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Community perspectives of flagship species: can conservation motivators mitigate human-wildlife conflict?

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Public perception of endangered species is crucial for successful management of community-based conservation and sustainability of national parks. By the method of choice experiment, our study evaluated conservation preferences and willingness to donate money for flagship and non-flagship species using a choice experiment with 409 residents living near the Lanstang river source of Sanjiangyuan National Park, China. We found that flagship species such as the Snow leopard (*Pristine plateau*) and White-lipped deer (*Przewalskium albirostris*) generated more conservation funds than non-flagship species. However, not all flagship species were accepted. Respondents disliked Tibetan brown bears (*Ursus arctos pruinosus*) due to direct human-wildlife conflicts such as bodily injury and property damage. Heterogeneity of preference was influenced by household income, religious beliefs, ethnicity, culture, and conservation awareness. Results can be used to establish a local community-participative framework by combining conservation motivations that alleviate human-wildlife conflict.

KEYWORDS

community-based conservation, national parks, conservancy motivations, flagship species, human-wildlife conflicts, choice experiment

1 Introduction

Protected areas are the keystone of global biodiversity conservation, a baseline for the typical earth ecosystem, endangered species, and maintenance of natural and cultural heritage (Schulze et al., 2018). The Chinese government developed a new, three-part classification system of protected areas by designating: 1) national parks (the main body); 2) nature reserves (intermediate); and 3) natural parks such as forest parks, wetland park,

scenic areas, geo-parks, etc. (Supplementary). China decided to adopt the national park system in 2013, more than 150 years after the establishment of Yellowstone, the world's first national park (Mi et al., 2023). However, the concepts and goals of national parks in China and the U.S. are similar: 1) protection, defined as – " a particularly large geographical area of national importance, including intact ecosystems as well as important habitats for wildlife and plant species."And 2) harmony between people and nature to achieve sustainable management of natural resources, defined as – "a complex natural-ecological and socio-cultural system in which humans are an integral part" (Charles, 2021).

At 15th Conference of the Parties to the Convention on Biological Diversity in 2021, China formally established its first set of five national parks. Among them Sanjiangyuan National Park (SNP) is the biggest and covers nearly 2% of the total land area of China (Figure 1). SNP contains typical, but important aspects of the Qinghai-Tibet Plateau ecosystem which is extremely fragile due to the impacts of climate change and human activity (Di et al., 2017). SNP covers 5 counties, 15 towns and 68 administrative villages. More than 95% of the residents are Tibetans, making it a challenge to ensure the livelihoods of locals while preserving ecosystem integrity (Zhang et al., 2020). The Chinese government has implemented an Ecological Relocation Program for relocating some local people to new villages outside the park boundaries to reduce environmental impacts (Peng et al., 2020). However, such projects are expensive and many people, especially long-dwelling residents do not want to leave. SNP proposed and enacted "one household, one post" program in 2016. If one member of the household is employed as an ecological conservator; the whole family can join. Until now, nearly 20,000 herdsmen have been hired, increasing the average annual income of each household by 21,600 RMB (Zhao et al., 2018). This policy not only raises the living standard of herdsmen, but also increases their awareness of conservation by participating in conservation work (Zhao et al., 2018).

Community involvement in national park management has a good foundation in China due to its rich history of co-management experiences for nature reserves over the years (Zhang and Yang, 2020). Resource sustainability, human well-being, and conflict resolution of community-based conservation (CBC) are aligned with the goals of national parks in China (Lee, 2018). CBC approaches integrate multi-disciplinary fields such as political ecology, conservation psychology and environmental history to address social-ecological coupled system (Berkes, 2003; Galvin et al., 2018). Success depends on cooperation among many stakeholders, including collective villager groups, park authorities, government administrative units, NGOs (Non-Governmental Organizations), and other institutions (Berkes, 2007; Doak et al., 2014). In China, CBC policy should focus on community empowerment, supporting autonomy, adaptive co-management projects, equal distribution of benefits, the use of traditional ecological knowledge, and development of cultural-linked conservation ethic, but the social psychological factors are not receiving enough attention (He et al., 2020). For example, establishing a belief system and providing incentives for people to participate in conservation work are poorly developed (Trudgill, 2001; DeCaro and Stokes, 2008).

Residents living near SNP are influenced heavily by Tibetan Buddhism which follows the basic principles of kindheartedness,

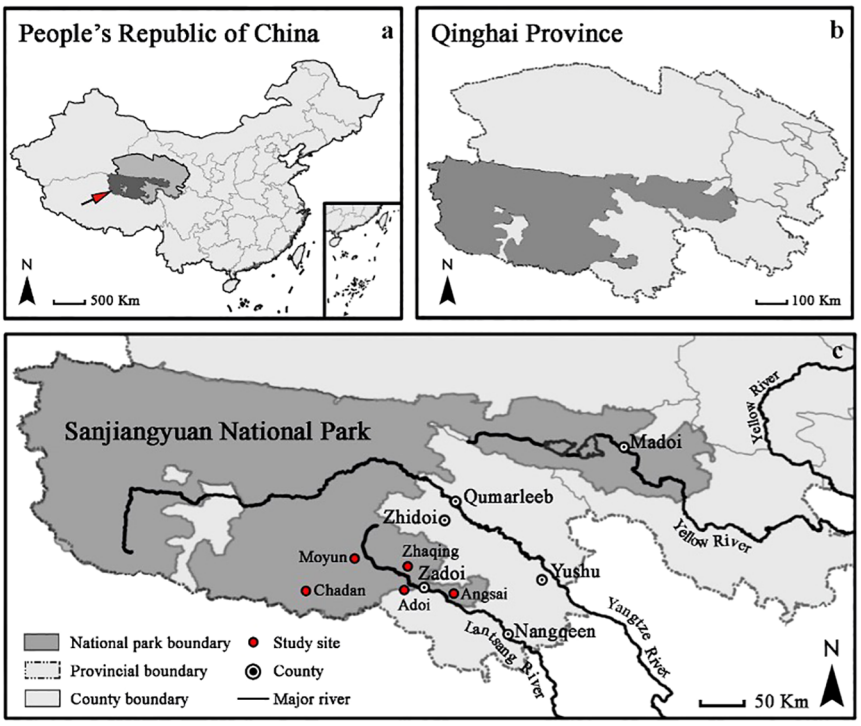

FIGURE 1
Location of Sanjiangyuan National Park in China **(A)**; in Qinghai Province **(B)**; and the study sites **(C)**.

