Assessing tourists' preferences for coastal land use management: a focus on oyster farming

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Abstract

The aim of this paper is to provide an analysis of tourists' preferences concerning land use management in Arcachon Bay (France). We focus more precisely on oyster framing, an activity which built a large part of the identity of the area. We refer to the notion of heritage to deal with the market and non-market dimensions linked to this activity in order to tackle sustainable territorial governance issues – as Integrated Coastal Zone Management (ICZM) supposes. To do that, we set out to establish which forms of oyster farming tourists in this coastal area value. The choice experiment method is applied in order to analyse individual preferences. This method has been used extensively in research on non-market issues (such as landscape preferences) and multi-functionality of agriculture but until now has never been applied to oyster farming. By implementing a latent class logit model, it allows us to bring to light, in the Arcachon Bay area, the fact that the heterogeneity of tourists is important. Our results also highlight the fact that the amenity dimension is valued as much as the productive dimension of this industry, but differently, depending on the class of tourist concerned. These findings have implications for decision makers of this territory, who are faced with complex issues of coastal management and productive sector survival.

Keywords:

Individual preferences; choice experiment; latent class logit model; coastal management; oyster farming heritage

Résumé

Evaluation des préférences des touristes en matière d'aménagement des zones côtières : regard sur et par l'ostréiculture

Ce papier se propose d'analyser les préférences des touristes en matière d'aménagement de la zone côtière dans le Bassin d'Arcachon (France). Il se focalise plus précisément sur l'ostréiculture, activité économique traditionnelle qui façonne en partie l'identité du territoire. En nous référant à la notion de patrimoine pour traiter des dimensions marchandes et non marchandes associées à cette activité économique, nous entendons traiter des enjeux de gouvernance territoriale durable – en cohérence avec les objectifs de la gestion intégrée des zones côtières (GIZC). Pour cela nous nous intéressons aux dimensions de l'ostréiculture valorisées par les touristes. Les préférences individuelles sont analysées à l'aide d'une méthode de choix multi-attributs (*choice experiement method*). Bien qu'ayant fait l'objet d'applications variées pour aborder diverses problématiques non marchandes (notamment les préférences paysagères) ou encore les dimensions multifonctionnelles de l'agriculture, cette méthode n'a jamais été appliquée au cas de l'ostréiculture. En implémentant un modèle logit en classe latente, elle permet pourtant de mettre en évidence l'importante hétérogénéité des préférences des touristes du Bassin d'Arcachon. En effet, selon les classes de touristes les dimensions aménitaires ou purement productives de l'ostréiculture sont diversement valorisées. Ces résultats ne sont pas sans implications pour les décideurs locaux confrontés au problème complexe de l'aménagement côtier et de du développement économique local.

Mots clé :

Préférences individuelles, modèle de choix multi-attributs, modèle logit en classe latente, patrimoine ostréicole

Codes JEL : D12 ; Q51 ; Q22

1. Introduction

Coastal zones are areas with huge challenges, under pressure from various sources. They provide many goods and services such as food, biodiversity, landscapes, recreational opportunities and the breaking down of degradable waste. However, the pressures resulting from economic activities (fishing, tourism, industries) and population growth require the implementation of management measures. In this regard, the analysis of the agents' preferences is a relevant tool for supporting public decision making, and its interest is reinforced by issues in terms of participatory democracy. Many studies have therefore emerged from the community of economists, in particular with regard to the creation of marine protected areas (MPAs), to assess agents' preferences in a non-market context (e.g. Eggert, Olsson, 2009; Glenn *et al.*, 2010; McVittie, Moran, 2010; Wattage et al., 2011; Boxall et al., 2012). In view of the intensity of competition between the different land uses in coastal zones (Goetz et al., 2007), the analysis of preferences is also necessary for solving management problems arising from the economic, social and environmental consequences of the different spatial configurations.

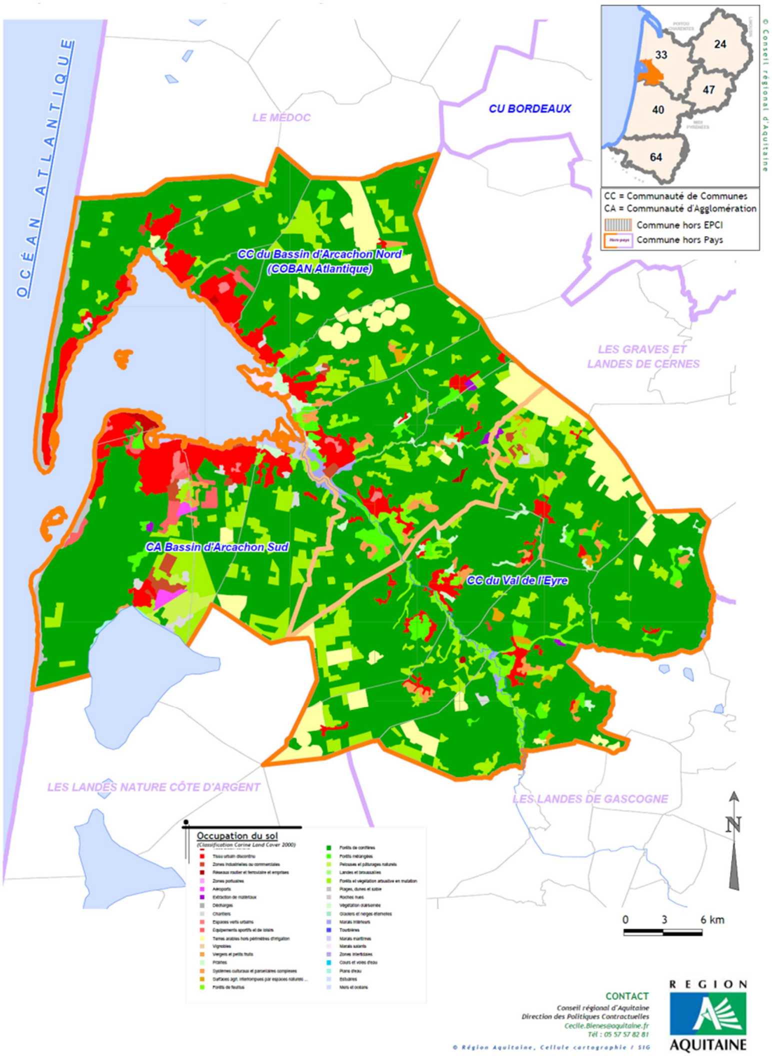
In accordance with the principles of Integrated Coastal Zone Management (ICZM), it is important to consider the possible development of different land uses in light of the sustainable triptych. In view of this, decision makers are signalling a need for information to help them in the elaboration of land planning policies. Duke (2008) explains that the analysis produced by economists should assist decision makers in prioritizing their objectives without dictating a specific policy. In other words, quantitative approaches engaging individuals should be considered as complementary tools to experts' analyses and working groups, and be used to arbitrate between different land planning options (Willis, 2006). As such, Willis (2006) stresses the relevance of the choice experiment method (CEM) to determine individuals' preferences with regard to coastal management and to study the utility and acceptability of some hypothetical measures. Considering the particularly question of spatial configurations as one of the complex challenges of ICZM – although it is not the only one –, the aim of the present work is to contribute to the researches around the land use management.

