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A discrete choice experiment approach.

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# The management of Natura 2000 Network sites: a discrete choice experiment approach

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## Abstract

One of the main problems that public institutions face in the management of protected areas, such as the European Natura 2000 network, is how to design and implement sustainable management plans accounting both for the social cost and benefits of conserving these sites. This paper provides with an empirical application of a discrete choice experiment undertaken in a Natura 2000 site in the Basque Country (Spain) aimed at evaluating the social preferences for different land-use options. This information is then used to evaluate the social desirability of some future management plans.

**Keywords:** discrete choice experiments; choice modelling; environmental valuation; Natura 2000

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## 1. Introduction

Natura 2000 is a European Union's network of protected areas established under the Habitats Directive (92/43/EEC) and the Birds Directive (2009/147/EC).[1] The main purpose of Natura 2000 (hereafter N2000) network is to assure the long-term survival of Europe's most valuable and threatened species and habitats. N2000 network currently includes 5.315 Special Protection Area (SPA) sites, accounting for 593.486 km2 and 22.529 Sites of Community Importance (SCI), accounting for 719.015 km2.

One of the key features of this network is that it is not strictly a system of nature reserves excluding all human activities but, acknowledging that most of the land is privately owned (and will most likely continue to be privately owned), it aims to ensure that future management is ecologically and economically sustainable. As a consequence, one of the main problems that public institutions face is how to design and implement sustainable management plans accounting both for the social cost and benefits of conserving these sites. While putting a figure on the cost of implementing these plans is an essential prerequisite to ensuring a sufficient allocation of resources, establishing its socioeconomic benefits may help to determine its social desirability as well as to increase awareness about the conservation of natural resources. The European Commission estimates at around 5,700 million euros the cost of managing the N2000 network but significantly lacks information on its social benefits.

In this context, the use of economic valuation methods may be ideally suited to deal with this issue, especially in the case of discrete choice experiments (DCEs). Since its first application in the context of environmental resources (Adamowicz et al., 1994), the number of applications of DCEs has significantly increased, playing an increasingly significant role in environmental decision making. One of the main reasons behind this blast may be found in its inherent flexibility in order to describe environmental changes. DCEs have been argued to be ideally suited to inform both the choice and design of multidimensional policies. By turning the focus from mere monetary values of environmental change onto how preferences for non-market goods are organised, the main purpose of a DCE is to identify the utility that individuals derive from the attributes conforming and environmental good or services.

This paper provides with an empirical application of a DCE undertaken in a N2000 site in the Basque Country (Spain) aimed at evaluating the social preferences for different land-use

[1] This is the codified version of Directive 79/409/EEC as amended.

options. This information is then used to evaluate the social desirability of some future management plans. The rest of the paper is structured as follows. Section 2 provides with a literature review of valuation studies of N2000 Network sites. Section 3 introduces the methodology used in this research. Section 4 presents the case study, the Garate-Santa Barbara N2000 network site. Section 5 reports the estimated models and simulated WTPs. Section 6 discusses the findings of the paper and, finally, Section 7 gives some concluding remarks.

## 2. Literature review

Stated preference method for environmental valuation were firstly used at the beginning of the 1960s to value recreational benefits of forests, and since then, not only CV but especially DCE have evolved significantly. Economic valuation of natural protected areas has also had an important tradition since the mid-20th century's first attempts. As a consequence, there is substantial literature providing with empirical applications in this field over the last few decades employing different methods[2]. However, economic valuation studies over N2000 sites are quite recent, as this ecological network is still being implemented all across Europe.

The following literature review focuses on valuation studies undertaken over N2000 sites (see table 1). Natural protected areas under other protection figures have not been considered. This table highlights the general features of empirical research and distinguishes valuation studies conducted at a regional/national scale and at specific sites.

[2] See e.g. Nunes et al. (2003) for a review on empirical valuation studies of protected areas.

**Table 1. Economic valuation studies of Natura 2000 sites**

| Author(s) | Year | Natura 2000 site | Surface (ha) | Method | Environmental change | Result (WTP/WTA) | WTP/year/ha |
|---|---|---|---|---|---|---|---|
| Pouta et al. | 2000 | Finnish N2000 network | 4,855,200 ha | CV | Marginal increase | 231.09 M €/year | 47,6 €/year/ha |
| Li et al. | 2004 | Finnish N2000 network | 4,855,200 ha | DCE | Marginal increase | WTP: 301.18 M €/year | WTP: 62 €/year/ha |
| Li et al. | 2004 | Finnish N2000 network | 4,855,200 ha | DCE | Marginal increase | WTA: 1,318 M €/year | WTA: 271,4 €/year/ha |
| Jacobs | 2004 | N2000 network in Scotland | 732,580 ha | CV | Total area | 300.69 M €/year | 410,5 €/year/ha |
| Prada et al. | 2005 | N2000 network in Galicia (Spain) | 344,440 ha | DCE | Marginal increases depending on attributes | 266.18 M €/year | 772,8 €/year/ha |
| Barreiro et al. | 2004 | Peñadil, Montecillo and Monterrey SCI (Navarra, Spain) | 2,922 ha | BT | Total area | 49,085 €/year | 16.8 €/year/ha |
| Hoyos et al. | 2008 | Jaizkibel Mountain SCI (Basque Country, Spain) | 2,434 ha | DCE | Marginal increases depending on attributes | 8.9 M €/year | 3.600 €/year/ha |

(1): 1 Euro corresponds to 5.94573 Finnish markka, in 1998.

(2): 1 Euro corresponds to 0.7033 British pound, in 2004.

(3): Methods: CV (Contingent valuation), DCE (Discrete Choice Experiment), BT (Benefit Transfer)

Pouta et al. (2000) report a study conducted in Finland at the time that the government was creating the N2000 network. The economic valuation relies on a dichotomous choice referendum elicitation of a CV survey aimed at analysing the preferences of Finnish households for a conservation programme for the full finish N2000 network. The CV questionnaire aim to elicit the WTP for different variations in the conservation area through an increase in income tax. The results from a random sample of 2,400 individuals reveal a mean WTP/household of 101 euros and an aggregated WTP of 231.09 million euros. Comparing these results with the costs derived from restrictions in forestry industry, the benefits exceeded them even when the most conservative estimates of WTP and the most restrictive method for estimating costs were used. Based on the same dataset, Pouta et al. (2002) found that the planning method employed had a significant effect on people’s WTP for nature conservation. According to these authors, respondents who were offered a conservation project within N2000 network were WTP about five times less for the same environmental change compared to those who received an hypothetical nature conservation programme described as participatory and similar to N2000 but without such label.

Once the Finnish N2000 network was defined, a DCE study was undertaken in order to analyse different management options using a sample of 1600 individuals (Li et al., 2004). Alternatives ranged from a decrease in the conservation area of 3% to an increase in this area of 3%, 6% and 9%. Results from a MNL model revealed that mean WTA for a decrease in the nature conservation area (575.12 euros) were much greater than the mean WTP for an increase in the same amount (131.42 euros). Quite interestingly, both Li et al. (2004) and Pouta et al. (2000) find a *satiated* value function after 3%, whereas the value of nature preservation does not seem to increase after the initial 3%.

