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Analysis

Out of sight, not out of mind: The effect of access to conservation sites on the willingness to pay for protecting endangered species

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ABSTRACT

According to the latest global assessment report on biodiversity and ecosystem services, nature and biodiversity have experienced a global decline, making the development of conservation policies urgent. Herein, we used a contingent valuation survey to estimate the economic value of a reintroduction program for the huemul (*Hippocamelus bisulcus*), an endangered charismatic species in Chile. Our novel approach exploits changes in the access to the site to disentangle nonuse value from use value. We use parametric and nonparametric models to estimate the willingness to pay for the program. Our findings consistently indicate that the conservation of the huemul is valued more when tourist access is restricted, as opposed to allowing visitors access to reintroduction areas. We also analyze the sensitivity of this main finding to different cut-off points of a certainty scale, showing that the results are robust. We hypothesize that people are willing to pay a "premium" to keep the conservation site "out of sight" from tourist activities. This could also be related to the belief that a reintroduction program would be more effective if access was not allowed. A cost-benefit analysis using the most conservative assumptions suggests that social benefit significantly outperforms cost.

1. Introduction

According to the latest global assessment report on biodiversity and ecosystem services, nature and biodiversity have experienced a global decline caused by direct and indirect drivers, including land and sea use changes, direct exploitation of organisms, human population dynamics, and unsustainable consumption patterns (IPBES, 2019). Among the declines in nature, the species extinction risk is associated with approximately 25% of the species of different groups of animals and plants (birds, reptiles, mammals, conifers, ferns, and dicotyledons, among others) in the "threatened" category (IPBES, 2019). This category includes "Critically Endangered," "Vulnerable," or "Endangered" species, according to the Red List of the International Union for Conservation of Nature (IUCN, 2012).

The growing number of threatened species requires some management to ensure survival (IUCN/SSC, 2014). Reintroduction is a widely used conservation tool to prevent species extinction, and it corresponds to a type of conservation translocation (IUCN/SSC, 2013; Bristol et al., 2014; Ma et al., 2016; Seddon et al., 2012). It consists of an organism's intentional movement into an area that has been part of its range but has disappeared or become eradicated (IUCN, 1987). This process aims to restore the population of the species, as long as it has a high probability of persistence, with minimal or no intervention (Seddon et al., 2012). Hundreds of reintroduction programs have been implemented worldwide but are not always successful (Ma et al., 2016). Some examples are the beaver, the red kite, and the wild boar in the UK (Goulding et al., 2003).

Although translocation is an effective tool for conservation, its use

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should be complemented by sound benefit-cost analysis and risk evaluation to design a socially optimal conservation policy (Cook et al., 2018; Haab et al., 2013; IUCN/SSC, 2013; Mitchell and Carson, 1989). The economic valuation of the benefits of species conservation policies, plans, and programs is essential for their design and implementation (CBD, 2004; Medina et al., 2012; OECD, 2002; Ren et al., 2022; Watkins and Poudyal, 2021; Zambrano-Monserrate, 2020). Nevertheless, a central challenge for policy design is that most of the benefits derived from conservation programs may ensue from benefits not traded in formal or informal markets, such as existence and bequest, recreation, aesthetic, and cultural services (nonmarket benefits).

The total economic value (TEV) of a nonmarket good includes use (direct use, indirect use, and option and nonuse (legacy and existence) values (Vásquez et al., 2007). While use value is less controversial, discussions about the existence and measurement of nonuse value have been fundamental in developing nonmarket valuation techniques. Estimating nonuse value is important in conducting a cost-benefit analysis since it could represent a significant amount of the total value. For instance, the Deepwater Horizon oil spill generated a loss-in-use value (recreation days) of US$661 million (English et al., 2018), while the passive value was estimated at US$17.2 billion (Bishop et al., 2017).

Nonuse value is mainly measured using stated preference techniques, including contingent valuation (CV) and choice experiment (CE), among others (Alberini et al., 2006; Haab and McConnell, 2003; Louviere et al., 2000; Mitchell and Carson, 1989). Both methods use surveys to elicit respondents' willingness to pay (WTP) or willingness to accept (WTA) for changes in the provision of environmental goods (Freeman et al., 2014; Hanemann, 1994; Louviere et al., 2000; Mitchell and Carson, 1989; Vásquez et al., 2007). Notably, CV assesses changes from the current status quo to an improved environmental service, whereas CE asks respondents to choose a preferred alternative, with variations in attribute levels defining the environmental commodity (Freeman et al., 2014; Kling et al., 2012; Marre et al., 2015).[1]

Economic valuation studies have been used to estimate the benefits of conservation programs aimed at increasing the population of endangered species, avoiding the loss of species, increasing the chances of survival, or reintroducing species (Loomis and White, 1996; Richardson and Loomis, 2009). Some studies assessing popular species include the valuation of wolves (*Canis lupus*) in Yellowstone National Park (Duffield and Neher, 1996), the giant panda (*Ailuropoda melanoleuca*) in China (Ma et al., 2016), the clouded leopard (*Neofelis nebulosa*) in Taiwan (Greenspan et al., 2020), and the elk (*Cervus canadensis*) in Tennessee (Watkins and Poudyal, 2021), among others.

In particular, the species "charisma" has become a relevant variable in conservation efforts (Dobson et al., 2022; Macdonald et al., 2015; Richardson and Loomis, 2009; Veríssimo et al., 2009). Specifically, *flagship species*, defined as "popular and charismatic species that serve as symbols and meeting points to stimulate conservation awareness and action" (Heywood, 1995), are expected to attract more public support for a conservation program. Researchers and policymakers also hypothesize that they generate more benefits that allow the protection of less-charismatic species, thus achieving broader conservation goals (Ma et al., 2016; Macdonald et al., 2015).

Herein, we use CV to estimate the economic value of a reintroduction program for the huemul (*Hippocamelus bisulcus*), an endangered charismatic species in Chile. This paper contributes to the literature on the economics of species extinctions and, more specifically, on the valuation of species at risk of extinction (Bristol et al., 2014; Zander et al., 2022) in two ways. First, we suggest a new approach to estimate nonuse value based on valuing endangered species under a scenario with access to reintroduction sites and another without. To the best of our knowledge, this approach has not been used previously in the literature. Second, and more particularly, we contribute to the scarce literature on reintroduction programs of endangered and emblematic species by comparing the use and nonuse values for the same individual.

Our findings consistently indicate that the conservation of the huemul is valued more when tourist access is restricted, as opposed to allowing visitors access to reintroduction areas. Our findings are relevant for understanding the conditions under which nonuse value can be higher than use value from respondents' perspective in a stated preference survey. We show the relevance of nonuse value for species conservation as it has already been reported in the literature (Alexander and Robert, 2000; Lopes and Atallah, 2020; Vincent et al., 2014). Some studies have found that the nonuse value is lower than the use value (Cazabon-Mannette et al., 2017). Other studies, such as ours, have found the opposite (Loomis, 2006). We believe this issue is an important area of research for those interested in protecting biodiversity.

The type of value held by individuals, whether use or nonuse, is known to play an essential role in estimating their WTP for species conservation (Richardson and Loomis, 2009). While some targeted species have both use and nonuse value, a significant portion of their economic value may ensue from nonuse considerations (Bandara and Tisdell, 2003; Krutilla, 1967; Marre et al., 2015; Otrachshenko et al., 2022; Whitehead, 1993). In our case application, given the extension of the market (the whole population of the country), the nonuse value represents a significant amount of benefits, leaning any cost-benefit analysis toward avoiding extinction (Hanley and Perrings, 2019), in contrast with the smaller population that could have a use value. But more importantly, we found that the value changes depending on the approach proposed to conserve the species (with or without access), as in Zander et al. (2022).

Discriminating between use and nonuse values in empirical applications has been challenging. Researchers have attempted to decompose the TEV for various types of goods into use and nonuse, as well as direct use, indirect use, existence, and bequest value categories. Two common approaches to this decomposition are dividing the sample into users and nonusers or asking respondents to assign their total WTP to different value categories (Damigos et al., 2017; Ferreira and Marques, 2015; Kontogianni et al., 2012; Marre et al., 2015; Martínez-Paz and Perni, 2011; Wattage and Mardle, 2008). However, no consensus exists on which approach is more appropriate for disentangling the TEV.

In the context of species conservation programs, Kotchen and Reiling (2000) study the relationships between the WTP for the protection of falcons (*Falco peregrinus*) and sturgeons (*Acipenser brevirostrum*), respondents' environmental attitudes, and their underlying motivations. The authors assume that the value is entirely nonuse and include possible motivations for their values, including option, altruism, bequest, existence, and rights-based values, while concluding that those with stronger pro-environmental attitudes place more weight on ethical or rights-based motivations. However, they do not estimate these five different nonuse values. Chambers and Whitehead (2003) consider both the decomposition of WTP into use and nonuse values, and respondents' motivations. They estimate the contribution of some motives (representing altruistic, bequest, existence, and ethical values) to the WTP for the preservation of wolves. The authors conclude that these factors are important WTP determinants. However, they do not explicitly estimate the individual values of each component. Bandara and Tisdell (2005) study how the change in the abundance of Asian elephants (*Elephas maximus*) affects WTP. These include existence, legacy, and nonconsumptive use as covariates, defined as ordinal variables. They find that nonuse values are predominant when the elephant population is closer to extinction, while use values predominate when the species becomes more common.

By and large, estimates from stated preference studies are considered nonuse values if the author explicitly states that the estimation corresponds primarily or exclusively to nonuse values, respondents indicate what part of their TEV represents the nonuse value (stated decomposition), or respondents are nonusers of environmental goods (Brooks and

[1] Experts have addressed the limitations of the methods and provided guidelines for their implementation (see (Johnston et al., 2017).

Newbold, 2014; Nobel et al., 2020). The first approach can be subjective and biased, as it imposes the author's belief about the value of a species. In the second approach, respondents are asked to allocate their WTP to different value categories (use/nonuse or bequest/existence/option, etc.), which may generate cognitive difficulties. In the third approach, information about the users of the environmental good is lost, as users may also have nonuse values, which may even be higher than those of nonusers, given their experience and familiarity with the goods (Marre et al., 2015). For this reason, we believe that the approach proposed in this study represents a less biased way of estimating nonuse value, as the survey explicitly states whether access to the conservation site is possible, thus capturing nonuse value from users and nonusers without generating serious cognitive difficulty.

