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Ecological and Public Advantages of a Dual Flagship Strategy: Giant Panda and Snow Leopard

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Abstract: Flagship species' conservation strategies hold significant prominence in biodiversity preservation. The giant panda, a globally recognized species, has drawn attention to its benefits and constraints as a flagship species. This study aimed to assess the potential benefits of a dual flagship strategy using both the giant panda and snow leopard, compared to an approach solely using the giant panda. We identified the number of potential beneficiary species based on their habitat overlap with the giant panda and snow leopard in Sichuan and Gansu, China. Subsequently, we examined public preferences for these two flagships and their influencing factors through questionnaire surveys within and outside China. The dual flagship strategy covered the habitats of more species and amplified existing protection for those species already benefiting from giant panda conservation efforts. The giant panda was commonly perceived as "Adorable", "Innocent", and "Rare", while perceptions of the snow leopard leaned towards "Mighty", "Mysterious", and "Rare". Though the giant panda is widely favored, the survey indicates a notable preference for snow leopards among a proportion of respondents. The dual flagship strategy offers expanded wildlife habitat coverage and benefits a broader range of species. Moreover, the combined appeal of the snow leopard and giant panda, each possessing unique charm and symbolism, holds the potential to garner broader societal interest and support. This study may serve as a reference for policy decisions in the Giant Panda National Park and other similar protected areas, optimizing conservation management and outreach initiatives for flagship species strategies. It may also benefit conservation strategies centered on other flagship species.

Keywords: surrogate species; biodiversity conservation; dual flagship species strategy; *Ailuropoda melanoleuca*; *Panthera uncia*

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1. Introduction

Excessive resource exploitation, environmental pollution, and climate change threaten species' survival [1,2]. Flagship species play a key role in biodiversity conservation [3–5]. Flagship species are described as "popular, charismatic species that serve as symbols and rallying points to stimulate conservation awareness and action" [6,7]. Using a flagship species, conservation organizations can enhance public awareness regarding ecological preservation, stimulate broader societal interest in biodiversity conservation, and ultimately realize the objective of preserving biodiversity [8]. Umbrella species refer to a species whose habitat requirements encompass those of other species, and the conserving will also

extend to other co-occurring species, thereby simplifying the complexity of biodiversity conservation efforts [9,10]. When a species fulfills both the roles of a flagship species and an umbrella species, i.e., a flagship umbrella species, it has the potential to raise both public and political awareness regarding imperiled species and ecosystems, while providing a focus-point for conservation efforts which will "trickle down" and benefit wider ecological communities [11].

Despite the extensive application of flagship and umbrella species in conservation management, their efficacy remains a matter of debate [11,12]. Research suggests that protection centered on surrogate species may hinder the preservation of broader biodiversity as the requirements of a singular species often prove inadequate in meeting the needs of all background species [13,14]. The excessive inclination toward flagship species or single umbrella species in allocating conservation resources almost inevitably results in insufficient protection extended to diverse background species, especially for those species that most urgently need protection [15–17]. Meanwhile, research on the koala, a flagship species, revealed that despite possibly receiving disproportionate funding, it effectively serves as both an influential flagship species for conservation education and an umbrella species for broader biodiversity protection [18].

The giant panda (*Ailuropoda melanoleuca*), serving as both a flagship and an umbrella species, holds a preeminent position in global wildlife conservation, exerting significant influence through its charisma. The giant panda's status on the IUCN Red List has been reclassified from "Endangered" to "Vulnerable" [19], due to efficacious long-term protection actions. Giant pandas inhabit the global biodiversity hotspot, the "Southwestern Mountains of China" [20]. However, even these biodiversity hotspots are not immune to severe biodiversity loss [21]. The giant panda's distribution area presents an opportunity for conservation managers to protect not only this flagship and umbrella species but also provide refuge for other rare and endangered species sharing its habitat, thereby advancing broader biodiversity conservation. The efficacy of the flagship approach centering on giant panda's has also been scrutinized [22]. Within the distribution region of the giant panda, habitat requirements vary among wildlife. This can lead to divergent outcomes in population recovery for different species when applying conservation measures tailored to the giant panda. Research has revealed a decline in the distribution range of large carnivores within giant panda reserves since the 1960s [23]. The degradation of biodiversity can have detrimental impacts on ecosystems. Even rare species [24] and species that may seem redundant [25] play crucial ecological functions, with their decline potentially disrupting ecosystem stability and ecosystem service. Currently, local conservation managers are advocating for a dual flagship species strategy that involves both the giant panda and the snow leopard (*Panthera uncia*). This proposal comes in response to the perceived limitations of the flagship species approach centered solely on the giant panda. The intention of this innovative approach is twofold: firstly, to engender the participation of a broader spectrum of stakeholders in conservation efforts; and secondly, to encompass a more comprehensive array of background species.

The snow leopard (*Panthera uncia*), an iconic symbol of Central Asia's great mountain wilderness, serves as a flagship species for high-altitude ecosystems [26]. Although it was reclassified from the category of "Endangered" to "Vulnerable" on the Red List of Threatened Species, the snow leopard still faces substantial conservation threats [1]. As a top predator, the snow leopard plays a vital role in maintaining the stability of the high mountain ecosystem [27]. In China, the snow leopard's habitat covers the headwaters of major rivers like the Yellow River, Yangtze River, and Lancang River, making their conservation crucial not just for protecting wildlife but also for ensuring water sources downstream that serve billions of people [28].

The giant panda predominantly resides in montane forests at elevations of 1500–3500 m [29,30], complemented by the snow leopard's habitat in alpine meadow and steppe ecosystems from 3000 to 5000 m [31]. Adopting a dual conservation strategy surrogated by both the giant panda and snow leopard may expand protection from mon-

tane forests to the alpine meadow and steppe ecosystems, addressing the limitations of a panda-centric approach and better-safeguarding biodiversity. Additionally, the dual flagship species strategy may transfer conservation practices from the giant panda to the snow leopard, promoting the latter as a flagship species and attracting support from enthusiasts of large carnivores. However, research comparing single and dual flagship species conservation is limited, so the effectiveness of a combined giant panda–snow leopard strategy remains to be determined.

