medium (score 2), and high (score 3) categories. Descriptive statistics produced scores ranging from 1 to 3. Subsequently, the variables related to the people's knowledge level were tested for their relationship with the willingness to conserve pangolins based on the urgency of protecting Sunda pangolins. The nature of this relationship was determined using the Rho Spearman Correlation, while the extent of the relationship between variables (level of perspective similarity) was mapped using a perceptual map or non-metric multidimensional scaling (MDS). MDS visualizes the degree of similarity among individual cases from a dataset, assisting in formulating targeted conservation strategies [58]. MDS is executed without the Distance option, allowing for default preprocessing by MDS, which results in improved Kruskal Stress values (closer to zero) [59]. A good model is indicated by an S-Stress value lower than 0.25. All statistical analyses were conducted using the Orange Data Mining 3.36.1 tool, with the processing flow presented in Fig. 2.

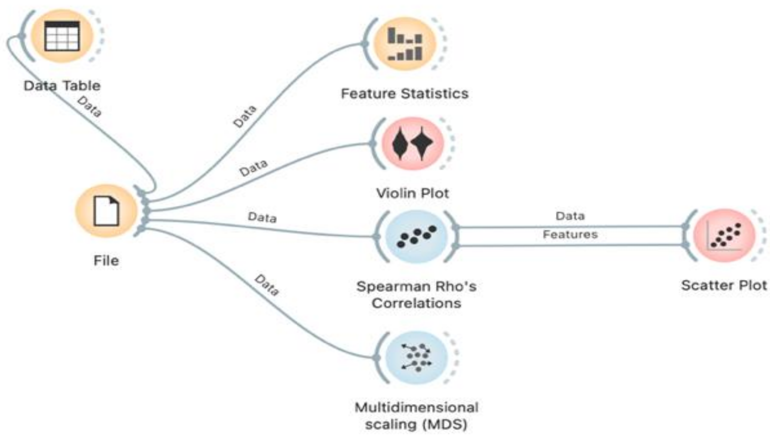

Fig. 2. The flow of the analysis process on the research data was constructed using the Orange Data Mining application

Results and discussion

The knowledge of the people assessed in this study includes their understanding of the Sunda pangolin from ecological, social, economic, and policy perspectives. Such understanding is a key element in supporting conservation efforts for this species. While previous studies have recorded related data, none have comprehensively integrated different aspects of sustainability to predict positive attitudes and trigger future conservation efforts. In Malaysia, communities showed positive attitudes towards pangolin conservation, with the highest attitude score (93.34%), followed by knowledge (81.15%) and practice (79.63%). However, conservation practices still need to be improved, and factors influencing these practices need to be further identified [60], especially since there is lower awareness of incentives for reporting wildlife crime [61].

General distribution of people's knowledge on all aspects of the study

This study found that most respondents in Jambi province, an area known for illegal pangolin trade, are familiar with pangolins. Only 5.45% claimed to have never seen a pangolin, while 10.91% had only encountered them through books, the internet, or television. More than 83% of respondents had seen a pangolin in person (Fig. 3).

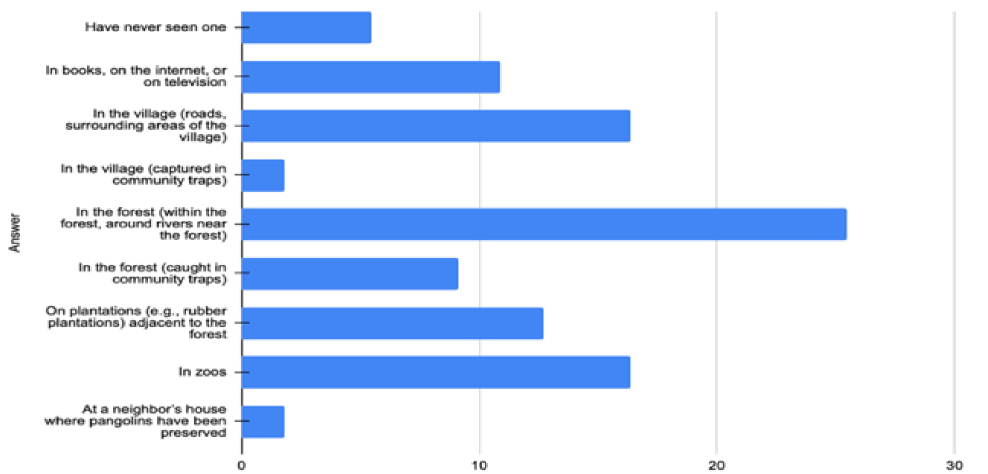

Fig. 3. Specific locations of respondents who have seen the Sunda pangolins (%)