Another assessment conducted at a national level was undertaken by Jacobs (2004) in Scotland. The author compares the results of valuing seven N2000 sites and all 300 N2000 sites using CV method. The survey was carried out over three stakeholder groups: the general public, including local residents and wider population living in Scotland, for which non-use values were elicited; visitors to the 7 case study areas, for which use-values were estimated; and non-Scottish visitors, whom non-use value were elicited. According to this paper, the national welfare benefits were estimated at 300.69 million euros/year, from which only 1% relates to use-values and 99% to non-use values (51% accrues to the Scottish general public and 48% to visitors to Scotland). The programme was argued to pass a CBA, although it failed to do so when non-use values were excluded. The average Scottish households' WTP for non-use value of all 300 N2000 sites were estimated at 68.57 euros/year, whereas the non-Scottish visitors' WTP was estimated at 8.57euros/adult-visit. At a site level, non-Scottish visitor use values ranged from 0.85 to 2.43 euros/adult-visit, whereas Scottish visitor use values ranged from 0.07 to 2.43 euros/adult-visit. These values were found to be deeply dependent on both the distance and characteristics of the site (e.g. walking, angling, etc.). However, when reasonably detailed information (i.e. with descriptions and photos) was provided in the survey, average WTP values increased by 9% and as much as 28% for respondents living within 10 Km of the site.

Prada et al. (2005) leaded a piece of research focused on the regional scale, attempting to value the Galician N2000 network (Galicia, Spain). The methodology employed was DCE using four attributes: protected surface, woodland quantity, woodland type, and time horizon. The results of a MNL model specification reveal that individuals' WTP for protected surface and woodland type were approximately three times higher than for woodland quantity and time horizon. In particular, mean marginal WTP/household-year for an increase in protected surface from 36.000 ha to 280.000 ha is estimated at 113 euros, and for a change from woodland plantations to indigenous-leafy woodland at 122 euros.

According to their findings, both protected surface and woodland quantity are more highly valued in urban than in rural areas, in consonance with the results reported by Pouta et al.

(2000). The authors argue that this may be due to the existence of a lower educational level in Galician remote rural areas, although cultural reasons may also influence these results.

As mentioned before, economic valuation studies of particular N2000 sites have also been undertaken. Barreiro et al. (2004) employed the benefit transfer methodology to estimate both use value and non-use value of Peñadil, Montecillo and Monterrey SCI (2,922 ha) in Navarre (Spain). The overall benefits were grouped in four categories: recreational use, landscape, and carbon sequestration, and existence. Based on a previous estimation of the total economic value of biodiversity in Navarra, benefits were allocated to this particular site as a value of 16.8 euros/ha/year. The authors conclude that the conservation plan does not pass a CBA given that the costs of conserving the site exceed its social benefits. However, as the authors stress, social benefits may be underestimated both due to methodology employed and to the fact that its social value may increase as environmental quality of the site improves along with the management plan's implementation. Moreover, when estimating non-use values, the use of benefit transfer method may be problematic due to the fact that the context is decisive in these cases and the difficulty of defining the transference "unit" (Navrud, 2000).

Finally, Hoyos et al. (2008) estimated the non-market value of conserving Jaizkibel Mountain SCI (2,434 ha) in the Basque Country (Spain). A DCE was undertaken in order to value its four main attributes: landscape, flora, avifauna, and seabed. Results from a MNL model specification reveal that the mean marginal WTP per person for a 1% increase in its protection level on each of them would be, respectively, 1.39, 0.87, 0.68, and 0.63 euros. Based on the same dataset, Hoyos et al. (2009) find that cultural identity is an important explanatory variable of WTP, estimating that WTP is approximately 28-33% higher when respondent's cultural identity is Basque. They also find that certain socioeconomic characteristics of respondents, such as being a climber or having children, positively influence WTP. This latter result is sound with the findings reported by Prada et al. (2005) as active users' (climbers, riders, swimmers, etc.) willingness for protecting natural areas is higher.

In sum, it is important to denote the significant difference in terms of WTP between particular sites and regional/national networks. As Prada et al. (2005) have argued, the economic value of a particular natural protected areas network should be lower than the sum of the value of each area within the network. Therefore, the use of regional/national networks valuation studies rather than particular sites may contribute to avoid aggregation bias in addition to save some operational research costs. In any case, economic valuation studies may be considered a promising evaluation instrument as it may contribute to manage an ecological network with relevant socio-economic implications (Rojas-Briales, 2000; Ten Brink et al., 2002), in particular in the regional context (Getzner and Jungmeier, 2002).

## 3. Methodology

Choice Modelling is a stated preferences method of valuation that converts subjective choice responses into estimated parameters. DCEs were first used in marketing research during the 70s in order to analyse consumer choices. Later, this technique was used in transport economics and health economics, and more recently it has considerably gained in popularity in the fields of environmental and ecological economics. A comprehensive overview of this valuation method can be found in Louviere, Hensher and Swait (2000), Alpizar, Carlsson and Martinsson (2001), Train (2003), and Hoyos (2010).

The classical econometric specification for estimating DCEs, the multinomial logit (MNL) model (McFadden 1974, Louviere et al. 2000), is generally overcome by the mixed logit (MXL) specification (Train 2003). In these models, a random term whose distribution over individuals and alternatives depends on underlying parameters is added to a classical utility function associated with each alternative. The use of a MXL model involves three main specification issues: (1) the determination of which parameters should be modeled as randomly distributed; (2) the choice of mixing distribution for the random coefficients; and (3) the economic interpretation of the randomly distributed coefficients. The classical procedure to determine the random coefficients is to select among different model specifications (including/excluding random coefficients) using the likelihood ratio (LR) test. A second possibility is the use of the Lagrange multiplier (LM) test, as proposed by McFadden and Train (2000). The mixing distribution of the parameters can be discrete or continuous. If the mixing distribution is formed by a finite set of distinct values, the MXL becomes the latent-class model. If the mixing distribution is continuous, a random parameters model (also known as random coefficients model) or an error component (EC) model can be derived from the MXL probability.

Following standard consumer theory, the marginal rate of substitution (MRS) between attributes can be obtained by calculating the ratio of the partial derivatives of the IUF with respect to each attribute. In the presence of a linearly additive IUF, compensating surplus (CS) welfare estimates for DCEs may be obtained from Hanemann (1984):

$$CS = -\frac{1}{\alpha}\left[\ln(\sum \exp(\beta X_{ij}^{0}) - \ln(\sum \exp(\beta X_{ij}^{1})\right], \quad (1)$$

where $\alpha$ is the marginal utility of income (usually represented by the coefficient of the payment attribute), $\beta$ the parameter to be estimated, and $X_{ij}^{0}$ and $X_{ij}^{1}$ represent the vector of environmental attributes at initial level (status quo) and after the change levels, respectively.[3] So, Hicksian compensating variation measures a change in expected utility due to a change in the level of provision in the attribute or attributes by weighting this change by the marginal utility of income. Therefore, the WTP for a marginal change in the level of provision of each environmental attribute is obtained by dividing the coefficient of the attribute by the coefficient of the cost attribute (sometimes referred to as implicit price).

Estimating WTP measures using MXL models may be complicated because of the difficulty of maintaining theoretical consistency and actual behavior of decision makers, constrained by the data collection and model specification. The researcher should bear in mind two issues: first, the importance of choosing an appropriate mixing distribution for the random parameters (and their economic interpretation); and second, that model fit may not always be an appropriate indicator of model performance (Hoyos, 2010).