To evaluate the efficacy of a dual conservation strategy surrogated by the giant panda and snow leopard, this study assessed its potential benefits for ecological and public perception. We compared potential beneficiary species within both habitats of the giant panda and snow leopard to evaluate whether the dual approach potentially covers more species than focusing solely on giant pandas. Through a questionnaire survey, we assessed public preferences for each species and the driving factors influencing these preferences. We also compared public perceptions towards images of the giant panda and snow leopard images to inform tailored conservation outreach initiatives. This study provides insights for flagship species conservation, potentially guiding policy for the Giant Panda National Park and offering reference points for other flagship initiatives.

2. Method

2.1. Habitat of Species

The study, focusing on the provinces of Sichuan and Gansu in China, covers an area of approximately 935,800 km^2 (Figure 1). Our study area, located on the northeastern edge of the Qinghai–Tibet Plateau, is unique for its geographical position and varied elevation. The vegetation displays a distinct vertical stratification, with lower to mid-altitude regions dominated by forest ecosystems, while alpine meadow and steppe ecosystems primarily characterize higher altitudes.

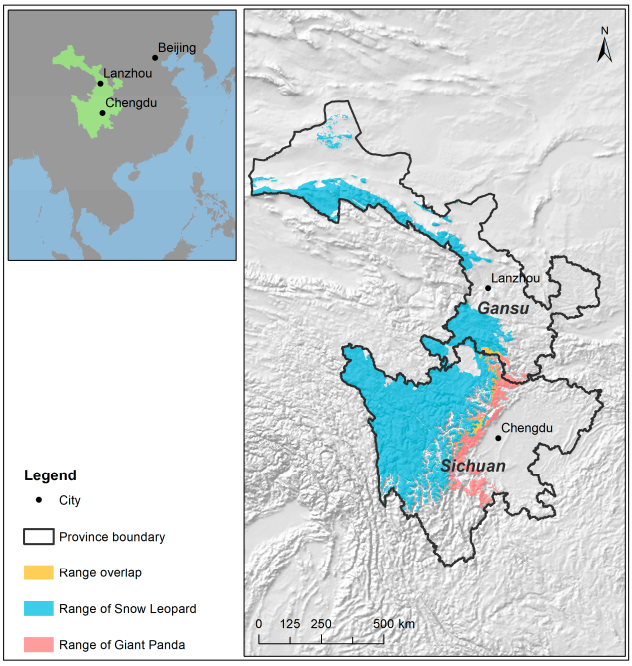

Figure 1. Study area.

Both the giant panda and snow leopard have habitats in the two provinces. While species distributions do not naturally adhere to administrative boundaries, conservation management often does [32]. Thus, using the provincial boundary as a basis for this study holds practical significance for policy making and implementation.

We first sourced distribution ranges for terrestrial vertebrates (amphibians, reptiles, birds, and mammals) in the two provinces from the IUCN (International Union for Conservation of Nature) Red List database. These ranges were then refined based on species-specific habitat preferences and elevation ranges to enhance accuracy. Both habitat preferences and elevation ranges were also derived from the IUCN Red List. The habitat type map following the IUCN habitat classification scheme was provided by Jung et al. [33], and the data on elevation were obtained from the U.S. Geological Survey [34].

2.2. Questionnaire Survey

We utilized an online questionnaire to assess the potential impact of a dual flagship conservation strategy. The survey reached 1834 individuals from China and 271 from 17 other countries, including Japan, Canada, and Australia (Table S1).

The questionnaire started with demographic questions on respondents' personal and socio-demographic information, including gender, age, education level, and nationality/residence.

The second section of the questionnaire collected participants' respective perceptions toward the two species, including: (1) their level of affection, as measured by a 5-point Likert scale (1: Strongly dislike, 2: Somewhat dislike; 3: Neutral; 4: Somewhat like; 5: Strongly like); and (2) their self-perceived familiarity, using a 4-point Likert scale (1: Not at all familiar, 2: Slightly familiar, 3: Moderately familiar, 4: Very familiar).

For conservation advocacy, the chosen portrayal of a species can significantly influence the effectiveness of promotional campaigns, given that species images can be multifaceted. In the third section of the questionnaire, we assessed participants' perceptions of the images associated with the two species. In the absence of photographs, participants were asked to select their immediate impressions of the giant panda and snow leopard from options: Silly, Innocent, Adorable, Mysterious, Mighty, and Rare. Subsequently, we presented three distinct photos of each species and asked participants to select their favorite, aiming to find which type of portrayal for the giant panda and snow leopard was most favored by the public. The photos were displayed in a random order to avoid sequence bias. The three photos' portrayals were determined based on a pilot independent survey, where the most voted representation was selected for each photo (Figure 2). In the pilot survey, we presented 119 respondents with three photographs of the giant panda and three of the snow leopard in random sequences. Respondents were asked to select the most fitting image description from the Mysterious, Adorable, Mighty, Silly, Innocent, and Rare options. The portrayal represented by each photograph was determined based on the description most frequently chosen by the respondents. Lastly, participants were asked to choose their preferred species between the giant panda and snow leopard or opt for neither.

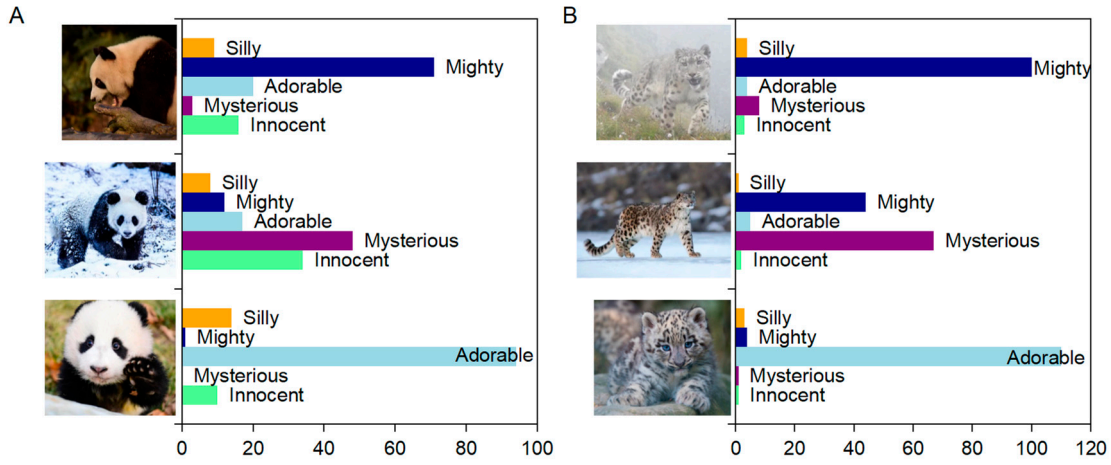

Figure 2. Immediate impressions from respondents to the photos for the giant panda (**A**) and the snow leopard (**B**) in an independent pilot survey.