Overall, participants' knowledge level was medium, with a mean of 1.96 on a 1-3 scale across all measured variables. The distribution of knowledge levels showed no significant differences between variables, indicating a balanced understanding of the Sunda pangolin's ecological, social, economic, and policy aspects (Fig. 4). The study clearly demonstrates a similar, interconnected understanding of pangolins among people in Jambi province.

Meanwhile, the gender gap in knowledge levels is evident among local policy entities, though it's not particularly pronounced elsewhere. Women's awareness of local policies remains limited. The results of the in-depth interview clarify this. Poaching activities are primarily conducted by men, so it's not surprising that the effort to extract information is also predominantly carried out by men. Fig. 5 provides detailed information on gender and knowledge levels.

	Name	Distribution	Mean	Mode	Median	Dispersion	Min.	Max.	Missing
N	EcologicalKnowledgeLevel		1.96078	2.22062	1.98398	0.164287	1.03744	2.45725	0 (0 %)
N	EconomicUseValue		1.96078	2.43902	2.43902	0.371101	0.00	2.43902	0 (0 %)
N	ExistLocalPolicy		1.96078	0.00	2.27273	0.856027	0.00	4.54545	0 (0 %)
C	Gender			Male		0.693			0 (0 %)
C	NatPolicyProtectedKnowledge			Protected		0.624			0 (0 %)
N	SocialUseValue		1.96078	2.17178	2.17178	0.212691	0.00	2.72698	0 (0 %)
C	Tribe			Jambi Malay		1.66			0 (0 %)
C	WillingProtect			5. StronglyNeeds		0.719			0 (0 %)

Fig. 4. Descriptive statistics for all features analyzed. Code N for numeric data type, C for categorical data

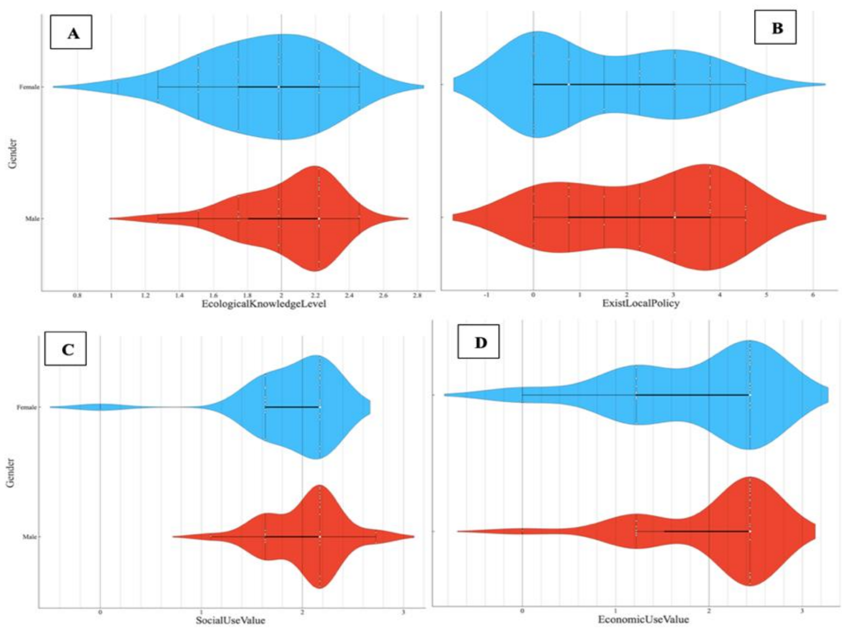

Fig. 5. The violin plot level assesses people's knowledge of the Sunda pangolin's ecological, social, economic, and policy aspects towards its gender

People's knowledge of the ecological aspects of the Sunda Pangolin

The ecological knowledge of the individuals surveyed in this study encompasses species classification, physical characteristics, reproductive mode, and the ecological benefits of the Sunda pangolin. Understanding public knowledge of the Sunda pangolin is a fundamental step in educational efforts and information dissemination to increase societal support for conservation initiatives [60]. Furthermore, familiarity with these ecological aspects can aid in recognizing the species' presence despite its declining population [50]. Table 1 presents the range of responses measuring respondents' knowledge of the Sunda pangolin.

