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Social Preferences and Choice Experiments in Biodiversity Conservation in Manu National Park, Peru

Preferências Sociais e Experiências de Escolha na Conservação da Biodiversidade no Parque Nacional de Manu, Peru

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Abstract

In Peru, Protected Natural Areas (PNAs) represent 18.2% of the national territory and are a fundamental tool for biodiversity conservation and the provision of ecosystem services. Among all the PNAs in Peru, Manu National Park (MNP) stands out as one of the most biodiverse areas in the world, declared a Natural World Heritage Site by UNESCO in 1987. In recent years, the MNP has been facing problems of biodiversity loss, among other reasons due to land use change, illegal logging, and the advance of illegal mining. Thus, the objective of this study was to estimate the economic value of biodiversity conservation in this PNA using attributes based on representative indicators. A total of 2,240 choice experiments were conducted with 560 heads of households in the city of Lima, based on face-to-face surveys, assuming homogeneity of individual preferences and using a conditional logit model to estimate marginal willingness to pay. Thus, the attributes most valued by society are the reduction in endangered plant species (from 24 to 8): 4.79 PEN/month (≅ 1.29 USD/month); the reduction in deforestation (from 1,400 ha/year to 300 ha/year): 3.42 PEN/month (≅ 0.92 USD/month); and the reduction in the loss of ecosystem functionality (from 40% to 0%): 1.61 PEN/month (≅ 0.43 USD/month). These results may contribute to the design of environmental policies linked to the implementation of in situ biodiversity conservation programs, or to the conservation of charismatic species and/or habitats as substantial attributes of tourism activity in general.

Keywords: Endangered species, willingness to pay, protected natural area, ecosystem functionality, public policies

JEL Codes: Q51, Q57, O13

Resumo

No Peru, as Áreas Naturais Protegidas (ANP) representam 18,2% do território nacional e são uma ferramenta fundamental para a conservação da biodiversidade e a prestação de serviços ecossistémicos. Entre todas as ANP do Peru, destaca-se o Parque Nacional do Manu (PNM) por ser uma das áreas com maior biodiversidade do mundo, declarado Património Natural da Humanidade pela UNESCO em 1987. Nos últimos anos, o PNM vem enfrentando problemas de perda de biodiversidade, entre outras razões, devido à mudança no uso do solo, extração ilegal de madeira e avanços da mineração ilegal. Assim, o objetivo deste estudo foi estimar o valor económico da conservação da biodiversidade nesta ANP utilizando atributos baseados em indicadores representativos. Foram realizados um total de 2240 experiências de escolha com 560 chefes de família da cidade de Lima, com base em inquéritos presenciais, assumindo a homogeneidade das preferências individuais e utilizando um modelo *logit* condicional para a estimativa da disposição marginal a pagar. Assim, os atributos mais valorizados pela sociedade são a redução das espécies de flora em perigo de extinção (de 24 para 8): 4,79 PEN/mês (≅ 1,29 USD/mês); a redução da desflorestação (de 1400 ha/ano para 300 ha/ano): 3,42 PEN/mês (≅ 0,92 USD/mês); e a redução da perda de funcionalidade do ecossistema (de 40 % para 0 %): 1,61 PEN/mês (≅ 0,43 USD/mês). Esses resultados podem contribuir para a elaboração de políticas ambientais relacionadas à implementação de programas de conservação da biodiversidade *in situ* ou para a conservação de espécies carismáticas e/ou *habitats* como atributos substanciais da atividade turística em geral.

Palavras-chave: Espécies ameaçadas de extinção, disposição a pagar, área natural protegida, funcionalidade do ecossistema, política pública.

Classificação JEL: Q51, Q57, O13

1. INTRODUCTION

Because biodiversity plays a crucial role in the development of societies, its conservation should be of interest to humanity. However, global biodiversity is at a critical juncture: up to one million plant and animal species are in danger of disappearing, mainly due to human activities, to such an extent that the rate of species extinction is ten times higher than the average over the last ten million years (Yuan et al., 2024; Yue et al., 2023; Butchart et al., 2010).

In this regard, Spash (2022; 2020) argues that biodiversity loss is accelerating with the financialization of nature through a series of new instruments (e.g., biodiversity banks, trading, offsetting, green/blue bonds, species credits, extinction futures markets, and climate catastrophe bonds). The preservation, empowerment, and development of alternative socioecological ways of managing economies are therefore considered the central issue in protecting both humans and nonhumans (Spash, 2021).

In this regard, Spangenberg and Settele (2010) point out that one argument in favor of conservation is that nature has value in itself, that is, it is not necessary for humans to use it productively or act upon it. Conservationists must therefore seek to maintain the diversity of species, ecosystems, and genetics. In this regard, Ascioti and Moraci (2024) argue that the value of nature, like that of "God," can never be fully explained by a monetary estimate. They also emphasize that nature makes us healthier, richer, and, last but not least, happier through both tangible and intangible goods, services, and experiences.