respect, and compassion for all living things. These tenets are shared among those who support nature conservation (Karmapa and Dorje, 2011). The Buddhist faith is an important driver to maintain biodiversity (Shen et al., 2015) since it imparts a sanctity that encourages protection of wild species (James and Cooper, 2007). SNP was once a vast wilderness and a paradise for wildlife, but now the interaction between humans and the environment have led to many conflicts, especially for large carnivores because of their extensive range and dietary needs often overlapping with human activities (Su et al., 2023). The Tibetan brown bear (*Ursus arctos pruinosus*) and gray wolf (*Canis lupus*) are the main species who experience conflict because they kill livestock, destroy houses, and injure people (Dai et al., 2020). Most local people at SNP can tolerate carnivores killing free-range livestock, but bodily injury and house damage are harder to accept (Dai et al., 2019). Conflicts worsen this relationship between locals and wild animals, exhibited by retaliatory actions of residents toward carnivores which threatens species survival (Northrup et al., 2012; Miller et al., 2016; Proctor et al., 2018). As a consequence of these conflicts, the attitudes and behaviors of locals are complex, influenced by publicity for protection, religious and cultural backgrounds, intrinsic value and significance of wildlife, and economic losses caused by these conflicts (Dickman et al., 2011; Kansky and Knight, 2014; Gebresenbet et al., 2018; Tang et al., 2023).

Promotion of flagship or umbrella species is a strategy used by conservationists to achieve sustainable development goals (Brambilla et al., 2013). Flagship species often refer to 'known charismatic species that serve as a symbol or focus point to raise environmental consciousness' (Home et al., 2009). However, the criteria for designating a species as flagship is controversial, on the whole, charismatic species have three attributes: ecological (ethological perspective on the human/environment perception), aesthetic (referring to species behavior or appearance, thus dealing with human emotions), and corporeal (referring to 'affection and emotions engendered by different organisms in their practical interactions with humans') (McGowan et al., 2020; Lundberg and Arponen, 2022). As compared to ecosystem protection, establishing a flagship species is more attractive to the public, which can result in more habitat conservation (Abigail, 2000; Assandri et al., 2017). Flagship species also serve as indicators for conservation outcomes since they increase public awareness and attitudes for endangered species and generate financial support (Bowen-Jones and Entwistle, 2002; Caro et al., 2004). Threatened, charismatic species, usually large vertebrates, have been used as a symbol and rally point for projects, issues, and campaigns (Walpole and Leader-Williams, 2002), thus uniting people to prioritize conservation (Liordos et al., 2017; Thompson and Rog, 2019; Kim et al., 2021). Flagship species, combined with community-based projects, promote attitudinal and behavioral changes of locals, especially if used by the non-governmental organizations (NGOs) as incentives for conservation (Kanagavel et al., 2014; Polgar and Jaafar, 2018).

We used a choice experiment (CE) method to explore the attitudes and perceptions of local Tibetans toward flagship and non-flagship species at SNP in the context of human-wildlife conflict. Our purpose was to assess: 1) community perspectives of endangered species and the emotion and belief basis for participation in conservation; 2) differences in species preference and the heterogeneity of community groups using socioeconomics background; 3) the welfare value of endangered species based on integrated attributes (species importance and degree of conflict); 4) and to propose some viable solutions for community-involved species conservation.

2 Materials and methods

2.1 Study area

Sanjiangyuan National Park (SNP) is located in the hinterlands of the Qinghai-Tibet Plateau. It is a vast area of 190,700 km^2, occupying 26.4% of the total area of Qinghai province (Figure 1). Elevation ranges between 3,335 to 6,564 m, ranging from snow mountains to high-altitude wetlands, forest, rivers, lakes, and grasslands. Known as the "water tower of China," Sanjiangyuan is the source of three great rivers: the Yangtze River, Yellow River, and Lanstang (Mekong) River. SNP is the world's largest, highest, and most concentrated water resource region, including more than 180 rivers, 16,500 lakes, 66,600 km^2 of freshwater marsh, and 1812 km^2 of glaciers (Fan and Fang, 2020). Ecological restoration measures enhance water retention and withstand grassland degradation (Li et al., 2018a).

SNP has a large proportion of threatened and endangered species, including 32.26% mammals and 19.90% birds respectively (Zhang et al., 2023). About 47 mammal species are distributed in SNP, and most of them are endemic to the Qinghai-Tibet Plateau. In addition to Snow leopard (*Pristine plateau*), other carnivores include Gray wolf (*Canis lupus*), Tibetan brown bear (*Ursus arctos*), Eurasian lynx (*Lynx lynx*), Tibetan fox (*Vulpes ferrilata*), Chinese mountain cat (*Felis bieti*) and Pallas' cat (*Otocolobus manul*). Main ungulates include Tibetan antelope (*Pantholops hodgsonii*), wild yak (*Bos mutus*), Tibetan wild donkey (*Equus kiang*), White-lipped deer (*Przewalskium albirostris*), Blue sheep (*Przewalskium albirostris*), Tibetan red deer (*Cervus elaphus wallichii*), and Alpine musk deer (*Moschus chrysogaster*).

2.2 Choice experiment design

The choice experiment (CE) is suitable for evaluating awareness and preferences using marginal willingness to pay (MWTP) for improving programs based on the current situation, followed by a series of options or scenarios which contain different attributes and levels on a specific topic (García-Llorente et al., 2012; Lee and Wang, 2017). The theory of CE is based on the consumer theory and random utility theory of economics, among which multinomial Logit model (MNL), random parameter Logit model (RPL) and latent classification model (LCM) are widely used in CE research (Nguyen et al., 2022). Therefore, respondents can select preferred choice sets to make "optimal" decisions rationally, instead of relying on estimations created by statistical models (Sriarkarin and Lee, 2018). Protected area managers find this decision-making approach

to be useful for revealing stakeholder opinions and values associated with conservation actions regarding endangered species (Lew and Wallmo, 2017) and to assess policies for community-participative management actions and human-wildlife conflict solutions (Tait et al., 2016).