A common assumption about MXL models is that the only source of variability is preference heterogeneity, although there is a growing evidence that variance (i.e. scale) heterogeneity may still exist and that it can produce serious bias in welfare measures (Adamowicz et al. 2008). More recently, the G-MNL model (Fiebig et al., 2009) has been proposed in order to accommodate both preference and variance heterogeneity although other authors have attempted to specify heterogeneity in the error variance through a parameterization of the scale factor (Swait and Adamowicz, 2001; DeShazo and Fermo, 2002).

Finally, recent developments in respect of hypothesis testing within the DCE framework have attempted to fill some gaps. Nonlinear specifications (piecewise linear specifications, power-

[3] It is important to bear in mind the assumptions underlying the closed-form solution for the welfare measure in Equation (1) as being: additive disturbances, an extreme-value distribution and constant marginal utility of income. The problem of relaxing the hypothesis of constant marginal utility of income is that it complicates the estimation of compensating surplus measures because income enters the utility function non-linearly. Some approaches to incorporate income effects in random utility models have been proposed by McFadden (1995) and Morey et al. (1993).

series expansions and Box–Cox transformations) can be easily tested using LR tests. However, other potentially problematic issues such as model misspecification or the appropriateness of the distributional assumptions in RPL models are increasingly being analysed. Model misspecification generally invalidates statistical inference, although it is rarely tested in DC models. For this purpose, Fosgerau (2008) has recently proposed the use of a non-parametric test of functional form, the Zheng test, to discrete-choice models. The appropriateness of distributional assumptions of the random parameters included in RPL models is also rarely tested. For this purpose, Fosgerau and Bierlaire (2007) have proposed a test based on semi-non-parametric techniques.

## 4. Description of the case study

### 4.1. Legal context

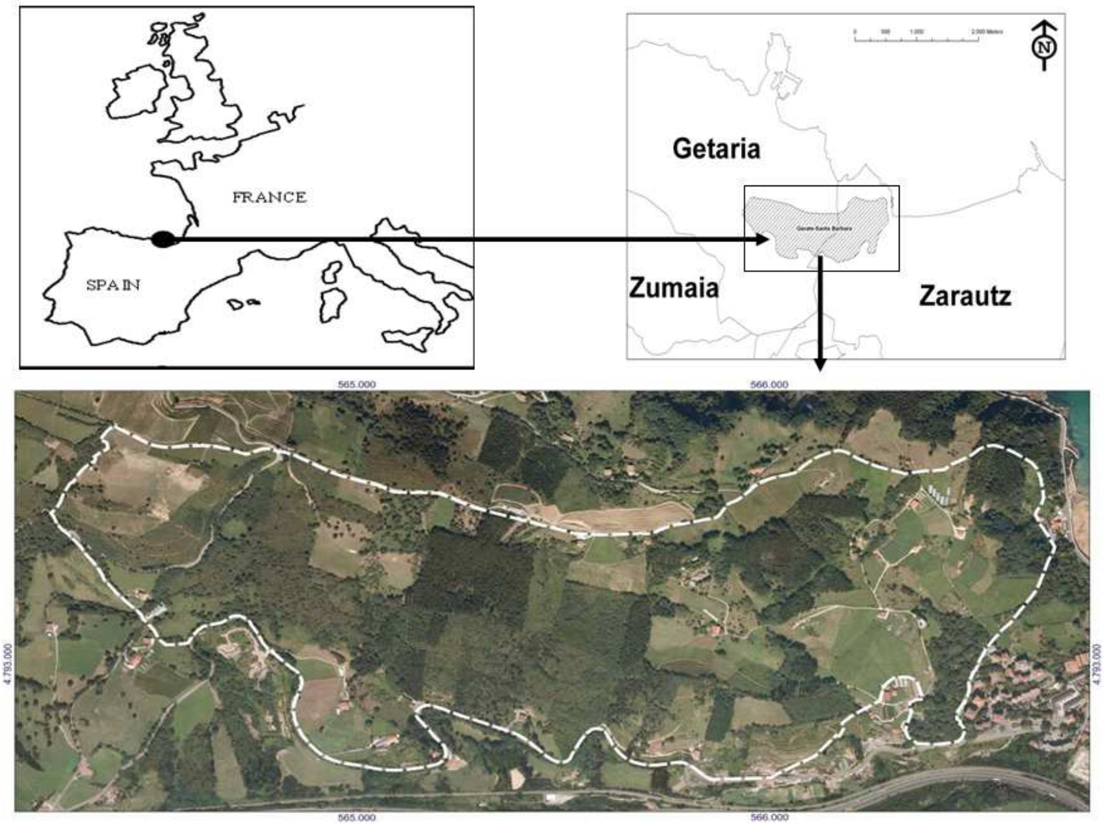
The increasing awareness about nature conservation is also reflected in the Basque society and in this line the land area under protection has increase significantly since the 1990s'. Through the 16/1994 Nature Conservation Act. Regarding the N2000 network, up to date 52 sites of Community interest (SCI) and six special protection zones for birds (SPZB) have been designated, reaching 147.000 hectares (20,3% of the region). All these areas under the SCI and SPZB will encompass the N2000 ecological network in the Basque Country. The selection of these sites has been based in scientific and technical criteria. More precisely, SCI have been designated according to Annex I (habitat types) and Annex II (habitats of species) of the Habitat Directive (92/43/EEC) and the SPZB have been designated according to specifications under the Bird Directive (79/409/EEC). Hence, other social and economic aspects have been excluded in the designation process up to data.

### 4.2. Description of the site

The case study focuses in th Basque SCI known as Garate-Santa Barbara (GSB) which is located in the province of Gipuzkoa (see Fig 1). It covers about 142 ha, under private property, that are distributed between the municipalities of Zarautz and Getaria. GSB was proposed to be part of the N2000 network in 2003 as a SCI (code: ES2120007) taking in to account the presence of five environmentally valuable habitats. According to Annex I of Habitat Directive (code) this are: Quercus suber forest (9330); Quercus ilex and Quercus rotundifolia forest (9340);

European dry heaths (4030); Endemic oro-Mediterranean heaths with gorse (4090); and Lowland hay meadows (Alopecururs pratensis, Sanguisorba officcinalis) (6510). Based in this proposal in 2004 it became part of the European list of SCI and updated in 2008 (EU Commission, 2004, 2008). GSB-SCI also encompasses a relevant place within the Basque Country's list of highly valuable environmental areas due to the presence of cork oak (Quercus suber). This specie is really scarce in the Basque Country and GSB is the only area in which it can self-regenerate. Besides these environmental values, GSB also contains significant landscape and recreation values. More detailed information about the environmental characteristics of Garate-Santa Barbara can be found in Etxano et al. (2009).

**Fig 1. Location Garate-Santa Barbara N2000 site (Basque Country- Southern Europe)**




In this area the economic activity focuses mainly in agriculture and to a lesser extends, in forestry. Within the agricultural sector, it is remarkable the production of highly valuable sharp wine, known locally as *txakoli* which has enhance in recent years the relevance of the wine sector in GSB and the surrounding areas. While in 1998 90 ha of vineyards could be found, in 2008 327 ha were under production of *txakoli* directly employing 52 people. This increase in wine production has occurred at the expense of a decline in cattle production, which has shift land use from grasslands to vineyards. This changes has rice the concern among conservationist, given that an increasing land demand for vineyards driven by economic profits, can derive in additional pressure for the all ready threaten cork oak forests.