The previous literature has used site access, acknowledging that access is related to use and nonuse values. Kotchen and Reiling (2000) and Chambers and Whitehead (2003) consider the access variable as an explicit determinant of respondents' motivation. They include, among the possible motivations to pay, "*The importance of enjoying the species*," "*Maybe one day I want to see the species*," or "*I like to know that other people can enjoy the species*." Jacobsen et al. (2012) estimate the WTP for an increase in the population of a threatened species using CE, in which the access condition is an attribute. De Wit et al. (2017) perform a multiple CV to estimate the WTP for the restoration of a lagoon ecosystem by combining different access options. Finally, in a CE by Estifanos et al. (2021) about the WTP of tourists for the protection of the Ethiopian wolf (*Canis simensis*), an emblematic and charismatic species, the management of access to its habitat was considered as an attribute of the conservation program, with the options "without restriction" and "restricted (access only by designated footpaths)." All of these studies show respondents' preferences for accessing the species' sites or habitats. However, none of these studies restrict access entirely to determine the nonuse value of a species.

In our study, we obtain a value associated with the program with restricted access to the huemul reintroduction site, which can be linked to a "pure nonuse value," as respondents are explicitly informed that they cannot access it. Our new approach to identifying the nonuse value from the TEV contributes to filling the gap vis-à-vis better estimates of nonuse values using stated preference techniques, which has been considered a challenge in the literature (Brooks and Newbold, 2014; Marre et al., 2015; Nobel et al., 2020). There is increasing interest in including nonuse values in policy evaluations, especially in the case of valuing biodiversity protection (Nobel et al., 2020; Brooks and Newbold, 2014).

2. Material and method

2.1. The huemul and the reintroduction program

The huemul is an Andean Patagonian deer from Chile and Argentina (Escobar et al., 2020). This species is currently classified as in danger of extinction (Black-Decima et al., 2016; Ministerio Secretaría General de la Presidencia, 2007). The main threats that are driving huemul deer to the risk of extinction are the small current population size and isolation due to habitat loss and fragmentation of its habitat, hunting in the past, as well as predation by dogs, and changes in migratory patterns caused by human activities, runover due to the presence of roads, causing its current population to be <2500 individuals (Escobar et al., 2020; Flueck et al., 2022; Povilitis, 1998; Tadich et al., 2005; Texera, 1974; Vila et al., 2006). In addition to these drivers, climate change modeling has indicated an increase in extinction risks (Riquelme et al., 2020) and high morbidity and mortality due to a foot disease caused by a virus that is also present in bovines represents a considerable threat (Vila et al., 2019). In conclusion, multiple factors explain the huemul risk of extinction, of course, being the loss of habitat a significant driver.

Its historical distribution ranges from the Andes south of the Río Cachapoal (O'Higgins Region) to the Estrecho de Magallanes in Chile (Vila et al., 2010). However, at present, their distribution has decreased considerably, and their populations are confined to sub-Antarctic areas in the extreme south of what their distribution was before (Riquelme et al., 2018), and even isolated populations, such as the case of Nevados de Chillán – Laguna del Laja, in the Ñuble and Biobío Regions (Iriarte et al., 2017).

The huemul is an emblematic species for Chile, as it is part of the national coat of arms (along with the condor) (Iriarte et al., 2017). The huemul uses large extensions of habitat, which means that its conservation protects a wide variety of other species (known as umbrella species) (Povilitis, 2002). Owing to these characteristics (threatened, emblematic, and umbrella species), several authors suggest that the huemul has a charismatic potential that makes it an ideal candidate for the design of a conservation policy (Corti, 2008; Hughes, 2002; Povilitis, 1998, 2002).

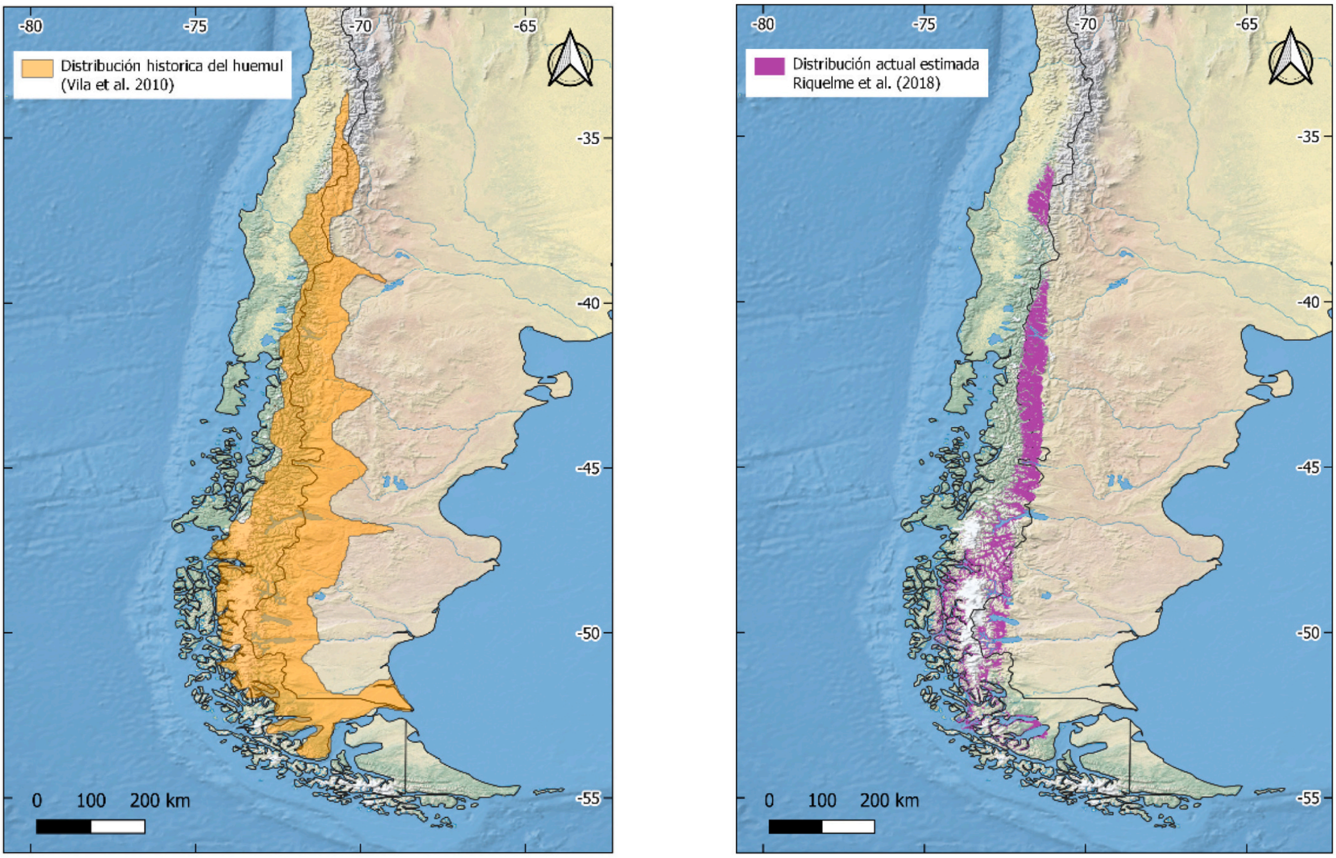
In Chile, there are several policies and initiatives to conserve the huemul. The hunting law prohibits hunting or capturing it throughout the territory (Ministerio de Agricultura, 1998); the establishment of the Nature Sanctuary Los Huemules del Niblinto as a priority site for its conservation (Ministerio de Agricultura, 1999); the plan for the conservation of the southern huemul in Chile (CONAF and CODEFF, 2001); the Huemul Conservation Program of the Huilo-Huilo Foundation, a private strategy (Fundación Huilo-Huilo, 2018); Plans for the Recovery, Conservation, and Management of Species of the Ministry of the Environment (Ministerio del Medio Ambiente, 2022), and binational meetings on the huemul between Chile and Argentina (Corti, 2011). However, none of these policies or initiatives have explicitly calculated an economic value for huemul conservation.

Therefore, the huemul was selected as a case study to establish a reintroduction program. The program was located in the Region de Los Ríos, comuna de Panguipulli (Fig. 2). The huemul disappeared several decades ago in this area, and a private experience of reintroducing them has already been implemented (Fundación Huilo-Huilo, 2018). In addition, the selected location is in the Andes mountains, 1000 m.a.s.l., near to the Pirehueico Lake within the Valdivian forest in which Coihue, Raulí, and Tepa predominate (Campos, 2000). The area's ecosystem corresponds to the habitat for the huemul, as Vila et al. (2010) describe. (See Fig. 1).

2.2. Contingent valuation scenario design

Notably, CV is used to evaluate nonmarket goods. It consists of a survey design in which researchers describe the environmental goods of interest and build a provision scenario, clearly defining property rights. In our setting, the scenario is the reintroduction program of the huemul in the Región de Los Ríos, Chile. Respondents are asked about their WTP to fund this program. The program aims to increase the number of huemules in the area and contribute to reducing the risk of extinction.

In a CV study, respondents are asked to express their WTP to improve the quality or quantity of the goods (Vásquez et al., 2007). Using a simple dichotomous choice, "yes/no" format under a decision rule (majority, for example) (also known as a referendum or closed-ended format) is highly recommended for CV studies (Arrow et al., 1993; Hanemann, 1994; Johnston et al., 2017). Respondents are asked to vote for or against paying US$$A_i$ to implement a policy that changes the good provision (Bishop and Heberlein, 1979). This form of elicitation is incentive-compatible. Respondents are familiar with this form because it is similar to decision-making in real markets (Hanemann, 1994; Johnston et al., 2017). Each individual in the sample received one bid (A_i), and the bid vector is randomly assigned to respondents (Cooper, 1993). With the efficient allocation of bids in the sample, the WTP distribution can be recovered (Carson et al., 1998; Hanemann and Kanninen, 1998). In this study, the aforementioned recommendations were followed.



(1) (b)

Fig. 1. (a) Historical huemul distribution, (b) Current huemul distribution.
Source: (Riquelme et al., 2018)

2.3. Survey design and administration

For the survey design, the best-practice recommendations of the contemporary guidance for stated preference studies (Johnston et al., 2017) were followed, corresponding to an update of the NOAA Blue Ribbon Panel on CV (Arrow et al., 1993). Owing to the global health issue (i.e., the COVID-19 pandemic), which limited face-to-face interactions, we conducted an online survey between April and May 2021.