As applied to this study, we selected five important species at SNP as CE model attributes for evaluating local preferences for endangered species conservation, and divided them to two groups: flagship and non-flagship species. We collected species information at SNP from the literature and through focus group discussions with local managers, NGOs, and biological conservation scholars (Nawaz et al., 2008; Zong et al., 2017; Sriarkarin and Lee, 2018; Lee et al., 2019a). A relatively wide range of physical, ecological and cultural characteristics were used to determine flagship species (McGowan et al., 2020): 1) ecological importance, being representatives for promoting endangered species protection in the ecosystem; 2) attractive or symbolic appearance, having cultural significance for local people (Jepson and Barua, 2015; Senzaki et al., 2017); and 3) generate positive attention for agencies and appeal for collective participative conservation action (Liordos et al., 2017; Lundberg et al., 2020).

Snow leopards, some of the most attractive large felids are distributed in Central Asia mountains. They are representative of snow mountains and plateaus and are important endangered species according to many people and institutions, worldwide (Schutgens et al., 2019; Yang et al., 2021). White-lipped deer are found only in Qinghia-Tibet Plateau and the surrounding areas of alpine forest and grassland in China, known as 'sacred deer' by locals. Snow leopards and white-lipped deer have special ecological status in SNP. Tibetan brown bears are an endemic subspecies of the Tibetan Plateau, They are large and fierce omnivores, often considered as the most dangerous animals because they destroy houses and injure people (Worthy and Foggin, 2008; Wu, 2014). It has a unique ecological value, and has an important impact on the relationship between human and wildlife in the SNP area. So, these three species were chosen as flagship species. Blue sheep and gray wolves, which are not flagship species in the SNP area, both in terms of public subjective evaluation and ecological importance, they're not as charming as snow leopards, white-lipped deer and Tibetan brown bears. All five species represent the Qinghai-Tibet Plateau ecosystem and are familiar to local people. Each are important in the endangered species protection plan and for managing human-wildlife conflict at SNP.

Levels of attributes were determined for each of the five species using information regarding their conservation targets and status. Levels of national key protected wildlife of China were used because local people are familiar with this category but hardly know IUCN protection levels of endangered species in Red List. China's legal protected wildlife are divided into first-class and second-class species by the department of wildlife administration under State Council. These species have high ecological, scientific, cultural and social value, including endangered, precious and rare species, and species with high intensity of exploitation and utilization (Jiang, 2016). These two categories of protected species in China include 686 terrestrial wildlife, and only part of them belong to IUCN' threatened species (Huang et al., 2021). SL and WLD are first-class, national key protected species with 3 levels of conservation attributes, and Tibetan Brown Bear (TBB), Blue Sheep (BS) and Gray Wolf (GW) are second-class national key protected species with 2 levels (Table 1). The conservation target of these species at SNP was to recover endangered species populations, and for first-class species Snow Leopard (SL) and White Lipped Deer (WLD) the periodic target was to improve their conservation status.

We designed scenarios for alternative programs by assuming that relevant institutions would set up a conservation trust fund for endangered species. To determine the value of conservation fund options, we delivered 50 pre-survey questionnaires to local respondents, and entered the funding amount they deemed appropriate for sum of species conservation. The numerical

TABLE 1 Attributes and levels for endangered species conservation in Sanjangyuan National Park.

Attributes	Levels	Variables	Types
White Lipped Deer (WLD)	a. Status quo: Class I National key protected species (IUCN, VU)	WLD±	Flagship species
	b. Improve conservation status by reducing threats	WLD1	
	c. Recover the population through conservation efforts	WLD2	
Snow Leopard (SL)	a. Status quo: Class I National key protected species (IUCN, VU)	SL±	Flagship species
	b. Improve conservation status by reducing threats to SL	SL1	
	c. Recover the population through conservation efforts	SL2	
Tibetan Brown Bear (TBB)	a. Status quo: Class II National key protected species (IUCN, LC)	TBB±	Flagship species
	b. Recover the TBB population to non-threatened species	TBB	
Blue Sheep (BS)	a. Status quo: Class II National key protected species (IUCN, LC)	BS±	Non-flagship species
	b. Recover the population through conservation efforts	BS	
Gray Wolf (GW)	a. Status quo: Class II National key protected species (IUCN, LC)	GW±	Non-flagship species
	b. Recover the population through conservation efforts	GW	
Conservation fund	a. Status quo: no conservation fund	FUND*	
	b. 250 RMB/household/year		
	c. 500 RMB/household/year		
	d. 750 RMB/household/year		
	e. 1000 RMB/household/year		

*FUND is a financial attribute, means fund for biodiversity conservation, and RMB means Chinese Renminbi (Yuan).

values were ranked from lowest to highest and percentiles of 24%, 42%, 58% and 72% were selected as the grades of four groups of conservation trust funds (250RMB, 500RMB, 750RMB, and 1,000RMB) (Table 1). Through SPSS orthogonal experiment, 25 level combinations were generated. After eliminating unreasonable options, 19 combinations and 1 status quo remained, resulting in 66 paired choice sets. Each version of the questionnaire consisted of 3 choice sets, and each choice set included 2 alternative programs for a total of 26 versions of the questionnaire (Table 2). Questionnaires (Supplementary Data) consisted of three parts: 1) cognition and attitude toward the endangered species and its conservation; 2) conservation preference for the endangered species at SNP; 3) social-economic data and information on human-wildlife conflict.