As shown in Table 1, 96.36% of respondents could recognize the physical characteristics of the Sunda pangolin. The most commonly identified traits included a body covered in scales, a long tail, a long and sharp tongue, a long and sharp snout, and long and sharp claws (n = 45.75%). Additionally, 10.91% of respondents recognized the Sunda pangolin as a mammal that curls into a ball as a defense mechanism. These variations in knowledge indicate that while the species' physical traits are widely recognized, its behavioral aspects receive less public attention.

Most respondents (78.18%) correctly identified the Sunda pangolin as a mammal, although 21.82% mistakenly classified it as a reptile. This misconception aligns with responses regarding its reproductive mode, where 85.45% correctly stated that the Sunda pangolin is viviparous, while 12.73% erroneously believed it lays eggs. The respondents' correct answers align with studies confirming the Sunda pangolin as a mammal within the order Pholidota, characterized by mammary glands and viviparity, with a gestation period ranging from 70 to 140 days depending on the species [62], [63]. However, the misconception arises from the pangolin's scaly exterior, which resembles reptilian characteristics and leads to confusion regarding its reproductive biology. This highlights how the unique physical traits of the pangolin can obscure taxonomic understanding despite clear scientific evidence [64].

Table 1. Survey responses describing the ecological aspect of the Sunda pangolin in research

Ecological Question	Respondents's Answer	Percent of the answers	Number of answers
What kind of animal is the Sunda Pangolin?	1. Mammal	78.18	43
	2. Reptile	21.82	12
		100.00	55
What does a pangolin look like?	1. Body: covered in scales; long tail, tongue and snout; long and sharp nails	81.82	45
	2. Behavior: rolling (making the body like a ball), creeping, walking	10.91	6
	3. Strong animal	1.82	1
	4. Food type: ants	1.82	1
	5. Don't know	3.64	2
		100.00	55
What is the Sunda pangolin's reproductive mode?	1. Viviparous	85.45	47
	2. Oviparous	12.73	7
	3. Don't know	1.82	1
		100.00	55
What are the benefits or functions of pangolins to nature/ecology/environment?	1. Ecosystem balancers: part of the food chain, they can maintain habitat for other species	36.36	20
	2. Insect population control (natural pest control): insect eaters, restrain overgrowth of ants and termites	16.36	9
	3. Soil quality maintainers: Loosens the soil, helps the decomposition process, mixes organic matter in the soil through holes	16.36	9
	4. Don't know	30.91	17
		100.00	55

Regarding its ecological benefits, a significant portion of respondents (30.91%) were unaware of the Sunda pangolin's role in the ecosystem. This is concerning, given its critically endangered status and vulnerability to illegal trade. Many people lack in-depth knowledge about the species and its habitat, except for poachers and individuals living near forested areas who have encountered pangolins firsthand. The Sunda pangolin primarily feeds on ants and termites. Among respondents, 36.36% recognized its ecological function in controlling ant and termite populations, while 16.36% acknowledged its role in soil aeration and organic matter decomposition through its foraging behavior. However, knowledge about the pangolin's activity patterns was less prevalent. According to in-depth interviews with poachers, Sunda pangolins are commonly observed at night (as a nocturnal species) near anthills or termite mounds, particularly during the rainy season or after light showers. During the day, they typically rest in tree hollows of species such as Kulim (*Scorodocarpus borneensis*), fig trees (*Ficus* spp.), and kapok trees (*Ceiba pentandra*). These behavioral patterns have also been reported in previous studies [65]-[70].