### 4.3. Survey design

A valuation survey was conducted in the Basque Country in order to determine the non-market values of the main environmental attributes of Garate-Santa Barbara N2000 Network Site (GSB). The proposed programs of protection aimed at preventing future environmental degradation at the site provoked by land use changes derived from the human activity. The hypothesized future land use changes and the proposed protection programs were found to be both credible and understandable by focus group participants. The questionnaire started by describing the actual situation in GSB, facilitated by the provision of information and pictures. Further in the questionnaire, certain changes in the quality of the site's main attributes were described. It was stated that if the area was not protected, these environmental attributes could suffer different levels of degradation in the future.

Environmental attributes and the level of provision become critical aspects of any choice experiment given that the only information about preferences provided by respondents takes the form of choices between the options (Hensher, 2007). According to Lancaster (1991), an environmental attribute can be considered relevant if ignoring it would change our conclusion about a consumer's preferences. The construction of the choice sets included in an experiment requires a correct definition of the change to be valued and the attributes and levels that would be used. Previous investigation into the environmental characteristics of GSB, expert advice derived from an interdisciplinary group of researchers (e.g., geographers, biologist, forest-managers, agronomist, etc.), in-depth interviews with several stakeholders (e.g., mayors of the council, rural development agency, representatives from the regional authority and the Basque Environmental Ministry, Labour Unions, etc.) and focus groups facilitated the definition of environmental attributes and levels of provision.

**Table 2. Attribute and levels considered.**

| Attribute | Level | | | | | |
|---|---|---|---|---|---|---|
| Native forest | 2% | 10% | 20% | 30% | | |
| Vineyard | 40% | 30% | 20% | 10% | | |
| Exotic tree plantations | 40% | 30% | 25% | 15% | | |
| Biodiversity | 25 | 15 | 10 | 5 | | |
| Recreation | low | Medium | High | Very High | | |
| Cost | 0€ | 5€ | 10€ | 30€ | 50€ | 100€ |

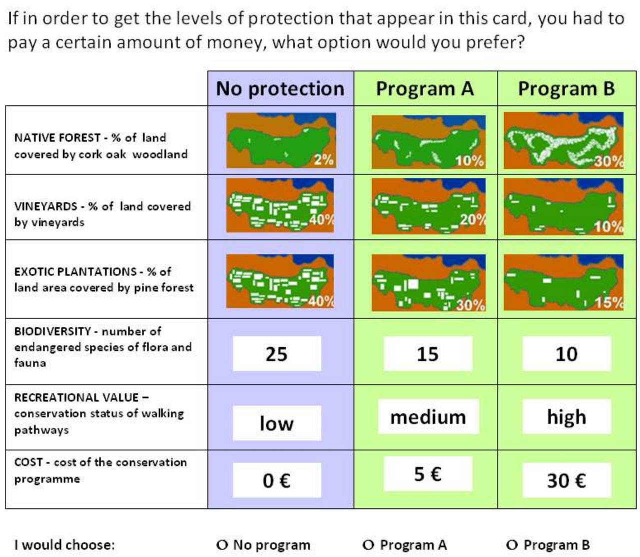
In this case instead of offering information regarding different degrees of protection, the information included in the DCE refers to the potential effects of such degrees of protection in terms of the following 6 main attributes (see table 2): (1) native forest represented by the percentage of land area covered by cork oak woodland (levels ranging 2-30%), (2) percentage of land area covered by vineyards (levels ranging 10-40%), (3) Exotic tree plantations represented by land area covered by productive pine forest plantations (levels ranging 15-40%) (4) biodiversity, based on the number of endangered species of flora and fauna (levels ranging 5-25 species), and (5) the level of conservation of recreational and cultural facilities (qualitative level ranging from 'low' to 'very high'). (6) A cost attribute regarding the cost of the conservation programme (ranging from 0 to 100 euros per capita) was also included. These attributes were selected based on focus groups, bio-geographic analysis and external expert advice by key informants.

A main effects fractional factorial design with second order interactions was used to simplify the construction of choice sets (Louviere et al., 2000). The final version of the questionnaire had 120 choice sets (blocked into 20 groups of 6 choice sets); each formed by the status quo or 'business as usual' option plus two alternative protection programmes for GSB (programme A and programme B). For a better understanding of the trade-offs between the attributes and alternatives, the choice sets included maps and percentage values (see Fig. 2). The complexity of the choice task was satisfactorily pre-tested in focus groups and through pilot surveys.

The proposed payment Vehicle was an annual contribution by all Basque citizens to a Foundation exclusively dedicated to protecting GSB. This payment vehicle was proposed because Europeans are unfamiliar with more typical payment vehicles such as levies on income taxes (Morrison et al., 2000). The “don’t know” option was included in order to avoid the “yea saying” bias (Arrow et al., 1993) that could arise because of Basque respondents´ unfamiliarity with the use of CEs. These answers were eliminated from the data set, assuming that these respondents’ preferences were similar to those of the rest of the sample. The questionnaire also contained the usual reminder of budget constraint as well as an additional choice set with a dominant alternative aimed at identifying respondents understanding of the choice task. At the end of the six choice sets, in this additional choice set respondents would face the same attribute levels as in the status quo with increasing prices, so that we would expect respondents to always choose the status quo.[4]

The questionnaire was finally structured in three parts. The first part was devoted to explaining the environmental quality changes to be valued, i.e. the current situation of Garate-Santa Barbara was briefly described along with some possible future changes to its environmental attributes derived from different degrees of protection. The second part (the preference elicitation part) contained the choice experiment questions. The last section contained some debriefing and socioeconomic questions.

**Figure 2. Example of a Choice set with different protection alternatives used in the valuation exercise, translated into English.**

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[4] Although some authors have argued that this could be incorrect because respondents may attach other attributes to the non-status quo alternatives, we opted for this approach in order to provide with more reliable welfare estimates.

### 4.4. Data collection

The survey was administered through in-person computer-aided individual home interviews. The relevant population considered was that of the Basque Autonomous Community, accounting for 1.8 million people aged at least 18. A stratified random sample of 400 individuals was selected from the relevant population. The strata used included age, gender and size of the town of residence, following official statistical information by the Basque Statistic Office (EUSTAT). In each of the locations in the Basque Country, the questionnaire was distributed using random survey routes.

## 5. Results

### 5.1. Basic statistics

The data analysis used 221 completed questionnaires, yielding 1326 observations, as each respondent faced six choice situations. Table 3 shows the descriptive statistics of the socioeconomic variables (SEV) used in the estimation stage. The mean age (45.03 years), gender (46.6% male and 53.4% female) and personal disposable income ( 965 euros/month) of respondents are in consonance with the average age, gender and disposable income decomposition of the population of the Basque Country. Other explanatory variables considered were HINCOME (for respondents net monthly disposable income higher than 2500 euros), NCHILD (for respondent's number of children), IDENTB (taking the value 1 if the respondent considered herself as having Basque cultural identity at an above average level and 0 otherwise), NVISIT (for respondent's number of visits to the site during the last year), CONIFER (taking the value 1 if the respondent likes pine tree plantations), and CLIMBER (taking the value 1 if respondent was a climber and 0 otherwise). Table 3 also presents the variance inflation factor (VIF), commonly used in regression analysis for detecting problems of multicollinearity, where values greater than 30 indicate highly collinear data. In our case, all values are very low, so no problem of multicollinearity is expected.