More specifically, this article examines the coastal land use management preferences of land users in the Arcachon Bay area in France. This territory is faced with a significant increase in the degradation of environmental quality in the broad sense (i.e. natural environment, living environment) because of the large population influx (both permanent and seasonal): the population growth of the coastal zone exceeds 25 per cent since 1990; in summer, the population increases more than 2.5-fold, or three-fold in some municipalities; the annual number of tourists is estimated at 10 million (Le Berre et *al.*, 2010). The "lower" scenario of the Territorial Coherence Scheme (SCOT), foresees 50,000 additional inhabitants in the Arcachon Bay area in 2030[1]. With the demographic issue and various pollutions related to the surplus of people, the problem of physical reception capacities of this population influx – permanent or temporary – arises. It reflects the concerns in terms of land use planning. It is the more relevant that the other main land uses of the Arcachon Bay area, that is, forest land use, agricultural land use and oyster farming land use (see figure 1), are also face to their own challenges. Questions about sustainable coastal management are of the utmost importance. The present study contributes meaningfully by examining the various changes in coastal land use and coastal management options, with regard to these four main land uses, by assessing the preferences of tourists' about these options. In view of the role of oyster farming in this area and because of specific issues of this industry since the middle of the 2000s', it seems appropriate to focus on the results in relation to this activity.

[1] "SCOT-PADD Bassin d'Arcachon Val de L'Eyre" report, January 2011, 72 p.

Figure 1

Arcachon bay area



Main elements of legend:

Various green : forest land use
Red : residential land use
Yellow : agricultural land use

Oyster farming is indeed an emblematic activity of Arcachon Bay. It contributes significantly to the identity of the area and is a promotional argument for tourism. It produces a high-end product symbolizing a certain image, shapes the landscape, and acts as a guardian of the environment. For all these reasons, oyster farming is viewed as a heritage of Arcachon Bay and can be analyzed in terms of multifunctionality. Although the multifunctionality issue has been widely discussed in the framework of agriculture, to justify several public policies (i.e. Anderson, 2000; Libby, 2002; Vatn, 2002; Batie, 2003; Vanzetti, Wymen, 2004), very few studies have dealt with oyster farming. To our knowledge, no study has specifically concerned the assessment of individuals' preferences regarding the multifunctionality of oyster farming. As such, the contribution of this paper is original. The concept of multifunctionality assumes the existence of multiple joint outputs (positive externalities) associated to the initial output of an activity. Following

Barthélemy and Nieddu (2007) who focus on agriculture, we treat the productive dimensions and amenities dimensions of oyster farming simultaneously. This positioning allows us to consider the existence of a variety of “market output/non-market output” combinations, because of a variety of production models.

To illustrate our point and before studying tourists’ preferences (section 3, 4 and 5), we provide in section 2 the three oyster farming production models in Arcachon Bay, and the link between each model and the local heritage. As there are several “oysters/heritage” combinations, it seems crucial to provide adequate insight on tourists’ preferences regarding these combinations. This could guide decision makers in their choices of measures to support the industry and its amenities dimensions in the context of crisis of oyster farming industry. As noted above, we apply the stated preference valuation method called choice experiment (CEM) (Adamowicz et al., 1994; Louviere, et al, 2000; Bennett Blamey, 2001). A latent class model (LCM) is implemented on the basis of CEM data, in order to consider the heterogeneity of tourists’ preferences regarding the heritage/landscape dimension and the productive dimension of oyster farming. This choice modelling allows us to stress the variety of expectations about oyster farming, according to the different segments. It is important to underlying that this first work dealing with oyster farming doesn’t set a goal of producing necessarily a cost-benefit analysis. The main objective is to characterize the tourists’ preferences.