2.3 Survey implementation

We conducted a survey in Lanstang river source of SNP during April to July of 2018. Investigation sites included 5 towns of Zadoi county, in Yushu Tibetan Autonomous Prefecture of Qinghai Province, respectively are Chadan, Moyun, Zhaqing, Adoi and Angsai (Figure 1). We sampled households randomly at 19 villages, asking only one individual per household to complete the questionnaire. Because more than 90% of the residents were Tibetan, and the second part of questionnaire was difficult to understand, we hired Tibetan translators. During face-to-face interviews, the investigators explained the scenarios of endangered species conservation, the meaning of choice set, and the alternative programs of different level combinations, so that respondents could match suitable options with their own opinions. A total of 26 versions of the questionnaire were used. We visited 416 residents and collected 409 valid questionnaires (98.3% response), consisting of 110 in Zhaqing, 89 in Moyun, 85 in Chadan, 73 in Angsai and 52 in Adoi township.

2.4 Statistical analysis

Random parameter logit (RPL) and latent class model (LCM) were used to explore the local preferences and heterogeneity for conservation options with endangered species. The models were built using NLOGIT 5. The RPL model evaluated each attribute in relation to heterogeneous preferences and welfare (Sriarkarin and Lee, 2018; Lin et al., 2020). Coefficients from RPL were used to calculate MWTP from potential scenarios of attributes and levels (Lee et al., 2019b; Lin et al., 2020; Wang et al., 2020). LCM can subdivide respondents into different classes based on preferences and socio-economic perspectives to determine explicit management policies (Juutinen et al., 2011; Lee et al., 2019b; Lin et al., 2020).

In the RPL model. Local preferences for endangered species conservation can be expressed as Equation (1):

$$V_{ni} = \beta_1 WLD_i + \beta_2 SL_i + \beta_3 TBB_i + \beta_4 BS_i + \beta_5 Wolf_i + \beta_6 Conservation\ \ fund_i \quad (1)$$

Where $\boldsymbol{V_{ni}}$ the utility function linked with alternative i, β_i is the estimated coefficient of alternative i, and WLD_i, SL_i, TBB_i, BS_i, $Wolf_i$ and $Conservation\ \ fund_i$ represent attribute vector coefficients. Results of the RPL model were used to calculate the marginal welfare effects. the values of community marginal conservation fund for five endangered species are calculated as the ratio of two parameters associated with the attribute ($\beta_{attribute}$) and the estimated coefficient of the monetary attribute (β_c), as shown in Equation (2):

$$Marginal\ \ conservation\ \ fund_{per\ \ attribute} = \frac{\beta_{attribute}}{\beta_c} \quad (2)$$

Where $\boldsymbol{\beta_{attribute}}$ is the coefficient of local preference for endangered species conservation, and $\boldsymbol{\beta_c}$ is the coefficient of conservation fund.

TABLE 2 Example of a choice set for locals' preferences toward endangered species conservation (Red, yellow and green represent the different levels for conservation and recovery of these species).

Choice set 1	Program 1 ⌈ Additional conservation action ⌋	Program 2 ⌈ Additional conservation action ⌋	Status quo ⌈ No additional conservation action ⌋
White-lipped Deer	Status quo—**First-class** national key protected species	**Recover the population** through conservation efforts	Status quo—**First-class** National key protected species
Snow Leopard	**Improve conservation status** by reducing threats	Status quo—**First-class** national key protected species	Status quo—**First-class** national key protected species
Tibetan Brown Bear	Status quo—**Second-class** national key protected species	Status quo—**Second-class** national key protected species	Status quo—**Second-class** national key protected species
Blue Sheep	Status quo—**Second-class** national key protected species	Status quo—**Second-class** national key protected species	Status quo—**Second-class** national key protected species
Gray Wolf	**Recover the population** through conservation efforts	Status quo—**Second-class** national key protected species	Status quo—**Second-class** national key protected species
FUND	$750 RMB/person/year	$250 RMB/person/year	—
CHOICE	☐	☐	☐

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3 Results

3.1 Attitudes and cognition to endangered species conservation

The sample consisted mostly of males (71.8%) since they were more willing to be interviewed than females (28.2%). However, gender was non-significant (*Pearson Chi-Square test, $\chi 2 = 1.576$, df=1, p=0.209*, using a 95% confidence interval). Overwhelmingly, respondents were from Tibet (96.1%) and most of them (54.4%) attended a Tibetan language school. Education levels were comparatively low: 50.9% primary school education or lower. Over two-thirds (68.5%) of respondents have lived in community for more than 10 years (for more information on socioeconomics of respondents, see Table 3). Over half (59.9%) of the households had annual incomes of more than 50,000 RMB, mostly from cordyceps (*Cordyceps militaris*) (87.3%). Others had monthly wages (30.3%), grassland awards and subsidies (25.2%), turf income (12.5%), and subsidies for poor households (9.5%).

Regarding the cognition of conservation status and willing to protect endangered species, Snow leopard scored the highest (92.4% and 99.3% respectively), white lipped deer and blue sheep had lower cognition (77.3% and 75.8%) and higher willingness (99.3% and 99.5%). Fewer respondents knew that Tibetan brown bears and gray wolves were second-class national key protected animals (68.7% and 60.6%, respectively) and willing to protect them (86.6% and 85.8%, respectively). Over three-fourths (81.9%) of the respondents were concerned about endangered wildlife conservation, and they had more positive attitudes toward the protective effect of national park, and participating to protect these species (see the first three group of bars, Figure 2). Factors prompting wildlife protection mainly consist of religious beliefs (93.4%), national regulations and policies (89%), contact with nature (77.3%), family tradition and inheritance (76.3%), and guidance by NGOs (67.7%) (see the fourth to eighth group of bars, Figure 2).

TABLE 3 Basic social-economics information of locals' respondents.