The photographs used in this survey were provided by the China Conservation and Research Center for Giant Panda, the World Wide Fund for Nature, and the Wolong National Nature Reserve. Surveys conducted within China were in Chinese, while those outside China were in English. The questionnaire was initially designed in Chinese and then translated into English, with a subsequent back-translation ensuring term consistency. We also engaged individuals of Chinese cultural background currently residing in English-speaking countries to ensure the proper conveyance of emotionally charged terms.

2.3. Data Analysis

Under the concept of umbrella species, conserving the habitat of an umbrella species should also ensure the protection of its beneficiary species. Thus, we identified potential beneficiary species that can be effectively protected by conserving the giant panda and snow leopard based on overlapping between the species' habitats and those of the umbrella species.

Let

$$P_1 = \frac{H_b \cap H_u}{H_u} \tag{1}$$

where H_b represents the habitat of the background species in the study region, and H_u denotes the habitat for umbrella species. A high value of P_1 suggests that the habitat of the background species is adequately extensive within the umbrella species' habitat. And let

$$P_2 = \frac{H_b \cap H_u}{H_B} \tag{2}$$

where H_B represents the habitat of the background species within a region of significant conservation interest. In this study, that region is China. While a species might have a broad global distribution, we focused solely on its habitat in China, recognizing that its population within China may require distinct protection management. A high value of P_2 indicates that the habitat of the background species within the umbrella species' habitat is significant for the protection of the background species.

A species can be regarded as a potential beneficiary species to the flagship species when a sufficiently high P_1 or P_2 value is observed. In this study, multiple thresholds were established for both P_1 and P_2 (namely, 1%, 5%, 10%, and 20%), culminating in a total of 16 combined criteria. For each flagship species, the number of potential beneficiary species was tallied for each criteria combination separately, serving as the count of potential beneficiary species.

We calculated both the count of respondents selecting each impression and the weighted percentage of selections for each impression to represent perceptions toward the giant panda and snow leopard since multiple responses were allowed for this question. A respondent was counted as 1/n if the respondent chose n impressions. This adjusted count was then used to calculate the weighted percentage. To compare the respondents' perceptions towards the giant pandas and snow leopards across different groups, we employed the Wilcoxon rank-sum test.

To identify key factors influencing the respondents' fondness for the giant panda and snow leopard, we utilized mixed-effects ordinal logistic regressions. The model took the respondents' affection level for the giant panda or snow leopard as the dependent variable, with gender, education level, age, and self-perceived familiarity as independent variables. The mixed-effects ordinal logistic regressions were implemented in the R environment using the 'clmm' function from the 'ordinal' package [35]. Furthermore, to determine the impact of respondents' characters on their species preference choice, we employed mixed-effects multinomial logistic regressions with gender, education level, and age as independent variables. The regressions were executed in the R environment utilizing the 'nnet' package [36]. Data from China and those outside China were analyzed separately, owing to the limitation of data from countries other than China. For Chinese respondents,

their province of residence was considered as a random factor, while for respondents outside China, nationality was used.

G-test was used to ascertain whether or not there was a significant difference in the species preference choice between respondents from China and those outside China. Additionally, this test was applied to assess preferences in favorite photograph selections. We employed the 'DescTools' package to execute the G-test in the R environment [37].

3. Result

3.1. Beneficiary Species

The count of potential beneficiary species for the giant panda and snow leopard decreased with increasing P_1 and P_2 values (Figure 3, Table S2). Using a 1% threshold for both P_1 and P_2, an additional 81 species distributed in snow leopard habitats can be protected by the dual flagship conservation, including 11 species listed as "Vulnerable" ("VU") or higher on the IUCN Red List. Also, 284 species have more habitats covered by snow leopard habitats than those of the giant panda. At the strictest 20% threshold for P_1 and P_2, 56 additional species can still be protected by the dual flagship conservation strategy, including 10 with "VU" status or above. At a moderate 5% threshold, 70 additional species can be protected, including 10 with "VU" status or higher, like the steppe eagle (*Aquila nipalensis*), Chinese mountain cat (*Felis bieti*), Sichuan hot-spring keelback (*Thermophis zhaoermii*), and the piebald alpine toad (*Scutiger maculatus*). Moreover, at this 5% threshold, the habitats of 262 species are better covered by the snow leopard's habitat than by the giant panda's.