A specialized survey firm administered the survey and sent participation invitations to the panel following quota sampling. The design of the final survey followed two steps. First, we conducted online focus groups to not only explore how people reacted to specific aspects of the hypothetical scenario but also identify wording problems or misleading sections in the survey. Second, we applied some pilot surveys to field-test the instrument's design. We surveyed people in all regions of Chile to ensure that the sample was representative of the Chilean population. A total of 1416 surveys were completed and validated for the analysis.

As the huemul is part of the "national coat of arms" together with the condor,[2] it is fair to say that its conservation should be relevant for the whole country's population. The typical formulae for a sample size provide an N of around 380 observations, considering a ± 5% margin error when the population of interest is sufficiently large (Champ et al., 2003, p. 62). We aim to obtain at least 380 observations in each subsample (S_1 = CV without access first; S_2 = CV with access first). Additionally, we attempted to maximize the number of responses subject to our budget to reduce the standard error of the WTP estimate (higher precision) (Boyle, 2017). Initially, we expected approximately 700 surveys per subsample, but as the respondents were randomly assigned to each subsample, we obtained an uneven distribution of N_1=694 and N_2 = 722. Fortunately, our sample size is on the upper bound of recent systematic reviews of CV studies (Halkos et al., 2020; Ke et al., 2022).

The survey has two sections. In Section A, several questions were used to perform a sociodemographic characterization of respondents (age, gender, income, and education, among others). Other questions characterize the attitudes and knowledge of respondents regarding the environment. They include membership in an environmental or conservation organization, experience visiting protected areas in the last five years, motivation for those visits, and a question about familiarity with the huemul. The familiarity question used a visual aid in which six images of different species of ungulates were presented: fallow deer (*Dama dama*), pudú (*Pudu puda*), guanaco (*Lama guanicoe*), taruca (*Hippocamelus antisensis*), red deer (*Cervus elaphus L.*), and huemul (*Hippocamelus bisulcus*). Respondents indicated which they believed corresponded to the huemul, being able to select from one to six images.

Section B provided simple and complete information on the huemul's conservation status and threats. Maps with the historical and current distribution of the huemul were used to help respondents understand the huemul's status. This section includes an explanation of the reintroduction program and WTP questions.

The program creates a huemul reproduction center with sound conditions for their movement, feeding, and reproduction, followed by

[2] You can see it at: https://www.ecured.cu/Escudo_de_Chile (Escudo de Chile - EcuRed)

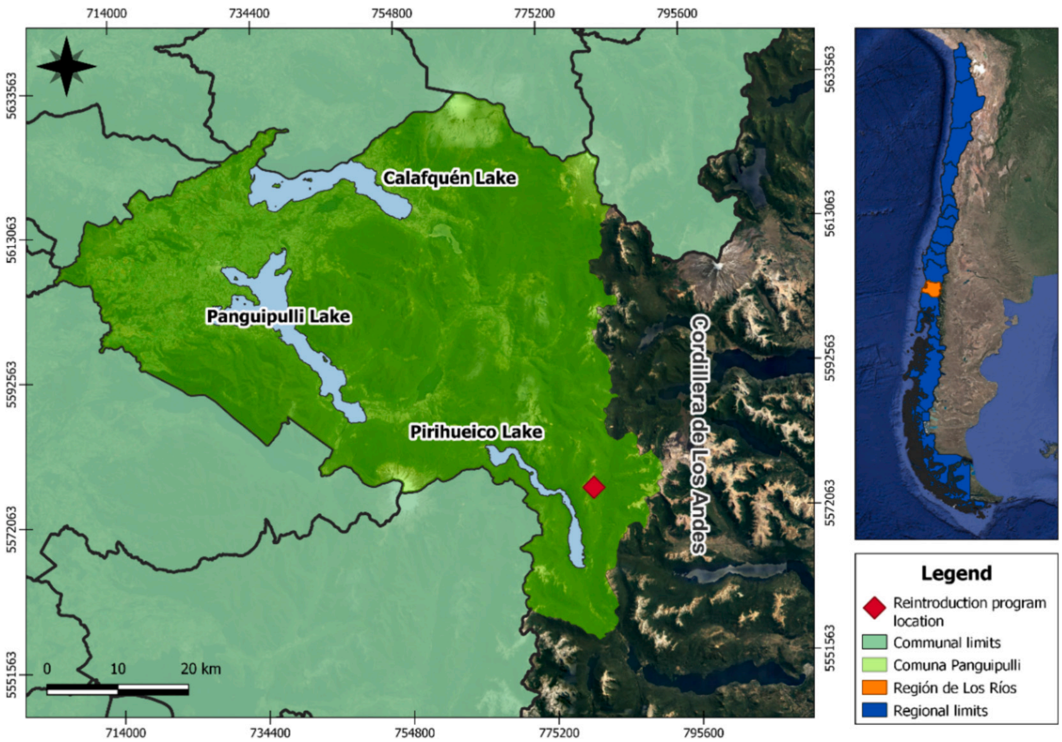


Fig. 2. Reintroduction program location.

transferring pairs of huemules from non-protected wild areas to the center to achieve their reproduction under the monitoring of their health status and control of possible threats. At the same time, an area is identified in the same zone to reintroduce the huemules and adapt them by increasing and restoring the native forest therein. The huemules would be released in this area under a surveillance and monitoring system, controlling the presence of cattle, dogs, and unauthorized persons, hoping that they would survive and reestablish their population. Fortunately, a similar program in Chile has already been implemented by a private organization but on a lower scale. This demonstrates the credibility of the proposed program.

Following the recommendations of the contemporary guide for stated preferences, the survey includes a remainder of their budget constraint. We use two possible payment vehicles, the electricity or water bill, because a small portion of the population pays income taxes, leaving this payment vehicle out of the possibilities. We include two options to be chosen by the individuals to reduce protests, as some people have strong preferences for some of these (private) utility companies. A monthly payment was included in the survey, and the corresponding annual amount was also indicated. Finally, the payment was scheduled to last five years. After the valuation questions, respondents declared their certainty about their answers on a certainty scale of 1 to 10 (from not very sure to very sure). This question will be used to evaluate the impact of the certainty scale on the paper's main conclusion (see Appendix A for more details on the questionnaire).

For instance, in Scenario 1, people face the following WTP question:

> "*Considering the proposed program, and remembering that you have a limited monthly budget, with which you must cover your expenses, would you be willing to pay* US$*At monthly to the huemul's reintroduction fund for the next 5 years? This amount will be added to your monthly electricity or water bill, according to your preference. Remember that visitor access to the reintroduction area will be prohibited. [Consider that paying* US$*At monthly implies contributing* US$$(12 \bullet At)$ *annually.]"*

Respondents faced two WTP questions for the same program, albeit with different access conditions. In one scenario, visits to the reintroduction area were prohibited, and in the other scenario, they were allowed. The sample was randomly divided into two groups in which the order of questions was shifted to avoid order effects. We used six randomly assigned bids following the optimal design suggested by Cooper (1993). Pilot surveys provided initial bids to run the optimal design approach. The bids were US$ 0.71, 1.42, 3.56, 5.69, 8.53, and 11.38[3] in the first WTP question, regardless of the access condition, and for the second question. If the condition changed from without access to allow access, the bid vector was US$ 1.42, 3.56, 5.69, 8.53, 11.38, and 14.22 in the second question. This new vector was slightly "higher" to consider that visitor access contemplates the construction of infrastructure in the area (viewpoints and trails), the implementation of measures to avoid negatively affecting the habitat of the huemul, and the training of guides. However, if the condition changed from permitted to prohibited visits, the bid vectors were US$ 0.43, 0.71, 1.42, 3.56, 5.69, and 8.53. The flow of the survey, with the order of the questions and offer vectors, is shown in Fig. 3.

If the response was negative, they were asked a follow-up question regarding why they were unwilling to pay to identify with the protest (Table 1). Protest responses include reasons other than financial limitations or people not valuing the good. Some people may react adversely to the interview or be concerned about injustices or inefficiencies in public administration (Labao et al., 2008; Sun et al., 2016).

2.4. Model specification

We estimate a discrete choice model based on random utility theory (Hanemann, 1984). The indirect utility function can take several functional forms (Bishop and Heberlein, 1979; Hanemann, 1984; Hanemann and Kanninen, 1998). We use a linear functional form and a traditional parametric bivariate probit model. The dependent variable takes the value of 1 if the individual accepts to pay A_i and 0 otherwise. The difference in the indirect utility function between the status quo (current

[3] 1 dollar = 703 CLP (between April and May, survey application date range).

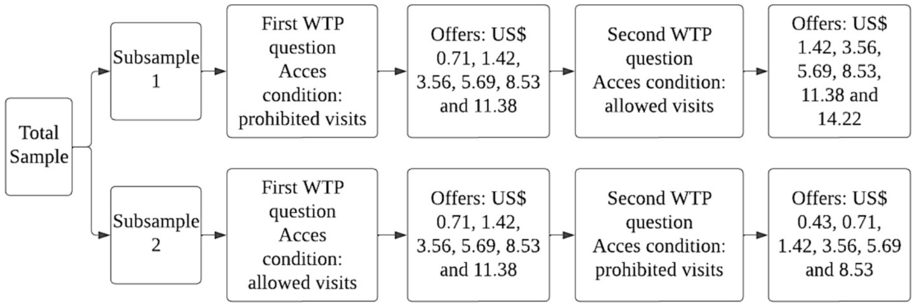


Fig. 3. Survey flow.
Respondents were asked both WTP questions regardless of whether their response was positive or negative to the first question. See Appendix B for a table of the combination of YES/NO responses.

Table 1
Follow-up questions by non-positive WTP responses.

Response type	Reason
Genuine zero responses	We do not have money available to contribute to the fund.
	I prefer to "pay" with time (working for the reintroduction of huemules)
	I do not want to pay for this program.
	It is not necessary to carry out this type of program.
	The benefits that we would obtain for paying this sum of money are insufficient.
Protest responses	I do not think the proposed program can be carried out.
	The state should pay for the entire program using the resources it obtains through our taxes.
	I don't think this type of program is successful.
Other	Other reason (specify)

situation) and the improved situation is (Bateman and Willis, 1999; Champ et al., 2017; Haab and McConnell, 2003):

$$\Delta v = \alpha - \beta A_i \tag{1}$$

where A_i corresponds to the amount that must be paid to improve the conservation status of the huemul, and α is a constant when one does not include any other explanatory variable. This constant will include other explanatory variables with their respective parameters ($\alpha = x\acute{}\delta$) for a more comprehensive model. We estimated a model with only BID as an explanatory variable, and a model with sociodemographic characteristics, attitudes, and environmental knowledge. The welfare measure (mean and median) in the linear functional form, is calculated as $WTP = -\alpha/\beta$ in the first specification or $WTP = -x\acute{}\delta/\beta$ when more explanatory variables are included (Vásquez et al., 2007).

