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A valuation of social and ecological functions of the Marais des Baux wetland in Southern France.»

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To restore or not? A valuation of social and ecological functions of the Marais des Baux wetland in Southern France.

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Abstract

The Marais des Baux wetland in southern France has for centuries been subject to drainage, almost causing its entire disappearance. With an increasing awareness of wetland ecosystem services, the extensive drainage is being questioned today. To guide policy-makers and landowners in their decision-making, we use a Choice Experiment to elicit the preferences of the general public for potential land use and activity changes in the Marais des Baux. These changes concern wetland restoration, the extent of tree hedges, recreational opportunities, mosquito control and biodiversity.

Using a random parameter logit model, we take account of unobserved and observed preference heterogeneity, revealing that demand for a high level of biodiversity is conditional on respondents expressing a high level of environmental concern, and that parenthood raises the WTP for any future management alternative different from the current situation. Further, we find that mosquito control or attachment to the area is essential for support of large-scale wetland restoration. From the perspective of maximising the compensating surplus, the recommendation is to restore the wetland to one third of its original size in conjunction with biological control of mosquitoes, more tree hedgerows and recreational facilities, while increasing efforts to induce higher levels of biodiversity.

Key Words

Wetlands, Valuation, Choice experiment, Random parameter logit model, interactions, Willingness-To-Pay, Marais des Baux.

JEL classification

Q25,Q26,Q51,Q57

1 Introduction

The current landscape configuration and agricultural orientation of the Marais des Baux (MdB) is quivering for change. Once an extensive wetland, the history of land use in MdB is marked by continuous attempts to drain the wetland, dating back to the middle ages (Bouchard et al., 2007). This paper employs a Choice Experiment (CE) to estimate the values to the public of potential changes in ecological and social functions in the MdB in Provence, Southern France. While wetlands have been described as “biological supermarkets” and “the kidneys of the landscape” (Mitsch and Gosselink, 1993) they have long suffered from a negative image in France, which can be illustrated by the late ratification of the Ramsar convention in 1986. It is roughly estimated that about two thirds of French wetlands were lost between 1900 and 1993 (PEWI, 2004) driven mainly by agricultural expansion (Beaumais et al., 2007). The same story applies to the MdB. Today however, a number of factors, such as concerns over water quality, the increasing costs of water drainage, the flooding of the valley of the Baux in 2003, the decoupling of financial aid for cereal production scheduled to take effect in 2012, and the designation of the MdB as a Natura 2000 area, have all contributed to a critical reflection of the present agricultural exploitation of the MdB. Consequently, the regional nature park of the Alpilles (PNR des Alpilles), a local entity of inter jurisdictional cooperation and the conservation organisation A Rocha France have since 2006 been engaged in a consultation process with the five largest landowners in MdB to define future land use priorities for the area. Consensus between landowners, hunters, tourist associations, regional and local planners over the future landscape configuration of the Valley of the MdB is far from settled. Several questions remain to be addressed: In particular, wetland restoration is met with resistance amongst the representatives of the local community due to the fear of marked increases in the mosquito populations and the loss of jobs in the agricultural sector. The interesting question is whether the resistance in the local community towards wetland restoration is lessened if mosquito control is introduced in the management scheme and in that case, what kind of mosquito control? Other obstacles in the decision process are conflicting interests regarding recreational uses and access to the area, and the general lack of knowledge about the publicly preferred landscape configuration.

The aim of this study is to provide policy-makers with answers to these questions and offer insight into public preferences over the range of possible future landscape configurations for the MdB. In order to assess the economic value associated with the benefits of various management options for the area, a CE is conducted. In the literature there has been an increasing focus on the value of wetlands with many applications of the Contingent Valuation Method (Birol et al., 2008; Baumais et al., 2008; Boyer and Polasky, 2004; Brouwer et al., 2003; Ojeda et al., 2008) and more recently the CE method (Birol et al., 2006a; Carlson et al., 2003; Birol and Cox 2007, Milon and Schrogin, 2006). As the first of its kind in France, the CE study in the present paper provides a valuable contribution to this literature, allowing for a richer insight into the role of cultural factors in explaining resistance to or acceptance of wetlands conservation and restoration. Furthermore, the CE also allows respondents to state preferences for landscape, ecological and social functions of the area regardless of any wetland restoration taking place. In that sense, the current study's non-exclusive focus on wetland restoration differs from previous studies and thus brings a novel contribution to the existing literature.

The results of the CE show that respondents derive positive and significant benefits from changes in the ecological and social functions of the area through improving recreational facilities, increasing biodiversity, planting tree hedges and restoring the wetland to one third or two thirds of its original size. However, the specific configuration and management scheme chosen for the wetland restoration proves to be very important. The fear of mosquito problems associated with wetland restoration is indeed present, but not to an extent that would affect the restoration of the wetland. Respondents show significantly positive preferences for a small-scale restoration of the wetland in terms of doubling the current size. However, the respondents do not seem to derive benefits from a large-scale wetland restoration, unless mosquito control is conducted through the use of natural predators and water level variations. Chemical mosquito control is negatively perceived, though there is a considerable amount of heterogeneity in the sample with regard to this issue. The paper is organized as follows: In section 2 we present the study area, section 3 provides an insight into the theory underlying the CE method, the major elements in designing the survey and the statistical models employed. Section 4 reports the results of the econometric analysis and section 5 concludes the paper.

2 The case study area

The case study area is located in the department of the Bouches du Rhone, between the Alpilles Mountains and the Plain of the Crau and spans over 1,700 hectares across five municipalities (Maussane les Alpilles, Le Paradou, Mouriés, St Martin du Crau and Arles). The wetland reached its smallest size in the 1960s when polders and electrical pumps were installed for purposes of water drainage, minimising it to 50 hectares. Recently however, initiatives by landowners have increased the size of the wetland to its current size of about 200 hectares. Throughout the history of the MdB, agricultural production has been the main driver of wetland conversion. But water drainage and pollution due to run-off from agricultural production have had adverse effects on water quantity and quality, which in turn affect the level of biodiversity that the area is able to support (Birol et al., 2006b). Indeed, prior to the 1960s, the MdB hosted several species that are endangered today (Tron, personal communication, 2007). Despite this loss, the area still provides a habitat for a total of 208 different bird species of which 27, such as the European Roller (*Coracias garrulous)* and Bonelli's eagle (*Hieraaetus fasciatus)*, are protected by international treaties. The area also serves as an important autumn roosting point for 600,000 migrating barn swallows (*Hirundo rustica)* and supports a wide array of fauna diversity including mammals, amphibians, reptiles and fish. Furthermore, the 46 different species of dragonflies supported by the area make it one of the highest density zones for dragonflies in Europe (A Rocha France, 2006; Lempers et al., 2007; Crofton, 2003). The MdB is also designated under the EU Habitats Directive (92/43/EEC) as it supports thirteen habitat types listed under Annex I, three of which - Mediterranean temporary ponds, Calcareous fens with *Cladium mariscus and Carex davalliana*, and pseudo-steppe with grasses and *thero-Brachypodietea* annuals - are priority natural habitats under Article 1 (Ministère de l'écologie et du développement durable, 2009). Figure 1 shows a map of the area.