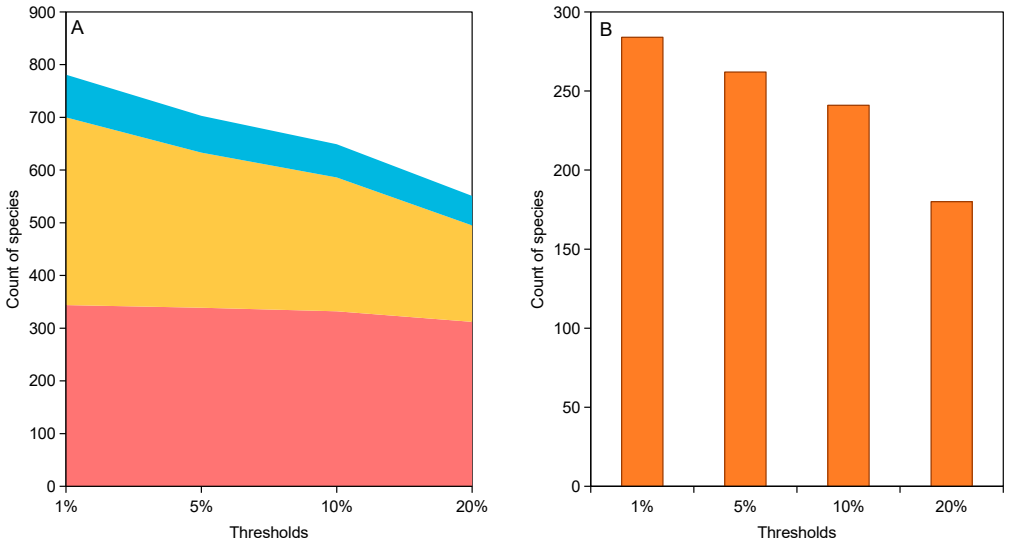

Figure 3. The coverage of potential beneficiary species for the giant panda and snow leopard across varying P_1 and P_2 threshold levels. Panel (**A**) shows the count of potential beneficiary species. Red indicates the number of species effectively covered only by the giant panda's habitat, blue represents those covered only by the snow leopard's habitat, and yellow are species effectively covered by both habitats. (**B**) is the count of potential beneficiary species with larger habitat coverage by the snow leopard than the giant panda.

3.2. Socio-Demographic Profile

A total of 1834 questionnaires were completed within China, and all were valid. Meanwhile, outside China, we received 311 responses, with 271 being valid. Details on survey respondents' gender, age, and education are in Table 1. In China, 95.64% of respondents were aged 15–55, with only 4.36% outside this range. Outside of China, 80.07% were between 15 and 55 years, with those aged 6–9 and above 55 each accounting for 9.96%. Regarding educational level, 54.80% of Chinese respondents achieved a Univer-

sity/Undergraduate level. Among respondents outside China, University Graduates were the predominant level, accounting for 40.96%.

Table 1. Demographic characteristics of survey respondents.

Characteristics of Respondents	Count of Respondents	
	Within China	Outside China
Gender		
Female	1080 (58.89%)	138 (50.92%)
Male	754 (41.11%)	129 (47.60%)
Prefer not to say	0 (0%)	4 (1.48%)
Age		
6–9 years	13 (0.71%)	27 (9.96%)
10–14 years	26 (1.42%)	29 (10.70%)
15–25 years	647 (35.28%)	37 (13.65%)
26–35 years	660 (35.99%)	46 (16.97%)
36–45 years	221 (12.05%)	64 (23.62%)
46–55 years	200 (10.91%)	41 (15.13%)
55+ years	67 (3.65%)	27 (9.96%)
Education		
Primary School	44 (2.40%)	48 (17.71%)
Secondary School	173 (9.43%)	26 (9.59%)
Post Secondary/High School	171 (9.32%)	32 (11.81%)
University/Undergraduate	1005 (54.80%)	54 (19.93%)
University Graduate	441 (24.05%)	111 (40.96%)

3.3. Affections and Self-Perceived Familiarity

Overall, respondents within China and those outside China both showed a significantly stronger affection for the giant panda compared to the snow leopard (Wilcoxon rank sum test, within China: W = 2,633,105, $p < 0.001$; outside China: W = 52,523, $p < 0.001$). Nonetheless, a considerable portion expressed equal preference for both species (within China: 29.39%; outside China: 37.23%), with some showing a higher fondness for the snow leopard over the giant panda (within China: 3.60%; outside China: 7.38%) (Figure 4).

For familiarity, both respondents from within China and those outside exhibited a significantly higher self-perceived familiarity with the giant panda compared to the snow leopard (Wilcoxon rank sum test, within China: W = 2,516,472, $p < 0.0001$; outside China: W = 46,053, $p < 0.0001$). In particular, 58.18% of respondents in China had higher Likert scale values for the giant panda than for the snow leopard, while this percentage was 41.33% for those outside China.

Mixed-effects ordinal logistic regression analyses revealed that for respondents within China, age and self-perceived familiarity significantly influenced their affection for the giant panda (Table 2). Older respondents showed a greater affection for the giant panda, and those who perceived themselves as more familiar with the giant panda also expressed higher levels of affection. For the snow leopard, only gender and self-perceived familiarity had a significant impact. Male respondents and those who felt more familiar with the snow leopard showed a greater affection for the species. For respondents outside China, only their self-perceived familiarity significantly positively influenced their affection for both the giant panda and the snow leopard.

3.4. Species Preference Choice

There were more respondents who preferred the giant panda (China: 1503, 81.95%; Outside China: 168, 61.99%) than those who preferred the snow leopard (China: 297, 16.19%; Outside China: 76, 28.04%) (Figure 5). Only a few opted for neither species, with 34 respondents (1.85%) within China and 27 (9.96%) outside China. However, a significant divergence in species preferences was observed between respondent proportions from China and those outside China (*G*-test, $G = 65.2984$, $df = 2$, $p < 0.001$). Among those with

neutral affection for the giant panda, a considerable portion chose the snow leopard in their species preference choice (China: 60, 33.90%; Outside China: 21, 48.84%). The mixed-effects logistic regression analysis further showed a gender-based trend, where males were more inclined to prefer the snow leopard than females. (Table 3).