We must cognize a few relevant issues when considering the uncertainty scales. Several researchers (Blomquist et al., 2009; Champ et al., 1997; Champ and Bishop, 2001) suggest that the "magic number" should be 8 based on a comparison of real and hypothetical payments. Nevertheless, Blomquist et al. (2009) also mentioned that this cutoff point varied in the literature, and other values could and have also been selected. Unfortunately, there are no guidelines regarding this issue in a context similar to Chile. Therefore, we perform a sensitivity analysis considering the original data and the cutoff values of 50%, 60%, 70%, 80%, and 90% of certainty. We test whether the estimated WTPs with and without access are statistically different.

For the parametric model, we use a bivariate probit model that directly estimates the matrix of variance and covariance for the coefficients for both regressions (one with access and another without access) in the estimation process. This allows us to test the null hypothesis using the delta method.

Furthermore, we use a nonparametric (Kriström, 1990) estimation following Blomquist et al. (2009). We add this nonparametric approach because one of the implications of requiring a higher level of certainty is that the WTP tends to become negative when the probability of accepting the first BID drops below 50%. This implies that the median and mean are negative in the linear model (logistic or normal). The second implication is a loss of monotonicity in the probability of accepting the BID (decreasing probability).[4] Blomquist et al. (2009) follow two solutions: first, they estimate the model using Kriström (1990) nonparametric estimation, and second, they use the formula for the "positive WTP" given by $\beta^{-1}ln(1 - e^{\alpha})$. Unfortunately, this last option is inappropriate, as it will "*unambiguously overestimate true WTP*" according to Haab and McConnell (2003, p. 92).

The nonparametric approach requires a monotonic empirical distribution. In other words, the probability of a positive answer should not increase when the BID increases. If this is not satisfied, the approach suggests pooling the bids and answers until the monotonicity is satisfied. Following Kriström (1990), the response to the discrete CE can be summarized in a sequence of proportions of yes answers:

$$\hat{\boldsymbol{\pi}} = (\hat{\pi}_1, \hat{\pi}_2, \dots, \hat{\pi}_m)$$

$\hat{\pi}_i$ is the proportion of yes answers to bid A_i. The proportion is calculated using $\hat{\pi}_i = \frac{k_i}{n_i}$, with k_i being the number of positive responses and n_i being the subsample size in bid A_i. If this sequence is non-monotonic, then the adjacent values are pooled, and the proportion is replaced by $\hat{\pi}_i = \frac{k_i + k_i + 1}{n_i + n_{i+1}}$. This is called the pool-adjacent violator algorithm (PAVA). Finally, a value A_T is added to the bid vector, for which the probability is $\hat{\pi}_T = 0$. To determine this upper bound, we use the following linear interpolation:

$$A_{m+1} = A_m + \frac{(\hat{\pi}_{m+1} - \hat{\pi}_m)(A_m - A_{m-1})}{(\hat{\pi}_m - \hat{\pi}_{m-1})}$$

To estimate the variance of the WTP estimated using this approach, we used an adaptation of Duffield and Patterson (1991), in which the nonparametric WTP could be written using a trapezoidal approximation as[5]

$$WTP = \sum_{i=1}^{m} \Delta A_i{}^{*}\hat{\pi}_i$$

With

$$\Delta A_i = \frac{A_{i+1} - A_{i-1}}{2} \; for \; t = 2, \dots, M-1$$

$$\Delta A_1 = A_1 + \frac{A_2}{2}$$

$$\Delta A_m = \{(A_m - A_{m-1}) + (A_T - A_k)\}/2$$

[4] Both results are also observed in all cases presented in Table 4 on page 489 in Blomquist et al. (2009). In that table, almost all probabilities of paying the Lowest BID are lower than 50%.

[5] The derivation of these equations is available upon request.

As k_i is a binomial random variable with parameters $n_i$and $\hat{\pi}_i$, the variance is given by.

$$Var(WTP) = \sum_{i=1}^{m} [\Delta A_t]^2 * \frac{\hat{\pi}_t(1-\hat{\pi}_t)}{n_{i.}}$$

3. Results and discussion

3.1. Descriptive Statistics

Of the total sample (1416 observations), 694 (49%) answered the questionnaire with the first WTP question for the program without access to the reintroduction area and a follow-up question with access. The questionnaire was answered in reverse order by 722 individuals (51%). Table 2 presents the descriptive statistics of the relevant variables. Ultimately, 73 observations were classified as protests. In this study, we estimate with and without the protests (Johnston et al., 2017). Because the results are qualitatively similar, we do not report the estimate that excludes protests.[6]

Respondents were aged between 18 and 70 years old, with an average age of 41.5 years. Regarding gender, 44% were men and 56% were women. Moreover, 12% of respondents had incomplete secondary education, 46% had completed secondary education, and 42% had completed university and/or technical education. The average monthly household income is $877,400 CLP (US$1247.95). The average distance (km) from the respondents' regional capital to the area of huemul reintroduction is 678 km.

Regarding attitudes and knowledge about the environment, 5.8% of respondents were members of an environmental or conservation organization, 54.4% had visited protected areas (national parks, nature reserves, sanctuaries of nature, etc.) during the last five years, and their primary motivations were the beauty of the landscape, presence of native vegetation, peacefulness, and possibility of observing native animals. In the question about familiarity with the huemul, 38.1% of respondents correctly selected the image of the huemul. In other words, only 540 people managed to recognize it among the options, indicating that the majority could not identify it visually. In addition, 384 people selected only the huemul (27.1% of the total sample); they knew with certainty which image corresponded and which did not correspond to the huemul. Finally, 67.7% of respondents preferred a nongovernmental private nonprofit corporation to administer the funds, and only 32.3% wanted the government to be involved in the administration.

Table 2
Descriptive Statistics.

Variables	Definition	Mean (SD.)
Sociodemographic characteristics		
Age	Continuous. Age of respondents (in years) in 2021	41.51 (14.83)
Gender*	Dummy variable, 1 if male and 0 for female.	0.44 (0.50)
Education	Incomplete secondary education. 1 true and 0 otherwise	0.12 (0.33)
	Complete secondary education. 1 true and 0 otherwise	0.46 (0.50)
	Complete university and/or technical education. 1 true and 0 otherwise	0.42 (0.49)
Income**	Continuous. Average monthly household income in thousands of CLP.	877.38 (683.47)
Distance	Continuous. Distance (km) from the capital of the region of each respondent to the program located (Panguipulli, Los Ríos Region).	677.67 (497.03)
Environmental attitudes		
Environmental organization	Dummy variable, 1 if participate in an environmental or conservation organization, 0 otherwise.	0.06 (0.23)
Visits to protected areas	Dummy variable, 1 if they have visited protected areas in the last 5 years, 0 otherwise.	0.54 (0.50)
Familiarity	Dummy variable, 1 if the huemul was correctly selected and 0 otherwise.	0.38 (0.49)
Fund administration		
Agency	Dummy variable, 1 if he/she prefers the fund to be administered by a Non-Governmental Private Non-profit Corporation, 0 otherwise.	0.68 (0.47)
WTP Question Order		
Order	Dummy variable: 1 if the first question was about the program without access, 0 otherwise.	

* Respondents only male/female answers were considered, dropping "Other" and "I prefer not to answer," resulting in N=1401 for the total sample, $N = 689$ for subsample 1, and $N = 712$ for subsample 2.

** Some individuals preferred not to answer this question. Leaving $N = 1374$ for the total sample, $N = 673$ for subsample one, and $N = 701$ for subsample 2.

3.2. Main results

Of the total sample, 53.0% answered positively to the WTP question regarding the program for reintroducing huemules with prohibited access. In comparison, 42.9% responded positively to programs in which access was allowed. Fig. 4 shows each program's empirical survivor function of the WTP, that is, the empirical distribution of positive responses. This figure uses a piecewise linear function and the PAVA to ensure non-increasing monotonicity, following (Kriström, 1990). Furthermore, we assume that if the bid is zero ($A_i = \$US\ 0$), then the probability of acceptance is equal to one, and also selected an arbitrary point $A_i = US\$\ 22$ (CLP$15000) for which we assume the probability of acceptance is zero. The survival function without access is always above the function with access for all the bids included in the survey.

Table 3 presents the estimated econometric models (bivariate probit) using the original data. The models are estimated separately for the scenarios with and without access. We report results from a simple model that includes only the BID as an explanatory variable (associated with the coefficient β) and a model with other explanatory variables. The sign of the price coefficient is negative and statistically significant in all the models. The higher the price that individuals must pay for the program, the less likely they are to pay. This result is consistent with economic theory and has been found in various studies on species valuation (Wang et al., 2018; Zambrano-Monserrate, 2020).

The models show that age is negative and statistically significant. Younger respondents are more likely to accept the offer. In the context of species valuation, this finding is consistent with the study by Wang et al. (2018) on the conservation of the African elephant (*Loxodonta africana*), and it is contrary to the findings of De Wit et al. (2017) and Watkins and Poudyal (2021), who find that older people are more likely to pay. The gender variable is positive and statistically significant only in one case at 10%, indicating that if respondents were men, they had a higher WTP. This result contrasts with those of other studies that have found that women are more likely to pay for conservation programs (Wang et al., 2018; Watkins and Poudyal, 2021).

Concerning education, some studies suggest that a higher level of education implies a greater WTP (Ma et al., 2016; Watkins and Poudyal, 2021). However, education is not statistically significant in any of our models. Therefore, there is no evidence that it affects WTP. This finding is consistent with CV studies by Zambrano-Monserrate (2020) on the conservation of the Andean condor (*Vultur gryphus*) and by Indab (2016) on the preservation of the continued presence of whale sharks (*Rhincodon typus*).

The effect of income is significant and positive. In other words, WTP increases with income level, which indicates the theoretical validity of

[6] They are available upon request.