**Table 3. Socioeconomic variables and summary statistics**

| Variable | Mean | Std.Dev | Min | Max | Cases | Missing | VIF |
|---|---|---|---|---|---|---|---|
| NVISIT | 0.2127 | 1.0487 | 0 | 10 | 3978 | 0 | 0.93 |
| CONIFER | 0.5701 | 0.4951 | 0 | 1 | 3978 | 0 | 4.04 |
| CLIMBER | 0.5023 | 0.5001 | 0 | 1 | 3978 | 0 | 4.23 |
| AGE | 45.0362 | 18.7328 | 18 | 89 | 3978 | 0 | 0.02 |
| GENDER | 0.4661 | 0.4989 | 0 | 1 | 3978 | 0 | 4.14 |
| NCHILD | 0.3077 | 0.6560 | 0 | 4 | 3978 | 0 | 2.36 |
| PINCOME | 965.0000 | 1018.4500 | 0 | 8000 | 2340 | 1638 | 0.01 |
| HINCOME | 0.0362 | 0.1868 | 0 | 1 | 3978 | 0 | 0.02 |
| IDENTB | 0.2308 | 0.4214 | 0 | 1 | 3978 | 0 | 5.82 |

## 5.2. Model specifications and estimation results

We started our estimations with the basic MNL model including interactions with SEV. The MNL estimations involved numerous specifications with different combinations of the attributes and SEV in order to account for heterogeneity among respondents' tastes. The indirect utility function used for the MNL specifications is presented in equation (2), and the corresponding estimates can be found in Table 4.

$$\begin{aligned} V_{nj} = {} & \beta_1 + \beta_2 Cost_{nj} + \beta_3 Aut_{nj} + \beta_4 Vin_{nj} + \beta_5 For_{nj} + \beta_6 Bio_{nj} + \beta_7 Rec_{nj} \\ & + \beta_8 Cost_{nj}.HIncome_n + \beta_9 Aut_{nj}.IdentB_n + \beta_{10} Vin_{nj}.IdentB_n + \beta_{11} For_{nj}.Conifer_n \\ & + \beta_{12} Bio_{nj}.NChild_n + \beta_{13} Rec_{nj}.NVisit_n + \beta_{14} Rec_{nj}.Climber_n \end{aligned} \quad (2)$$

This expression corresponds to the indirect utility function for the status quo option. It includes a constant term because it is considered identifiable by the respondents. The indirect utility functions of the other two alternatives do not include any constant terms, as they are produced from the same experimental design.

**Table 4. Estimated models**

| | MNL | | | MXL | | |
|---|---|---|---|---|---|---|
| **Variable** | **Coefficient** | | ***t-value*** | **Coefficient** | | ***t-value*** |
| Constant | 0.18982 | | *0.74* | -0.05338 | | *-0.18* |
| Cost | -0.01778 | *** | *-13.51* | -0.02214 | *** | *-10.18* |
| AUF | 0.04223 | *** | *7.91* | -3.49054 | *** | *-10.77* |
| Vineyard | 0.01290 | ** | *2.42* | 0.01622 | ** | *2.50* |
| Plantation | -0.01722 | ** | *-2.36* | -0.02062 | ** | *-2.42* |
| Biodiversity | -0.03999 | *** | *-4.07* | -3.76038 | *** | *-6.55* |
| Recreation | -0.01591 | | *-0.57* | -0.02510 | | *-0.73* |
| Hincome*Cost | 0.00943 | * | *1.76* | 0.01334 | ** | *2.29* |
| Identity*AUF | 0.01993 | ** | *2.17* | 0.02030 | * | *1.80* |
| Identity*Vineyard | -0.02163 | ** | *-2.43* | -0.02594 | ** | *-2.41* |
| Nchild*Biodiversity | -0.01582 | ** | *-2.15* | -0.01797 | ** | *-1.92* |
| Conifer*Plantation | 0.01835 | ** | *2.57* | 0.02251 | *** | *2.72* |
| Nvisit*Recreation | 0.02943 | * | *1.79* | 0.03246 | * | *1.80* |
| Climber*Recreation | 0.05219 | * | *1.79* | 0.06934 | ** | *2.03* |
| | | | | | | |
| Std. Dev. AUF | | | | 1.25407 | | *3.21* |
| Std. Dev. Biodiversity | | | | 1.43062 | | *2.96* |
| | | | | | | |
| Log likelihood | -1184.71 | | | -1177.09 | | |
| Pseudo R2 | 0.15 | | | 0.19 | | |
| AIC | 1.8080 | | | 1.7995 | | |
| BIC | 1.8628 | | | 1.8622 | | |
| Observations | 1326 | | | 1326 | | |
| Sample size | 221 | | | 221 | | |

*Notes:* ***, **, * indicate the coefficients are statistically significant at the 1%, 5% and 10% levels respectively, using the P-values in maximum likelihood estimation.

The MNL model estimation results (see table 4) show that utility increases if the percentage of land area covered by autochthonous forest increases (even more if respondents' cultural identity is Basque); utility also increases for respondents' whose cultural identity is not Basque if the percentage of land area covered by vineyards increases; and utility increases for recreationalists and climbers if the level of conservation of recreational and cultural facilities increases. On the other hand, utility decreases if the area covered by exotic three plantations increase (unless respondents like pine tree plantations); and utility also decreases if the number of endangered species of flora and fauna increases (even more if respondents have children). Finally, the negative coefficient of the cost attribute indicates, as predicted by economic theory, the probability of accepting an annual contribution for protecting the site decreases as the price increases (especially if respondents have higher income).

Next, a RPL model was estimated. As mentioned before, it is important to bear in mind that moving from MNL to a mixed logit (MXL) model involves three main specification issues: (1) the determination of which parameters should be random, (2) the choice of mixing distributions for the random coefficients and (3) the economic interpretation of the randomly distributed coefficients. The first task can be done following the Lagrange Multiplier (LM) test proposed by McFadden and Train (2000). This test seems to be the most appropriate one for detecting random parameters (Mariel et al., 2010). As shown in Table 5, the LM test identifies two coefficients as clearly random, i.e. autochthonous forest (AUF) and biodiversity (BIO).

**Table 5. McFadden and Train (2000) LM test results**

| Variable | p-value | Conclusion |
|---|---|---|
| COST | 0.1590 | Not random |
| AUF | 0.0140 | Random |
| VIN | 0.1730 | Not random |
| FOR | 0.1510 | Not random |
| BIO | 0.0005 | Random |
| REC | 0.1590 | Not random |

The next step will be to choose an appropriate mixing distribution for these coefficients because the LM test provides no information about the distribution that these parameters should follow. In fact, this issue is part of an ongoing debate given the fact that an inappropriate choice of the mixing distribution may bias the estimated means of the random parameters. This problem may be overcome using Fosgerau and Bierlaire’s (2007) semi-nonparametric test for mixing distributions in discrete choice models. This procedure tests if a random parameter of a discrete choice model follows an a priori postulated distribution. Given that the true distribution may be different from the postulated distribution, this procedure expresses the true distribution in a semi-nonparametric fashion using Legendre polynomials (also known as SNP terms). The number of SNP terms must be chosen in advance and a higher number of SNP terms makes the alternative hypothesis more general at the expense of a higher computational demand. Fosgerau and Bierlaire (2007) argue that two or three SNP terms give a large degree of flexibility sufficient for most empirical applications. The model with a priori postulated distribution is a special case of the model with the true distribution and, consequently, a simple likelihood ratio test for nested hypotheses can be applied here.