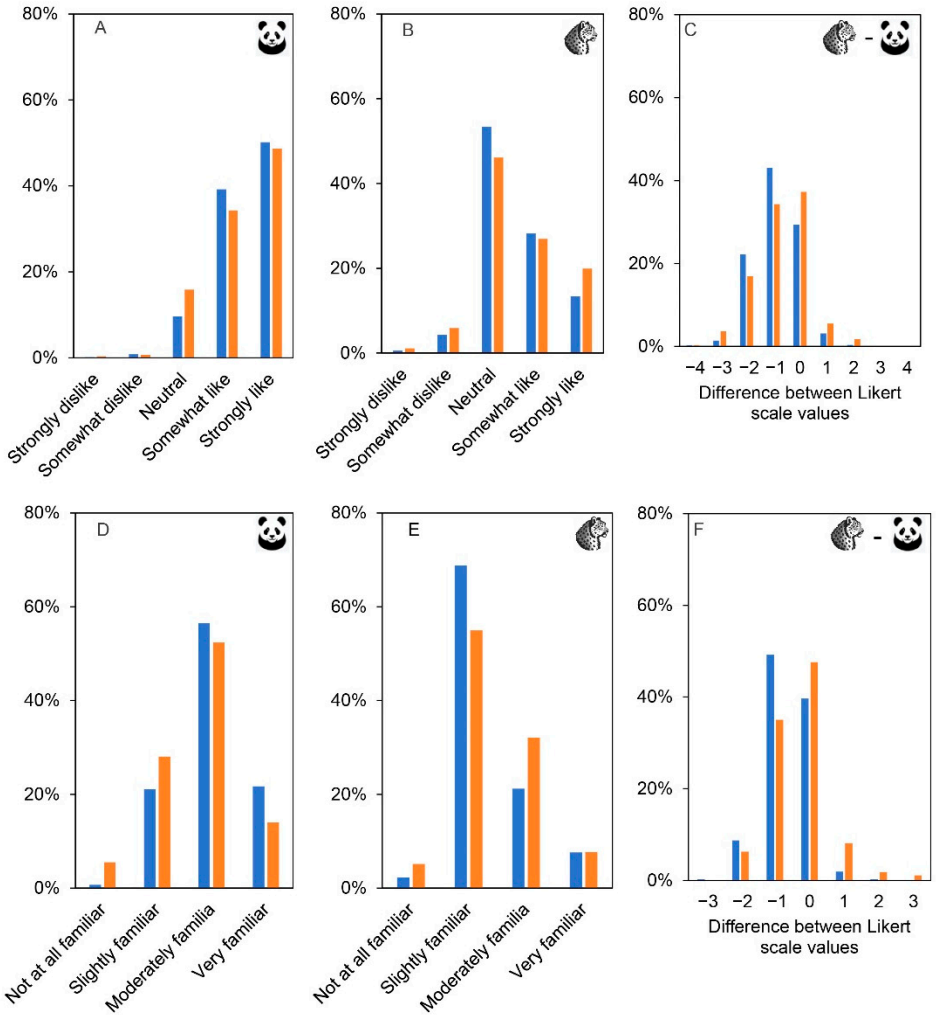

Figure 4. Respondents' level of affection (**A**–**C**) and self-perceived familiarity (**D**–**F**) towards the giant panda and snow leopard. Panels (**A**,**D**) represent the giant panda; (**B**,**E**) denote the snow leopard; (**C**,**F**) illustrate the difference in affection and familiarity between the two species. Blue bars indicate respondents from within China, while orange bars are those outside China. Differences in affection and familiarity levels for the two species are derived by subtracting the Likert scale values for the giant panda from those for the snow leopard. Species illustrations were generated by DALL-E.

3.5. Species Image Perceptions

In terms of immediate impressions toward the giant panda and snow leopard, both the number and weighted percentage of respondents selecting each impression showed similar trends (Figure 6). For Chinese respondents, the leading impressions of the giant panda were "Adorable" (1534, 35.40%), "Innocent" (1174, 20.33%), and "Rare" (1182, 20.76%). For those outside China, the predominant impressions were likewise "Adorable" (166, 33.52%), "Innocent" (87, 14.03%), and "Rare" (140, 29.10%). As for the snow leopard, the top impressions both within and outside China were "Mighty", "Mysterious", and "Rare", with counts for respondents in China at 1343 (40.13%), 1021 (26.02%), and 895 (21.15%), and for those outside China at 125 (25.03%), 147 (32.96%), and 146 (31.03%), respectively.

Table 2. Results of mixed-effects ordered logistic regression analysis examining the relationship between respondent characteristics and their affection levels for the giant panda and snow leopard.

	B	*SE*	*Z*	*P*
Within China				
Giant panda				
Gender: male	−0.1031	0.0964	−1.0700	0.2848
Age	0.1081	0.0447	2.4200	0.0155 *
Education	0.0590	0.0541	1.0920	0.2750
Familiarity	1.3971	0.0811	17.233	<0.0001 **
Snow leopard				
Gender: male	0.3262	0.0984	3.3140	<0.0001 **
Age	0.0444	0.0442	1.0050	0.3151
Education	0.0043	0.0547	0.0780	0.9377
Familiarity	2.1549	0.0905	23.821	<0.0001 **
Outside China				
Giant panda				
Gender: male	−0.3548	0.2505	−1.4161	0.1568
Gender: PNS	−1.3405	0.9860	−1.3595	0.1740
Age	−0.1151	0.1007	−1.1429	0.2531
Education	0.0810	0.1211	0.6691	0.5034
Familiarity	1.0707	0.1793	5.9723	<0.0001 **
Snow leopard				
Gender: male	−0.0178	0.2472	−0.0720	0.9426
Gender: PNS	0.9362	1.1358	0.8243	0.4098
Age	−0.0215	0.1026	−0.2092	0.8343
Education	−0.0967	0.1190	−0.8125	0.4165
Familiarity	1.2714	0.1888	6.7358	<0.0001 **

B: coefficients; *SE*: Standard error; PNS: Prefer Not to Say. Level of Significance * $p \leq 0.05$ and ** $p \leq 0.01$.