The discrepancies in ecological knowledge among respondents indicate a knowledge gap, potentially influenced by varying levels of participation and access to information via mass media. Individuals involved in the pangolin trade at the local level (driven by external demand), as poachers or intermediaries, are more exposed to market information regarding pangolin prices, which in turn motivates them to hunt and inadvertently acquire knowledge through experience in the species' habitat. In contrast, most study participants had occupations unrelated to land use or direct interaction with pangolin habitats, including employees (28.9%), entrepreneurs (17.8%), teachers and lecturers (17.8%), homemakers (13.3%), students (8.9%), civil servants (6.7%), and midwives (2.2%). The higher recognition of pangolins among respondents is likely influenced by their proximity to national parks [71] and the tendency of urban working groups and students to have lower awareness of local ecological knowledge [43]. Additionally, improved road infrastructure and closer proximity to urban centers, such as in Cameroon, have been identified as factors facilitating greater public exposure to pangolins and their market value [72]. These findings highlight the urgent need for more targeted educational initiatives to bridge the existing knowledge gap.

People's knowledge of the socioeconomic aspects and regulatory framework of the Sunda Pangolin

Descriptive statistical analysis and previous findings indicate that most people recognize the physical characteristics of the Sunda pangolin and understand its role in human life. However, dispersion analysis (Fig. 6) shows that knowledge about ecological (*EcologicalKnowledgeLevel*) and social aspects (*SocialUseValue*) has the lowest dispersion values (0.16 and 0.21, respectively). In contrast, knowledge about economic aspects (*EconomicUseValue*) and policies (*ExistLocalPolicy*) exhibits greater variance, around 0.37 and 0.86, respectively. This suggests that while nearly all respondents acknowledge the high economic value of this species—either for medicinal use or illegal trade—they are also aware of existing regulations in Indonesia.

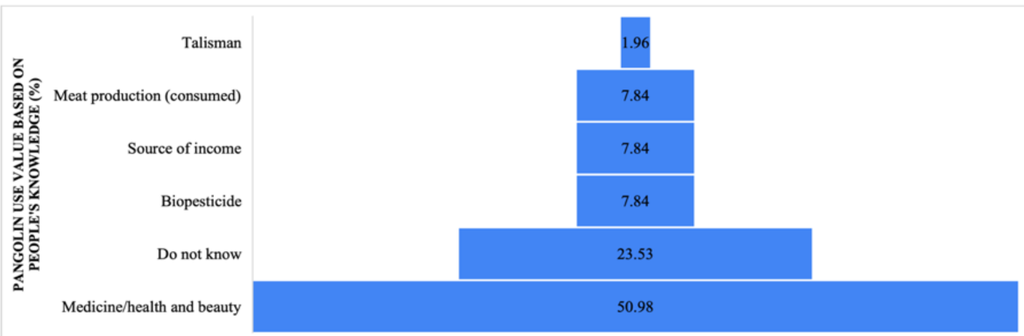

Fig. 6. The Sunda pangolin's value for humans is based on people's perspectives

A significant portion of respondents (n = 78.43%) believe that the government strictly protects the Sunda pangolin (*NatPolicyProtectedKnowledge*). However, some remain uncertain about whether the species is regulated under local policies (Table 2), as reflected by a minimum value of 0 in those aspects. There are no customary laws or local policies specifically governing Sunda pangolin management, such as harvest limits, designated hunting areas or seasons, or specific hunting methods. Currently, legal protection for the Sunda pangolin in Indonesia is primarily enforced under the Minister of Environment and Forestry Regulation No. 106/2018, which lists protected flora and fauna species. Nonetheless, these findings suggest a general consensus among respondents that the Sunda pangolin holds ecological, social, and economic significance. Evidence of this is seen in the five primary uses of the species identified through interviews (Fig. 6), including its use in traditional medicine and cosmetics (n = 50.98%), as a natural pest control agent against ants and termites (n = 7.84%), for consumption (n = 7.84%), as a talisman (n = 1.96%), and as an alternative source of income through illegal trade (n = 7.84%).