2. Oyster farming and heritage

Oyster farming is an aquaculture practice, consisting in shell cultivation. It takes place mostly in coastal water and is heavily reliant on the natural environment. This economic activity has been present since the 19th century in Arcachon Bay and is one of the area's specific heritages. The link between oyster farming and Arcachon Bay's heritage can best be seen in the above-mentioned notion of multifunctionality. Generally speaking, multifunctionality concerns the non trade benefits of agriculture (Vanzetti, Weymen, 2004). It explains why many studies have measured public preferences or economic value only for the non-market goods and services of agriculture, without their connection with market production. The literature survey on multifunctionality valuation by Moon and Griffith (2011) highlights this. However, at the micro-economic level, the non-commodity outputs differ according to the production model of each producer. Indeed, the amenity aspect of the activity is strongly impacted by the kinds of practices implemented during the productive process (Bartélemy, Nieddu, 2007). Thus, we have to acknowledge the diversity of production models and variety of “market output/non-market output” combinations, in order to understanding the complex relationships between a specific industry and its territory in the core of heritage dimensions.

The first step in identifying the different oyster farming production models is to study the industry and especially the local conditions of production in Arcachon Bay. Currently, the industry is faced with various factors of disruption, at both national and local level. At national level, it was dealt a serious blow when a mortality crisis struck in the spring and summer, first in 2007 and then recurrently thereafter[2]. These massive and devastating mortalities affect the juveniles (twelve month-old shells) and decimate between 20 and 100 per cent of the oyster population every year[3]. Even though a package of measures has been implemented by the European Union, the French State, the Regions and the producers themselves, stocks tend to be

[2] This type of mortality among the *Crassostrea Gigas* also occurs in Ireland and New Zealand.

[3] Depending to the production site, the total production period is between three and four years to reach the commercialization size.

reduced and production has declined in real terms (30 to 40 per cent drop between 2009 and 2010). The oyster farmers are deeply concerned about how to maintain the production level in view of this new parameter. At local level, oyster farming has been faced since 2009 with a substantial decrease of catchment[4]. This problem, combined with to the mortalities, has seriously destabilized oyster farming. The oyster farmers of this area are moreover confronted with the interruption risk of selling, which can lead to a considerable shortfall[5]. Finally, oyster farming is subject to significant competition with regard to access to natural resources, reflected in various land use conflicts (Cazals, Lemarié, 2010). The demographic growth noted above and the large number of tourists and boat owners cause not only land pressures and situations of congestion in the production zones at sea, but also a potential increase in pollution of the environment in which the production is carried out. In this unsettled context, the oyster farmers of Arcachon Bay are seeking solutions and trying to change their practices. However, the changes involved could seriously disrupt some of the heritage aspects of the activity.

The second step of our research consisted in deciphering the current practices of oyster farmers through face-to-face interviews (see Rivaud & Cazals, 2012, for more details). From data analysis, three typical production models have been identified: (i) traditional oyster farming; (ii) production-driven oyster farming; and (iii) adaptive oyster farming. As these models match the practices actually implemented, we are in a position to realistically describe the impacts of each model on the non-market benefits. In other words, it is possible to characterize the effective link between production and heritage (Table 1). To provide a more legible analysis, we consider the impact of each productive model on the traditional oyster farming landscape (i.e. the exploitation of oyster beds on the foreshore). The landscape is regarded here as a representative form of the Arcachon Bay heritage.

The productive models corresponding to various production practices do not imply the same non-market benefits. Nor do they imply the same productive potential in terms of both safety of shells and production volumes. The traditional oyster farming model is associated with a high risk level on the productive potential: oysters are exposed to all the disruptions of the environment and producers do not use hatchery oysters to counter the drop of production. The production-driven oyster farming model is the one which guarantees the greatest productive potential, in so far as the practices implemented by oyster farmers are aimed to limit the risks associated with certain stages of production. Lastly, the adaptive oyster farming model is mid-way between the two. The oyster-farmers strive to maintain the productive potential, but as traditional practices are still used, there is a significant risk level.

Considering this first characterization of the link between oyster farming and heritage, the objective of this paper could be reworded as follows: if, as we have shown, there are different combinations between market and non-market outputs, it is important to (i) assess the individual preferences for an “oyster/heritage” mix and (ii) study the choices concerning oyster farming at the same time as the choices concerning the other activities of the coastal zone. Since the integrated coastal zone management principle underpins our approach of land use planning, we cannot deal with oyster farming independently the other land uses. The choice experiment method (CEM) implemented to assess the tourists’ preferences for coastal land use management in the Arcachon Bay area (*cf. infra*) addresses these two criteria: (i) oyster farming is presented by articulating the dual dimension between shell production and landscape, and (ii) the valuation of the tourists’ preferences covers the management options of the main land use of the area, and not only oyster farming.

[4] Catchment is the collection of oyster larvae.

[5] In the Arcachon Bay area, the interruption risk of selling echoes the “crisis of the mouse bioassay” (Roussary et *al.*, 2011).

Table 1. Production models: productive practices and heritage

Production model	Productive practices	Shape of landscape induced (non-market dimensions)
(i) **Traditional oyster farming** *Trade-off in favour of heritage to keep a traditional production system as main objective*	- Use of natural spat - No triploid production - Breeding on trestles on the foreshore - Picking of wild oysters - Development of diversification (shell tasting)	Landscape dimension preserved: - Exploitation of oyster beds on the foreshore
(ii) **Production-driven oyster farming** *Trade-off in favour of production to limit the decrease of volume produced as main objective*	- Intensive use of hatchery* spat - Intensive triploid production - Breeding on trestles on the foreshore and in deepwater to improve the growth rate	Landscape dimension changed: - Reduced exploitation of oyster beds on the foreshore (because of the stopping of catchment and breeding in deepwater)
(iii) **Adaptive oyster farming** *Intermediate trade-off to test different solutions to the current crisis as main objective*	- Use of natural spat and hatchery spat in small proportions - Practice of triploid production on a small scale - Breeding on trestles on the foreshore - Picking of wild oysters - Development of diversification (shell tasting)	Landscape dimension slightly changed : - Limited reduction of the exploitation of oyster bed on the foreshore