Characteristics	All respondent (n=409)	Concern about the topic of endangered species conservation	
		Yes (n=335)	No (n=74)
Gender			
Male	294 (71.8%)	245 (73.1%)	49 (66.2%)
Female	115 (28.2%)	90 (26.9%)	25 (33.8%)
Age			
20-29 years old	91 (22.3%)	80 (23.9%))	11 (14.9%)
30-39 years old	117 (28.6%)	98 (29.2%)	19 (25.7%)
40 years old and elder	201 (49.1%)	157 (46.9%)	44 (59.4%)
Education level			
Primary school and under	208 (50.9%)	162 (48.4%)	46 (62.2%)
Junior and senior high school	56 (13.7%)	52 (15.5%)	4 (5.4%)
College and above	145 (35.4%)	121 (36.1%)	24 (32.4%)
Family size			
1-3 people	95 (23.3%)	80 (23.9%)	15 (20.3%)
4-6 people	212 (51.8%)	175 (52.2%)	37 (50.0%)
More than 6 people	102 (24.9%)	80 (23.9%)	22 (29.7%)
Household annual income			
50, 000RMB and under	395 (96.6%)	325 (97.0%)	70 (94.6%)
50, 000-100, 000RMB	13 (3.2%)	10 (3.0%)	3 (4.1%)
100, 000RMB and above	1 (0.2%)	0 (0.0%)	1 (1.3%)
Residence length in the community			
1-10 years	129 (31.5%)	102 (30.4%)	27 (36.5%)
11-20 years	187 (45.7%)	160 (47.8%)	27 (36.5%)
More than 20 years	93 (22.8%)	73 (21.8%)	20 (27.0%)
Raise domestic livestock or not			
Yes	130 (31.8%)	100 (29.9%)	30 (40.5%)
No	279 (68.2%)	235 (70.1%)	44 (59.5%)
Join environmental group or not			
Yes	110 (26.9%)	89 (26.6%)	21 (28.4%)
No	299 (73.1%)	246 (73.4%)	53 (71.6%))
Know the conservation and monitoring institutions of endangered species [a]			
Yes	328 (80.2%)	291 (86.9%*)	37 (50.0%*)
No	81 (19.8%)	44 (13.1%*)	37 (50.0%*)
Willing to donate money to endangered species conservation [b]			
Agree and strongly agree	316 (77.3%)	272 (81.2%*)	44 (59.3%*)
Neutral	80 (19.6%)	54 (16.1%*)	26 (35.1%*)
Disagree and strongly disagree	13 (3.1%)	9 (2.7%*)	4 (5.4%*)

a: $\chi^2 = 31.723$; P=0.000; b: $\chi^2 = 11.031$; P=0.004

The relationship between humans and wild animals was discussed during the face-to-face interviews. Two-thirds of respondents (66.5%) think that wildlife damage results in trouble. Main conflicts included: 53.3% destruction of houses and other property by Tibetan brown bears; 27.3% livestock injured or killed by snow leopards or wolves; 18.1% human injury mostly by bears; and 8.6% ungulates competing with livestock for grass.

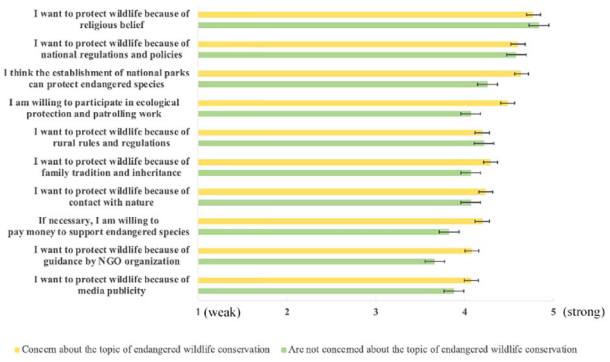

FIGURE 2
Local' attitudes to endangered species conservation, participation, and wildlife protection motivators.

3.2 Local preferences for endangered species conservation

The log-likelihood ratio (LLR) indicated that our RPL models had a high fitness for endangered species protection preference estimation since nearly all the attributes and levels were significant including conservation fund after the interaction with FUND (Table 4). Results from the RPL model showed that respondents would like to select additional conservation actions rather than status quo. Local people were more inclined to support population recovery for SL, WLD and BS, than improve conservation status of SL and recover the GW population. Yet TBB population recovery was not supported. Willingness to contribute to the conservation fund goes down as the amount goes up. Moreover, the coefficient of interaction between FUND with D4, D6 and D3 was significant, meaning that residents who are Tibetan, with annual household incomes not higher than 70000RMB, think wild animals can injure livestock, and were more reluctant to support a conservation fund for endangered species.

The welfare effect of endangered species conservation was estimated based on marginal conservation fund. For flagship species conservation, the highest value of Mean WTP was recovering WLD population (361.4 RMB/household/year, 95% CI 340.8~381.9), followed by the SL population (308.8 RMB/household/year, 95% CI 289.1~312.5). However, the Mean WTP of recovering TBB population had a negative value (-91.8 RMB/household/year, 95% CI -125.9~57.7). For results of non-flagship species, recovering the BS population got more conservation fund support (234.8 RMB/household/year, 95% CI 138.3~331.3) than

TABLE 4 Estimation results of Random Parameter Logit Model.

Attributes and levels	Coefficient (*t* Value)	Coef. Std. (t value)	Attributes and levels	Interaction with FUND	
				Coefficient (t value)	Coef. Std. (t value)
WLD1	-0.159 (-0.940)	1.398 (2.190)**	WLD1	-0.198 (-1.140)	0.909 (2.090)**
WLD2	2.355 (2.880)***	0.911 (1.420)	WLD2	2.812 (3.590)***	0.783 (0.960)
SL1	0.415 (2.200)**	0.577 (1.300)	SL1	0.565 (2.810)***	0.327 (0.580)
SL2	1.455 (2.900)***	0.301 (0.340)	SL2	1.775 (3.710)***	0.270 (0.370)
TBB	-0.592 (-2.510)**	0.375 (0.590)	TBB	-0.714 (-3.060)***	0.973 (1.970)**
BS	1.553 (2.810)***	1.501 (2.320)**	BS	1.826 (3.520)***	1.680 (2.830)***
GW	0.239 (2.070)**	0.807 (1.550)	GW	0.322 (2.560)**	0.839 (1.730)*
FUND	-0.001 (-0.890)	0.000 (0.020)	FUND	-0.008 (-2.530)**	0.000 (0.110)
			D1*FUND	0.001 (0.760)	0.000 (0.020)
			D2*FUND	-0.001 (-1.120)	0.000 (0.050)
			D3*FUND	0.003 (1.700)*	0.014 (3.250)***
			D4*FUND	0.007 (2.590)***	0.000 (0.040)
			D5*FUND	0.001 (0.790)	0.000 (0.040)
			D6*FUND	-0.002 (-2.219)**	0.000 (0.130)
Log-likelihood ratio	825.427		Log-likelihood ratio	887.610	
Chi Square	$\chi^2_{0.01}$ (16) = 23.540***		Chi Square	$\chi^2_{0.01}$ (28) =37.920***	