The economic importance of biodiversity lies in the support it provides to ecosystems for the provision of goods and services to productive sectors, such as agriculture, forestry, fisheries, and tourism, mainly (Baumgärtner et al., 2006). Mogollón et al. (2023) also highlight its economic importance in the fields of medicine, the pharmaceutical industry, and the food trade.

In this context, Kassahun et al. (2021) and Welling et al. (2023) emphasize that biodiversity should be considered an essential input for many ecosystem services, and therefore its economic value should be derived from the value of these services (use value). Regarding non-use value, Czajkowski et al. (2009) point out that biodiversity has economic value when people care about its conservation. From this, we can infer the importance of the concept of biodiversity valuation,

highlighting its economic role, especially in the design of efficient environmental policies (Strange et al., 2024).

Economic valuation allows us to quantify in monetary terms the changes in people's well-being as a result of the loss or conservation of biodiversity (Hanley and Perrings, 2019). This is achieved by estimating the willingness to pay (WTP) for its conservation (Manhique and Wätzold, 2024). Obtaining this information is key, as it provides a benchmark for comparing biodiversity conservation with other development alternatives for society (Orihuela et al., 2020).

However, one of the main limitations in measuring the importance of biodiversity in monetary terms or values (Bartkowski, 2017) is related to the abstract and complex nature of its definition (Birnbacher, 2021). This makes it difficult to adequately represent biodiversity to respondents in stated preference studies. In this regard, Hanley and Perrings (2019) point out that the public's lack of knowledge about biodiversity is a barrier to their effective participation in conservation and management programs. It should be noted that biodiversity conservation is considered a public good, so its economic valuation is carried out using stated preference techniques, which collect relevant information through the construction of hypothetical markets or scenarios (Balmford et al., 2022).

In this regard, choice experiments (CE) are a valuation method in which respondents choose between alternative sets of goods or services characterized by different attributes and levels. This method is based on consumer theory and behavioral randomness, which allows for estimating willingness to pay for changes in attributes in order to predict choice in different scenarios (Louviere et al., 2000). Therefore, the identification and characterization of what is to be valued must be understood by respondents, especially considering that this method allows for a wide range of policy changes to be considered (Kassahun et al., 2021).

On the other hand, PNAs are considered a fundamental pillar for in situ conservation. Their importance is not only due to their role in conserving biological diversity, but also to the provision of ecosystem services, which are essential for the development of society and the economy. These areas are part of the world's natural capital and, if conserved and used sustainably, could contribute to sustaining the economy in the long term (Cisneros et al., 2022).

They are also one of the main sources of employment for thousands of families who depend on them, providing direct and indirect benefits to society, particularly to local populations in their surrounding areas. It is also worth noting that these areas are of great importance for building institutional capacity and strengthening capabilities to safeguard natural and cultural heritage (Sims and Alix-Garcia, 2017).

In the case of megadiverse countries, such as Peru, PNAs are considered a fundamental pillar for the *in situ* conservation of biological diversity, the storage of genetic material, and, fundamentally, the provision of a wide range of ecosystem services that promote human well-being and the economy. In addition, these areas enable the planet to cope with increasing pressures and threats, especially from climate change, food insecurity, and rapid population growth (Mercado et al., 2023; Mogollón et al., 2023; Lavado et al., 2021).

In this regard, Peru possesses more than 70% of the planet's biodiversity, with more than 20,375 species of flora (León et al., 2013), 523 mammals, 1,847 birds, 446 reptiles, 624 amphibians, and 2,145 marine fish (MINAM, 2014). Similarly, this country has 84 of the planet's 117 life zones. Currently, Peru has 250 PNAs established in different categories, representing approximately 18.2% of the national territory (SERNANP, 2025).

Specifically, the MNP stands out for the following characteristics: this ANP has the greatest biological diversity in Peru: 223 species of mammals and 1,005 species of birds (Patterson et al., 2006). In addition, it is home to 42% of Peruvian mammal species (SERNANP, 2014). According to Red Team Network (2019), the MNP is the ANP with the greatest diversity of terrestrial species in Peru and worldwide.

Studies on the conservation of protected natural areas and biodiversity in Peru highlight the importance of protecting them due to the great biological diversity they harbor. However, this assessment must be translated into conservation policies that help mitigate impacts (Lundhede et al., 2015). According to Czajkowski et al. (2009) and Hanley et al. (2003), people are willing to pay for biodiversity policies that contribute to improving and protecting natural ecosystem processes, species conservation, and the preservation of natural spaces.