**A hatchery is a fish farm in which the production of juveniles is carried out in a controlled environment.*

3. Methodological framework

3.1 Choice experiment implementation

CEM is essentially a procedure designed to generate survey protocols in order to reveal the factors that influence individual preferences. It was first developed in the field of transport and marketing economics (Louviere and Woodworth, 1983) before its adaptation to environmental valuation (Adamowicz et al., 1994, 1998; Morrison et al., 1999). Even though it has been used extensively in the field of environmental economics since the late 1990s, there are surprisingly few studies concerning the application of choice experiments to coastal management and resource issues (Pendleton et al., 2007). Constructed as an ex-ante valuation method, CEM allows public decision makers to take into account non-market values in their decision process. Moreover, the multi-attributes dimension of this method allows users of the CEM to focus on the multidimensional aspect of public intervention (Dachary-Bernard, Rambonilaza, 2012).

Within the context of our specific case study, use of the CEM consists in presenting several respondents with different hypothetical scenarios that are supposed to express different changes in the coastal land use of our area. Based on Lancaster's theory (Lancaster, 1966), the good is considered to be composed of a set of attributes that provide satisfaction to the consumer. Respondents have to choose their preferred situation between the different proposed alternatives. This experience of choice is repeated several times with new alternatives each time.

The objective of our valuation is to look at people's preferences for different coastal land use changes and coastal management options. We suppose that the satisfaction of people who come to visit the Arcachon Bay depends of different attributes of this area, mainly the different land uses. People we are concerned with in this survey are tourists, defined as visitors spending at least one night on the area. We apply literature reviews and focus groups to the Arcachon Bay study area to define the attributes that are relevant to people, while expert consultations serve to identify the attributes that will be impacted by the policy (Dachary-Bernard, Lemarié, 2010). We retain four 3-levels main attributes: agricultural land use, forest land use, residential development, and oyster farming. In addition, as a monetary attribute is usually added to the choice design, we choose an accommodation cost that tourists have to pay when they stay more than one night. Different levels are assigned to each of these attributes in order to allow for a variety of scenarios according to different combinations of attribute levels. These attributes and their levels are presented in Table 2 below.

Table 2. Choice attributes and their levels

Attributes	Level 1	Level 2	Level 3
Agricultural land use	Large decrease of agricultural surface	Slight decrease of agricultural surface	Current agricultural surface
Forest land use	High level of recreational use and low level of productive use	Medium level of recreational use and medium level of productive use	High level of productive use and low level of recreational use
Residential land use	Detached housing Distance ++ to services	Adjoining housing Distance + to services	Collective housing Null distance to centre services
Oyster farming land use	Traditional production (heritage ++ & risk ++)	Mixed production (heritage + & risk +)	Standardised production (no heritage & low risk)
Accommodation cost [Status quo : cost=0]	+10%	+15%	+20%

Note: grey cells conjointly describe the current situation of Arcachon Bay regarding these attributes (with a null cost attribute since the current situation assumes no specific public measure to have been taken so no additional costs).

Except for the agricultural attribute, we decided to define the attribute level from two points of view. The oyster farming attribute is defined from both its productive dimension and its non-market dimension. This latter should be analyzed in relation to the heritage or amenity dimension of oyster farming (mainly landscape), and the market dimension should be explored in relation to the risk exposure of the activity. Indeed, in the current situation oyster farming is a traditional activity, with an important landscape heritage but with a high degree of exposure to health risks –

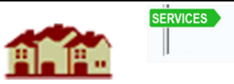
because of pollution bio-accumulated in the shells – and shells' mortality risk – uncertain production capacity. The hypothetical options regarding this specific oyster attribute would be to standardize the activity by developing production in a hatchery to reduce the risks of exposure, but at the same time this would reduce the landscape amenity produced by the activity, as mentioned above.

The next step in the CEM implementation consists in designing the experiments, i.e. building the scenarios and grouping them into choice sets to be presented to respondents. These scenarios are statistically computed, and are note drawn by local decision makers as in prospective studies. We used a fractional factorial design as proposed by Rose et al. (2008) since a complete factorial design involving 3^5=243 possible scenarios is not feasible. The final choice design is composed of 2 versions of the survey, each of which proposes 7 experiments of 3 scenarios each: 2 hypothetical scenarios and the status quo option (reflecting the current situation). We decided to illustrate each level of each attribute with a photograph or a pictogram to facilitate the understanding of the scenarios and of the choice task (Bateman et al., 2009). The following Figure 2 shows an example of choice experience as presented to the tourists.

The survey[6] is composed of 4 different parts: the first one deals with the tourist activity; the second part presents the choice experiments; the third one directly follows with some precise questions about the way people understand the scenarios and attributes; and the last part deals with the socio-economic profile of the respondent. This survey was administered during the summer of 2010, on 398 tourists.

[6] A copy of the survey is provided by the authors on request.