***, **, * ==> significance at 1%, 5%, and 10% level, respectively. D1: Know the conservation and monitoring institutions of endangered species; D2: Willing to donate money to endangered species conservation; D3: Think wild animals injure livestock; D4: Tibetan; D5: Junior high school and under; D6: Annual household income higher than 70000 RMB.

that of the GW population (41.5 RMB/household/year, 95% CI 12.5~70.5). In general, locals were willing to pay more for conserving flagship species than non-flagship species, but not including conflict species.

3.3 Preference heterogeneity based on community perspectives

Results from the LCM analysis showed heterogeneity after incorporating social-economic variables into the model and segmenting respondents into three types by their preferences (Table 5). Over half of the locals (56.0%) are multi-species conservation seekers who prefer a variety of animals except for Tibet brown bears (without significant t value). The second type (30.7%) of individuals have strong preference and conflict simultaneously. They prefer fund to WLD, BS and SL population recovery, but dislike TBB and GW, and disapprove the conservation status of two first class national key species. The third type is also the smallest group (13.3%). They are less concerned about endangered species conservation, only willingness to recover WLD population and dislike TBB, and exhibit a lack of preference for other species.

Heterogeneity of community perspectives can be useful for distinguishing separate groups based on social-economic characteristics (Table 6). The group of multi-species conservation includes more people with higher household income for contributing to the protection of endangered species due to religious beliefs. In contrast, people in the other two groups have lower household income. The group that has the least amount of conservation concern consists of those who are less focused on endangered species conservation and who know little about the agencies who protect and monitor them. These residents suffered more human-wildlife conflict issues (i.e., they think wild animals

TABLE 5 Estimation results of Latent Class Model.

Attributes and Levels	Class I (56.0%) Multi-species conservation		Class II (30.7%) Strong preference and conflict		Class III (13.3%) Less concern to conservation	
	Coefficient	*t* value	Coefficient	*t* value	Coefficient	*t* value
WLD1	0.771***	3.110	-3.240***	-3.660	-0.619***	-2.820
WLD2	1.960***	5.230	4.560***	3.900	0.729***	3.040
SL1	1.89***	4.750	-3.860***	-2.960	0.005	0.040
SL2	1.98***	6.870	1.480***	2.970	0.107	0.430
TBB	0.475	1.500	-1.840***	-3.840	-0.373**	-2.050
BS	1.190***	6.050	3.190***	4.220	0.077	0.570
GW	0.753***	4.600	-1.170***	-2.670	0.111	0.790
FUND	-0.009***	-4.280	0.017***	3.570	0.002**	2.150
Parameters			Class I		Class II	
			Coefficient	*t* value	Coefficient	*t* value
Constant			-10.540**	-2.010	-10.710**	-2.030
Gender			-6.220	-0.930	-6.680	-1.000
Age			10.890	1.410	10.670	1.380
Tibetan			16.330*	1.920	16.270*	1.910
Annual household income above 70,000 RMB			14.590*	1.760	13.930*	1.680
Concern about the topic of endangered animal conservation			15.110*	1.820	15.640*	1.880
Think wild animals injure livestock			-25.150*	-1.600	-25.950*	-1.650
Think wild animals compete with livestock for grass			27.560*	1.720	28.080*	1.750
Number of choice sets			1227.000			
Log-likelihood Ratio			980.110			
Chi Squared			$x^2_{0.01}(40)$= 51.800***			

***, **, * ==> significance at 1%, 5%, and 10% level, respectively.

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TABLE 6 The cross comparison for clusters and attributes of locals' attitude towards endangered species conservation.

Clusters / Variables	Multi-species conservation	Strong preference and conflicts	Less concern to conservation
	Frequency (Percentage)		
Annual household income (RMB)			
Higher than 70,000	151 (60.6)	27 (28.1)	16 (25.0)
Lower than 70,000	98 (39.4)	69 (71.9)	48 (75.0)
Chi-square=44.69*			
Tibetan or not			
Yes	244 (98.0)	94 (97.9)	55 (85.9)
No	5 (2.0)	2 (2.1)	9 (14.1)
Chi-square=9.15*			
Concern about the topic of endangered species conservation			
Yes	211 (84.7)	89 (92.7)	36 (56.2)
No	38 (15.3)	7 (7.3)	28 (43.8)
Chi-square=40.9*			
Know the conservation and monitoring institutions of endangered species			
Yes	213 (85.5)	79 (82.3)	36 (56.3)
No	36 (14.5)	17 (17.7)	28 (43.8)
Chi-square=27.85*			
Raise domestic livestock			
Yes	72 (28.9)	22 (22.9)	36 (56.3)
No	177 (71.1)	74 (77.1)	28 (43.8)
Chi-square=22.09*			
Think wild animals injure livestock			
Yes	50 (20.1)	4 (4.2)	58 (90.6)
No	199 (79.9)	92 (95.8)	6 (9.4)
Chi-square=7.65*			
Think wild animals hurt people			
Yes	28 (11.2)	18 (18.8)	28 (43.8)
No	221 (88.8)	78 (81.3)	36 (56.3)
Chi-square=36.33*			
Think wild animals destroy house and other property			
Yes	116 (46.6)	52 (54.2)	50 (78.1)
No	133 (53.4)	44 (45.8)	14 (21.9)
Chi-square=20.38*			
Willing to donate money to endangered species conservation			
Disagree and strongly disagree	3 (1.2)	3 (3.1)	7 (10.9)
Neutral	39 (15.6)	23 (24.0)	18 (28.1)
Agree and strongly agree	207 (83.2)	70 (72.9)	39 (61.0)
Chi-square=24.90**			