In this regard, one of the most common strategies for conserving biodiversity is the creation of PNAs. PNAs are cornerstones for safeguarding, managing, and restoring what remains of

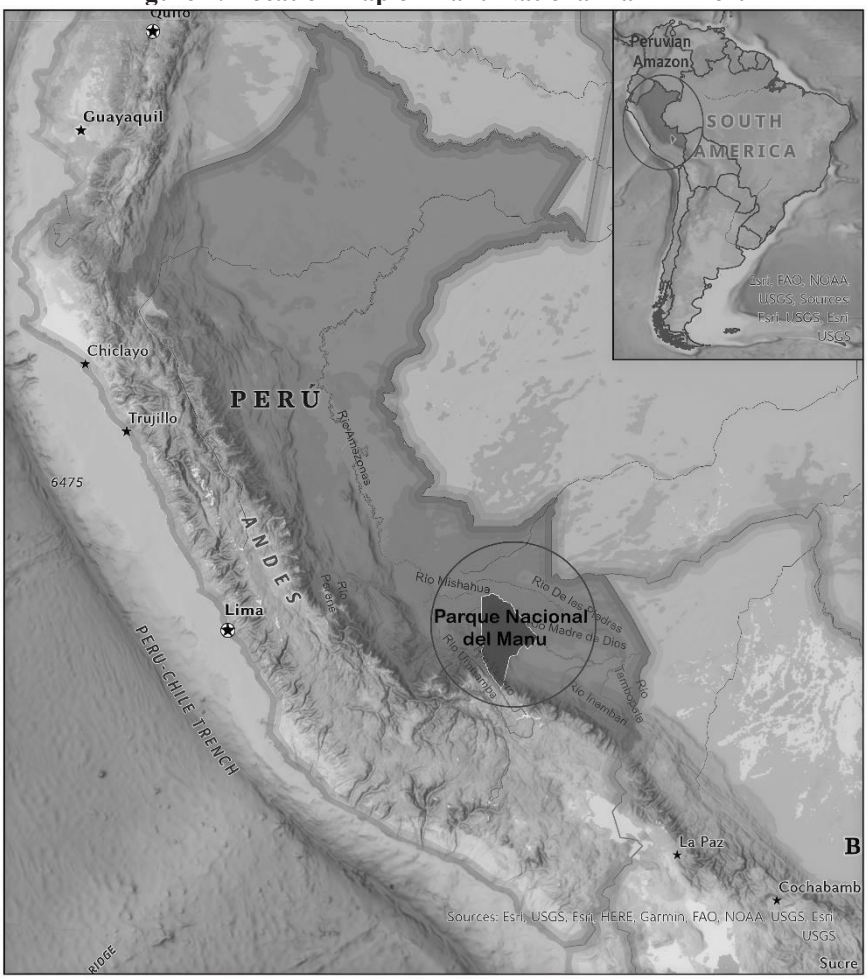
biodiversity (Ameca et al. 2024). However, in many cases, these PNAs are insufficient to protect the resources they are linked to, including biodiversity, as they are relatively few in number, small, isolated, and subject to changes that ultimately make it difficult to maintain large areas to preserve ecosystem functions and the resulting ecosystem services (Orihuela et al., 2020). In this context, the present study aims to estimate the economic value of biodiversity conservation in the MNP, the PNA with the greatest biological diversity in Peru, in order to contribute to the efficient design of environmental policies.

2. MATERIALS AND METHODS

2.1 Area of study

Manu National Park (MNP) covers an area of 19,098 km2 and is located in southeastern Peru, in the departments of Cuzco and Madre de Dios (Figure 1). According to Orihuela et al. (2020), the most important characteristic of the MNP is that it is the most biologically diverse Natural Protected Area (NPA) in Peru, as it contains a large part of the flora and fauna species of the Peruvian Amazon. In addition, it contains at least 50 globally threatened animal species, according to the International Union for Conservation of Nature [IUCN] Red List (2024).

Figure 1: Location map of Manu National Park in Peru



Likewise, Dávila et al. (2023) maintain that the MNP contains 42.4% of the mammal species in all of Peru, as well as 10% of the world's bird species; and that its tropical forests are considered among the least intervened by anthropogenic activities, which makes possible the settlement of indigenous populations in isolation and a notable diversity of Amazonian ethnic groups.

2.2 Choice experiments (CE)

The CE method assumes that individuals, in the rational choice process of purchasing goods, reveal their preferences based on the value of each of their characteristics or attributes; and not on the value of the good itself (Louviere et al., 2000).

In this sense, Melo-Guerrero et al. (2020) point out that the design of experiments begins with the generation of several choice sets containing mutually exclusive (hypothetical) options. The alternatives are integrated by the previously defined attributes of the good, which are defined by one or more levels. Thus, the choice sets are made up of a constant alternative (*Status Quo*), and, at least, two improvement alternatives (Xuan et al., 2017).

Thus, according to Orihuela et al. (2020), the utility that an individual n obtains from choosing alternative j in choice situation t can be expressed as:

$$U_{njt} = V_{njt} + \varepsilon_{njt} \dots [1]$$

Where U_{njt} is the total utility of individual n for alternative j in choice situation t., V_{njt} is the observed component of individual n's utility, which is based on the attributes of the good; and on objective and subjective variables of the individual. Finally, Train (2009) emphasizes that ε_{njt} is the unobservable random component of utility, which captures factors unknown to the researcher.