Table 2. Aspects of customary rules in the pattern of using pangolins

Aspects	Formerly*)	Presently**)	Description
Amount of individual	Unregulated	Unregulated	No rules regarding how many pangolins can be poached from their habitat.
Size	Unregulated	Unregulated	No guidelines regarding the size of pangolins that are permitted to be poached.
Sex ratio	Unregulated	Unregulated	No guidelines regarding male or female pangolins that permit poaching.
Time and location	Unregulated	Unregulated	No rules regarding when and where the pangolins can be poached from their habitat.
Method or technique	Unregulated	Unregulated	No rules, but there is a limited knowledge of conventional techniques (climbing trees or using fire to get pangolins down from trees, machetes, and dogs)

*) Before protected status; might be 20 years ago

**) Before IUCN fixed the status as critically endangered and CITES as Appendix I

The inconsistency in responses regarding local policies and national protection measures for the Sunda pangolin highlights the urgent need to enhance public awareness. Strengthening monitoring efforts for illegal trade distribution is crucial. An open-market survey was conducted to verify people's knowledge of Sunda pangolin utilization and confirm these findings. Pills marketed for treating skin diseases were discovered in a major market in Jambi City (Fig. 7). Although discussing pangolin-based medicine with traditional drug sellers proved challenging, one shop openly displayed and allowed documentation of such a product. Further online research revealed a surprising discovery: similar products were also available for sale on Indonesian e-commerce platforms (Fig. 8).

Fig. 7. A traditional medicine product made from pangolins (it is unclear whether it is from Sunda pangolins). This product is popular because many believe it is effective in treating skin diseases, especially acne, although it is only available in one shop

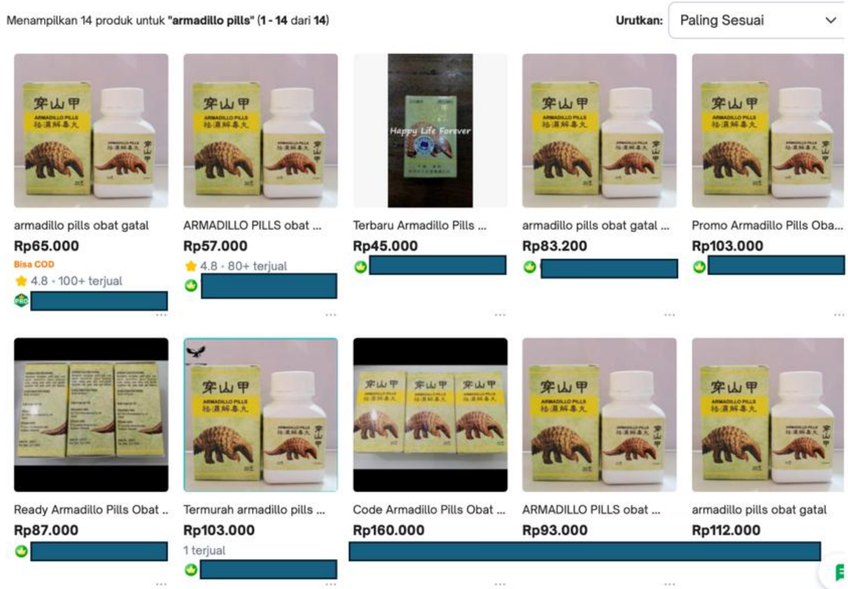

Fig. 8. One of the Indonesian e-commerce sites sells many medicinal products made from pangolins to treat skin diseases

Relationships Among Factors Constituting People's Knowledge in Sunda Pangolin Conservation

Ecological knowledge within various communities serves as a foundation for environmental management [73]. Local knowledge offers practical wisdom to address environmental challenges [74], [75] and bridges traditional understanding and conservation science, fostering community-driven conservation initiatives [76].

Understanding the interrelation between different aspects of community knowledge is crucial for the conservation of the Sunda pangolin. Species protection decisions are influenced by more than just functional reasoning. For instance, farmers' awareness of species protection does not significantly differ between those with and without ecological knowledge [42]. Studies on indigenous forest communities [13] and urban or semi-traditional societies [77], [78] suggest that ecological, social, economic, and policy-related factors interact to shape conservation awareness. Analyzing these interconnections helps assess the community's "willingness to conserve" and informs targeted conservation strategies.