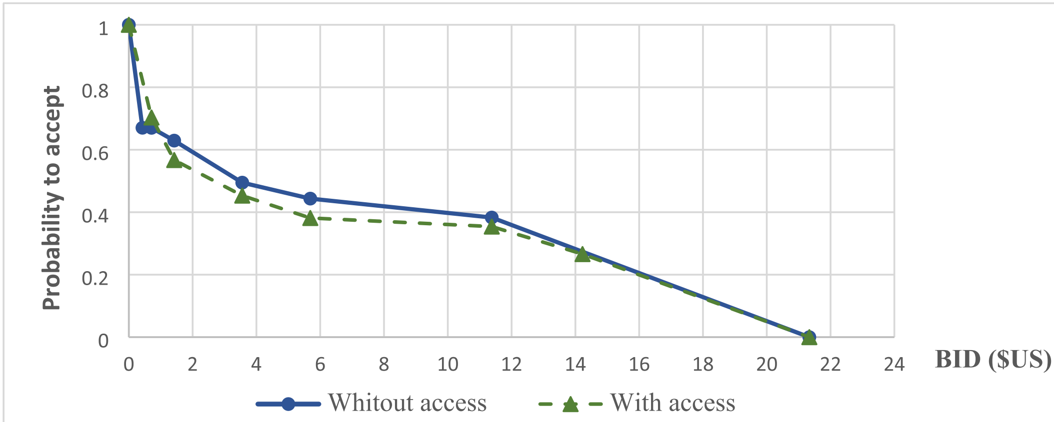


Fig. 4. Empirical survivor functions.

Table 3
Bivariate Probit Model and WTP.

	With access		Without access	
β	−0.0000866*** (−6.99)	−0.0000671*** (−4.96)	−0.000112*** (−6.87)	−0.000136*** (−7.66)
α	0.167** (2.81)	0.106 (0.62)	0.376*** (6.83)	0.0978 (0.58)
Age		−0.00502* (−2.03)		−0.00487* (−1.99)
Gender (1 male, 0 female)		0.172* (2.37)		0.115 (1.60)
Complete secondary education		−0.0689 (−0.61)		−0.0512 (−0.46)
Complete university and/or technical education		−0.0880 (−0.72)		−0.144 (−1.18)
Income		0.000264*** (4.39)		0.000276*** (4.54)
Distance		0.00000765 (0.11)		0.0000268 (0.38)
Environmental organization (1 if participate, 0 otherwise)		0.463** (3.12)		0.549*** (3.51)
Visits to protected areas (1 if they have visited in last 5 years, 0 otherwise)		0.104 (1.40)		0.181* (2.47)
Familiarity (1 if recognized, 0 otherwise)		−0.181* (−2.47)		−0.124′ (−1.71)
Agency (1 if Private Corporation, 0 State Institution)		0.219** (2.87)		0.216** (2.86)
Order (1 if was asked first about program without access, 0 otherwise)		−0.434*** (−5.88)		0.214** (2.91)
WTP US$	2.73***	1.92‘	4.80***	4.79***
Confidence interval US$	[1.38–4.08]	[−0.17–4.00]	[3.91–5.68]	[4.03–5.55]
Rho	0.808*** (43.83)	0.830*** (38.77)	0.808*** (43.83)	0.830*** (38.77)

t statistics in parentheses, ‘$p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

the estimated models (Martínez-Paz and Perni, 2011; Nicholson and Snyder, 2010) and coincides with various studies in this context (Kontogianni et al., 2012; Watkins and Poudyal, 2021; Zambrano-Monserrate, 2020).

The distance variable is not statistically significant. One cannot affirm that people living closer to the reintroduction site are more willing to pay for reintroduction programs, as expected, particularly for programs with allowed access. Wang et al. (2018) obtained a similar finding regarding the geographical location of respondents, which did not significantly influence the WTP estimates. This result aligns with the idea that nonuse values are more important than use values. Distance should not be relevant to WTP if people hold nonuse values. Because distance affects the probability of visiting a site, it should play a role when calculating use values.

Concerning environmental attitudes, the variable belonging to an environmental organization is statistically significant and has a positive sign, indicating a positive correlation with WTP. People with favorable and proactive attitudes toward the environment are also more willing to pay for the conservation of species, which is common among CV studies on this matter (Kotchen and Reiling, 2000; LaRiviere et al., 2014; Lundberg et al., 2018; Ma et al., 2016; Tonin, 2018; Zambrano-Monserrate, 2020).

The variable "visits to protected areas" is statistically significant at the 10% level in the model that estimates the program's value without access. People who have visited protected areas in the last five years are more willing to pay. People interested in the beauty and tranquility of the landscapes and the presence of native flora and fauna (the main motivations indicated in the survey) have favorable attitudes toward the environment. After visiting a protected area, greater "environmental awareness" or a tendency to "care for fauna" is generated, which could be part of a learning process based on the experience of contact with nature, thus inducing people to accept paying for the program.

The familiarity variable is only statistically significant in the model with access and has a negative sign. This finding is highly relevant to this study, as it indicates that if the respondents are familiar with the huemul, they are less willing to pay for a program that allows access to the huemul reintroduction area. We argue that this result aligns with the idea that previous experience with protected areas, knowledge of the sites, and the huemul generate greater interest in the program, particularly if tourist interventions are limited to avoiding disturbance or other risks. Although the literature discussing access to conservation sites is scarce, De Wit et al. (2017) find that residents and tourists are more sensitive to the quality of the ecosystem and are less interested in improving access to walks and bird watching. Some individuals even disapproved of such infrastructure. In our opinion, this is good news for conservation programs.

Concerning funding management, respondents are more likely to accept the offer if a private, non-governmental, non-profit corporation manages the resources. This is an expected result, as many people show apprehension or protest toward the state administration of protected areas, natural reserves, and parks, or a lack of trust toward government institutions. In fact, many protesters referred to their mistrust toward state institutions, which generated a bias in estimating the WTP. In conclusion, institutional trust in the agency managing the conservation fund is relevant in explaining WTP. This has also been shown by Watkins and Poudyal (2021), who find that individuals with higher trust and security in wildlife management agencies are more likely to pay for conservation programs.

Finally, the order variable is statistically significant in all estimations. It has a positive sign for models in which the program is not accessible, and a negative sign for those with allowed access. This finding indicates that if respondents are first asked about the program without access, they are more willing to accept the offer for that program and less likely to be willing to pay for the program with access allowed. This result shows a high acceptance of the program with access prohibition, indicating that it has more value for individuals to protect the species if no one can access the reintroduction site.

The WTP values of the models are statistically significant and higher for the program without access to the huemul reintroduction site. This preliminary result indicates that the nonuse value (value of existence) is higher than the program's value when access to the site is allowed. However, this result is conceptually challenging. We would expect access to the site to increase WTP since it would add some use value to the program (besides the nonuse value). However, our results suggest the opposite. We hypothesize that this seemingly counterintuitive result is explained by the desire to keep huemules safe from possible detrimental tourist intervention. Our results are not uncommon in the literature. Using a CE, Vásquez et al. (2016) found that tourists were willing to reduce the quality of their visiting experience by increasing the distance between themselves and penguins to avoid damaging nesting areas. In other words, some altruistic behaviors were observed in the conservation program. People are willing to pay a "premium" to keep the conservation site "out of sight" from tourist activities. This could also be related to the belief that a reintroduction program would be more effective if access was not allowed.

The annual WTP values would be US$32.76 and US$57.6 for options with and without access, respectively. Zambrano-Monserrate (2020) provides a benchmark for the values obtained in this study. They value the Andean condor, which has similar characteristics to the huemul; it is emblematic and is also on the Chilean coat of arms. They found a WTP between US$ 18.65 and US$ 34.54 per year, with a median of US$ 24.83 per year for condor conservation. Another close study is the assessment for the preservation of elk in Tennessee (USA) by (Watkins and Poudyal, 2021) since it also assesses the conservation of a reintroduced species that belongs to the Cervidae family, like the huemul. In this study, the authors find a WTP of US$ 45.53 per household, which is within the range of our estimates.

In contrast, a study by Cazabon-Mannette et al. (2017) of sea turtles in Tobago shows that the WTP for immersion in tanks for a first encounter with turtles is more than US$62, and the WTP for the conservation of turtles was only US$ 31.13. Contrary to our findings, the use value associated with tourism and encounters with turtles was higher than the nonuse value. However, Loomis (2006) finds that the nonuse value of sea otters (US$21 million per year) exceeds the value of sea otter tourism ($1.77–9.67 million annual direct income from tourism) using Benefit Transfer. This result is similar to ours, in which the nonuse value exceeds the value associated with tourism. This suggests that the relationship between use and nonuse values is context-specific and that attributes such as charisma, type of contact that can be handled (swimming with turtles is different from spotting a huemul, which is also unlikely), level of threat, and methodological decision (CE, CV, Benefit Transfer) may explain these results.

3.3. Sensitivity analysis to uncertainty scales[7]

Fig. 5 shows the implications of changing positive to negative responses according to a different cutoff point in the certainty scale on the empirical distribution of the WTP (we present the data before using PAVA to ensure non-increasing monotonicity). All distributions shifted downward, with the probability of paying the lowest BID dropping below 0.5 in most cases. This decision will generate a negative WTP in some parametric models.

Table 4 presents the estimated WTP for the different uncertainty treatments. In each case, if people responded "yes" but with a certainty lower than the cutoff point (50%, 60%, 70%, 80%, and 90%), the dependent variable was changed to a negative response.

As expected, we observe a decreasing WTP as we move from the original data to stricter certainty requirements (from the original to 90%). The WTP becomes negative at the 60% certainty level. Nevertheless, in the parametric model, the WTP is systematically higher in situations without access, and their differences are statistically significant. A negative WTP indicates that the project would be detrimental to the population. Since it is more likely that people are unwilling to pay but are not negatively affected by the project, the literature suggests focusing only on the positive part of the distribution. Blomquist et al. (2009) use the formula for a positive WTP; however, as Haab and

[7] Appendix B present results for the parametric models (with BID and covariates) for different cut-off points of the uncertainty scales with and without protests. Since the results without protest are qualitative similar we decided to have them in the Appendix.