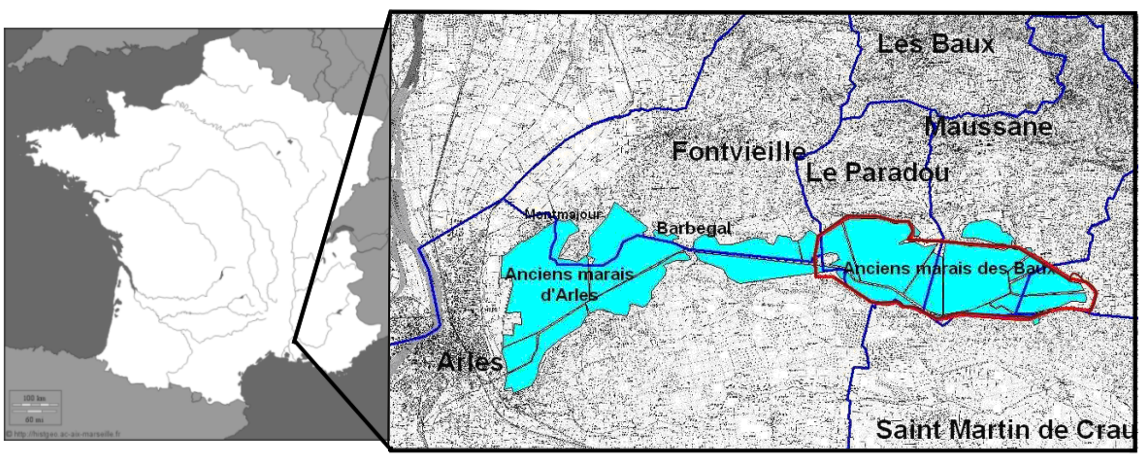

Figure 1: Location and extent of the original wetlands Marais d'Arles (1100 hectares) and Marais des Baux (1700 hectares). The area susceptible to policy changes is marked by the red line

3 The Choice Experiment survey set-up

In CEs, a number of respondents are asked in a questionnaire to select their preferred option from a range of potential management alternatives, usually including a status quo alternative. Discrete choices are described in a utility maximising framework and are determined by the utility that is derived from the attributes of a particular good or situation. It is thus based on the behavioural framework of random utility theory (Manski, 1977) and Lancaster's theory of demand (Lancaster, 1966). The CE can be used ex-ante to estimate use and non-use values for any environmental resource, and in particular the implicit value of its specific attributes and their internal ranking (Louviere et al., 2000; Birol et al., 2006a). By describing the MdB in terms of a number of policy relevant attributes and levels that these attributes might take, and including a monetary attribute, the CE will facilitate an estimation of the welfare economic value of the changes to the MdB area under various future management options. We may thus answer questions such as how much more the public is willing to pay for wetland restoration relative to open agricultural fields and/or more hedgerows, or how much enhanced recreational facilities are valued relative to biodiversity enrichment and/or the management of mosquitoes. For an in-depth description of the method, the reader is referred to Bateman et al., (2002).

3.1 Attribute identification: Design of landscape and activity configurations

The process of identifying relevant attributes and levels for the CE survey was initiated by interviewing landowners, planners, experts and stakeholders (e.g. employees at the regional nature park of the Alpilles, mosquito experts, hydrologists and ecologists) as well as consulting existing literature on the valuation of wetlands. Subsequently, the identified attributes and their levels were pre-tested in focus groups. For the price attribute an increase in the municipal tax of which the extra revenue would be earmarked for an inter-municipal association in charge of the restoration works, was perceived to be a realistic and credible payment vehicle (PNR, 2006).

Within the realms of political feasibility and hydrological conditions it can be envisaged to make a small-scale restoration of the wetland to one third (600 hectares) of its original size or a large-scale restoration to two thirds of its original size (1,200 hectares). The landscape features concerned with wetland restoration comprise ponds, reed beds, and marchland replacing cereal and alpha alpha cropland. A larger wetland is expected to create use values as "many visitors to wetlands immediately appreciate their natural beauty, experience the sense of tranquillity they offer and recognize their role in the local landscape" (Environment Canada, 2004). The feasible extent of wetland restoration was identified according to hydrological conditions, landowner preferences and Natura 2000 objectives. The planting and maintenance of ash and poplar tree hedges is an existing conservation strategy in the area due to their hydrological and biological functions (PNR, 2006; Le Grand, 2003). While this strategy may be favourable from an ecological point of view, hedges may constitute a visual barrier in the landscape. Considering the current scenic view of the nearby Alpilles Mountains to be seen everywhere in the MdB, introducing visual barriers in the landscape may be considered undesirable by visitors. On the other hand, in a region characterised by the frequent aggressive wind “le Mistral” and 300 days of sun per year, wind blocks and shade may be demanded. It is likewise possible that the distinctly structured landscape created by tree hedges is a desired alternative to the typical Provence-like open landscape.

Mosquitoes have long been considered incompatible with tourist development and a general nuisance to residents (Claeys-Mekdade and Morales, 2002). Due to these concerns, a part of the neighbouring wetland of the Camargue has since 2006, been subject to a preliminary experiment of chemical mosquito control using a biological insecticide, the bacteria Bacillus thuriengiensis israelis (Bti). It has previously been exempt from control, due to its ecological status. Bti is the only mosquito control insecticide allowed in France, and was registered in 1961 as a mildly toxic pesticide and a natural bacteria of the soil that produces toxins which cause the death of insects (Pont, 1989). Aside from chemical control by the Bti toxin, another feasible mosquito management strategy consists of modifying the schedule of water table variations and using biological control such as small fish (*Gambusia affinis*), which are natural predators of mosquito larvae. Both this strategy, termed “natural mosquito control” as well as chemical mosquito control can be envisioned in the MdB.

Natural ecosystems such as wetlands are places where people can come for relaxation, refreshment and recreation. With enlarging populations, affluence and leisure-time, the demand for recreation in natural areas (‘eco-tourism’) will most likely continue to increase in the future (De Groot et al., 2002). However, if some activities are not carefully managed, they may disturb and fragment wildlife habitat thereby hindering the full potential for biological diversity (Mathevet et al., 2003). Instead, carefully managed passive recreational uses may ensure the least impact on the wetland ecosystem (Brett Lane and Associates, 2002). Inspired by the different management strategies in the nearby wetlands of the Camargue, interviews with landowners, tourist and hunting societies, two future attribute levels were identified: “Passive recreation” with emphasis on protection and wildlife observation on the surrounding circuits and the publicly accessible dyke and “active recreation”, a more intensive form with access to the wetland allowing for hunting, cycling and walking.