(Continued)

TABLE 6 Continued

Clusters / Variables	Multi-species conservation	Strong preference and conflicts	Less concern to conservation
	Frequency (Percentage)		
Protect wildlife for the reasons of religious belief			
Disagree and strongly disagree	5 (2.0)	2 (2.1)	1 (1.6)
Neutral	41 (16.5)	35 (36.5)	20 (31.3)
Agree and strongly agree	203 (81.5)	59 (61.4)	42 (65.6)
Chi-square=27.90**			
Protect wildlife because of the guidance of NGOs			
Disagree and strongly disagree			
Neutral	3 (1.2)	2 (2.1)	4 (6.3)
Agree and strongly agree	72 (28.9)	30 (31.3)	21 (32.8)
Chi-square=16.42**	174 (69.9)	64 (66.7)	39 (60.9)

*$\chi^2_{0.05}$ (2) =5.99, P<0.05. **$\chi^2_{0.05}$ (4) =9.49, P<0.05.

injure livestock, destroy houses and other property), because most of them raise domestic livestock. The group consisting of strong preference and conflict shared similar characteristics with the first group, i.e., those who are concerned about species conservation, but they also have more conflicts with Tibetan brown bears (because they destroy houses and hurt people; Table 6).

4 Discussion

4.1 Flagship species conservation preference and the impacts of human-wildlife conflicts

Successful biodiversity conservation requires stable and reliable support from local people, rooted in positive attitudes and awareness for endangered species, which influence their behavior and participation for protection (Addison et al., 2016; Colléony et al., 2017). Conservation awareness of community residents is important since it will help them understand the existing problem and what can be done to protect the endangered species (Baharum et al., 2017; Jalil and Mat Sharif, 2018). If positive, public opinion on flagship species can increase fundraising and improve conservation targets and ecosystem services (Senzaki et al., 2017; Gonga et al., 2020). Conservation awareness can be raised through effective policy implementation and appropriate incentives for information dispersal aimed at enhancing attitudes toward flagship species (Barua et al., 2010; Thompson and Rog, 2019). Yet the effectiveness of this approach for promoting regional biodiversity is controversial in many regions worldwide who invest large sums of money for conservation efforts (Sergio et al., 2008; Timmer et al., 2019).

Our results showed that snow leopards, as a symbolic endangered species at SNP, generated the most concern and support for protection. They also received the greatest preference for population recovery and conservation status improvement. Welfare values of snow leopards and white-lipped deer are higher than other non-flagship species. Most respondents were concerned about conserving endangered species and the relevant agencies for managing them. In other words, positive attitudes and perceptions benefit species conservation strategies at SNP and local governments (Li et al., 2013; Qian et al., 2020; Dai et al., 2022). For non-flagship species (such as BS and GW), conservation preference and MWTP value were also high, indicating that less popular species can reflect local support for conservation (Veríssimo et al., 2017). This is noteworthy when compared against unique "charismatic" species. Tibetans have a tradition of protecting all life, meanwhile special conservation and management measures are implemented to snow leopards and white-lipped deer because of their important ecological status in SNP. There are some examples for different conservation preference of public to different kinds of species (Wallmo and Lew, 2012; Garnett et al., 2018; Lundberg et al., 2019). Improving media propaganda, knowledge and attitudes of locals would benefit the conservation of non-flagship species (Curtin and Papworth, 2018; Shreedhar and Mourato, 2019).

But not all flagship species at SNP have local support. Aversion to the Tibetan brown bear illustrates the seriousness of human-wildlife conflict for endangered species conservation. Over half of the respondents (53.3%) reported house damages with little compensation. Human-bear conflict has emerged as a severe problem, complicated by Tibetan Buddhism. Herdsmen at SNP leave dead livestock in the fields which easily attract brown bears who are naturally drawn the to smell of carrion. This food source

brings them closer to residential areas, thus increasing the risk of house damage, especially during the winter. Bears also threaten the livelihood and safety of local herders, decreasing community tolerance for Tibetan brown bear conservation (Dai et al., 2020). Therefore, attitude change regarding bears is a hindrance for conservation outcomes at SNP, something that should be evaluated from ecological and social-economic aspects (Molina et al., 2019; Lundberg et al., 2020). Conflict mitigation measures should include house protection and reinforcement, guiding residents to dispose of dead livestock properly, developing compensation programs, and creation of insurance policies. Park rangers should focus on bear education and their ecological importance, but also explain causes of conflict and defense strategies for local communities.

4.2 Conservation preference heterogeneity of different community groups

Demographics and socio-economic factors were entered into LCM as categorical variables (Alegre et al., 2011; Juutinen et al., 2011; Sriarkarin and Lee, 2018). They included: gender, age, household annual income, Tibetan or not, endangered species conservation attitudes (Li et al., 2013), human-wildlife conflicts (Zong et al., 2017; Cai et al., 2020). Our results showed heterogeneity of endangered species conservation preferences in local communities, which were significant among groups with different social-economic background and conservation attitudes.

The highest proportion of respondents is 'multi-species conservation seekers' who prefer nearly all species with multiple levels and ecological status. They have higher annual incomes, lower impacts from wildlife, highest awareness, and contribution to endangered species, and the most religion reasons for participating in conservation. On the contrary, the 'less concern to conservation' group only focused on conservation of a few species and have no strong attitudes. They have the highest negative impacts from wildlife, lowest concern for endangered species, lower awareness of conservation institutions, less willing to contribute money for conservation, and less support for NGOs. The 'strong preference and conflict' group has strong likes and dislikes to endangered species. They are most concerned about the topic of endangered species conservation but have incurred the most house damage by bears. The common characteristics of the latter two groups is comparatively low household incomes, fewer religious beliefs, and much more conflicts with wild animals.