Figure 2. Example of choice card (B2-Exp5)

Arcachon Bay land use management	**Scenario 1**	**Scenario 2**	**Scenario 3 (Status Quo)**
Agricultural land use			
Forest land use	 	 	 
Residential land use	 **Distance :**	 **Distance :**	 **Distance :**
Oyster farming land use	 	 	 
Accommodation cost	 **+15%**	 **+15%**	 + **0%**
Which scenario do you prefer?(Only	☐	☐	☐

3.2 Econometric model

Once the data has been collected, the next step consists in estimating choice behaviours, assuming that people choose the alternative or scenario that maximizes their utility or well-being. The choice exercise is analysed in the random utility framework as proposed by Thurstone (1927) and formalized by Mcfadden (1974): the utility function (U_{ij}) that an individual i can expect from choosing an alternative j is assumed to be composed of a deterministic part (V_{ij}) and a random part (ε_{ij}). Thus, an alternative j is chosen when the utility associated with it is higher than for all other alternatives $q \neq j$ of the choice set C:

$$U_{ij} > U_{iq}, \forall j \neq q \;\Leftrightarrow\; (V_{ij} - V_{iq}) > (\varepsilon_{iq} - \varepsilon_{ij}) \qquad (1)$$

According to the assumptions we make concerning the distribution of the random parameters, different discrete choice econometric models should be estimated. The usual one is the logit when the error terms are assumed to have a Weibull form:

$$P_{ij} = P(U_{ij} > U_{iq}) = \frac{\exp(V_{ij})}{\sum_q \exp(V_{iq})}$$
$$\Leftrightarrow \ P_{ij} = \frac{\exp(\beta X_{ij})}{\sum_q \exp(\beta X_{iq})} \qquad (2)$$

where β is the vector of the parameters to estimate and X_{ij} is a vector of attributes.

However, such an approach assumes homogeneous preferences across respondents, whereas they are in fact heterogeneous, and taking into account this heterogeneity enables unbiased estimation of individual preferences and the formulation of policy measures that take equity concerns into account.

In order to deal with heterogeneity, CEM practitioners develop extensions to the multinomial logit, including the latent class model (LCM). The LCM specification is based on the concept of latent preference segmentation (Wedel, Kamakura, 2000) and in this model individuals are sorted into *k* classes (or segments) and parameters are the same for all individuals in that class but may vary between classes. “In the LCM, belonging to a segment (…) depends on the social economics and attitudinal characteristics of the respondents” (Birol et al., 2006, p.152).

Equation (2) is thus simply modified since the choice probability is now conditional on belonging to class *k*:

$$\Pr(i \text{ chooses } j \mid k) = \frac{\exp(\beta_k X_{ij})}{\sum_q \exp(\beta_k X_{iq})} \qquad (3)$$

Following Greene et al. (2003), the probability of individual *i* belonging to class *k*, denoted H_{ik} , is itself determined by the conditional logit model:

$$H_{ik} = \frac{\exp(\delta_k s_i)}{\sum_{k=1}^{K} \exp(\delta_k s_i)} \qquad (4)$$

where s_i denotes a set of individual characteristics that enter the model for class membership. Error distributions for equation (4) are assumed to be of type I and the choice likelihood for individual *i* is then expressed as the joint probability:

$$P_i = \sum_{k=1}^{K} H_{ik} P_{i|k} \qquad (5)$$

An alternative econometric model may be used to deal with heterogeneity, the mixed logit model. Some authors have compared the two approaches and have concluded that each one “has its own merits” (Greene, Hensher, 2003, p. 697) or even that LCM performs better than the mixed logit (Shen, 2009). Others, such as Scarpa et al. (2005), explain that LCMs have the advantage of being based on a joint estimation and allowing “intuitive interpretation and communication to policymakers” (p.426). That is why we apply this model to our data, the main object being to understand the heterogeneity in tourists’ preferences for coastal land use changes and, more particularly, to put hypothetical changes in oyster farming into perspective with the oyster farmers’ production strategies.

4. Results

4.1 Descriptive statistics

The survey was conducted during the summer of 2010, based on a geographical sampling representing three municipal areas corresponding respectively to the north of the bay, the south and the area slightly inland. Tourists were surveyed at popular tourist locations. Second-home residents were not concerned by this study since they were assumed to have specific preferences (Torres et al., 2009). Of the 418 respondents, 20 were excluded from the analysis because of their failure to answer the socioeconomic questions in the questionnaire. Thus, 398 respondents' answers were finally taken into account and the final data set included their 8,358 choices. Our samples were composed of 54.8% women, and more than half of the respondents were under 45 years old (see Table 3 below).

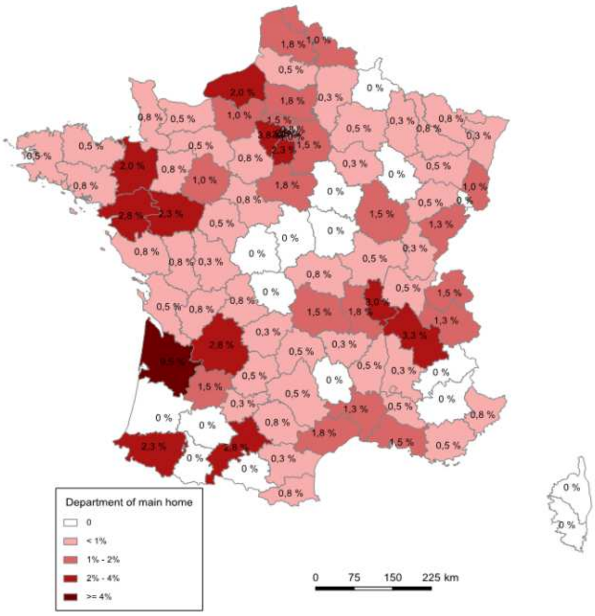
Table 3. Some sample descriptive statistics

Variables	Sample average (%)
Gender (% female)	54.8
Age	
< 30	13.8
[30;44]	41.5
[45;59]	34.4
> 60	10.3
Number of children under the age of 13 in the household	
0	57.5
1	20.6
2	17.6
More than 2	4.3
Household income /month	
< €1,299	6.8
[€1,300; €1,999]	11.8
[€2,000; €3,999]	52.8
> €4,000	28.6
Employment	79.2
Education (% with equiv. "A-level" or more)	69.3

Tourists we met had good knowledge of the area: 54% of them had already been to Arcachon Bay, and 28% had been there more than 5 times. The average holiday period was quite long with half of the sample spending more than 8 days there; however, 10% were one-day visitors.