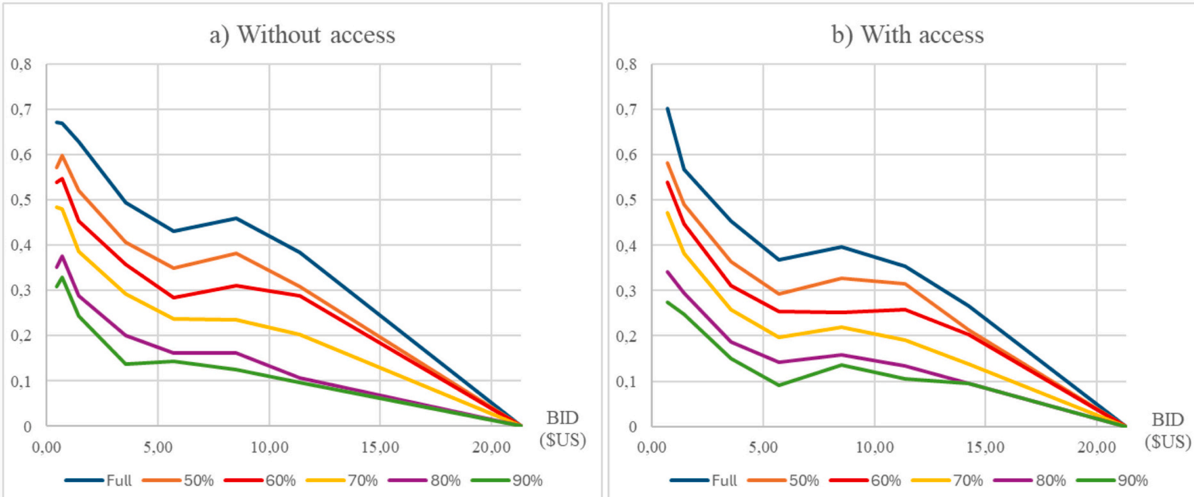


Fig. 5. Empirical distribution for different uncertainty levels.

Table 4
WTP for different uncertainty cut-off points for parametric and nonparametric models.

	Bivariate Probit Model			Nonparametric Estimation		
	With access	Without Access	t-test	With access	Without Access	t-test
Original	US$2.73 (3.97)	US$4.80 (10.61)	3.03	US$7.15 (23.87)	US$12.45 (11.84)	4.82
50%	US$0.08 (0.1)	US$1.98 (4.17)	2.78	US$6.77 (11.65)	US$9.54 (15.74)	2.58
60%	-US $1.84 (1.66)	US$0.09 (0.13)	2.19	US$6.26 (10.46)	(US$8.67 (9.72)	2.24
70%	-US $6.37 (3−11)	-US$2.03 (2.23)	2.60	US$4.13 (17.23)	US$5.14 (11.52)	2.00
80%	-US $10.82 (3.58)	-US$4.51 (3.8)	2.52	US$3.05 (14.96)	US$2.76 (11.11)	−0.90
90%	-US $14.34 (3.4)	-US$7.04 (4.16)	2.16	US$2.59 (13.28)	US$2.40 (11.00)	−0.66

individual t-test in parenthesis.

McConnell (2003) point out, this approach tends to overstate the true WTP.

Additionally, Blomquist et al. (2009) use a nonparametric WTP. These results are also presented in Table 4. Again, the WTP decreases, and it is always positive by construction. This WTP is a welfare measure associated with a small proportion of the population willing to pay a positive amount for the conservation program. It would be necessary to adjust the population accordingly to perform a cost-benefit analysis. In the nonparametric models, WTP is higher, with a statistically significant difference in most situations. When the cutoff point is very strict, the WTP values are not statistically different. Thus, we can conclude that the main result holds for more of the estimated models.

3.4. Additional perspectives

The huemul represents a flagship species with charismatic potential (Hughes, 2002). Occasionally, terms such as "charismatic," "flagship," "key," "iconic," and so on, are used interchangeably in the literature, leading to confusion about these concepts. Charismatic species are expected to create a positive bias toward the huemul since it is an aesthetically pleasant animal (Christie et al., 2006; Jacobsen et al., 2008). On the upside, this means that it can help to mobilize funds to protect the species and, at the same time, reach broader conservation objectives (Veríssimo et al., 2009). However, attributing the characteristic of "charismatic" to a species is a subjective exercise, and according to Richardson and Loomis (2009), there is no clear and plausible definition for charismatic in the literature, and sometimes, a species is classified as charismatic just because it is characterized as such in some article (Subroy et al., 2019).

Some attributes discussed in the literature related to the "charisma" of species include physical traits, behavior, colors, and the size of the animal. Certain characteristics of these attributes, such as the grandeur of an animal, evoke positive emotions and enhance people's willingness to protect them (Prokop et al., 2023). Albert et al. (2018) provided a list of the 20 most charismatic animals in the Western world, and some of the approaches used to compile the list involved a survey in which people identified charismatic species and associated them with the following traits: Rare, Endangered, Beautiful, Cute, Impressive, and Dangerous. Among the species on the list were animals such as tigers, lions, elephants, and pandas.

In this context, there remains a lack of clarity and concern about reaching a consensus on the definition of "charisma." Nevertheless, some authors have argued that the concept of "charismatic species" or "charismatic megafauna" may be underrated and contribute significantly to conservation projects and valuation (Albert et al., 2018; Ducarme et al., 2013).

Particularly, when we talk about the huemul, we know it is a medium-sized deer, with friendly and peaceful behavior, showing no fear of humans and allowing close approach. It is part of Chile's national emblem (Escobar et al., 2020; Iriarte et al., 2017) and has charismatic potential (Hughes, 2002). However, there is a lack of studies investigating whether it is considered charismatic by the population, and if so, for what reasons or attributes, and whether this characteristic generates higher WTP values than other species that are not considered charismatic.

This distinction is relevant, as, in some cases, the "charisma" of a species positively affects WTP (Richardson and Loomis, 2009; Subroy et al., 2019). According to a meta-analysis by Richardson and Loomis (2009), which included 31 studies on the valuation of threatened species, the WTP for charismatic species was between 115% and 180% higher than that of non-charismatic species. However, Zander et al. (2022) assessed 12 threatened species in Australia and found that one of the highest values belonged to one species, and some would not be considered charismatic. Unfortunately, we cannot know from our results whether the valuation of the huemul is affected by the attribute of "being charismatic." This is a relevant question for future research as this attribute may contribute to implementing projects that protect biodiversity.

Nevertheless, our study shows that people value the conservation of the huemul, which can serve as a precedent to drive and justify implementing a policy intervention of this nature in Chile. However, additional ecological and biological analyses are required to complement this information. Translocation has associated risks that must be fully accounted for and are not considered by simple valuation exercises (IUCN/SSC, 2013; Strayer, 2022). Some risks associated with translocation can affect the focal species, their communities, and ecosystem functions, both in the origin and destination areas; therefore, any translocation must undergo a thorough risk assessment (IUCN/SSC, 2013). For instance, there is a potential transmission of pathogens that could cause disease outbreaks at the release site, affecting the health of wildlife, domestic animals, and/or even humans. Therefore, it is recommended to conduct a disease risk analysis (Riga et al., 2022; Shadbolt and Sainsbury, 2021). In the case of the huemul, there is a population located in the Aysen Region diagnosed with an infectious bacterial disease called caseous lymphadenitis, which is very common among sheep worldwide, caused by the bacterium *Corynebacterium pseudotuberculosis* (Iriarte et al., 2017; Tadich et al., 2005). Hence, conducting disease risk analysis before reintroduction is highly relevant. The second risk is endangering the source population. The probability of successful translocation increases with the number of translocated individuals (IUCN/SSC, 2013). However, this can negatively affect the population of the origin. Therefore, the program includes the reintroduction of huemuls and their reproduction in a center, which can help mitigate the risk of impacting the source population (although the genetic risks associated with them should also be evaluated).

The net social benefit (without risk analysis) associated with this translocation project can be evaluated through a cost-benefit analysis. For the huemul reintroduction program, costs include those derived from conditioning the huemul reproduction center, ecosystem restoration, such as native forest, costs associated with monitoring and controlling the presence of livestock, dogs, and unauthorized persons in the area, and those associated with the tracking system to assess the progress of the reintroduced huemul population. Although these costs have not been estimated for this project, some approximations can be obtained from the available literature or reports. For example, closely related to our study, the Chilean Ministry of the Environment prepared a huemul conservation plan in Nevados de Chillán, Chile, which considers reducing huemul threats and effectively protecting the species in an area of 570,000 ha. This program has an estimated cost of US$ 1.8 million over a 12-year horizon (Ministerio del Medio Ambiente, 2021). Another example is given by Lloyd et al. (2023), who determined that the cost of conserving the Woodland Caribou (*Rangifer tarandus Caribou*), which, like the huemul, is a deer (family Cervidae), ranged from US$1.1 to 3.3 million over ten years. Additionally, considering that they studied programs to conserve 20 different species, they found that programs were more expensive if they required a captive breeding component for conservation, as was the case in our study.

The benefit can be estimated using our WTP results and adding some assumptions and information, as presented in Bristol et al. (2014), such as the size of the beneficiary population (or number of households benefiting in this case), the time horizon in which benefits are perceived, and discount rates. Around 5.5 million Chilean households will benefit from the program (obtained from Superintendencia de Servicios Sanitarios (2022), corresponding to residential customers of sanitation services). Furthermore, more conservative benefits are obtained by using the nonparametric WTP estimated with a certainty of 90%, that is, US $2.4, and considering that that mean WTP is representative of only the portion of the population having a positive WTP, that in this case is equivalent to 27% (see panel b, Fig. 5). With this, the most conservative assumption of the annual benefit of the huemul reintroduction program is US$ 46.3 million and using a social discount rate of 8% (Chilean social discount rate) and a horizon of 5 years (as declared in the survey), the present value of the benefits is around US$185 million. This value contrasts favorably with the available cost information: US$1.8 million over a 12-year horizon (Ministerio del Medio Ambiente, 2021) and US $1.1 to 3.3 million over ten years (Lloyd et al., 2023).

While this value represents what Chileans are willing to pay to prevent the huemul's extinction, it shares the limitations of any non-market valuation application. In particular, we do not yet know the real socio-ecological cost of extinction since, so far, there is not a clear convergence between ecological and economic dimensions of value. While there is extensive literature valuing endangered species, there is less research linking the economic value to the ecological cost of species extinction, and misunderstanding the ecological and functional consequences of a species' extinction can lead to an underestimation of extinction costs (Cardoso et al., 2020; Fraser et al., 2023; Hanley and Perrings, 2019). Since the huemul is an emblematic species for the population, the social costs would imply a cultural and identity loss for the country if it were to become extinct. In other words, this species cannot be substituted even considering its closest "relative" (Conrad, 2018). Additionally, since it is considered an umbrella species, its protection has significant ecological importance. Therefore, we might be underestimating the value of the huemul.