Based on this procedure, uniform, normal, triangular and lognormal distributions of the random parameters were tested as shown in Table 6, using the free software package Biogeme (Bierlaire, 2003, 2008).

**Table 6: Fosgerau and Bierlaire's (2007) test for the choice of mixing distribution**

| Uniform distribution | | | | | Normal distribution | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | *AUT* | | *BIO* | | | *AUT* | | *BIO* | |
| *SNP terms* | *LR* | *p-value* | *LR* | *p-value* | *SNP terms* | *LR* | *p-value* | *LR* | *p-value* |
| 1 | 137.23 | <0.001 | 69.03 | <0.001 | 1 | 81.54 | <0.001 | 41.76 | <0.001 |
| 2 | 157.35 | <0.001 | 70.00 | <0.001 | 2 | 103.92 | <0.001 | 43.08 | <0.001 |
| 3 | 158.65 | <0.001 | 72.67 | <0.001 | 3 | 111.052 | <0.001 | 43.92 | <0.001 |
| Triangular distribution | | | | | Lognormal distribution | | | | |
| | *AUT* | | *BIO* | | | *AUT* | | *BIO* | |
| *SNP terms* | *LR* | *p-value* | *LR* | *p-value* | *SNP terms* | *LR* | *p-value* | *LR* | *p-value* |
| 1 | 30.89 | <0.001 | 19.38 | <0.001 | 1 | 16.06 | <0.001 | 3.34 | 0.07 |
| 2 | 42.89 | <0.001 | 27.42 | <0.001 | 2 | 24.52 | <0.001 | 3.29 | 0.19 |
| 3 | 47.86 | <0.001 | 30.47 | <0.001 | 3 | 118.47 | <0.001 | 10.05 | 0.02 |

Table 4 also shows the estimation results of the RPL model. These results are very similar in terms of magnitude and significance level to those obtained in the previous MNL estimation. The main difference can be found in the value of the random coefficients although they are not directly comparable because of using a lognormal distribution.

## 5.3. Welfare measures

The simulation of WTP, as presented in this section, is an unconditional one. In other words, these estimates are generated from out-of-sample populations by randomly sampling each individual from the full distribution (Hensher et al., 2005; Hoyos et al., 2009; Krinsky and Robb, 1986). Table 9 presents WTPs for the RPM model in which both the random nature of two parameters as well as the effect of SED variables was included.

The simulated WTPs were estimated taking into account both the observed and unobserved heterogeneity. As the values of the SEV enter into the WTP formula we have to define a base scenario which will be used as a benchmark for WTP comparisons. In the base scenario the all SED variables were set to zero. By setting the values of these variables to one, their effect can be examined. In case of the four dummy variables the analyzed effect on WTP is to have high income (Hincome), to have Basque cultural identity (Identity), to like pine tree plantations

(Conifer) and to be climber (Climber) with respect not to have it, not to like them and not to be climber. The effect of the remaining two variables is the following. The effect of having one child with respect to not having any and to have visited the site during last year once with respect no to have visited it. Thus, e.g. WTP of the base scenario for the BIO with coefficient distributed as lognormal distribution and based on the notation of equation (2) is defined as:

$$\mathrm{WTP}_{\mathrm{BIO}} = \frac{-\exp(\hat{\beta}_6 + \hat{\sigma}_{\beta_6} * v) + \hat{\beta}_{12} * NChild}{\hat{\beta}_2 + \hat{\beta}_8 * Hincome} \qquad (3)$$

where *v~N(0,1)*. The variables NCHILD and HINCOME appear in (3) because of their interactions with the attributes BIO and COST. WTP for the others attributes are computed in a similar way. As stated before, in (6) the variables NCHILD and HINCOME are set to zero in base scenario. In the case of a non-random parameters, i.e., VIN, FOR and REC, the effects of SED variables on their WTP the corresponding standard deviation $\hat{\sigma}_{\beta}$ is set to zero.

**Table 7: Simulated WTP based on the random parameter model (RPM) with heterogeneity, in euros/person/year (standard deviations in parenthesis)**

| | AUF Median WTP | VIN Mean WTP | FOR Mean WTP | BIO Median WTP | REC Mean WTP |
|---|---|---|---|---|---|
| Base scenario | 1.4 | 0.73 | -0.93 | 1.13 | 0 |
| | *4.48* | | | *(2.79)* | |
| High Income | 3.43 | 1.84 | -2.34 | 2.57 | |
| | *(15.85)* | | | *(22.83)* | |
| Basque Identity | 6.08 | -0.44 | | | |
| | *(15.33)* | | | | |
| Child | | | | 1.80 | |
| | | | | *(2.51)* | |
| Conifer | | | 1.94 | | |
| Nvisits | | | | | 1.46 |
| Climber | | | | | 3.32 |
| ***Weighted means*** | ***2.55*** | ***0.50*** | ***0.66*** | ***1.39*** | ***1.98*** |

So, mean WTP for a one percent increase the land area covered by native forest is estimated at 2.55 euros per person per year, in 2008 values. The WTP increases to 3.43 euros if respondent has high income and 6.08 if her cultural identity is Basque. In physical terms, this result suggest that the mean WTP to increase the surface of cork oak woodland is estimated at 1.80 euros per Ha per year. The mean WTP for a one percent increase the land area covered by vineyards is estimated at 0.50 euros per person per year. However, in these case preferences differ among the population: respondents with higher income's WTP is estimated at 1.84 euros while respondents with Basque cultural identity's WTP is negative (-0.44 euros), suggesting that these individuals should be compensated. Similarly, the mean WTP for a one percent increase the land area covered by exotic tree plantations is estimated at 0.66 euros per person per year. However, on the one hand, respondents with higher income should be compensated at 2.34 euros per year while those people stating that they like pine trees are WTP 1.94 euros per year. The mean WTP for a unit increase the number of endangered species protected is estimated at 1.98 euros per person per year. This WTP increases to 2.57 euros if the respondent has high income and 1.80 if she has children. Finally, the mean WTP to improve the recreation and cultural facilities is estimated at 1.98 euros per person per year. Although the general population seems indifferent about this attribute recreationalist are WTP 1.46 euros while climbers are WTP 3.32 euros. These results are similar, in terms of population heterogeneity, to those obtained in a previous DCE in the same region (Hoyos et al., 2009).

Finally, Figures 3 and 4 illustrate the box plot of the simulated WTPs of the attributes with random parameters BIO and AUT, thus offering more information than the mean values in Table 9 as it depicts in a convenient way the five-number summaries (minimum, lower quartile, median, upper quartile and maximum) of the 1,000 generated WTPs. The box plots in Figures 1 and 2 are presented without outliers due to the underlying lognormal distribution with long right-hand tail. Here, the outliers are defined as any values more than one and a half times the interquartile range from the 1st and 3rd quartiles.