Concerning their accommodation during their stay, 20% were invited by family or friends, which meant that only 80% actually paid for accommodation (and were thus potentially concerned by the accommodation cost increase proposed in the scenarios). Finally, 10% of the tourists are permanently living in the Gironde department but 25% of the sample permanently resided at least 500 km from the Arcachon Bay area (see Figure 3).

Figure 3. Geographical representation of main home department of tourists



Other information was collected and used in the latent class model, mainly the individual's motives for choosing Arcachon Bay as a holiday destination. More specifically with regard to oyster farming in the study area, we also asked respondents whether this was of any relevance to them and, if so, whether they were more concerned about the landscape dimension of the attribute, about its productive and high-risk dimension, or both. This specific information allowed us to identify people for whom the main issues of oyster farming in Arcachon Bay concerned its productive and risk aspects. We therefore assumed that these people were the ones who said they had taken into account the risk dimension of the oyster attribute (only for itself or jointly with its amenity dimension). We created a dummy variable "risk" that takes the value 1 if people actually took into account the risk dimension (7.8% of respondents said they were concerned about the risk dimension only and 41.4% about both dimensions, equally), and that takes the value 0 otherwise (11.6% of respondents said they had no interest in the oyster attribute at all and among the others 39.2% only looked at the landscape dimension of this attribute). Thus, the variable "risk" takes the value 1 for 49.2% of the sample and 0 for the remaining 50.8%.

4.2 A latent class logit choice model[7]

We can analyze the 8,358 observations elicited from 398 respondents to estimate the latent class logit model as presented earlier. The LCM assumes that respondent characteristics affect choice

[7] All the estimations are performed with NLOGIT 4.0.

indirectly through their impact on segment membership; the main aim is then to find which characteristics are the sources of the heterogeneity. The specification of the segments and the determination of the number of segments are supported by qualitative and quantitative criteria (Wallmo and Edwards, 2008). We first looked at the respondents' main motives for going to Arcachon Bay. In doing so we implemented a factor analysis (Boxall, Adamowicz, 2002) to have some intuitive ideas of the attitudinal and socio-economic variables that should be used in the model (Birol et al., 2006).

Determination of the optimal number of segments (denoted *k* in the equations (3) to (5)) requires a balanced assessment of the statistics reported in Table 4, mainly the minimum Akaike Information Criteria (AIC) and the minimum Bayesian Information Criteria (BIC) (Allenby, 1990). These two criteria should be used to guide our determination of *k*, but conventional rules do not exist and "judgement and simplicity play a role in the final selection (…)" (Boxall, Adamowicz, 2002, p.433).

Looking at the results for 1 to 5 segment estimations in Table 4, we note that log-likelihood and ρ^2 statistics improve as more segments are added, supporting the existence of multiple segments in the model (Birol et al., 2006). The AIC decrease but BIC is at its minimum for 3 segments, so we retain the 3-segment model.

Table 4. Criteria to determine the optimal number of segments

Number of segments	Log likelihood	ρ^2	Parameter number	AIC	BIC
1	-2,906.97	0.034	11	2,095	2,118
2	-2,566.3	0.16	23	1,859	1,908
3	-2,478.5	0.19	35	1,804	1,879
4	-2435.3	0.204	47	1.782	1.882
5	-2405.5	0.214	59	1.769	1.895

As attributes are qualitative, we introduce each of their levels as variables in the utility function. We then create (*l*-1) variables for each *l*-level attribute and keep the corresponding level for the status-quo scenario as the reference. Effects coding constitutes an alternative to dummy coding (Bech and Gyrd-Hansen, 2005) and attribute levels are effects coded. They are set to 1 for the scenario in which the attribute level is present, equal to −1 if the status-quo level is present and equal to 0 otherwise.

The 3-segment logit model results are presented in Table 5 below: both utility function parameters and segment membership parameters are displayed (coefficients are interpreted in relation to the third segment that is the normalized one). The 1-segment model results are also displayed. Wald tests have been done to compare by pairs the estimated coefficients of each of the 3 segments: all the coefficients are significantly different from the ones of at least another segment[8]. Attribute baseline levels are not introduced in the regressions. With coding effects, their estimators may be calculated as the opposite of the sum of the coefficients of their other levels (Rambonilaza, Dachary-Bernard, 2007). The significance tests are driven from the variance-covariance matrix. Results are reported below for each segment of the LCM (Table 6).

[8] Results are available upon request.