A different land use configuration will also impact the fauna and flora. As MdB is uniquely placed within a mosaic of natural environments the potential for biodiversity is significant (PNR, 2006).

Hedgerow restoration may for example increase the number of birds, such as the European roller *(Coracias garrulus)* and the green woodpecker (*Picus viridis)*, whereas wetland restoration would increase the number of waders (migratory birds that profit from shallow water), herons, ducks and reed warblers *(Acrocephalus)*. The habitat for the European pond terrapin (*Emys orbicularis)*, a red listed species present in small numbers, will also be favoured. In the case of a large-scale wetland restoration, rare species such as the great bittern (*Botaurus stellaris)* and the white stork (*Ciconia ciconia)* may again inhabit the MdB (A Rocha and PNR, 2008; Tron, personal communication, 2007). The hydroperiod of a wetland system nevertheless implies sensitive periods of flora and fauna development, while recreational activities such as hunting, fishing and boating may disturb and fragment wildlife habitats. Consequently, a change in any of the above mentioned attributes - access and recreation, mosquito control, wetland and hedgerow restoration - will most likely also impact the level of biodiversity in the MdB.

To put these potential policy scenarios into perspective, the status quo situation is one in which the wetland is no bigger than 200 hectares, there are few poorly maintained white poplar and ash tree hedges but permitting a full view of the background mountain chain of the Alpilles. There is limited access to the area via a dyke (about 10 kilometres long and 3 meters wide) with no public facilities, in which fishermen, hunters and those practicing passive recreation experience space-use conflicts. Furthermore, the level of biodiversity is low compared to the potential that the area holds. The attributes, levels and descriptions are provided in table 1.

Table 1: Description of attributes and levels of the choice experiment

Attribute	Levels	Description
Size of wetland	No restoration Small-scale restoration Large-scale restoration	Current size (200 hectares) 1/3 of original size (600 hectares) 2/3 of original size (1200 hectares)
Tree hedges	Few more most	Full view of the Alpilles Allowing a partial view of the Alpilles Dense tree hedges blocking any view of the Alpilles
Biodiversity	Low Medium High	Low number of rare and common species compared to the potential. The population of common and rare species of ducks, birds, insects, dragon flies, turtles and fish will increase. The population of common and rare species of … will increase significantly, and several species that have ceased to exist in the area may return again.
Access and recreation	No access and facilities Passive recreation Active recreation	Only access to the publicly owned dyke from which hunting is allowed. A surrounding circuit is created with recreational and observational facilities. Hunting is not allowed. Access to the wetland, with trails for walking and bicycling. Hunting is allowed in certain areas.
Mosquito control	No control Natural control Chemical control	No effort to reduce the mosquito nuisance. Strict water level management and biological control such as fish. From the Bt toxin, a selective naturally occurring bacteria.
Monetary attribute	3,5,10,20,30,50 €	Increase in municipal taxes per person per year

3.2 Choice Experiment design

With six payment levels[1] and five policy attributes with three levels, a full factorial design would have resulted in a total of 1458 alternative management combinations. As this would constitute an unreasonably large design in practice, a D-optimal fractional factorial design with 36 alternatives was developed and paired into 18 choice sets in two separate blocks of nine choice sets using an array of procedures and macros in SAS[2] (Kuhfeld, 2004). Using an efficient design ensures that as much information as possible can be extracted from respondents' choices. In the design procedure it was also ensured that the estimation of two-way interaction effects between attributes would be possible in the econometric analysis. As the fractional factorial design resulted in a few cognitively unrealistic attribute combinations (e.g. high biodiversity and no wetland restoration), the swapping and relabeling procedure suggested by Huber and Zwerina (1996) was employed to avoid these implausible combinations in the final design.

[1] While the status quo levels where included in the design for all other attributes, this was not the case for the monetary attribute. Hence, the price of 0 € was not included in the design.
[2] The *"%choiceff"* macro which optimizes the variance for a logit model was used.

3.3 Questionnaire design and data collection

Data collection took place through personal interviews in which respondents were given time to fill in the questionnaire themselves with or without the help of the interviewer. The population, from which the sample was chosen, was defined as those between 18 and 75 years living within a 10 km radius of the MdB; in all approximately 20,000 citizens. The interviews were conducted by approaching respondents on the street and in their homes in January and February 2008. Convenience sampling was chosen as the survey mode, while effort was made to fit census data reflecting the socio demographic characteristics of the underlying (expected) population as specified in table 2. Personal interviews were considered advantageous and chosen as the mode of survey. Each interview lasted between 20 and 40 minutes and permitted the researcher (corresponding author) to obtain a rich understanding of how the task was perceived by respondents, meanwhile ensuring that respondents understood the attribute and task descriptions. This is critical to ensure that responses are consistent with utility maximisation. Respondents were also encouraged to ask for additional information or clarification if needed.

To ensure as far as possible true preference revelation, the accuracy of information provided to survey respondents is only one facet. Unless individuals connect with and understand a piece of information on an emotionally ‘affective’ level, then that information will lack meaning. Respondents may distinguish an increase from a decrease, but if they do not comprehend the magnitude of that change then their response fails to tap into any underlying true preference (and lacks ‘evaluability’). In such cases the continuous nature of an attribute level may be reinterpreted as say a category variable or worse a simple discrete good/bad change, resulting in lack of scope sensitivity (Bateman et al., 2009; McFadden, 2001). Visual aids such as photographs are a simple way of depicting multiple landscape changes (Bateman et al., 2002) and in their virtual relations format, they are known to improve the evaluability of attributes (Bateman et al., 2009). We therefore used visual information in terms of GIS maps, photos and icons to reduce unfamiliarity with the attributes, hereby reducing the potential impact of heuristics. Figure 2 depicts an example of a choice set and figure 3 shows how the impact of more hedges and wetland restoration was illustrated in the info-sheet presented to respondents.