Following McFadden and Train (2000), if the random component ε_{njt} is independently and identically distributed with an extreme value type I distribution, the probability that individual n chooses alternative i in choice situation t is given by the conditional logit model:

$$P_{nit}(y = i \ / \ x_{njt}) = \frac{e^{\beta * x_{nit}}}{\sum_{j=1}^{J} e^{\beta * x_{njt}}} \dots [2]$$

Where x_{njt} represents the total attributes that compose the biodiversity conservation in the MNP and the sociodemographic and economic variables of the individuals surveyed, while β is a vector of the parameters associated with each attribute or characteristic of the individuals (Dávila et al., 2023; Orihuela et al., 2020).

2.3 Design of choice experiments

This study considers a base scenario (*Status Quo*), corresponding to four attributes that make up the biodiversity within the MNP, by considering 24 species of flora, in danger of extinction, 24 species of fauna, also in danger of extinction, a deforestation size, average, of 1400 ha/year; and a percentage of 40% loss of functionality of the ecosystems in this NPA (i.e., that currently the degree of functionality in the MNP is 60%).

Based on the above, a hypothetical scenario of changes in the levels of these attributes was constructed, based on the reduction of impacts in this NPA derived from the implementation of a program conducted by the Universidad Nacional Agraria La Molina (UNALM) and the MNP.

Table 1: Expected changes in biodiversity attributes in the MNP

Base scenario (*Statu Quo*)	Hypothetical scenario
Flora Diversity: 24 endangered species in MNP	Expected plant diversity: 8 species in danger of extinction in MNP
Fauna Diversity: 24 species in danger of extinction in MNP	Expected Fauna Diversity: 8 endangered species in the MNP
Current deforestation: 1400 ha/year on average in MNP	Expected deforestation: 300 ha/year on average in MNP
Loss of ecosystem functionality in the MNP: 40%.	Loss of ecosystem functionality in the MNP: 0%.

Table 1 shows the improvement in the levels of biodiversity attributes in the MNP. In other words, situations that counteract the loss of biodiversity in this NPA. It should be noted that, although it is true that the situation of the hypothetical scenario would be questionable from a

scientific-ecological point of view, the certainty of real expected changes, in terms of biodiversity, would be a commendable task. In this regard, Orihuela et al. (2020) argue that studies on economic valuation of biodiversity conservation, based on CE, are useful insofar as they make it possible to determine preferences for conservation options, since these are directly linked to changes in human welfare.

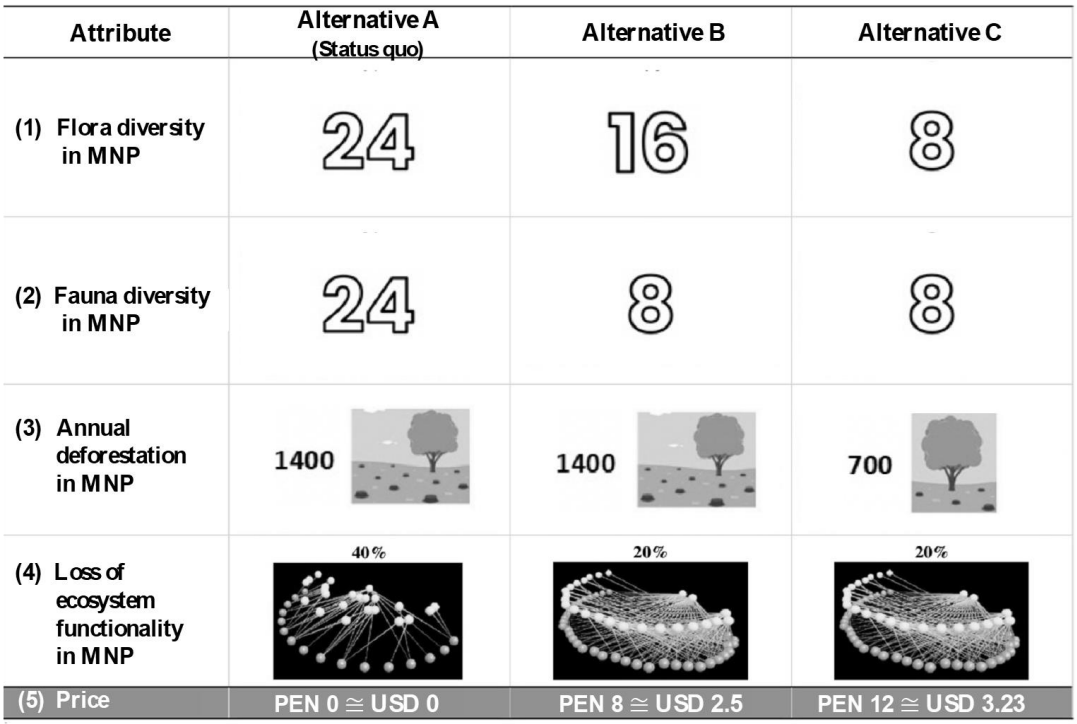
Additionally, for economic valuation, through CE, it is essential to incorporate the price attribute (Melo-Guerrero et al., 2020). In this context, the study proposed establishing a monthly monetary contribution for one year (Orihuela et al., 2020; Dávila, 2023). This funding is intended to finance the impact reduction program, causal to the loss of biodiversity in the MNP.