Table 5. Results of the 3-segment latent class model estimation

	1-segment model	3-segment model		
		Segment 1	Segment 2	Segment 3
Utility function	**coefficient (s.e)**			
Agrec1	0.008 (0.05)	-0.32*** (0.15)	0.081 (0.74)	0.29*** (0.08)
Agrec2	0.13** (0.06)	0.18 (0.14)	0.09 (0.098)	-0.13 (0.10)
Forec1	0.010 (0.04)	-0.64*** (0.16)	-0.20*** (0.064)	0.76*** (0.08)
Forec2	0.32*** (0.06)	0.74*** (0.14)	0.33 *** (0.10)	0.11 (0.10)
Resec1	0.26*** (0.05)	0.385*** (0.14)	0.033 (0.06)	0.399*** (0.06)
Resec3	-0.75*** (0.06)	-0.91*** (0.17)	-0.62*** (0.08)	-1.37*** (0.09)
Oystec2	0.21*** (0.05)	0.38*** (0.16)	0.39*** (0.076)	0.07 (0.09)
Oystec3	-0.26*** (0.05)	-0.92*** (0.18)	0.27*** (0.07)	-1.12*** (0.10)
Cost	-3.47*** (0.80)	-11.77*** (2.56)	-1.05 (1.05)	-1.52 (1.25)
ASC1	0.003 (0.14)	0.27 (0.39)	0.66*** (0.20)	1.20*** (0.21)
ASC2	0.17 (0.13)	0.65 (0.42)	0.73*** (0.19)	1.52*** (0.20)
Segment membership function	**coefficient (s.e)**			
Constant	-	0.78 (1.19)	0.16 (1.30)	0[a]
Risk	-	0.064 (0.31)	0.84*** (0.34)	0
Age	-	0.04*** (0.01)	0.04*** (0.02)	0
Inc_cl	-	-0.057 (0.21)	-0.37** (0.21)	0
Prof_cat	-	-0.23** (0.11)	-0.16 (0.12)	0
Nb_child	-	0.30 (0.19)	0.60*** (0.20)	0
BA_Attach	-	0.66 (0.72)	1.34** (0.74)	0
Length_stay	-	-0.29** (0.15)	-0.16 (0.17)	0
Latent class prob.		0.399	0.326	0.275
ρ^2	0.035		0.196	
Log-likelihood	-2,906.966		-2,458.704	

Two-tailed tests show 10% (*), 5% (**) and 1% (***) significance levels .[a] Parameters of segment 3 equal 0 since they are normalized during estimation.

Table 6. Estimates of the reference levels for effect coded attributes

	Segment 1	Segment 2	Segment 3
Utility function	*coefficient (s.e)*		
Agrec3	0.1414* (0.13)	-0.1744*** (0.07)	-0.1647*** (0.07)
Forec3	-0.0939 (0.13)	-0.1266* (0.08)	-0.8698*** (0.095)
Resec2	0.5275*** (0.15)	0.5922*** (0.08)	0.9694*** (0.10)
Oystec1	0.5386*** (0.14)	-0.6617*** (0.06)	1.0474*** (0.08)

Two-tailed tests showed 10% (*), 5% (**) and 1% (***) significance levels.

The Segment 1 membership coefficients reveal that shorter stays and lower professional category (i.e. farmers and artisans) increase the probability that the respondent belongs to this segment. The utility coefficients of this first segment show that respondents are highly and significantly price sensitive. The "no change" scenario or, at least, slight changes are accepted. The reference level coefficients (Table 6) are all positively valued (except the reference level of the forest attribute). This "mid-position" peculiar to this class of tourists is especially relevant to the oyster farming attribute, in respect of which the other two segments refer to non-intermediary situations, as we will see below. Finally, this class of tourists is closer to the production strategy followed in the "adaptive oyster farming production model", as presented earlier in Section 2 (Table 1).

Segment 2 of the LCM is significantly characterized by stronger attachment to Arcachon Bay, lower incomes and a higher number of children in the household. More specifically related to their attitude towards the oyster farming attribute, the "risk" variable is highly and positively significant, meaning that tourists more attentive to the production and risk dimension of the oyster farming attribute in the choice experiment have a higher probability of belonging to this second segment. Some Wald tests show that this second segment differs from the other two essentially with regard to the oyster farming attribute: tourists belonging to Segment 2 positively and significantly value the standardized level of oyster farming. Moreover, they also negatively value the traditional oyster farming model (Table 6) that refers to a high landscape potential but an important risk exposure. This second class of tourists should be qualified as "oyster-risk driven", and is relatively close to the production-driven oyster farming model (Table 1).

The third segment is the normalized segment. Looking at the utility model parameters, we note that the 2 alternative specific constants (ASC) are highly and positively significant in the model, meaning that people value the change from the status quo (current) situation. They also value the attribute levels that refer to the more important change from the current situation, except for the oyster farming attribute. Indeed, this tourist class values the amenity and/or recreational dimensions of the scenario attributes, but concerning oyster farming it refuses any change, as shown by the highly negative coefficient for the standardized level of oyster farming attribute (oystec3). The heritage dimension of oyster farming is of great interest in this tourist class, making it closer to the traditional oyster farming model (Table 1). Oyster farming changes should strongly influence tourists' preferences with respect to land use change management.

The LCM has been estimated and a series of probabilities of each respondent belonging to either one of the 3 classes is calculated. Following Birol et al. (2007), each respondent is assigned to one of the segments according to his or her largest probability score. Thus, we finally have a very well balanced distribution of respondents in the 3 segments: 39.4% belong to the first segment, 32.7% to segment 2 and 27.9% to the third one. Descriptive statistics for some socio-economic and attitudinal individual characteristics are reported for each segment, in Table 7.