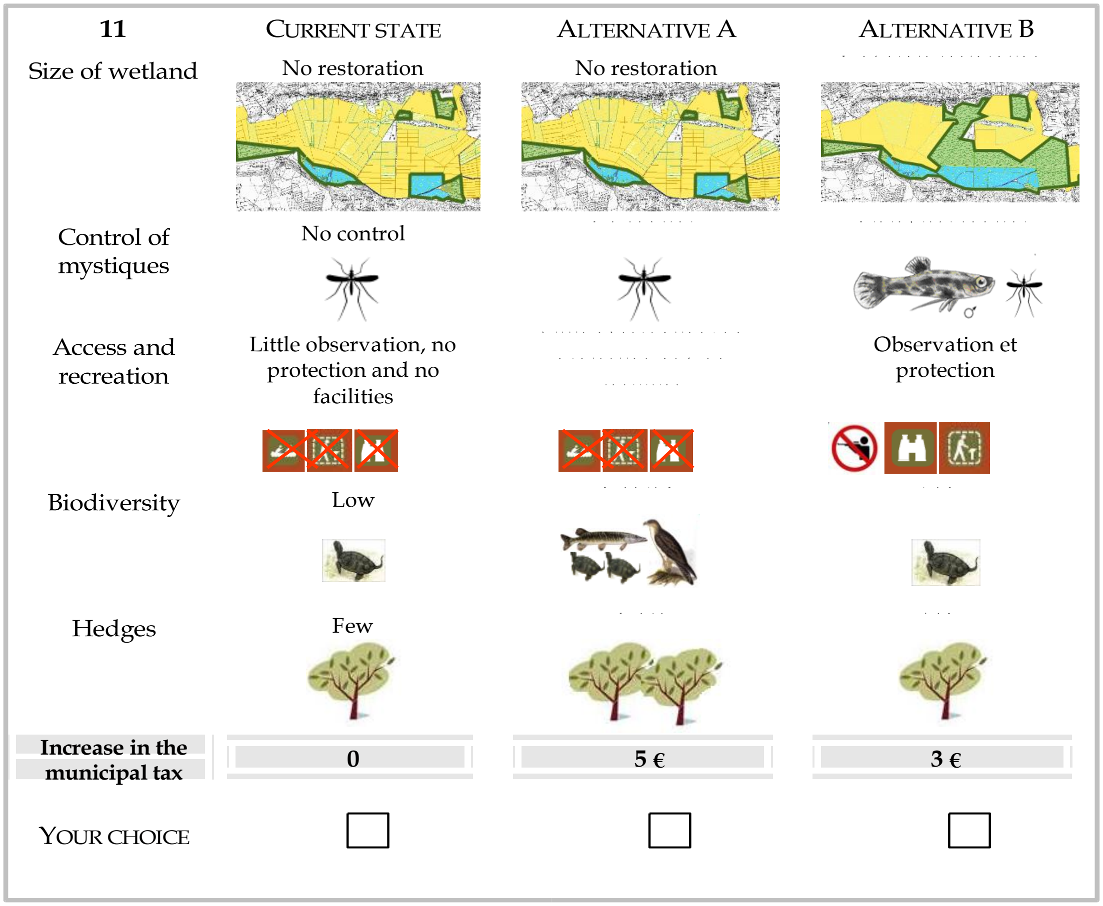

Figure 2: An example of a choice set

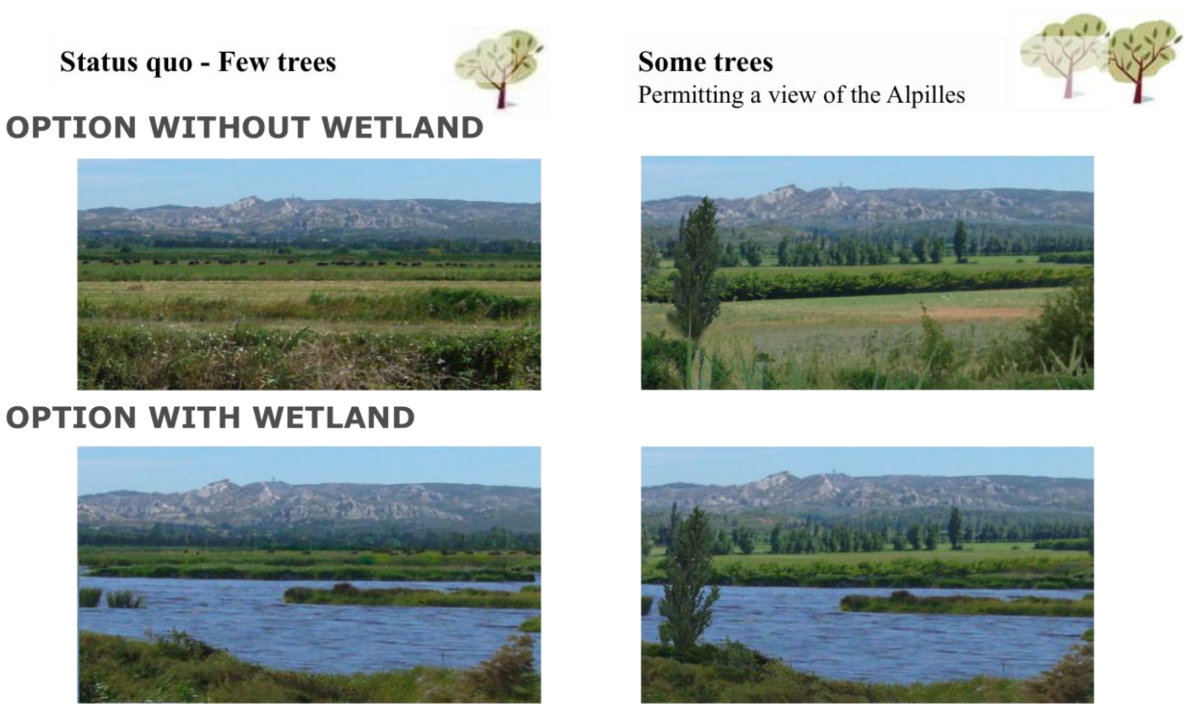

Figure 3: An extract from the info-sheet

3.4 Econometric specification

To describe discrete choices in a utility maximising framework, the CE employs the behavioural framework of random utility theory (RUT). In RUT, the individual *n*'s utility *U* from alternative *j* is specified as:

$$U_{nj} = V_{nj} + \varepsilon_{nj} \qquad (1)$$

where V_{nj} is the systematic and observable component of the latent utility and ε is a random or "unexplained" component assumed IID and extreme value distributed (Louviere et al., 2000). To account for unobserved preference heterogeneity across respondents, the Random Parameter Logit model (RPL) may be used. In that case the utility of alternative *j* may be reformulated as:

$$U_{nj} = \beta_n' X_{nj} + \varepsilon_{nj} = b' X_j + \eta_n' X_j + \varepsilon_{nj} \qquad (2)$$

where X_{nj} is a vector of observed variables, β' is a vector of tastes which may be expressed as the population mean (*b*) and the individual specific deviation from that mean η. In order to capture the repeated choice nature of the data the RPL accommodates a panel data structure, and thus takes into account the potential correlation between choice observations at the respondent specific level. For a more thorough and in-depth treatment of the RPL, the interested reader is referred to Train (2003), Hensher and Greene (2003) or Hensher et al. (2005).