Descriptive analysis results indicated that the average knowledge level among the studied communities was moderate (mean=1.96), with interviews confirming their willingness to conserve Sunda pangolins. Using Spearman's correlation analysis, this study examined factors influencing willingness to conserve. The results (Table 3) showed that while all knowledge aspects had positive but weak correlations (r_s values below 1), the variable *ExistLocalPolicy* (local policy awareness) had a negative correlation. Among these weak correlations, knowledge of social values aligned with economic values ($r_s = 0.422$) and ecological knowledge ($r_s = 0.297$), indicating their interconnected nature. The positive correlation between ecological, social, and economic knowledge suggests that these values reinforce one another. However, the weak correlation between policy awareness and other factors implies that policies are often viewed as separate or less relevant to daily life. Furthermore, local policy knowledge sometimes contradicts social values, reinforcing the perception that formal regulations have little tangible impact or even hinder economic benefits from pangolins. This may explain why no local policies specifically regulate Sunda pangolin conservation (see again Table 2).

Table 3. Spearman Correlation between Aspects of Community Knowledge in Sunda Pangolin Conservation Efforts

Variables	Ecological Knowledge Level	Social Use Value	Economic Use Value	Exist Local Policy
Ecological Knowledge Level		0.297	0.082	0.030
Social Use Value			0.422	-0.100
Economic Use Value				0.013
Exist Local Policy				

Ecologically, pangolins serve as natural predators of termites and ants, helping to control agricultural pests [6], [79]. They also contribute to soil health by aerating the soil during feeding, reducing the need for excessive fertilizer use, which can disrupt soil stability. Protecting this species supports ecosystem services, enhances agricultural productivity, and lowers pest management costs, thereby increasing economic awareness of biodiversity's value [80], [81].

Currently, in the absence of clear local policies, community willingness to protect pangolins depends on other factors, such as economic understanding or national policy pressures. This underscores the need for education on pangolins' ecological benefits to raise economic awareness of conservation importance. Public outreach should emphasize the species' vital role in ecological systems and its direct impact on social and economic aspects. Massive dissemination at the local level can strengthen cultural identity and participation, improve literacy, and promote sustainable social and economic development [82]. Ultimately, increasing awareness of pangolins' ecological and economic significance can drive public support for conservation efforts, potentially reducing illegal hunting and habitat destruction [83].

People's favorability towards Sunda pangolin conservation (willingness to conserve)

The future of Sunda pangolin protection depends largely on integrating various factors that influence people's desire to conserve them. The results of the correlation analysis suggest that the linkages among ecological knowledge, awareness of economic value, and local policies are key to designing effective conservation strategies. Improved ecological knowledge can enhance people's economic understanding of the benefits of these species, thereby strengthening support for conservation policies. However, for this synergy to be realized, local policies must be participatory and grounded in the community's understanding of Sunda pangolins' ecological and economic benefits. More inclusive education and policy socialization are needed to bridge the knowledge gap and improve the conservation effectiveness of this endangered species.

The results of the multidimensional scaling analysis (MDS) confirmed support for Sunda pangolin conservation among the communities involved in this study (Fig. 9). In Fig. 9, orange and green colors indicate the urgency of protecting this species, while other colors reflect opposing perspectives. The size of the symbols on the diagram illustrates the extent to which economic (Fig. 9A) and ecological (Fig. 9B) aspects are integrated in respondents' perceptions towards conservation.

Most respondents, especially those familiar with the Sunda pangolin's protection status in national policy, tend to be in the cluster that affirms the urgency of conservation (*StronglyNeeds*). People in this group are generally more knowledgeable about ecological aspects and conservation policies for this species. However, a small segment considers the protection of Sunda pangolins "not very urgent" or "merely necessary" (*Neutral* or *Highly Unnecessary*), as indicated by the blue and red colors in the MDS plot. This group is generally unaware of the species' legal status, as indicated by the X (cross) representing the unknown response to the legal protection status. This lack of understanding could potentially undermine conservation efforts, as ignorance of the legal aspects could reduce the sense of urgency in protecting the species. However, there are some respondents who do not know the legal status of pangolins but still believe that this species needs to be protected (*Need* and *Strongly Needs*).

Interestingly, Figure 9 also shows that there is a group of respondents (see dashed box) who are unaware of the Sunda pangolin's protection status (*Unknown*), have limited ecological understanding, but are well aware of the species' economic value, and still think that the Sunda pangolin should be conserved in the future. This phenomenon indicates a growing public awareness of the pangolin's critical status as an endangered species, possibly influenced by increasing attention to illegal trade and habitat loss.