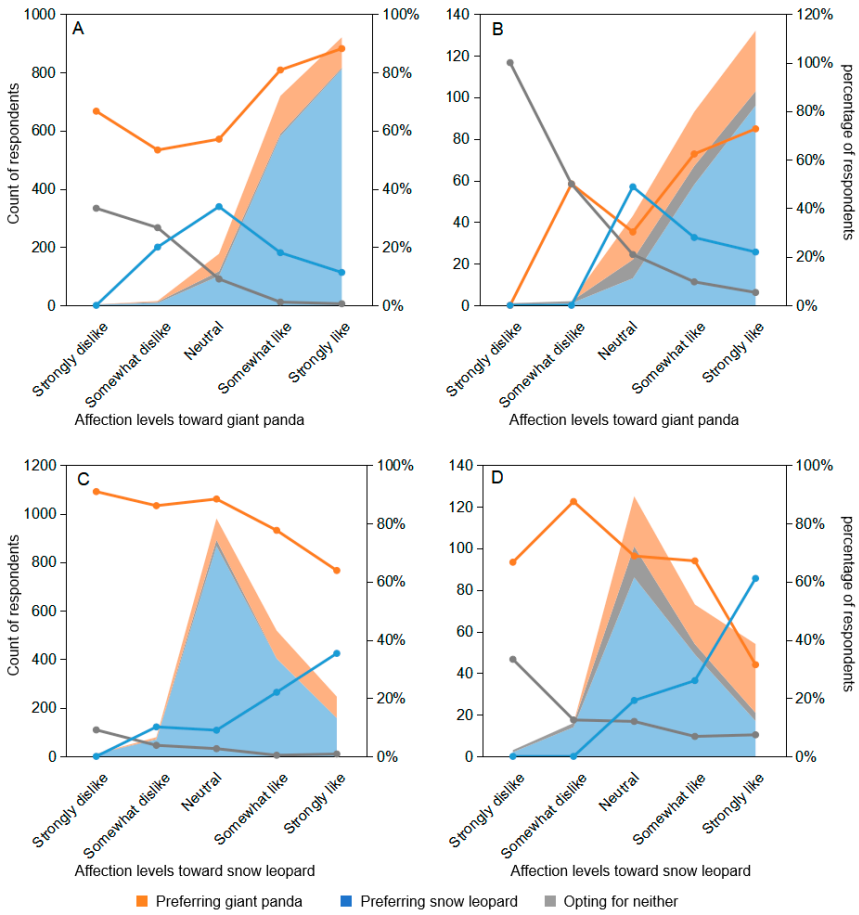

Figure 5. Influence of affection levels toward the giant panda (**A**,**B**) and snow leopard (**C**,**D**) on the species preference choice. Panels (**A**,**C**) show the effects of affection levels among Chinese respondents,

while panels (**B**,**D**) display the same for respondents outside China. Orange indicates preferring the giant panda, blue for the snow leopard, and gray denotes opting for neither. Stacked areas show respondent counts, and lines represent percentage distributions of preferences.

Table 3. Results of mixed-effects logistic regression analysis examining the relationship between respondent characteristics and their species preference.

	B	*SE*	*Z*	*P*
Within China				
Gender: male	0.5846	0.1287	4.5440	<0.0001 **
Age	−0.2388	0.0625	−3.8180	0.0001 **
Education	0.1077	0.0732	1.4700	0.1414
Outside China				
Gender: male	0.6063	0.2966	2.044	0.0409 *
Gender: PNS	27.24	264,700	0	0.9999
Age	−0.2645	0.13	−2.035	0.0419 *
Education	−0.06705	0.1439	−0.466	0.6412

B: coefficients; *SE*: Standard error; PNS: Prefer Not to Say. Level of Significance * $p \leq 0.05$ and ** $p \leq 0.01$.

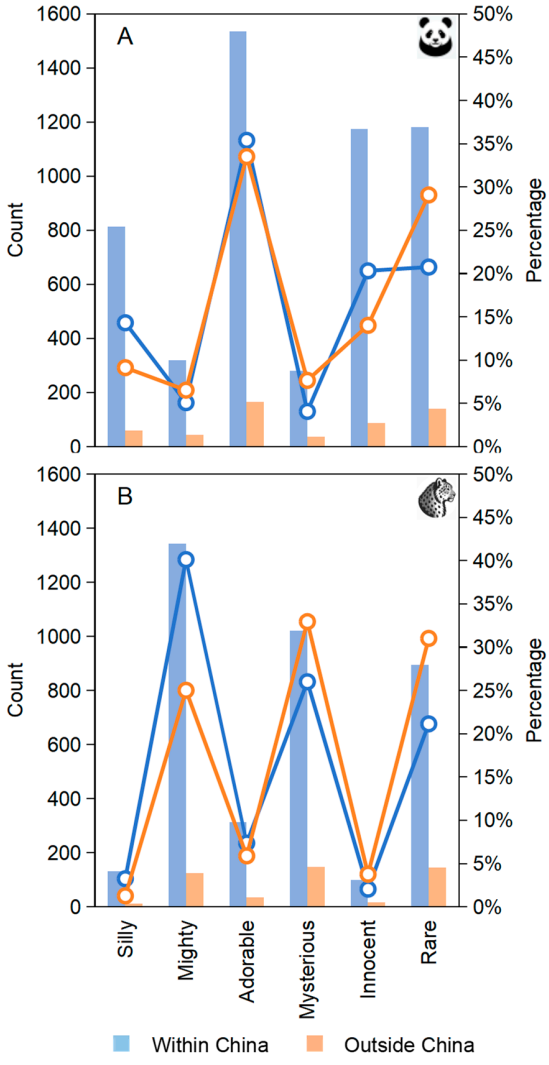

Figure 6. Perceptions of the giant panda (**A**) and snow leopard (**B**) among respondents. Blue represents responses from China, while orange represents those outside China. Bars indicate the counts of respondents choosing each impression, while the lines with circles present the weighted percentage of selections for each impression.

In the request to select their favorite photo of the giant panda, a significant disparity was observed between respondents from China and those outside China (*G*-test, $G = 65.2984$, $df = 2$, $p < 0.001$). Pairwise *G*-tests revealed that the proportions of respondents who chose "Adorable" and "Mysterious" photos varied significantly between those from China and those outside China (Bonferroni adjusted $p < 0.01$). Similarly, significant differences were detected in the proportions of respondents selecting the "Adorable" and "Mighty" photographs (Bonferroni adjusted $p < 0.001$). The majority of respondents within China chose the "Adorable" photo (1572, 85.71%) (Figure 5), followed by the "Mysterious" photo (200, 10.91%). The fewest, only 62 respondents (3.38%), chose the "Mighty" photo. Outside of China, the "Adorable" photo of the giant panda remained the most popular choice (163, 60.15%), but a higher percentage of respondents, 33.21% (90), preferred the "Mysterious" photo compared to those in China. The "Mighty" photo remained the least-selected, with 18 respondents (6.64%) choosing it.