3.5 Heterogeneity in preferences and WTP

While the RPL model allows capturing unobserved preference heterogeneity, observed preference heterogeneity is incorporated into the deterministic part of the utility function by interacting respondent characteristics with the MdB management attributes. Since social and economic characteristics are constant across choice occasions for any given respondent, they can only enter as interaction terms with the management attributes. With the expectation that different population segments might have different WTP, we thus incorporated a piecewise linear-in-spline cost parameter in the deterministic part of the utility function (Morey et al., 2003, Scarpa et al., 2007). While we test different specifications of the deterministic part of the utility function, specified to be linear in the parameters, the most elaborate one presented in section 4 (model RPL2) takes the following form:

$$V_{ij} = \beta_{ASC} + \beta_1 X_{PassiveRec} + \beta_2 X_{ActiveRec} + \beta_3 X_{MoreHedges} + \beta_4 X_{MostHedges} + \beta_5 X_{NatMos} + \beta_6 X_{Cost} + (\beta_7 + \eta)_{Small\text{-}scaleWet} + (\beta_8 + \eta) X_{Large\text{-}scaleWet} + (\beta_9 + \eta) X_{ChemMos} + (\beta_{10} + \eta) X_{MedBio} + (\beta_{11} + \eta) X_{HighBio} + 1(X_{LargescaleWet} \cdot X_{Mos})\delta_1 + 1(X_{HighBio} \cdot S_{Green})\delta_2 + 1(X_{LargescaleWet} \cdot S_{Child})\delta_3 + 1(X_{Cost} \cdot S_{MdBcare})\delta_4 \quad (3)$$

where 1(·) is a binary indicator function. The β_{ASC} is the parameter for the alternative specific constant (ASC) which accounts for variations in choices that are not explained by the attributes or socio-economic variables. The vector of coefficients $\beta_{1 \ldots}\ \beta_K$ and $\delta_{1 \ldots .}\ \delta_m$ is attached to a vector of attributes (X) and interaction terms (XX and XS) that influence utility respectively. Variables (S) that describe the characteristics of the respondents were derived from the follow-up questions in the questionnaire. These included socio-demographic characteristics of the respondents, their familiarity with the area, their intended use and regarded importance of the area. Furthermore, a range of attitudinal questions inspired by Birol et al. (2006a) and the New Environmental Paradigm index (Dunlap and van Liere 1978; Dunlap et al., 2000) were used to develop an index of psychometric attitudes towards the environment. These variables (S) are provided in table 2. The marginal willingness to pay (MWTP) is calculated using equation 4.

$$MWTP_k = - (\beta_k / \beta_{Cost}) \quad (4)$$

The same approach is employed for RPL models - that is, when the price parameter is held fixed (i.e. the denominator is a non-zero constant), the distribution of the random parameter in the numerator determines the distribution of the ratio (Revelt and Train, 1998).

Given the presence of interactions between the cost parameter and the socio-demographic and attitudinal characteristics, we also adjust the cost parameter to take into account this heterogeneity in the underlying sample (Morey et al., 2003; Scarpa et al., 2007). The linear-in-spline adjusted cost parameter employed in calculation of average welfare estimates is:

$$\beta_{adj\ cost} = \beta_{cost} + \beta_{cost \times child} \times Child \quad (5)$$

Within this equation, the mean value of the parenthood variable from table 2 is inserted. Estimates of compensating surplus for any particular future scenario V_1 (in table 4) are calculated using the equation:

$$CS = -\frac{1}{\beta_C}(V_0 - V_1) \quad (6)$$

where β_C is the marginal utility of income (assumed to be equal to the coefficient of the cost attribute or adjusted to take heterogeneity into account depending on the model specification), V_0 represents the utility of the status quo situation, and V_1 represents the utility of the change scenario.

4 Results

In total, 91 respondents were interviewed. One of these was excluded from the analysis due to protest behaviour, resulting in a final sample size of 90 respondents. While this number might seem low, the fact that each respondent evaluates 9 choice sets implies that a total of 810 choices are observed. This number is comparable to other studies in the literature (Birol and Cox, 2007; Ojeda et al., 2008). Furthermore, due to the applied two-block design, each specific alternative is evaluated about 45 times. These numbers are considered to indicate sufficient variation in the data for the following parametric analysis. Table 2 summarises the descriptive statistics of the sample used in the analysis.

Table 2: Descriptive statistics of the respondents

Variable	Description	Mean Expected[a]	Mean Observed	St dev	Min	Max
SOCIAL AND ECONOMIC CHARACTERISTICS						
Yrs-region	Number of years the respondent has lived in the Languedoc Roussillon region		18.7	15	1	61
Gender	= 1 if male	0.48	0.45	0.5	0	1
Age	Respondent age (years)	41	42	14	18	80
Education	= 1 if respondent holds a university degree or higher	0.1	0.43	0.5	0	1
Income	Income*	3.95	5.46	2.91	1	12
SOCIAL AND ATTITUDINAL CHARATERISTICS USED IN THE MODEL SPECIFICATIONS (S)						
Child	= 1 if respondent has a child that is less than 17 years old.		0.25	0.43	0	1
MdBCare	= 1 if respondent has simultaneously agreed that "she would like to visit Marais des Baux in the future". that "she considers wetlands part of the natural patrimony" and "she considers it important that it is maintained for future generations".		0.52	0.50	0	1
Green	= 1 if respondent scores high on environmentally conscious behaviour (recycle. donate. buy organic etc) or scores relatively high on their behaviour while being very preoccupied by the state of the environment as defined by the NEP index.		0.39	0.49	0	1
RESPONDENTS KNOWLEDGE OR USE OF MDB AND OTHER WETLANDS						
Know MdB	= 1 if respondent is aware of the existence of the MdB wetland		0.43	0.49	0	1
Visit MdB	= 1 if respondent has ever visited the MdB wetland?		0.22	0.42	0	1
Visit wetland	= 1 if respondent has visited a wetland elsewhere. e.g. the Camargue?		0.93	0.38	0	1

Note: Parameters in bold text are included in the parametric models
*A discrete categorical variable based on income intervals and not the exact income as such
[a]Source: The French national institute of statistics and economic studies (INSEE) 2006. www.insee.fr/fr/bases-de-donnees/

With regards to the use and knowledge of the area, it is interesting to note that while the average respondent has lived in the region for almost 19 years, less than half of the respondents are aware of the existence of a previously extensive wetland in MdB, and only about one fifth of them have actually visited the area. However, the vast majority have visited wetlands located at a further distance from their residence, indicating a general interest in wetlands.

4.1 Parametric analysis

All models are estimated using Biogeme v1.7 software (Bierlaire 2003, 2008). The parametric models are specified so that the probability of selecting a particular management scenario is a function of the attributes of that scenario and of the alternative specific constant (ASC). The ASC variable is specified to equal 1 when either management scenario A or B is chosen and 0 when the status quo option is chosen. Using a dataset consisting of the 810 choices obtained from 90 respondents, several different model specifications are tested. These are a basic conditional logit model (CLM), a basic RPL (RPL1), and a RPL with demographic, attitudinal and inter-attribute interactions included (RPL2). The latter is treated as the main model and retained for further analysis. The distribution simulations for estimation of the RPL models are based on 400 random draws which was found to be a sufficient number for results to stabilize. The results are presented in table 3.