Table 2: Biodiversity attributes and levels in the CE design

	Attribute	Detail	Type of attribute	Proposed levels
1	Flora diversity in MNP	Number of endangered plant species in MNP	Qualitative	Low (8) Medium (16) High (24) (*Status Quo*)
2	Fauna diversity in MNP	Number of endangered animal species in MNP	Qualitative	Low (8) Medium (16) High (24) (*Status Quo*)
3	Annual deforestation in MNP	Size of annual deforestation in the MNP	Qualitative	Low (300) Medium (700) High (1400) (*Status Quo*)
4	Loss of ecosystem functionality in MNP	Loss of the interrelationship of flora and fauna species, ecosystems and habitats in the MNP.	Qualitative	Low (0%) Medium (20%) High (40%) (*Statu Quo*)
5	Price	Monthly economic contribution to reduce the loss of biodiversity in the MNP	Quantitative	PEN 0 ≅ USD 0 (*Statu Quo*) PEN 4 ≅ USD 1.28 PEN 8 ≅ USD 2.15 PEN 12 ≅ USD 3.23 PEN 15 ≅ USD 4.03 PEN 20 ≅ USD 5.38

Thus, the *status quo* of the attributes flora diversity and fauna diversity corresponds to 24 species of plants and animals of the MNP in the endangered category, while in the case of the attribute annual deforestation, it corresponds to the magnitude in the period of one year. The case of the ecosystem functionality attribute is based on the study by Dávila et al. (2023). Thus, the following figure shows an experiment derived from the efficient design of the CE.

Figure 2: Example of an experiment presented to the individuals



It should be noted that the efficient design in the ES is derived from the factorial design, reducing the total number of combinations between attributes, based on a process of randomization and statistical efficiency. In this study, having a total of 5 attributes, 4 of them with 3 levels each, and the fifth attribute (price), with 6 levels, the factorial design would have a total of (3^4)x(6) total combinations, that is, a total of 486 experiments. Following Jumamyradov et al. (2023) and Feilhauer et al. (2022), the most widely used efficient design in the literature is called "D - efficient", which chooses attribute combinations by minimizing the inverse of the determinant of the variances and covariances matrix of a logit model. Thus, this study contemplated 48 experiments in total, divided into 12 formats of 4 experiments each (see Table 3).

2.3.1 Ethical considerations

All data collection procedures followed ethical research standards. Respondents were informed about the study objectives, the voluntary nature of their participation, and the confidentiality of their responses. Only individuals who gave their verbal informed consent were interviewed. No personally identifiable information was recorded, ensuring anonymity throughout the process.

3. RESULTS AND DISCUSSION

3.1 Descriptive results

The target population corresponds to all households located in urban areas of the 43 districts that make up the city of Lima. The unit of analysis is the head of household, since it is the head of household who makes decisions about the household budget. The type of sampling was probabilistic, with allocation proportional to the population size of the districts of the city of Lima. The size and distribution of the sample by districts is presented.

Table 3: Details of the surveys applied in the city of Lima - Perú

Formats	
1	30
2	29
3	47
4	59
5	62
6	45
7	52
8	56
9	53
10	52
11	28
12	47
Total	**560**

Districts*	
Centro de Lima	102
San Juan de Lurigancho	112
Los Olivos	44
San Martín de Porres	69
Comas	61
La Molina	15
San Borja	19
Ate Vitarte	64
Villa El Salvador	44
Chorrillos	30
Total	**560**

A total of 560 surveys were applied, obtaining a total of 2,240 experiments, between October, November and December 2023. Of the total, 85.7% chose a biodiversity conservation plan (showing a non-zero WTP), and the remaining 14.3% preferred the *Status Quo*. Of the latter group, 22.5% represented a protest choice, because these people consider that funding for biodiversity conservation is the responsibility of the state or third parties, in general.

It was also found that 71.79% (402 people) stated that they had traveled outside of Lima during the last five years to enjoy nature. Of this group, 75.12% were able to identify problems associated with biodiversity loss and environmental pollution problems in general. Of these 402 people, 52.24% reported having paid an entrance fee.