**Figure 3: Simulated RPM WTP for the random attribute Biodiversity**

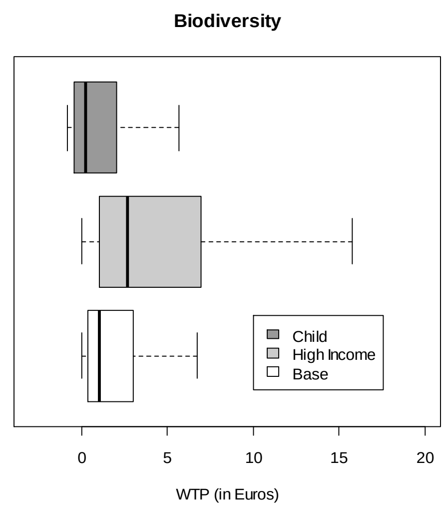
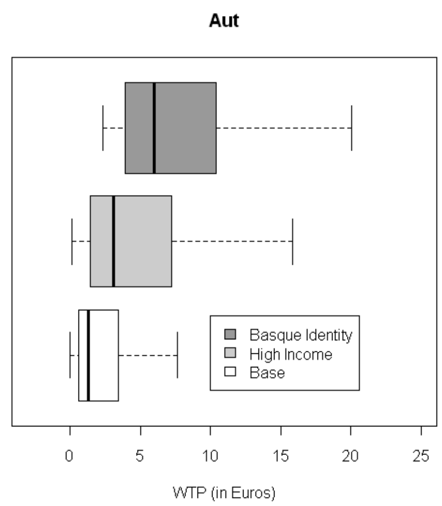



**Figure 4: Simulated RPM WTP for the random attribute Aut**




## 6. Estimating welfare changes for different management plans

The welfare measures obtained in the previous section were used to estimate welfare changes for different management plans. For this purpose, four different future scenarios were built in order to analyse the social benefits associated with them. As shown in table 8, the land use changes related to each of the proposed scenarios are: (1) promotion of vineyard plantations; (2) moderate promotion of ecological values; (3) high promotion of ecological values; and (4) maximum promotion of ecological values. These scenarios were built using GIS maps taking into account ecologically feasible land use changes (see table 9 and figures 5 to 9 in Annex 1).

**Table 8: Scenarios based on different land uses.**

| LAND USE | SCENARIOS | | | | |
|---|---|---|---|---|---|
| | Status quo | Promotion of vineyards | Moderate promotion of ecological values | High promotion of ecological values | Maximum promotion of ecological values |
| | E0 | E1 | E2 | E3 | E4 |
| Meadows, gardens and crops | = | ↓ | = | = | ↓ |
| Vineyard | = | ↑ | = | = | ↓ |
| Tree plantations | = | ↓ | ↓ | ↓↓ | ↓↓↓ |
| Other native forest | = | = | ↑ | ↑ | ↑↑ |
| Cork oak tree | = | = | ↑ | ↑↑ | ↑↑↑ |
| Heathland and bushes | = | = | = | ↑ | ↓ |
| Accesos | = | = | ↑ | ↑ | = |
| Recreational/ cultural areas | = | = | ↑ | ↑ | = |

NOTA:
=: equal or similar level
↑ / ↓: moderate increase/decrease compared to the status quo
↑↑ / ↓↓: high increase/decrease compared to the status quo
↑↑↑ / ↓↓↓: very high increase/decrease compared to the status quo

**Table 9: Land use scenarios for Garate-Santa Barbara (percentage of land under different uses)**

| Land use | Status quo | Scenario 1 | Scenario 2 | Scenario 3 | Scenario 4 |
|---|---|---|---|---|---|
| Cork oak tree | 11,59% | 11,59% | 14,71% | 19,81% | 36,10% |
| Heathland and bushes | 17,13% | 17,13% | 17,13% | 18,48% | 2,09% |
| Other native forest | 13,09% | 13,09% | 15,12% | 17,03% | 29,19% |
| Tree plantations | 15,99% | 14,91% | 10,83% | 2,47% | 0,00% |
| Meadows, gardens and crops | 31,00% | 29,39% | 31,00% | 31,00% | 23,85% |
| Vineyard | 11,21% | 13,90% | 11,21% | 11,21% | 8,78% |
| *Total* | *100,00%* | *100,00%* | *100,00%* | *100,00%* | *100,00%* |

Based on these scenarios, the annual compensating surplus (CS) for different land uses can be computed, based on Equation (1) using the following expression:

$$CS = \frac{-1}{\beta_{COST}} \left[ \Delta\beta_{AUF} + \Delta\beta_{VIN} + \Delta\beta_{FOR} + \Delta\beta_{BIO} + \Delta\beta_{REC} \right]$$

Accordingly, the annual social benefits associated with these different land use policies can be found in the next table.

**Table 10: Social benefits per annum in different scenarios (million euros, 2008)**

| | SCENARIOS | | | |
|---|---|---|---|---|
| | Promotion of vineyards | Moderate promotion of ecological values | High promotion of ecological values | Maximum promotion of ecological values |
| **Attributes** | **Scenario 1** | **Scenario 2** | **Scenario 3** | **Scenario 4** |
| Native forest | 0.00 | 23.34 | 45.91 | 166.19 |
| Vineyards | 2.39 | 0.00 | 0.00 | -2.16 |
| Plantations | -1.26 | -6.00 | -15.72 | -18.59 |
| Biodiversity | 0.00 | 16.51 | 33.75 | 49.28 |
| Recreation | 0.00 | 23.52 | 48.10 | 70.22 |
| ***TOTAL*** | ***1.13*** | ***57.37*** | ***112.04*** | ***264.93*** |

So, according to these results, the welfare benefits associated with the scenario 1 (promotion of vineyards) are estimated at 1.13 million euros per year. However, the social benefits of implementing different conservation policies are considerably higher: 57.37 million euros if the scenario 2 (moderate promotion of ecological values) is implemented; 112.04 if the scenario 3 is implemented (high promotion of ecological values); and 264.93 million euros if the scenario 4 is implemented (maximum promotion of ecological values).

## 7. Conclusions

One of the main issues in the management of protected areas, such as the European N2000 network, is how to design and implement sustainable management plans accounting both for the social cost and benefits of conserving these sites. Although the ecological services provided by these areas are usually raised as a reason for conserving them, the use of monetary measures may help, not only to increase social awareness, but to evaluate its social desirability in a Cost-Benefit Analysis framework.

This paper provides with an empirical application of a DCE designed to inform natural resource managers on the social benefits of different management plans of a N2000 network site taken into account the social preferences of the population of the Basque Country (Spain). According to our results, the mean WTP to increase the percentage of land area covered by native forest is estimated at 2.55 euros (per person per year); the mean WTP to increase the percentage of land area covered by vineyards is estimated at 0.50 euros (per person per year); the mean WTP to increase the percentage of land area covered by pine forest plantations is estimated at 0.66 euros (per person per year); the mean WTP to increase current levels of biodiversity is estimated at 1.39 euros (per person per year); and the mean WTP to increase the current level of conservation of its recreational and cultural facilities is estimated at 1.98 euros (per person per year). The use of a RPL model allowed us to explore the heterogeneity of social preferences. In line with economic theory, WTP increases according to individual's personal income. Basque cultural identity is identified as a main explanatory variable of higher WTP, in line with the results provided by Hoyos et al. (2009). Having children seems to increase awareness about the future level of biodiversity. The social preferences for pine tree plantations are mixed: while 57% of the sample likes these plantations, 43% dislikes them providing with a significantly negative WTP. Finally, while the majority of individuals are indifferent about the quality of recreational and cultural facilities, recreationalists and climbers show a significantly positive WTP.