Table 3: Model results

	CLM Model		RPL 1		RPL 2 model interactions		Marginal WTP(€)
FIXED PARAMETERS							
Alternative Specific Constant	-0. 50 (-1.6)		-0.29 (-0.7)		-0.29 (-0.7)		-9.3 [-41;20]
Active recreation	0.45 (3.2)	***	0.57 (3.2)	***	0.61 (3.7)	***	19.4 [4;36]
Passive recreation	0.35 (2.4)	**	0.44 (2.4)	**	0.62 (2.5)	***	20.0 [-3;44]
More hedges	0.40 (2.2)	**	0.71 (2.9)	***	0.77 (3.2)	***	24.7 [5;46]
Most hedges	-0.07 (-0.4)		0.19 (0.9)		0.23 (1.0)		7.4 [-8;22]
Mosquito cntr Natural	0.53 (2.8)	**	0.80 (3.2)	*	0.65 (2.1)	**	20.7 [2;41]
Small-scale wetland	0.25 (1.4)						
Large-scale wetland	-0.04 (-0.3)						
Mosquito cntr chemical	-0.63 (-3.1)	***					
Medium Biodiversity	0.30 (2.2)	**					
High Biodiversity	0.30 (1.6)						
Cost	-0.02 (-3.8)	***	-0.04 (-4.9)	***	-0.04 -(4.0)	***	
Large-scale wetland*Mosquito cntr Natural					0.64(1.7)	*	20.6 [-14;55]
RANDOM PARAMETERS (LATENT HETEROGENEITY)							
Small-scale wetland			0.52(1.9)	*	0.45(1.6)		14.6 [-3;34]
Small-scale wetland_Std Dev			1.09(4.9)	***	1.15(5.0)	***	37.0 [-67;-12]
Large-scale wetland			0.13(0.5)		-0.66(-1.9)	*	-21.2 [-53;9]
Large-scale wetland_Std Dev			-0.88(-3.6)	***	0.86(2.6)	**	27.5 [-52;-1]
Mosquito cntr chemical			-0.92(-2.9)	***	-0.90(-3.3)	***	-29.0 [-61;-1]
Mosquito cntr chemical_Std Dev			-2.02(-6.9)	***	2.01(6.3)	***	64.6 [25;112]
Medium Biodiversity			0.60(3.1)	**	0.49(2.2)	**	15.8 [2 ;31]
Medium Biodiversity_Std Dev			0.74(2.9)	***	0.69(2.0)	**	22.1 [-3 ;50]
High Biodiversity			0.44(1.6)		0.00(0.0)		0.0 [-20 ;18]
HIgh Biodiversity_Std Dev			-1.32(-5.0)	***	-1.07(3.5)	***	34.4 [-67;-10]
INTERACTIONS (OBSERVED HETEROGENEITY)							
High biodiversity*Green					1.14(3.1)	***	36.7 [6;74]
Large-scale wetland*MdBcare					0.80(2.2)	**	25.6 [-1;57]
COST*Child					0.03(1.9)	*	
Final log-likelihood:	-735.73		-674.99		-660.85		
Likelihood ratio test:	308.297		429.75		458.15		
Adjusted rho-square:	0.16		0.222		0.234		
Number of observations	810		810		810		
Number of individuals	90		90		90		

t-statistics are in parentheses.
*denotes significance at 10% level. **denotes significance at 5% level. and ***denotes significance at 1% level. WTP is calculated using the adjusted cost parameter and refers to the WTP for the average respondent in the RPL 2 model. The lower and upper bounds for 95% confidence intervals are calculated using the delta method and reported in the brackets.

4.1.1 Conditional logit model (CLM)

In the CLM model, recreation, hedgerow restoration, mosquito control and biodiversity are significant factors in the choice of a future management scenario. It is not possible to establish any consensus preferences for high biodiversity, most hedges and any size of wetland restoration. Nevertheless, signs are as expected a priori and the overall fit of the model, as measured by the adjusted McFadden's ρ^2 of 0.16, is good by conventional standards used to describe probabilistic discrete choice models (Ben-Akiva and Lerman, 1985; Louviere et al., 2000). However, using a Hausmann test, this model was found to suffer from violation of the independence of irrelevant alternatives (IIA) property and one should consequently be cautious in elaborating further on it. Hence, the CLM primarily serves as a benchmark model against which the following RPL models are evaluated. These models are not subject to the IIA assumption, and they take unobserved sources of heterogeneity into account. This enhances the reliability of estimates of demand as well as marginal and total welfare (Greene, 1997).

4.1.2 Random parameter logit model (RPL1)

In the RPL models, an assumption needs to be made concerning the distribution of each of the random parameters (Train, 2003). In this paper, the random parameters are specified as normally distributed to allow for both negative and positive preferences for the different attributes. Focus group interviews and a pilot test indicated that this could be expected. The cost parameter is treated as a fixed parameter rather than a random parameter, even though it implies fixed marginal utility of money. This is done for simplicity as it avoids a number of potentially severe problems associated with specifying a random price parameter (Train, 2003). The RPL is specified with a panel data structure to account for the correlation within repeated choices made by each respondent. . The MNL model however, can by definition not be run with panel specification. In an initial run of the basic RPL1 model, all the attributes apart from cost were specified as random variables. When using a panel specification, the estimated standard deviations of five of these were found to be significant, and hence specified as random. Without the panel specification, only three of these parameters were found to be random. This underlines the importance of accounting for the repeated choice nature of the data, especially for relatively small samples.

The RPL1 in table 3 shows that 'small-scale and large-scale wetland restoration', 'chemical mosquito control', 'medium biodiversity' and 'high biodiversity' are parameters subject to significant preference heterogeneity. This implies for example, that while some respondents would prefer wetland restoration, more biodiversity or chemical mosquito control to no control, other respondents would rather be without these changes. 'More hedges', 'natural mosquito control', 'passive' and 'active recreation' are non-random parameters indicating that preferences in the respondent sample are generally homogeneous with regard to these attributes. The parameter estimate of price is found to be negative and significant, which is in correspondence with the theoretical expectation that an increasing tax is associated with a negative utility.