Of the total number of respondents, 79.11% stated that they were aware of the existence of endangered animal species in Peru, while in the case of plant species, the result was 61.25%. However, it should be noted that both questions were designed to obtain a dichotomous response, i.e., the respondent could affirm or not, to know of plant and animal species in danger of extinction in Peru. For this reason, additional questions were included referring to the identification of these species (a maximum of three species), as well as a main cause of this condition. In the case of plants, only 32.4% were able to complement the information indicated. In contrast, for animals, the result was 62.23%. This suggests a greater association of biodiversity conservation to the case of animal species conservation.

Descriptive statistics of the main variables are presented in the following table.

Table 4: Main descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
History of nature consumption	560	0.72	0.45	0	1
Identification of biodiversity problems	413	0.73	0.44	0	1
Payment per entry	401	0.52	0.50	0	1
Identification of threatened plant species	554	0.62	0.49	0	1
Identification of threatened animal species	558	0.79	0.40	0	1
Gender	557	0.45	0.49	0	1
Marital status	552	0.73	0.65	0	3
Age	560	41.9	18.02	19	70
Education	506	5.59	1.89	1	10
Income range	543	4.75	2.52	1	11

It shows that 45.18% of the respondents are women. The average age is 42 years. Regarding marital status, 35.36 % present the status of single, while 56.79 % declared to be married. On the income side, only 14.11 % reported an income higher than PEN 5000 (≅ USD 1344.09), while 10.36% reported earning the minimum wage (PEN 1025 ≅ USD 275.54).

With respect to educational level, 47.32% reported having higher education, between technical and university studies. Those with a technical degree represent 17.5%, while professionals represent 22.68%; and those professionals with a master's degree represent only 0.89% of the sample.

3.2 Results of the conditional logit model

Choice experiments provide a methodological framework for exploring public preferences regarding environmental policies, but they are limited by the assumption of a homogeneous decision rule (Zen et al., 2025). This knowledge about people's preferences, if adequate, can help design more effective environmental policies (Petr et al., 2022).

According to Feilhauer et al. (2022), although groups with different preferences show significant heterogeneity in decision rules across multiple attributes of choice experiments, which are related to their socioeconomic and environmental characteristics, the background information provided by Dávila et al. (2023) and Orihuela et al. (2020), in the specific case of the application of choice experiments in PNAs in Peru, allow us to infer that social preferences are homogeneous.

This may be because Peru is a megadiverse country, which is why the non-use value as an aggregate benefit could finance in situ conservation policies involving affordable costs for relatively few species of flora and fauna, as well as certain charismatic habitats (Gutiérrez et al., 2021). In this regard, following Jumamyradov et al. (2023), who point out that the conditional logit model assumes that individuals' preferences are homogeneous, i.e., that there is no variation between individuals in terms of their preferences, this study will use the aforementioned model.

Table 5: Estimation of the conditional logit model

Log likelihood = -2270.1888		Number of obs =		6,720	
		LR chi2(10) =		381.41	
		Prob > chi2 =		0	
		Pseudo R2 =		0.0775	
Election	Coef.	Std. Err.	z	P > |z|	[95% Conf. Interval]
sq	-0.825	0.108	-7.64	0	-1.650
Plant_16	0.352	0.071	4.95	0	0.213 0.492
Plant_8	0.413	0.074	5.61	0	0.269 0.558
Animal_16	0.245	0.064	3.82	0	0.119 0.371
Animal_8	0.110	0.077	1.44	0.15	-0.040 0.261
Fx_Mean	0.124	0.079	1.6	0.11	-0.028 0.277
Fx_Null	0.139	0.072	1.94	0.052	-0.279 0.001
Def_700	0.322	0.067	4.8	0	0.191 0.454
Def_300	0.295	0.071	4.14	0	0.155 0.435
cost	-0.086	0.007	-12.92	0	-0.173

Since the logit model estimates the marginal effects of the explanatory variables with respect to L, the odds ratio, *a priori*, the estimation of the parameters per se, has no direct interpretation, except to identify the signs of the estimated parameters. Thus, all the variables show positive marginal effects, with the exception of the variables cost (price) and sq (*Status Quo*). According to the above, if a qualitative variable, which take the value of 0 and 1, changes, then it is to be expected that the probability of choosing an alternative other than the *Status Quo* will increase. Moreover, the model presents a pseudo R^2 of 0.0775, which, although modest, is typical in discrete choice models and consistent with values commonly reported in this type of analysis.

Table 6: Estimation of WTPs, according to changes in the levels of biodiversity attributes

	Plant_16	**Plant_8**	**Animal_16**	**Animal_8**	**Fx_Mean**	**Fx_Null**	**Def_700**	**Def_300**
DAP	4.08*	4.79*	2.84*	**1.28**	**1.44**	1.61*	3.74*	3.42*
Upper limit	2.43	3.09	1.36	-.46	-.30	-.00	2.13	1.76
Lower limit	5.73	6.49	4.32	3.02	3.18	3.22	5.34	5.08

Note: Coefficients with the symbol * have a p-value < 5%.