The 'strong preference and conflict' group account for certain proportion of locals. They dislike Tibetan brown bear and wolves very much but are willing to protect lower-conflict species like snow leopard, white-lipped deer, and blue sheep. Except for bears, killing livestock by wolves is the main cause of conflict, leading to poaching and retaliatory killings (Fowler et al., 2019; Estifanos et al., 2020; Janeiro-Otero et al., 2020; Kirilyuk and Ke, 2020). Due to the livestock loss caused by wolves, local herdsmen showed negative behavior by killing wolves with poison or traps, which also unintentionally kills snow leopards (Qian et al., 2020). Economic loss caused by animals is the main driver of human-wildlife conflict (Li et al., 2018b; Horgan and Kudavidanage, 2020; Siljander et al., 2020). If annual income is low, it is difficult for people to accept conflict without retaliation (Kleiven et al., 2004). Implementation of preventive measures, damage compensation and insurance policies are important to the "strong preference and conflict" group for changing their attitude toward conservation and coexistence with these species (van Eeden et al., 2021).

4.3 Implication to community-participative conservation action of SNP

Community participation is important for biodiversity conservation at national parks in China. Endangered species protection can be a source of community well-being, productivity, tourism, or connections with nature (Naeem et al., 2016). It provides residents with material welfare for their livelihoods and contributes to resiliency, security, social relations, health, and freedom of choice (Christie et al., 2006; Milkisso, 2020). Economic incentives, livelihood assistance, non-economic and intrinsic motivation are some of the reasons for community-based participation at SNP (Martín-Loípez et al., 2007). Knowledge, attitudes, and behavior of Tibetans are influenced by their spiritual values and religious beliefs of sacred mountains and lakes, combined with their ethnic tradition (Dudley et al., 2009). The idea of a wilderness cult may make a significant contribution to protection of endangered species and biodiversity (Mgumia and Oba, 2003; Bhagwat et al., 2005a, b; Bossart et al., 2006), so factors such as Tibetan culture and religious beliefs can be incorporated into adaptive conservation policies.

Our results suggest implications for a conceptual framework of endangered species conservation under community perspectives (Figure 3). Different conservation preferences for flagship and non-flagship species and the heterogeneity of different groups can be used to improve conservation efforts at SNP. The main community-involvement conservation actions are mitigating human-wildlife conflicts and increasing internal and external motivators to find a suitable balance between them (Tang et al., 2023). The goal of maintaining ecosystem integrity at national parks can be achieved by using flagship species or flagship fleets for promoting community-participative plans while addressing local conservation preferences and heterogeneity (Hemson et al., 2009; Veríssimo et al., 2014a; Lundberg et al., 2020). Other protected area studies also support this viewpoint (Zong et al., 2017; Sriarkarin and Lee, 2018; Lee et al., 2019).

We found that heterogeneity of conservation preference is influenced by household income, traditional ethnicity culture, and conservation awareness (Wiepking and Bekkers, 2012). Dividing individuals into groups with similar preferences helps governments, managers, and NGOs to develop strategies for communities (Veríssimo et al., 2014). For example, the 'multi-species

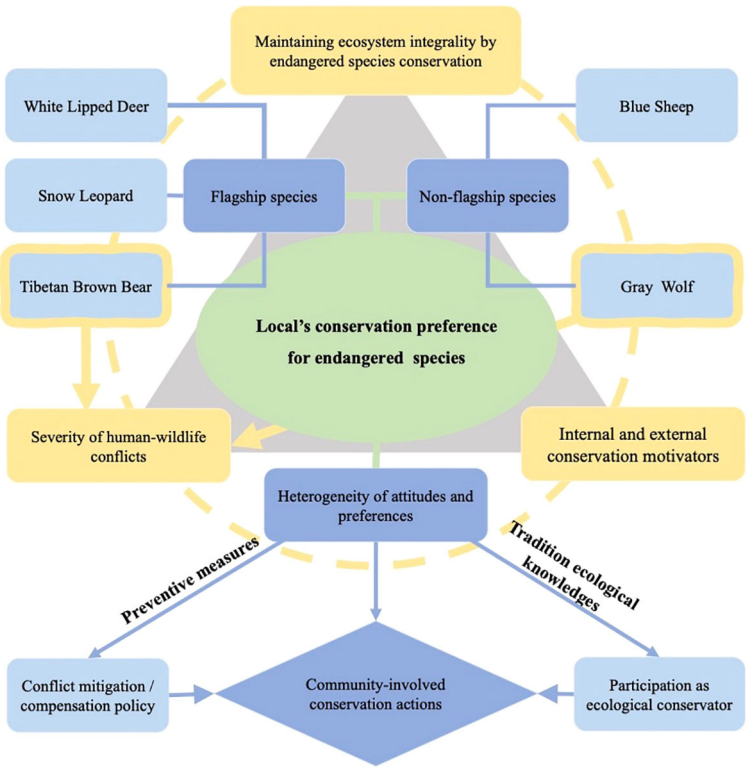

FIGURE 3
Conceptual framework of community participation consevation in Sanjiangyuan National Park.

conservation seekers' with strong preferences for wildlife protection were more willing to participate in endangered species conservation. Ecological conservator plans at SNP requires public support to monitor wild areas by patrols, so community-based conservation underscored the importance of involving this segment of people. Our study showed that community-involved species conservation at SNP should encourage more community participation mechanisms, conservation education and training for residents, promoting conservation emotive motivators, attaching importance to religious tradition and ethnoecological knowledge (Trudgill, 2001; Li et al., 2018c; Adom and Boamah, 2020; Qian et al., 2020).

Data availability statement

The original contributions presented in the study are included in the article/Supplementary Material. Further inquiries can be directed to the corresponding authors.

Author contributions

WX: Writing – original draft. LX: Writing – review & editing. YC: Writing – review & editing. JZ: Writing – review & editing. YW: Writing – review & editing. KC: Writing – review & editing. C-HL: Writing – review & editing. HD: Writing – review & editing. SM: Writing – review & editing. CZ: Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fevo.2024.1265694/full#supplementary-material

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