Furthermore, we did not consider the evolution of the WTP toward the limits or boundaries of extinction, as in Lopes and Atallah (2020). We think this issue could be a relevant future research issue to contribute to the emerging topic of recapturing values post-extinction (Fraser et al., 2023), comprising questions as to whether the WTP increases or decreases as we reach the tipping point of recoverability.

Despite these limitations, ensuring adequate biodiversity valuation and allowing society's preferences to be expressed appropriately is crucial for fully capturing the value of a species and thus avoiding the market failure associated with overexploitation and potential extinction (Ando, 2022; Dasgupta, 2021; Fraser et al., 2023). This information helps perform a cost-benefit analysis of different policy interventions to avoid species extinction (Akçakaya et al., 2017; Lewis et al., 2019; Lewis et al., 2022).

As a note of caution, since the survey was conducted during the COVID-19 pandemic, it might be possible that our main results (WTP higher for the option with access) were partly explained by the fact that many activities were restricted during that period. While we cannot discard this possibility completely, we think that the fact that people cannot be forced to visit the area, the possible existence of an "option value" (WTP for having the possibility of visiting the site in the future), the fact that the project needs several previous steps before huemuls can be introduced and people can visit the site (the project will not be implemented immediately), significantly reduces the probability that the fear of COVID-19 infection explains the results.

4. Conclusions

We estimate the economic value of the huemul, an emblematic species in Chile that is in danger of extinction. Using the CV method, we present scenarios with and without access to reintroduction sites to estimate nonuse value. In total, 1416 online valid surveys were obtained. The average WTP (using the original data) for the conservation of the huemul was US$ 4.8 per month per household for the program without access and US$ 2.73 per month per household for the program with access, corresponding to an annual payment per household of US$ 57.6 and US$ 32.76, respectively.

This study consistently shows that people value the conservation of the huemul more when tourist access is prohibited than when people have access to the reintroduction areas. Several explanatory variables support this conclusion. People familiar with the huemul and with experience with natural parks, among others, tend to value a program without access more. This result may be explained by the fact that it is a charismatic, symbolic (for the country), and threatened species. Additionally, the valuation could be affected by the perceived risks associated with visits to tourist interventions in areas with vulnerable species. However, these hypotheses require further investigation.

Our approach to disentangling the nonuse value of the TEV could be an important contribution to the discussion on the existence of nonuse values for protecting biodiversity. In other words, people are willing to pay a "premium" to keep the conservation site "out of sight" from tourist activities. This could also be related to the belief that a reintroduction program would be more effective if access were not allowed.

CRediT authorship contribution statement

Makarena Henríquez: Writing – review & editing, Writing – original draft, Software, Formal analysis, Data curation. **Felipe Vásquez-Lavín:** Writing – review & editing, Writing – original draft, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Manuel Barrientos:** Writing – review & editing, Methodology, Formal analysis, Data curation, Conceptualization. **Roberto D. Ponce Oliva:** Writing – review & editing, Writing – original draft, Supervision, Project administration, Investigation, Funding acquisition. **Antonio Lara:** Writing – original draft, Investigation, Funding acquisition, Conceptualization. **Gabriela Flores-Benner:** Writing – original draft, Validation, Investigation, Formal analysis. **Carlos Riquelme:** Validation, Supervision, Formal analysis, Data curation.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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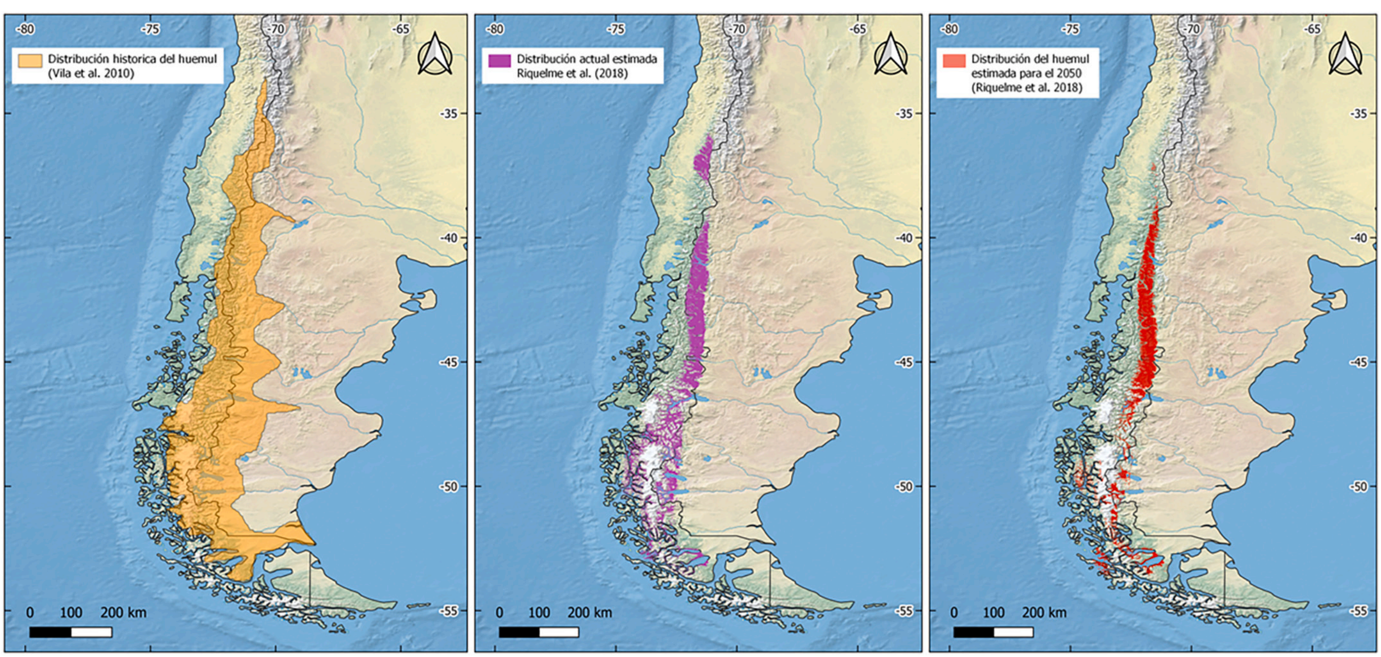
Appendix A. Extract of the survey

1. **Background**

The huemul is an endemic deer of southern America that inhabits the Andean forests of Chile and Argentina and is endangered. In Chile, it is currently found sporadically in small groups, from Nevados de Chillán to Magallanes, with an estimated population of fewer than 2000 individuals. Below, we present three maps showing the evolution of huemul populations. The first map shows the historical distribution, the second map depicts the current distribution, and the third map illustrates a projection of how the huemul population is expected to be distributed by the year 2050 if current trends persist.



The huemul population has been affected by various threats. The most significant are the following:

- Hunting of huemules.
- Habitat loss due to agriculture, livestock farming, and forest plantations.
- Loss of native forest, which increases the isolation of huemul populations.
- Attacks by dogs.

- Roads, which facilitate huemul roadkill.
- The presence of livestock in the huemul habitat facilitates disease transmission.

Recent studies estimate that if current trends continue, huemul populations will continue to decline, potentially leading to extinction.

2. **Program description**

The reintroduction program is described as follows:

There are pilot experiences of breeding and reintroducing huemules in wild areas in Chile. Considering this, the Chilean State proposes to implement a program to reintroduce the population of huemules in the Los Ríos Region, specifically in the wild area near the commune of Panguipulli. This program would consist of:

- *Conditioning a huemul's breeding center with ideal movement, feeding, and reproduction conditions.*
- *Transferring a few pairs of huemules from unprotected wild areas to the breeding center, where their health status, reproduction, and possible threats will be monitored.*
- *Identifying a suitable area for reintroducing huemules and increasing its coverage of native forest by at least 10%.*
- *Releasing the huemules born in the breeding center into the conditioned wild area for reintroduction.*
- *Implementing a system to monitor and control the presence of livestock, dogs, and unauthorized persons in the reintroduction area.*
- *Implementing a tracking system to assess the progress of the reintroduced huemul population.*

For Form A (subsample 1) of the survey, the following text is added:

VISITOR ACCESS TO THE REINTRODUCTION AREA WILL BE PROHIBITED, AND INVESTMENT WILL BE MADE IN MEASURES TO ENSURE COMPLIANCE WITH THIS CONDITION.

For form B (subsample 2) of the survey, the following text is added as an additional point on what the program comprises:

- *Investing in creating the necessary infrastructure to enable guided tours to the huemul's reintroduction area. This activity would incorporate all necessary measures to avoid negatively impacting the habitat and well-being of the huemules.*

3. **Valuation context and WTP question**

Considering that the State does not have sufficient resources to finance the huemul's reintroduction program, the proposal seeks to finance the program jointly with citizens interested in its implementation.

If the funding is sufficient to implement the huemul's reintroduction program, either a private non-profit NGO created solely for this purpose or a state institution (as chosen by the majority of citizens) will manage the funding. If the amount is insufficient, the program cannot be developed, which means that no investment will be made in the huemul's breeding center or the reintroduction of huemules in the Los Ríos Region.

Next, we will present you with some questions about the value you assign to the proposed program. We want to remind you that there are no right or wrong answers. We just want to know your opinion.