Table 6 shows the marginal WTP for each of the attributes. It should be noted that these values measure the change with respect to the status quo. Thus, for example, the WTP associated with Planta_16, indicates that a person is willing to pay 4.08 PEN / month (≅ USD 1.10/month), for a period of 1 year, so that the number of threatened plant species in the MNP is reduced from 24 to 16 only.

The interpretation is the same for each of the attributes, including the case of the lowest levels for each of the attributes (the best option in terms of biodiversity conservation). Thus, the WTP associated with Plant_8, 4.79, indicates that the same respondent increases his economic contribution, since he now prefers that there are only 8 threatened plant species, instead of 24 (*Status Quo*). Finally, it is shown that only the attributes Animal_8 and Fx_Mean were not significant at 5% p-value.

3.3 Discussion

Although biodiversity conservation has been widely studied, empirical evidence on how Peruvian citizens value specific attributes of biodiversity remains scarce. Most previous research emphasizes general ecosystem services or tourism benefits, but little is known about preferences regarding specific threats, such as endangered flora, deforestation, or ecosystem functionality. Addressing this gap, our study provides new evidence from Manu National Park showing differentiated willingness to pay for these attributes and thus offering insights directly applicable to conservation policy design.

The findings of the study provide valuable information on social preferences for biodiversity conservation in Manu National Park. The results show a clear marginal willingness to pay (WTP) for the reduction of specific environmental threats. These results indicate that citizens assign a significant value to the mitigation of biodiversity loss, reinforcing the idea that conservation-related attributes are perceived as valuable public goods (Nguyen, 2022).

These results are consistent with Allendorf et al. (2020), who point out that the prevalence of positive attitudes towards protected areas at the global level can be explained by the benefits they generate, such as sustainable ecosystem management, implementation of conservation projects, job creation and income generation. They argue that these areas can contribute to poverty reduction by offering economic opportunities and health benefits. In the Latin American context, and specifically in Peru, Mercado et al. (2020) note that Natural Protected Areas (NPAs) not only provide ecological benefits, but also provide recreational services and contribute to climate stability, thus reinforcing both their environmental and socioeconomic value.

The attribute with the highest WTP, the reduction of endangered flora species (4.79 PEN/month ≅ USD 1.29/month), highlights the sensitivity of respondents towards the conservation of endemic and vulnerable flora. This finding coincides with the case of the Lircay National Reserve in Chile, where Cerda et al. (2018) found positive and significant willingness-to-pay values, with a particular emphasis on the protection of animal species and biodiversity conservation, attributes that obtained the highest economic values.

Similarly, Tavárez et al. (2024) found that households in the Rio Hondo neighborhood in Puerto Rico showed a willingness to pay USD 43 per year to improve the biodiversity of the Rio Hondo Community Forest by creating a nursery of native plants and trees, as well as their subsequent transplanting in the forest. This result is linked to the assessment of urban forests by Tavárez and Elbakidze (2021), who noted that willingness to volunteer in forest management and environmental awareness (measured through commitment to at least one of three items assessed) correlate positively with supporting biodiversity through the use of native plants and trees from a nursery. Similarly, in the Colombian context, Pérez-Sánchez et al. (2021) analyzed the willingness to pay of the inhabitants of an urban area for the conservation of a tropical dry forest protected area in Colombia. The results indicated that citizens were willing to contribute a monthly fee of USD 2.02 for the maintenance of the forest's ecosystem services. In addition, determinants of a positive WTP were identified, such as years of residence in the area, perceived importance of the area, and interest in preserving ecosystem services for future generations.

Likewise, willingness to pay for reduced deforestation (3.42 PEN/month ≅ USD 0.92/month) also reflects social concern about direct threats to the park's ecosystems. This result is consistent with research indicating that the perception of forest cover loss has both ecological and economic implications, including water regulation and climate change mitigation, among these, Orihuela et al. (2020) found a WTP of 5.04 PEN/month for the same attribute in the Peruvian context, while Tadesse et al. (2022) documented that benefits derived from forests represent a significant source of income for forest communities. In their study, they identified a monthly WTP of between USD 0.14 and USD 1.53 for the supply of forest products, which can be explained by the fact that more than 95% of the surveyed households consider forests as an essential resource for their livelihood. However, in the study by Dávila et al. (2023), the deforestation attribute was not significant, which could be due to the virtual modality of the surveys applied, aligning with the observation of Lindhjem et al. (2011), who point out that non-face-to-face surveys can modify the relationships between the levels of economic valuation of the attributes.

Meanwhile, the reduction in the loss of ecosystem functionality (1.61 PEN/month ≅ USD 0.43/month) reflects a social recognition of the importance of maintaining critical ecosystem services. However, the lower value associated with this attribute could suggest a limited public understanding of the role that functional ecosystems play in human well-being. This result differs from Dávila et al. (2023), who found a WTP of 11.67 PEN for the same attribute, highlighting the challenge of communicating the complexity of this concept to the public.