4.1.3 Random parameter logit models with inter-attribute, social and attitudinal interactions (RPL2)

Even if unobserved heterogeneity can be accounted for in RPL1, it fails to account for those who may be affected by a policy change (Boxall and Adamowicz, 2002). Detection of sources of observed preference heterogeneity is done in the RPL2 by including variables constructed as interactions between respondent-specific characteristics and choice specific attributes. After extensive testing of various interactions with the respondents' social, economic and attitudinal characteristics collected in the survey, significant interaction effects were identified for the variables 'Green', 'Child' and 'MdBcare'. It was verified from the correlation matrix, that none of these variables are significantly correlated. Table 2 gives a description of these variables. Consistent with our expectations, 'MdBcare' is related to demand for the wetland itself, and thus shows significant explanatory power when interacted with large-scale wetland restoration. Having a child below 17 years of age in the household is shown to influence WTP for all the policy attributes in the CE (given the significant and positive parameter estimates of the cost attribute interaction). This indicates that these respondents associate the payment entailed by the cost attribute with a smaller disutility than other respondents. Considering the definition of these variables in table 2, this strongly suggests the presence of option values as well as bequest values (Pearce and Turner, 1990). Environmental consciousness ('green') is principally related to the demand for more biodiversity and was thus interacted with the 'High biodiversity' attribute. Indeed, RPL2 reveals that the demand for the highest level of biodiversity is significant and positive for 'green' respondents.

In accordance with focus group experiences, RPL2 demonstrates that respondents not in the 'MdBcare' category only derive utility from a large-scale level of wetland restoration, if this takes place with a simultaneous natural control of mosquitoes. That is, simultaneously employing natural mosquito control and significantly expanding the wetland size to two thirds of its original size, increases utility more than proportional to each of the two attributes effect on their own.

To formally test whether RPL2 is an improvement over the RPL1, a likelihood ratio test is conducted (Ben-Akiva and Lerman, 1985). With a chi-square test statistic of 29, exceeding the threshold of 7.8 at the 95% level of confidence, RPL2 is clearly superior to RPL1. With an adjusted McFadden's ρ^2

value above 0.2, the overall fit is very good (Louviere et al., 2000). RPL2 is also structurally and intuitively appealing as the various interactions enables the RPL model to pick up preference variation in terms of both latent and observed taste heterogeneity, and hence improves model fit (e.g. Revelt and Train, 1998; Birol et al., 2006a). Thus, we treat RPL2 as the main model. Not surprisingly, the latent heterogeneity found in the RPL1 carries through to RPL2.

4.2 Marginal willingness-To-Pay and welfare estimates

Table 3 reports the MWTP for the average respondent in the sample. When the cost attribute is used as the normalising variable, the most important landscape management attribute is tree hedge restoration allowing a view of the Alpilles. This management option is worth 24.7 € on average per person per year. At approximately the same level of importance is large-scale wetland restoration when coupled with natural mosquito control or when respondents have an attachment to the area. These levels are estimated to be worth 20.6 € and 25.6 € respectively. As such, the locals are not particularly attached to the traditional open landscape, whether dominated by water bodies, reed beds or agriculture. It is not possible to identify clear preferences for dense hedges, which would not permit a view of the Alpilles. This could imply that the scenic pleasure derived from tree hedges and the background of the Alpilles mountains is more important to respondents, than any ecosystem service that they may associate with the trees (a wind block against the mistral, water balance, shelter for birds etc.).

The respondents who do not have an attachment to the MdB consider large-scale wetland restoration as welfare deteriorating with a mean of -21.2 € and a standard deviation of 27.5 €. As such, large-scale wetland restoration is not a uniform preoccupation of the local citizens. This is also seen by the fact that though MdB translates as “the wetland of the Baux”, over half of the respondents were not aware of the existence of a wetland in this area (table 2). A small-scale wetland restoration rendering the wetland to one third of its original size is nevertheless welfare increasing for 65.2% of the sample, given that the mean MWTP is 14.6 € with a standard deviation of 37 €.

The preferred landscape associated attributes are closely followed by active and passive recreation, with an estimated MWTP of 19.4 € and 20.0 € respectively, and natural mosquito control independent of wetland restoration worth on average 20.7 €. There is significantly more heterogeneity in the sample regarding biodiversity. This is not surprising given that it is a rather complex attribute. While a medium increase in biodiversity appeals somewhat to average tastes worth 15.8 €, there is a sizeable share of the population who are indifferent or even perceive it as a change to the worse. While results suggest that only 76.1% of the sample respondents have a positive MWTP for a medium increase in biodiversity, preferences for high biodiversity are even more dispersed around a non-significant mean of zero, but with significant heterogeneity, observable as well as latent. Interviews suggested reasons for not having a positive MWTP as: "Biodiversity may be of nuisance to farmers", or "would be too wild to enjoy". Interestingly though, for the environmentally concerned respondents, the highest level of biodiversity is the most important management attribute worth 36.7 €.

Though mosquito nuisances are a reality, the majority of the respondents (67.3%) consider Chemical mosquito control by the Bti toxin to be welfare deteriorating. The model implies that the WTP for Bti treatment on the margin is normally distributed in the population with a mean of -29.0 € and standard deviation of 64.6 €, suggesting that a non-negligible part of the local population would probably be willing to lobby for its implementation. It should, however, be considered that use of the Bti may have a significant impact on the mosquito population, which in turn will affect the amount of biodiversity (especially migrating swallows) that the area can support, and could thus lower any welfare benefit from more biodiversity. This is the very same biodiversity that would be used actively in biological control. It therefore seems evident that controlling mosquitoes through water level variations and natural predators is the best option from the point of view of maximising welfare and minimising impacts on biodiversity.

4.3 Policy advice regarding the welfare estimates for future alternative management scenarios

In order to estimate the compensating surplus (CS) for changes in landscape and activity management relative to the present situation, we construct four possible future management options in table 4. For each of these management options we calculate the CS welfare measure for the average respondent using equation (6). Employing a "state-of-the-world" approach (Holmes and Adamowicz, 2003) and assuming that the utility expression in equation (3) is linear in attributes, the CS can be calculated simply by summing the over the relevant MWTPs. For example, the CS for the *high impact nature management scenario* presented in table 4 is calculated in the following way:

$$CS = MWTP_{\text{large-scale wetland}} + MWTP_{\text{Large-scale wetland*MosControl}} + (MWTP_{\text{large-scale wetland*MdBCare}} * 0.52) + MWTP_{\text{natural mosquito cntr}} + MWTP_{\text{more hedges}} + MWTP_{\text{passive recreation}} + MWTP_{\text{high biodiversity}} + (MWTP_{\text{high biodiversity*Green}} * 0.39)$$

Table 4: Compensating surplus for various management options

Scenario	CS per person per year
Low impact management scenario:	65.4 €
Medium impact leisure management scenario:	74.5€
High impact nature management scenario:	92.4€
High impact management scenario:	95.8€

When considering the three objectives “landscape, biodiversity and recreation” it is noteworthy that the values attributed to landscape qualities are of an order comparable to recreational opportunities and greater than biodiversity, depending on the character of the respondent. However, it should be stressed that at the level of policy discourse, these objectives are not contradictory. Passive recreation, which refers to the establishment of a surrounding circuit on public paths with observational facilities, is a feasible option independent of the decisions of the landowners regarding the future of the area. A large scale wetland restoration with more tree hedges and minor human influence will necessarily induce the highest level of biodiversity. This *high impact nature management scenario* is the most interesting scenario seen through the “green glasses”. Despite the fact that less than half of the respondents derive a positive and significant welfare benefit from the highest level of biodiversity, there are significant welfare benefits to be derived, as it yields an average consumer surplus of 92 € per respondent per year compared to the status quo. This suggests that values attached to the landscape and biodiversity are highly valued by the local society. Yet, from a policy point of view, there is arguably reason to improve the citizens’ understanding of the benefits linked to biodiversity, and thus increase the proportion of “green citizens” in the population. While implementing policies that yield the greatest welfare to society also involves passive recreation, natural mosquito control and more tree hedges, the locals prefer a medium level of biodiversity and a small-scale restoration of the wetland. This on average most preferred *high impact management scenario* is estimated to yield a CS of 96 € per year per respondent.