WTP questions for Form A:

First WTP question: Considering the proposed program and remembering that you have a limited monthly budget with which you must cover your monthly expenses, would you be willing to pay US$*Ai monthly for the huemul's reintroduction fund for the next 5 years? This amount will be added to your monthly electricity or water bill, according to your preference. Remember that visitor access to the reintroduction area will be prohibited. [Consider that paying* US$*Ai monthly implies contributing* US$$(12 \bullet Ai)$ *annually.] Yes or No.*

*Second WTP question: There is a proposal to extend the program, where THERE IS the possibility of conducting guided tours to the huemul's reintroduction area. This activity would incorporate the necessary measures to avoid negatively impacting the habitat and well-being of the huemules. This new situation requires additional viewpoints, trails, and guide training investments. Would you be willing to pay US$Bi*[8] *monthly to the huemul's reintroduction fund for the next 5 years? This amount would be charged to your monthly electricity or water bill as you decide. This amount will be added to your monthly electricity or water bill, according to your preference. [Consider that paying US$Bi monthly implies contributing US$*$12 \bullet Bi$ *annually.]*

WTP questions for Form B:

*First WTP question: Considering the proposed program where THERE IS the possibility of conducting guided tours to the huemul's reintroduction area and remembering that you have a limited monthly budget, with which you must cover your expenses, would you be willing to pay US$Ai pesos monthly to the huemul's reintroduction fund for the next 5 years? This amount will be added to your monthly electricity or water bill, according to your preference. [Consider that paying US$Ai monthly implies contributing US$*$(12 \bullet Ai)$ *annually.]*

*Second WTP question: There is a proposal to reduce the program by PROHIBITING the possibility of guided tours to the huemul's reintroduction area. This new situation does not require investment to condition the area for guided tours. Would you be willing to pay US$Ci monthly to the huemul's reintroduction fund for the next 5 years? This amount will be added to your monthly electricity or water bill, according to your preference. [Consider that paying US$Ci monthly implies contributing US$*$12 \bullet Ci$ *annually.]*

[8] We chose the following value to be consistent with the fact that the program with access would require more investment. So, it would be inconsistent for respondents to be asked for a lower quantity. For example, if the respondents were asked about US$1.42, they were subsequently asked about US$3.56 (see Figure 3). The same is true in the opposite direction: if the respondents were asked about US$1.42 with access, then they were subsequently asked about US$0.71 without access.

Appendix B. Appendix

Table B1
YES/NO responses by treatment.

	1° program without access	2° program with access	N
SUBSAMPLE 1	YES	YES	207
	YES	NO	165
	NO	YES	18
	NO	NO	204
TOTAL			694
	1° program with access	**2° program without access**	**N**
SUBSAMPLE 2	YES	YES	322
	YES	NO	61
	NO	YES	57
	NO	NO	282
TOTAL			722

Table B2
Bivariate Probit Simple Model.

	(1)	(2)	(3)	(4)	(5)	(6)
	Full	>50%	>60%	>70%	>80%	>90%
With access						
β	−0.0000866*** (−6.99)	−0.000110*** (−6.71)	−0.000109*** (−6.49)	−0.0000807*** (−5.99)	−0.0000795*** (−5.42)	−0.0000757*** (−4.70)
α	0.167** (2.81)	0.00653 (0.10)	−0.140* (−2.15)	−0.361*** (−5.85)	−0.605*** (−9.21)	−0.763*** (−10.66)
Without Access						
β	−0.000112*** (−6.87)	−0.000117*** (−7.17)	−0.000114*** (−6.90)	−0.000116*** (−6.90)	−0.000130*** (−7.01)	−0.000119*** (−6.29)
α	0.376*** (6.83)	0.162** (3.01)	0.00718 (0.13)	−0.165** (−3.04)	−0.414*** (−7.24)	−0.589*** (−10.22)
rho	0.808*** (43.52)	0.871*** (53.33)	0.879*** (61.07)	0.887*** (55.39)	0.896*** (55.84)	0.898*** (52.85)

t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table B3
Bivariate Probit Model with covariates: Program with access.

	(1)	(2)	(3)	(4)	(5)	(6)
	Full	>50%	>60%	>70%	>80%	>90%
β	−0.0000671*** (−4.96)	−0.0000977*** (−5.39)	−0.000101*** (−5.45)	−0.0000806*** (−5.46)	−0.0000819*** (−5.13)	−0.0000849*** (−4.83)
α	0.106 (0.62)	−0.329 (−1.86)	−0.00316 (−1.23)	−0.922*** (−4.95)	−1.033*** (−5.26)	−0.974*** (−4.75)
Age	−0.00502* (−2.03)	−0.00525* (−2.08)	0.233** (3.10)	0.000771 (0.29)	0.00247 (0.87)	0.000837 (0.28)
Gender (1 male, 0 famale)	0.172* (2.37)	0.187* (2.53)	0.0769 (0.64)	0.187* (2.41)	0.164* (1.99)	0.153 (1.76)
Complete secondary education	−0.0689 (−0.61)	0.0641 (0.55)	0.0319 (0.25)	−0.0824 (−0.67)	−0.216 (−1.69)	−0.324* (−2.49)
Complete university and/or technical education	−0.0880 (−0.72)	0.0845 (0.67)	0.000285*** (4.70)	−0.0851 (−0.64)	−0.197 (−1.42)	−0.385** (−2.71)
Income	0.000264*** (4.39)	0.000251*** (4.19)	0.0000576 (0.78)	0.000287*** (4.65)	0.000183** (2.77)	0.000158* (2.26)

(continued on next page)

Table B3 (*continued*)

	(1)	(2)	(3)	(4)	(5)	(6)
	Full	>50%	>60%	>70%	>80%	>90%
Distance	0.00000765 (0.11)	0.0000548 (0.76)	0.390** (2.66)	0.0000459 (0.59)	0.0000873 (1.07)	0.000109 (1.27)
Environmental organization (1 if participate, 0 otherwise)	0.463** (3.12)	0.465** (3.18)	0.172* (2.25)	0.437** (2.96)	0.345* (2.24)	0.370* (2.31)
Visits to protected areas (1 if they have visited in last 5 years, 0 otherwise)	0.104 (1.40)	0.156* (2.09)	−0.0299 (−0.40)	0.159* (2.00)	0.161 (1.90)	0.108 (1.21)
Familiarity (1 if recognized, 0 otherwise)	−0.181* (−2.47)	−0.0883 (−1.19)	0.172* (2.16)	0.00118 (0.02)	−0.0331 (−0.40)	−0.0141 (−0.16)
Agency (1 if Private Corporation, 0 State Institution)	0.219** (2.87)	0.220** (2.82)	−0.190* (−2.47)	0.250** (2.99)	0.189* (2.13)	0.180 (1.91)
Order (1 if was asked first about program without access, 0 otherwise)	−0.434*** (−5.88)	−0.261*** (−3.48)	−0.620*** (−3.42)	−0.146 (−1.85)	−0.0543 (−0.65)	0.0316 (0.36)
rho	0.830*** (40.93)	0.875*** (53.64)	0.879*** (49.32)	0.885*** (50.74)	0.894*** (59.68)	0.896*** (50.04)

t statistics in parentheses * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table B4
Bivariate Probit Model with covariates: Program without access.

	(1)	(2)	(3)	(4)	(5)	(6)
	Full	>50%	>60%	>70%	>80%	>90%
β	−0.000136*** (−7.66)	−0.000138*** (−7.72)	−0.000135*** (−7.42)	−0.000134*** (−7.32)	−0.000139*** (−6.92)	−0.000125*** (−6.13)
α	0.0978 (0.58)	−0.304 (−1.78)	−0.589*** (−3.41)	−0.775*** (−4.38)	−0.851*** (−4.55)	−0.807*** (−4.24)
Age	−0.00487* (−1.99)	−0.00493* (−2.00)	−0.00234 (−0.94)	0.00208 (0.82)	0.00428 (1.58)	0.00443 (1.57)
Gender (1 male, 0 famale)	0.115 (1.60)	0.181* (2.50)	0.213** (2.91)	0.153* (2.04)	0.123 (1.55)	0.0657 (0.80)
Complete secondary education	−0.0512 (−0.46)	0.0834 (0.73)	0.103 (0.89)	−0.0516 (−0.44)	−0.222 (−1.82)	−0.319** (−2.58)
Complete university and/or technical education	−0.144 (−1.18)	0.0355 (0.29)	−0.0268 (−0.21)	−0.160 (−1.25)	−0.329* (−2.47)	−0.485*** (−3.56)
Income	0.000276*** (4.54)	0.000258*** (4.31)	0.000299*** (4.97)	0.000277*** (4.56)	0.000205** (3.19)	0.000173** (2.59)
Distance	0.0000268 (0.38)	0.0000473 (0.67)	0.0000555 (0.77)	0.0000337 (0.45)	0.0000765 (0.98)	0.0000889 (1.10)
Environmental organization (1 if participate, 0 otherwise)	0.549*** (3.51)	0.505*** (3.35)	0.430** (2.89)	0.494*** (3.34)	0.407** (2.70)	0.373* (2.42)
Visits to protected areas (1 if they have visited in last 5 years, 0 otherwise)	0.181* (2.47)	0.249*** (3.38)	0.242** (3.24)	0.246** (3.22)	0.234** (2.87)	0.181* (2.14)
Familiarity (1 if recognized, 0 otherwise)	−0.124 (−1.71)	−0.0496 (−0.68)	0.00551 (0.07)	0.0129 (0.17)	−0.0614 (−0.77)	−0.0817 (−0.98)
Agency (1 if Private Corporation, 0 State Institution)	0.216** (2.86)	0.170* (2.23)	0.106 (1.37)	0.129 (1.63)	0.0986 (1.17)	0.0537 (0.61)
Order (1 if was asked first about program without access, 0 otherwise)	0.214** (2.91)	0.170* (2.31)	0.176* (2.36)	0.135 (1.78)	0.0473 (0.59)	0.0221 (0.26)
rho	0.830*** (40.93)	0.875*** (53.64)	0.879*** (49.32)	0.885*** (50.74)	0.894*** (59.68)	0.896*** (50.04)

t statistics in parentheses, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table B5
WTP (US$) for different uncertainty cut-off points for parametric models.

	Bivariate Probit Model (only BID)			Bivariate Probit Model with covariates			Bivariate Probit Model without protest (only BID)			Bivariate Probit Model without protest and with covariates		
	With access	Without Access	t-test	With access	Without Access	t-test	With access	Without Access	t-test	With access	Without Access	t-test
Original	2.73	4.80	3.03	1,92	4,79	2,79	3,40	5,37	2,90	2,79	5,28	2,58
50%	0.08	1.98	2.78	−0,61	2,34	3,00	0,66	2,40	2,79	−0,02	2,73	3,03
60%	1.84	0.09	2.19	−2,55	0,67	2,68	−1,20	0,50	2,14	−1,99	1,02	2,68
70%	6.37	−2.03	2.60	−6,84	−1,26	2,81	−6,19	−1,90	2,51	−7,03	−1,14	2,72
80%	- 10.82	- 4.51	2.52	−10,15	−4,26	2,49	−10,85	−4,56	2,43	−10,46	−4,60	2,34
90%	- 14.34	- 7.04	2.16	−10,54	−6,94	1,29	−14,01	−6,79	2,15	−10,51	−6,97	1,26

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