Evidence also suggests that the consumption of biodiversity as a tourism attribute contributes to the generation of economic income in NPAs, as demonstrated by Rossi et al. (2015) and Pickering et al. (2018). Along these lines, Kabil et al. (2022) argue that the tourism industry seeks to take advantage of the potential of NPAs to boost local economic development, generating employment, improving the living conditions of communities, diversifying sources of funding for conservation, and promoting the consumption of local goods and the growth of SMEs. Therefore, the incorporation of biodiversity as an added value in Manu National Park's tourism offer could translate into tangible economic benefits for the community.

Finally, these results have relevant implications for the design of public policies. The incorporation of programs that address the social preferences reflected in this research could increase

the legitimacy of conservation strategies and foster greater willingness to collaborate financially with them. As suggested by Nobel et al. (2020), NPA management strategies should integrate the WTPs of the public, recognizing the importance of the total economic value approach for effective management.

Therefore, the economic valuation of biodiversity in Manu National Park can also be framed within ecological economics, as a strategy to express in monetary terms the benefits that ecosystems generate for society (Costanza et al., 1998). However, more integrative approaches emphasize that ecosystem services encompass cultural, spiritual, and aesthetic dimensions that cannot always be adequately captured through economic values (Chan et al., 2012). In this sense, while monetary valuation is a useful but limited tool—and should not replace ethical or ecological considerations—it can nonetheless provide significant support for biodiversity conservation.

At the same time, the interpretation of these results requires caution, since this study focuses exclusively on urban residents of Lima, where biodiversity tends to be valued primarily from a recreational and environmental awareness perspective. Therefore, the results may not fully reflect the perspectives of rural or indigenous populations, where biodiversity is not only a source of ecological services but also provides health, cultural knowledge, and practices that directly contribute to the well-being of these communities, beyond conventional economic valuation (Russell-Smith 2016; Sangha et al. 2017).

This distinction suggests that the applicability of the results should be interpreted with caution when considering broader conservation strategies. Furthermore, framing biodiversity as a public good raises relevant theoretical debates about collective benefits and the challenges of securing financing mechanisms. In this regard, it is necessary to clarify whether the main objective of the valuation results is to inform public opinion and urban conservation policies, or whether they could also serve as a basis for future payment for ecosystem services (PES) initiatives in Peru.

4. CONCLUSIONS AND POLICY IMPLICATIONS

The willingness to pay was estimated for each of the attributes that make up biodiversity conservation in Manu National Park, Peru. The highest values were obtained in the cases of reduction in threatened plant species, from 24 to 8 species (PEN 4.79), and from 24 to 16 species (PEN 4.08), and deforestation, from 1,400 to 700 (PEN 3.74).

According to the above, it is clear that society attaches economic importance to projects or programs that address the problem of biodiversity loss, even in developing countries. These results are relevant for the design of environmental policies if we consider that it could be sufficient for Peruvian society to contribute financially to reducing the number of endangered plant species, and it would be irrelevant whether these decrease from 24 to 16 or from 24 to 8 (the difference between these marginal WTPs is not significant).

This could be explained by the fact that Peru is a megadiverse country, meaning that the non-use value per se could be sufficient to finance in situ conservation policies involving affordable conservation costs for relatively small populations of plant species associated with specific habitats linked to forests in protected natural areas. Thus, it can be inferred that, by conserving forests and plant species in general, society reveals an important and decisive non-use value for policy design.

Consequently, environmental policies for biodiversity conservation can be based on criteria of economic efficiency by comparing the benefits identified with the economic costs of conservation, considering a series of conditions necessary for the validity of the economic valuation results, especially regarding the homogeneity or heterogeneity of social preferences. In this case, the net benefits can be extrapolated to society as a whole, since preferences are considered to be homogeneous, thus constituting the main limitation of this study.

5. LIMITATIONS AND FUTURE RESEARCH

This study has some limitations that should be considered. First, the design of the choice experiment assumes homogeneity of individual preferences, which may underestimate the heterogeneity of social preferences among different socioeconomic groups or geographic areas.

Second, the survey was limited to heads of households in the city of Lima, which limits the representativeness of the results for rural populations or communities living closer to Manu National Park, who may perceive biodiversity conservation differently. Finally, the use of stated preference methods is subject to hypothetical bias, as respondents may express a higher willingness to pay than they would actually be willing to pay in real market situations.

Future studies could expand this work in several directions. First, extending surveys to rural communities and indigenous populations surrounding Manu National Park would enrich the understanding of local preferences and their potential role in conservation strategies. Second, longitudinal studies could help capture the stability of willingness-to-pay estimates over time, especially in the context of changing environmental conditions. Finally, integrating revealed preference methods or experimental payment schemes could reduce hypothetical bias and improve the robustness of economic valuation results.

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