Regarding the snow leopard, a significant disparity was also observed between respondents from China and those outside China (*G*-test, $G = 28.0606$, $df = 2$, $p < 0.001$). Pairwise *G*-tests performed among all photos between respondents from China and those outside China were significant (Bonferroni adjusted $p < 0.05$). The respondents within China predominantly chose the "Adorable" photo (1095, 59.71%), followed by "Mysterious" (526, 28.68%) and then "Mighty" (213, 11.61%) (Figure 7). For those outside China, the counts for the "Adorable" and "Mysterious" images of the snow leopard were almost equal, at 120 (44.28%) and 121 (44.65%), respectively. The "Mighty" photo was still the least popular, chosen by 30 respondents (11.07%).

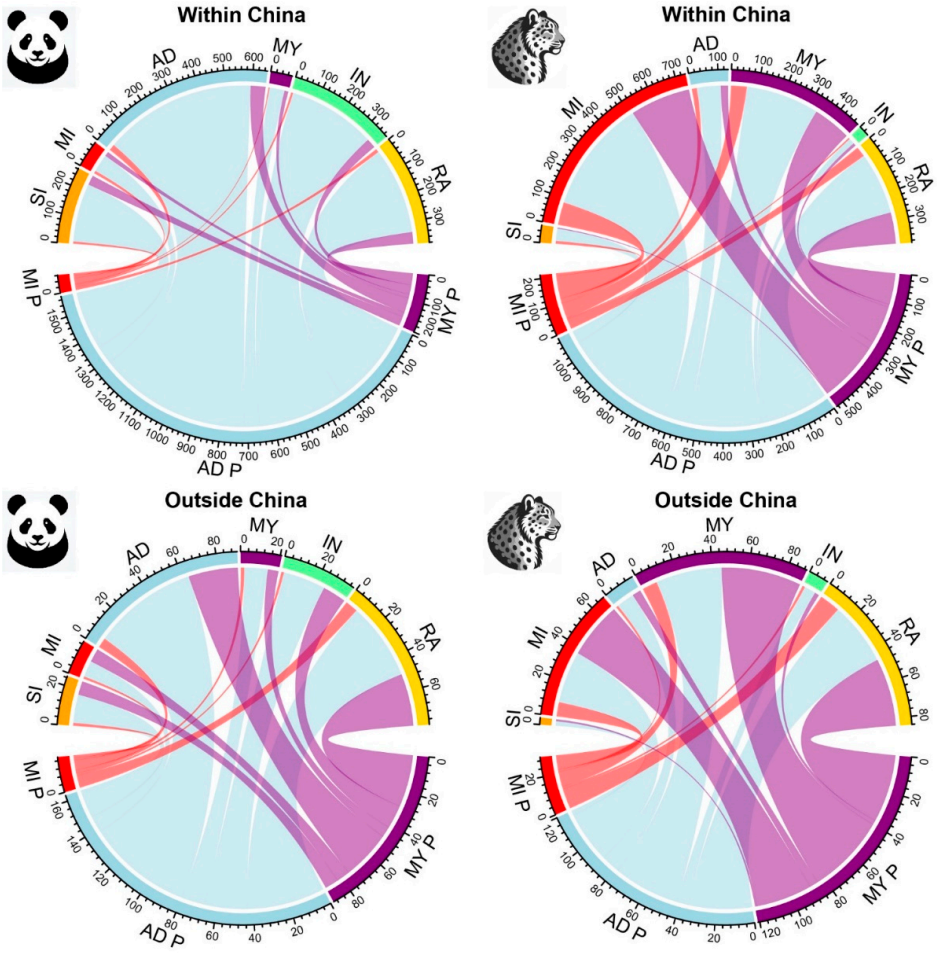

Figure 7. Chord diagrams show the associations between respondents' perceptions of the species and their preferred photo. The upper half of the diagram indicates the weighted number of respondents

selecting each impression, while the lower half illustrates the photo they chose. "SI" represents the perception of the giant panda or the snow leopard as "Silly", "IN" for Innocent, "AD" for Adorable, "MY" for Mysterious, "MI" for Mighty, and "RA" for Rare. "MI P" corresponds to the Mighty Photo of the giant panda or the snow leopard, "AD P" to the Adorable Photo, and "MY P" to the Mysterious Photo.

Respondents' initial impressions of the giant panda and snow leopard did not always match the photo they eventually chose, particularly for the snow leopard, both within and outside China. Although many respondents had an initial impression of the snow leopard as "Mighty", only a few ended up selecting the "Mighty" photo; many of them ultimately chose the "Adorable" or "Mysterious" photos. Additionally, some who initially viewed the snow leopard as "Mysterious" opted for "Adorable" photos. As for the giant panda, even with fewer "Mysterious" initial impressions, a considerable number, both within and outside China, favored the "Mysterious" photo.

4. Discussion

Choosing the appropriate species is vital when using surrogate species for biodiversity conservation [38,39]. This study compared conservation strategies in the biodiversity-rich provinces of Sichuan and Gansu, China: one using both the giant panda and snow leopard as dual flagship species, and another focusing solely on the giant panda. Our results suggest that the dual flagship approach is superior. From the perspective of habitat conservation, this strategy offers a broader coverage of wildlife habitats, benefiting more species and amplifying protection for those species already benefiting from giant panda conservation. Furthermore, regarding public outreach, the combined appeal of the snow leopard and giant panda, each possessing unique charm and symbolism, is expected to attract broader societal interest, potentially driving more funds and resources to support regional biodiversity conservation.

The flagship species strategy continues to prove highly effective. Wei et al. report that, in 2010, the conservation investment for the giant panda in Sichuan Province was approximately $197.429 million, generating ecosystem services valued at 10 to 27 times this amount [40]. From 2016 to 2022, China allocated US $20 million to the Giant Panda National Park and US $16 million to the Northeast China Tiger and Leopard National Park [41]. These substantial investments benefited not only flagship species but also co-occurring species in these regions, through measures such as development restrictions, logging bans, and hunting prohibitions. This underscores the flagship species strategy's role in broader biodiversity conservation. Moreover, flagship species like the giant panda, African elephant (*Loxodonta africana*) [42], polar bear (*Ursus maritimus*) [43], chimpanzee (*Pan troglodytes*) [44], and monarch butterfly (*Danaus plexippus*) [45], due to their iconic status and broad appeal, have significantly contributed to raising public awareness about critical ecological challenges and the urgency of conservation actions.