This information was then used to evaluate the social desirability of some future management plans. Based on the previous results and on different future management scenarios, the welfare benefits associated with the promotion of vineyards are estimated at 1.13 million euros per year. However, the social benefits of implementing conservation policies are considerably higher: 57.37 million euros in the case of implementing a moderate promotion of ecological values); 112.04 if ecological values are highly promoted; and 264.93 million euros if ecological values are promoted at the maximum level, given the resource's biogeographical limitations.

## Acknowledgments

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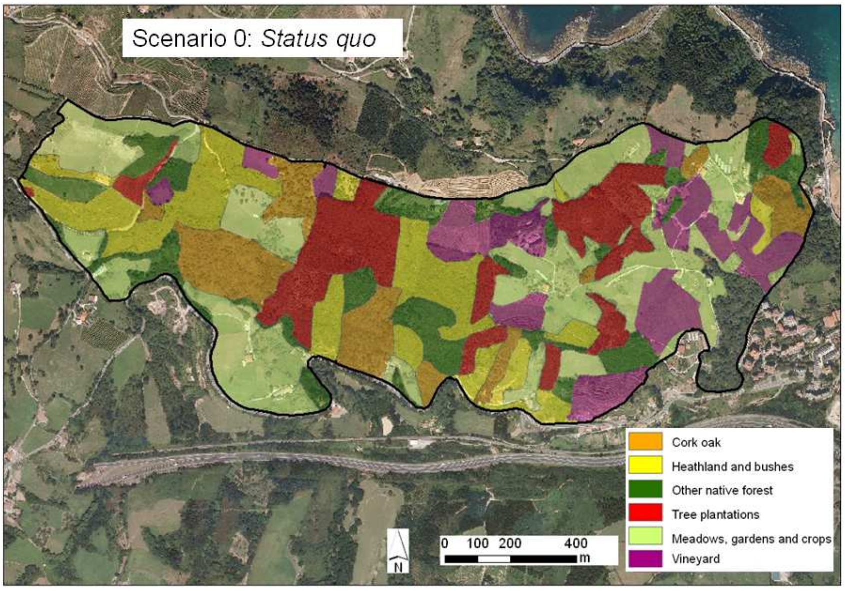
## Annex 1: GIS maps for the land use scenarios

### Figure 5. Map of the site: Scenario 0 (status quo)




### Figure 6. Map of the site: Scenario 1

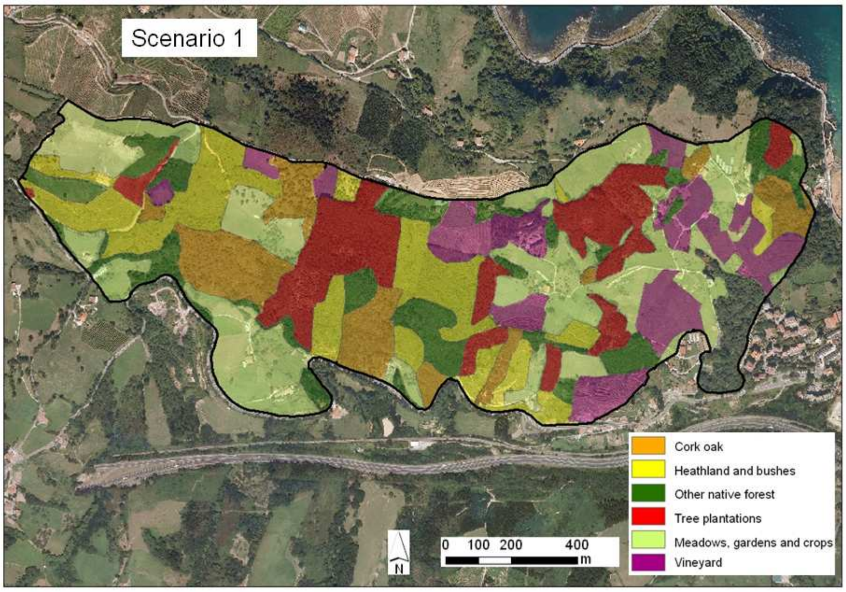


**Figure 7. Map of the site: Scenario 2**

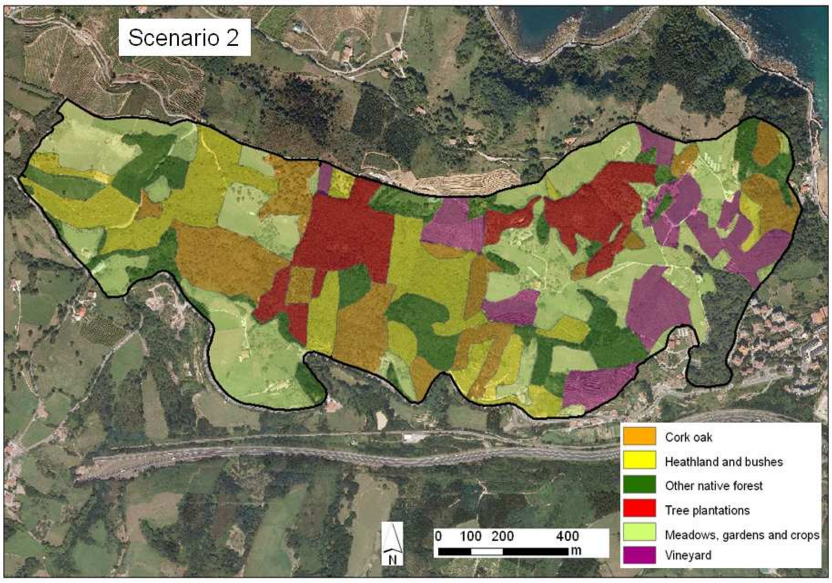



**Figure 8. Map of the site: Scenario 3**

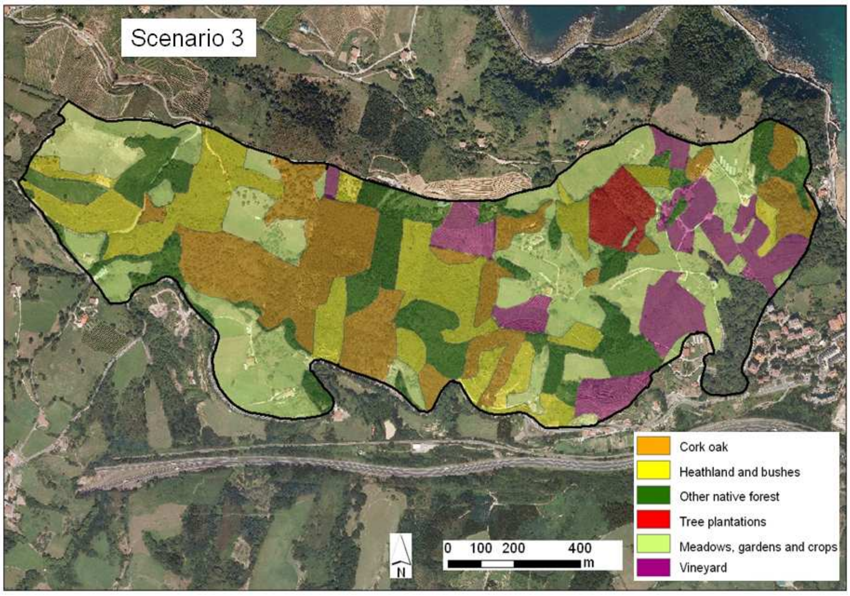


**Figure 9. Map of the site: Scenario 4**