The *medium impact management scenario* consists of a small-scale restoration of the wetland, more tree-hedges, coupled with recreational opportunities such as hunting, paths for walking and cycling (active recreation), and a medium level of biodiversity. This scenario is associated with significant welfare gains – estimated to be worth 75€ per respondent per year. Though it is not as highly valued as the most preferred scenario, it is arguably a more politically feasible scenario. This is particularly so, as active recreation provides benefits to multiple user-groups and thus lessens the user-conflicts that are already associated with the dyke – conflicts that may be all the more conflicting in the face of a larger wetland. Furthermore, a small-scale wetland restoration is not perceived to be conditional on mosquito control and this may well ease the political decision to restore the wetland given that both tourist stakeholders and the general public doubt the effectiveness of mosquito control. The questionnaire revealed that 63% "fear the mosquitoes and do not believe that mosquito control is really efficient". In the absence of any funds or political support for wetland restoration, one may still picture a *low impact management scenario* with some benefits to society, consisting of restoring tree hedgerows to the extent that the Alpilles mountains are still visible, coupled with improved public facilities for walking, picnicking and observational activities. The low impact management scenario is estimated to be worth 65 € relative to the status quo.

There is reason to argue that the welfare estimates provided in table 4 are lower bound estimates of the welfare benefits associated with wetland restoration. Given that the area includes Natura 2000 species, it suggests the existence of substantial non-use values for individuals independent of their distance to the MdB wetland. Moreover, the study presented here does not consider the total economic value from wetland restoration. Other valuable services include the recharge of the underlying aquifer, flood control, lower cost of water drainage, and improved water and soil quality. Valuing these services was considered outside the scope of this study. The underestimation of the welfare benefit derived from wetland restoration, should however be counterbalanced to some extent by the potential presence of hypothetical bias which is known lead to overstatements of true WTP in stated preference methods, see for example Harrison and Rutstrom (2008), List and Gallet (2001) and Murphy et al. (2005). Furthermore, the hypothesis that the sum of the attributes are equal to the value of the whole has likewise been contested (Barreiro-Hurlé and Gómez-Limón, 2008), potentially leading to an overestimation of welfare measures for the specific scenarios.

5 Conclusion

Wetlands are complex ecological systems requiring an integrated natural and social science approach to measure the economic value of their services. Naturally, if all benefits that come from wetland restoration could be enjoyed simultaneously without any negative externalities, realising specific ecosystem services would be easy. In Marais des Baux (MdB) however, multiple stakeholder groups with conflicting interests imply that this is not feasible. This paper contributes, as one of the first studies of its kind in France, to the existing literature on the valuation of wetlands by providing estimates of the welfare economic benefits to society associated with various restoration scenarios in the MdB. In particular, we highlight the importance of accounting for mosquito nuisances in the valuation of wetlands. Furthermore, specific guidance on potential management regimes is provided for the decision makers. By quantifying the preferences for different land use changes in terms of Willingness-To-Pay (WTP) for such changes, the conducted Choice Experiment may serve directly in this process as a conflict avoidance tool or conflict resolution tool.

Overall the results indicate that landscape and land use changes in MdB in terms of a restoration of the wetland is associated with a significant welfare economic benefit to society and thus justifies the (not yet implemented) Natura 2000 compensation payments for wetland restoration. While small-scale wetland restoration is considered welfare enhancing for the average respondent, large-scale wetland restoration *ceteris paribus* is welfare decreasing for about half of the sample. On the other hand, those who have a particular attachment to the area have a significant WTP for large-scale wetland restoration comparable to the value derived from more hedges and enhanced recreational facilities. Furthermore, large-scale wetland restoration is regarded as beneficial by the entire sample when it takes place in conjunction with "natural mosquito control". As such, the fear of mosquitoes associated with wetland restoration is present, but it is not strong enough to completely discard any interest in its restoration, as claimed by certain local politicians. Indeed, mosquito control is highly advisable, if a biological and water table management approach is chosen. Even though chemical mosquito control on average leads to a decrease in social welfare, this is subject to significant preference heterogeneity in the sample. While around 33% of the respondents would benefit from the use of the chemical mosquito control, as recently invoked on the neighbouring wetland of the Camargue, the majority of the respondents would be worse of if it is similarly employed in the MdB. Turning to the recreational aspect, the sample reveals a significant and positive WTP for an increase in facilities either in the form of surrounding circuits, observation towers and information boards or a more direct public access to the area with hunting allowed in designated areas. An increase in the amount of tree hedges is also regarded as a positive change, but this should be undertaken with care since increasing the amount of tree hedges to the point where it would obstruct the view of the

Alpilles would significantly reduce the possible welfare benefit from having more tree hedges in the landscape.

As for biodiversity, the econometric model estimated shows that even though the average respondent perceives it as a positive change, around 24% of the respondents would actually disregard an increase to a medium level of biodiversity. Furthermore, the highest level of biodiversity is only valued positively by respondents who can be classified as being environmentally aware and concerned. This fact raises some fundamental questions regarding the use of stated preference methods. What do people actually understand by "more birds, fish, insects, etc."? And how does this understanding differ between respondents? If biodiversity protection is a policy priority, our results suggest that there is a case for public awareness raising campaigns. To account for potential demographic or attitudinal differences in marginal utility of income, a piece-wise linear-in-spline specification was applied by interacting the cost attribute with a demographic variable. This revealed that parenthood leads to stronger preferences and thus higher WTP for different restoration scenarios. While the *low impact management scenario* shows that the recreational value of the area can be improved significantly even without a restoration of the wetland, the welfare maximising management scenario *(the high impact management scenario)* is one which, compared to the present situation, entails a restoration of the wetland to one third of its original size. This should take place in conjunction with natural mosquito control, a moderate restoration of tree hedges, some increase in biodiversity and the installation of a surrounding circuit of public paths with observational facilities. While this management option is the most favourable one seen from a welfare economic point of view, there is evidence of other factors affecting the applicability of this option in the policy setting. Nevertheless, the results obtained should prove useful as an input to the ongoing debate concerning the future plans for the Marais des Baux.

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