Alongside flagship species, approaches like ecosystem-based management [46] and biodiversity-hotspot conservation provide a more comprehensive and systematic framework for achieving regional conservation goals [21]. However, their efficacy depends on the scientific capacities of societies and institutions, facing challenges in attracting public awareness. Flagship species, serving as a potent public marketing tool, effectively bridge this gap. Our analysis reveals that the giant panda and snow leopard are not only impactful as flagship species but also function as effective umbrella species, indicating that their utility extends beyond mere conservation marketing. Nonetheless, it is crucial to recognize the advantages of strategies like ecosystem-based management and biodiversity-hotspot conservation as they offer advantages not afforded by flagship or umbrella species approaches. Effective conservation requires a multi-dimensional profile, incorporating multiple strategies to achieve comprehensive and systematic conservation goals.

The home range of the giant panda is relatively small, with its Minimum Area Requirements (MAR) being merely 114.7 km^2 [47]. The current panda reserves and national parks largely meet the species' conservation needs. However, large carnivores, like the snow

leopard, demand a more expansive home range. Specifically, female snow leopards have home ranges of approximately 124 km^2 and males around 207 km^2 [48]. Reserves designed for pandas often fall short in meeting the needs of these larger carnivores [32]. Including the snow leopard as a flagship species may facilitate the establishment of extensive protected areas, providing broader, continuous habitats that better address the needs of diverse species and reduce habitat fragmentation risks.

The snow leopard, a predominant apex predator in alpine ecosystems, mainly feeds on medium to large-sized herbivores [49]. Large carnivores, in their role as keystone species, can exert control on their prey through predation as well as by non-lethal effects, imposing strong regulating feedback on all the lower trophic levels [50], and initiate trophic cascades that influence primary ecosystem productivity [51]. Their presence plays a pivotal role in shaping vegetation structure and community composition [52]. Thus, by recognizing carnivores like the snow leopard as flagship species, a strategic move is made towards comprehensive ecosystem protection.

Adopting the dual flagship strategy encompassing diverse habitats can provide additional benefits for species. Giant panda habitats are often fragmented by high altitudes [53], while snow leopards face a similar problem with lower altitudes [54]. Corridors connect habitat patches of wildlife, but they need not always be the typical habitat of target species [55,56]. By simultaneously protecting habitats for forest species, such as the giant panda, and alpine meadow species, such as the snow leopard, we can reciprocally provide movement corridors and mitigate the impacts of habitat fragmentation. Camera traps in the Wolong Nature Reserve captured forest species like the Sichuan golden snub-nosed monkey (*Rhinopithecus roxellana*) and the Tibetan macaque (*Macaca thibetana*) in alpine meadows, indicating that these areas may serve as dispersal corridors. On the other hand, while snow leopards are typically associated with alpine regions, they have also been detected in lower-altitude forests in the Wolong Reserve, Xinlong County, in Sichuan, and Qilian Mountain National Park via camera traps. This implies their potential movement through these regions. While our study currently assesses potential beneficiary species based on habitat coverage, considering the corridor effect may reveal an even greater number of beneficiaries.

While the giant panda is widely favored, our survey indicates a notable preference for snow leopards among some respondents. It suggests that incorporating snow leopards into the flagship conservation strategy can enhance public support for conservation. Public perception is critical in supporting biodiversity conservation [57]. The current preference for pandas could be attributed to longstanding conservation promotions. Numerous studies demonstrate that knowledge about a species often leads to positive conservation attitudes [36,58], as seen with species such as dolphins [59] and sharks [60]. Therefore, by drawing from successful panda conservation campaigns, wildlife managers in Sichuan and Gansu may enhance public awareness and support for the snow leopard.

It is essential to recognize that large carnivores can evoke negative reactions, especially among females [61]. While females often exhibit negative emotions toward potentially threatening animals [62,63], they generally have a more positive attitude toward wildlife conservation than males [64]. Our results also demonstrated this trend, with males displaying a greater preference for snow leopards. Thus, based on these indications, outreach strategies should be tailored to address and alleviate the public's apprehensions towards large carnivores. Additionally, our study found that while some respondents were less favorable towards giant pandas, they had a preference for snow leopards. This suggests an opportunity to expand the conservation support base with targeted promotional strategies.

In flagship species conservation, while ecological significance is essential, the visual appeal that garners public attention and support also matters [65]. Our results show that respondents prefer "Adorable" images, regardless of their prior impressions of the species. Previous research has also revealed a greater affinity for "loveable animals" and a comparatively lower level of affinity for "fear-relevant animals". [66] Understanding the audience and using effective marketing can enhance a dual flagship approach. Though

snow leopards may not attain the same level of recognition as giant pandas, effective promotion can enhance their positive public perception.

This study's analysis of the potential beneficiary species of the giant panda and snow leopard was confined to terrestrial vertebrates, a group that garners significant attention from the public, conservation managers, and researchers. However, the importance of other taxa, including invertebrates and plants, should not be overlooked as they are crucial for ecosystem stability. Providing the public with targeted information about these 'less charming species' could help to shift rigid perceptions and foster a greater appreciation for less conventionally attractive flora and fauna [66].

5. Conclusions

Our findings highlight the snow leopard's potential as a flagship species in tandem with the widely adopted giant panda. The dual flagship strategy can expand the coverage of wildlife habitats, benefiting a broader range of species. Concurrently, the combined appeal of the giant panda and snow leopard in this approach can provide an effective means to elevate public interest and support. A dual flagship approach offers an expanded set of tools and flexibility, advancing comprehensive biodiversity conservation. Nevertheless, the tendency to over-incline resource focus on charismatic species still warrants caution. Evaluations and dynamic policy adjustments are essential to ensure that both flagship and background species receive appropriate attention and protection. By carefully defining conservation goals, applying proper criteria, and thoughtfully choosing surrogate species, we can address concerns around using flagship and umbrella species in management strategies, leading to more effective resolution of urgent conservation challenges [67].

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/d16020076/s1, Table S1: Location of the respondent; Table S2: The count of potential beneficiary species for the giant panda and snow leopard under various combinations of P1 and P2 threshold levels.

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