Table 7. Profiles of respondents belonging to the 3 segments

Tourists characteristics	Segment 1 N=157	Segment 2 N=130	Segment 3 N=111
	Mean (s.e)		
Age	44.4 (12.6)	45.5 (11.5)	40.6 (12.9)
	%		
Length_stay < 3 days	21.0	17.7	16.2
Inc_class < €1,300	3.8	10.8	6.3
Inc_class > €4,000	31.8	22.3	31.5
Nb_child >2	20.4	30.7	13.5
Risk	42.3	63.1	42.3
BA_Attach	7	13	3.6
Cobas	42	51.5	44.1
Coban	56.7	47.7	53.2
VE	1.3	0.8	2.7

As expected, tourists in Segment 1, who reveal a mid-position regarding attribute levels and in particular regarding the oyster farming attribute, spend significantly less time in the area during their holiday than do tourists of the two other classes. Likewise, tourists belonging to the Class 2 ("oyster-risk driven") have significantly lower levels of income, larger household size and a stronger attachment to the area score, and were more attentive to risk in the choice scenarios than were the other segments. Interestingly, each of the three segments is more spatially defined. Tourists of Segment 1 would mainly stay in the north of the bay and those of Segment 2 in the south of the bay. Knowing the connection we made between the oyster farming production models (Table 1) and the 3 respondent segments related to individual preferences for land use changes and more specifically for oyster farming changes (Table 5), we wonder whether such a spatial segmentation of the demand side could help to structure and organize the oyster management options.

5. Discussion & conclusion

To the best of our knowledge, this paper presents the first assessment of individual preferences for coastal land use management focused on the oyster farming industry and its heritage dimension. The study purpose was to contribute to the current debate on ICZM in the Arcachon Bay area through the specific angle of the oyster farming development strategies. Our results are useful inputs at three levels. They also support the idea of future research.

Concerning the technical aspects, we decided to apply a latent class model. This choice has been supported by the advantage of taking into account preferences heterogeneity and of easily communicating with policy-makers. The 3-segments model estimation therefore provides interesting results regarding the different preferences of tourists concerning changes in oyster farming. Indeed, the three segments of our tourists' sample differ from the way they accept changes in the oyster farming local activity. Some of them, as we supposed, are "changes adverse" according to the oyster farming attribute: they definitely prefer an artisanal activity with all the landscape amenities it allows even if it as associated with a high degree of exposure to water pollution. At the opposite, another group of tourists are "risk driven" and prefer loosing oyster-farming amenities if it reduces the risk of being impacted by pollution. The third group of tourists expresses a medium position. This analysis in terms of preferences is of main importance to decision makers at the local scale in order to qualify the way their decisions may differently impact the tourists' population. If the final goal would be to estimate the expected costs and benefits of a specific coastal land use plan or of a specific oyster farming development strategy, then we would implement a mixed logit (McFadden, Train, 2000; Hensher Greene, 2003), owing to its overall flexibility. This model would deal not only with a high degree of heterogeneity but also with a high degree of complexity, explaining why the LCM would be seen as a first step in the estimation and would probably help to define the random parameters of the mixed logit.

Concerning the conceptual contribution, market and non-market dimensions are both of specific interest to grasp the entire role of oyster farming in Arcachon Bay. The main point made in this study is that these two dimensions do not seem to be disconnected. From the production side, the landscape aspect of the activity is strongly attached to the kind of practices implemented during the productive process. The production models that we have specified take this into account. Even if all the oyster farmers realize the importance of the landscape/amenity aspect of their activity, their responses to the current crisis of the industry have various impacts on the oyster farming non-market benefits. From the demand side, by distinguishing the amenity dimensions from the productive and risk dimensions of oyster farming, it was shown that tourists assess oyster farming in Arcachon Bay as having significant value. This value is not only driven by amenity concerns, as risk- and production-related issues are also of specific concern to some classes of tourists. These findings confirm the relevance of studying market and non-market outputs jointly.

Lastly, concerning the empirical and practical contribution, this study, which sheds light on the heterogeneity of tourists' preferences concerning oyster farming, allows us to provide some possible answers for decision makers about the local management of the oyster farming industry, in view of the multi-functional dimensions of this activity. It is important to highlight the fact that the local industry is not totally homogeneous but, on the contrary, is characterized by the simultaneous existence of several production models, and that tourists actually value this diversity. The study thus highlights the complementarity between the different forms of oyster farming. While the multi-functionality of the activity can justify the development of support measures in order to maintain the aesthetic dimension, for example, in particular in the context of crisis, the analysis of tourists' preferences also stresses the importance of the problem of the productive capacity. The tourists in Segment 1 and 2 are clearly interested in the productive dimension. Only those in the third segment have a strong preference for traditional oyster farming based on its landscape aspect, without adaptation of the production model to the context of crisis. These results mean that the local oyster farming industry should find different ways to develop or maintain its activity. They also mean that the development of oyster hatchery appears to be a potential way out, even though not all the oyster farmers or all the tourists see it as an acceptable strategy. Oyster hatchery development is clearly mentioned by local managers of this industry as a way to avoid some of the difficulties that they have recently known. In the same time, some oyster farmers (a minority at the moment) start developing “pesca-tourism” activity as a complementary activity to oyster farming. The condition of a successful management of this industry in the framework of ICZM is finally more the preservation of the diversity of production models than the preservation of only the heritage dimensions or support only for the productive dimension.

An interesting way to extend this work would be to further explore the idea of diversity or heterogeneity, from both the production and the demand side. Is this heterogeneity expressed spatially? Is it expressed from the point of view of a different social and attitudinal segmentation? Two additional empirical enquiries would thus be required. First of all, by spatializing the analysis, policy makers would need to know whether the study area needs to be geographically specialized concerning the oyster farming land use. We have already looked at this specific point when we checked the geographical situation of each class of tourists. We should also study whether the oyster farming production strategies are spatially different in Arcachon Bay. Secondly, the resident population should also be surveyed in order to have a more global image of the way the users of this territory, and not only the tourists, value the multiple dimensions of the oyster farming industry. The twofold analysis of both tourists and residents has usually been of great interest (Oh et al., 2010 for example) and in our case we suppose that residents see the heritage and productive dimensions of the oyster farming land use differently, with a different point of view from the tourists concerning.

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