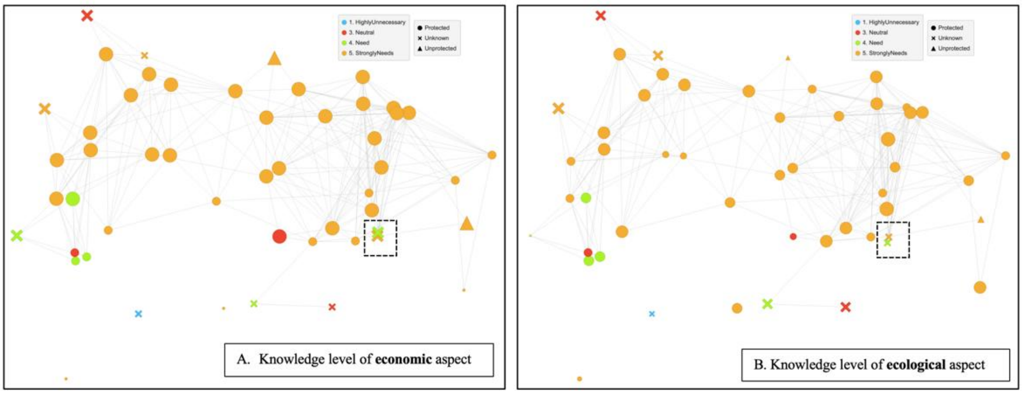

Fig. 9. Multidimensional Scaling (MDS). Colors indicate how important it is to conserve Sunda pangolins in the future. The circle, cross, and triangle symbols indicate people's level of knowledge about the Sunda pangolin's protection status in laws and regulations. The size of the colored symbols is determined by people's economic knowledge, which is used to ascertain, "Should we protect the Sunda pangolin while its economic value is high?" (A) and people's knowledge of its ecological aspects, which is used to ascertain, "will the more we know about pangolin ecology, the more we want to protect it?" (B)

The economic value of wildlife often reduces support for conservation, especially in natural resource-dependent communities. This is because economic benefits from wildlife that are not managed sustainably can create a dependency that reduces incentives for long-term conservation [84]. Conversely, while economic values can support conservation, approaches that focus solely on economic values can overlook non-economic values and lead to conflict [85]. Figure 9 also shows that high awareness of the economic value of pangolins (larger symbols) is not necessarily inversely proportional to willingness to conserve, although there may be a dilemma in making a decision. It is suspected that there is an internal conflict between the desire to economically utilize pangolins (e.g., through the scale trade) and an awareness of the importance of ecological sustainability.

The findings and results of this analysis imply that a complex interplay between levels of knowledge and a sense of belonging shapes people's willingness to conserve. For example, higher levels of ecological knowledge are often associated with greater social value for pangolins and a stronger propensity to support conservation efforts. In Nepal [43] and Hainan, China [50], it has been shown that local knowledge of pangolins is associated with greater support for conservation, for example, in providing supporting information despite declining pangolin populations. In Cameroon, local ecological knowledge is used to collect data on the status of the pangolin population and its threats [72], [86], [87]. Conversely, the economic motivations associated with pangolin exploitation can reduce the will to conserve; therefore, this research also underscores the need for economic alternatives to reduce dependence on the wildlife trade. Therefore, community-based approaches to reduce poaching and illegal trade by increasing incentives for conservation and reducing the costs of living alongside wildlife are essential. However, this must be accompanied by efforts to strengthen law enforcement and improve the monitoring of pangolin populations [61], [88], [89].

Conclusions

The level of community understanding of ecological, social, economic, and conservation policy aspects of Sunda pangolins was generally adequate. However, individuals involved in poaching and illegal trade possess a deeper grasp, particularly regarding ecological aspects. Overall, respondents' knowledge contributed to their willingness to conserve Sunda pangolins, although this effect was weak. The correlation value (r_s) obtained indicates a relationship that is far from strong. Among the weakly correlated factors, the community's understanding of the Sunda pangolin's social value was most clearly related to its economic value ($r_s = 0.422$) and ecological knowledge ($r_s = 0.297$).

Currently, in the absence of firm local policies, people's willingness to protect Sunda pangolins is influenced more by their understanding of the species' economic value or by pressure from national policies. This situation suggests that education on the ecological benefits of Sunda pangolins should be prioritized as a first step in raising community awareness and support for conservation.

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