Valuing the recreational services of the Port-Cros National Park (France): a re-designed travel cost method using count data models

Thierry Blayac, Fady Hamade, Jean-Michel Salles

Valuing the recreational services of the Port-Cros National Park (France):

A re-designed travel cost method using count data models

Thierry Blayac[1], Fady Hamadé[2] and Jean-Michel Salles[3]

Abstract

Travel cost method is used to estimate the value of the Port-Cros National Park, a marine and terrestrial natural protected area situated on and around a Mediterranean island in the South of France. We used a sample of 600 visitors surveyed on several places on site. In order to get appropriate time and travel costs for multi-destination travels, a motivation scale is introduced to weight the costs according to the influence of the Park in the decision to visit the region. The value of time is estimated following two methods and the results are discussed. The values obtained for consumer surpluses emphasize the uniqueness of the site which can be related to the insular situation and the fact that a marine protected area accessible to a large number of visitors remains exceptional.

Keywords: Count Data Models, Opportunity cost of time, Recreation Demand, Travel Cost Method.

JEL Classification: Q26, C35, D60.

[1] Université Montpellier 1, UMR5474 LAMETA, F-34000 Montpellier, France.
Corresponding author : blayac@lameta.univ-montp1.fr
Faculté d'Economie – LAMETA, Avenue Raymond Dugrand, Site de Richter, CS 79606, 34960 Montpellier Cedex 2, France. Tel: +33 4 34 43 24 81
[2] Ireedd and BRL Ingéniérie, fady.hamade@brl.fr.
[3] CNRS, UMR5474 LAMETA, F-34000 Montpellier, France. sallesjm@supagro.inra.fr

1. Introduction

> ***It's easier to see with the lights on.*** *Understanding the full range of ecosystem services makes tradeoffs visible and helps local policy makers make informed choices about different policy options. Examining which services will be enhanced and which ones degraded, can illuminate the various costs and benefits of each policy option – as well as their distribution between different community groups*.
>
> (Wittmer and Gundimeda, 2011),

The valuation of ecosystem services, namely for recreational uses, can be of real importance for better understanding of the issues and the definition of a more relevant management of the concerned areas (MEA, 2005; Kumar, 2010). This issue is particularly important for protected areas which receive numerous visitors. This is the situation facing the Port-Cros National Park (PCNP) in the South of France which is a mixed terrestrial and marine protected area, established on the Mediterranean island of Port-Cros (Cf. Figure 1).

FIGURE 1: LOCATION OF PORT-CROS NATIONAL PARK (PCNP)

There is an extensive experience of using the travel cost method (TCM) to value the recreational services provided by defined areas. In this paper, this approach is used to estimate the value of the PCNP as an institution that controls and offers a range of recreational activities related to natural protected areas. Several innovations have been introduced in the TCM or adapted in order to capture specific aspects of the policy of the PCNP.

Section 2 gives some background on the Port-Cros National Park (PCNP) and the offered recreational activities. Section 3 describes the protocol, the data and the variables used. Section 4 explains the estimation strategy, both for valuing the components of the travel costs (monetary expenses and opportunity cost of time) and the econometric models used to estimate the recreation demand. Section 5 presents and discusses the econometric results and their economic implications.

2. Background on the PCNP and the recreational activities it allows

One of the oldest national parks in France and the first marine park in Europe, the PCNP was established in 1963 on the Mediterranean island of Port-Cros. The state is the sole land owner on the Port-Cros island, which is a natural protected area. The Park includes today the islands of Port-Cros, Bagaud, La Gabinière and the Rascas with a marine perimeter of 600 meter wide. The central area of park (the so-called "Coeur de parc") covers 700 ha of terrestrial area and 1288 hectares of marine area.

The neighboring island of Porquerolles (1000ha) and, on the mainland, Cape Lardier (325ha), the former Salins d'Hyères (900ha) and Giens (110ha) belongs to the buffer zone (the "zone d'adhésion") and are also administered by the Park (Cf. Figure 2).

FIGURE 2: GEOGRAPHICAL AREA OF THE PORT-CROS NATIONAL PARK

The access is regulated through the control of the public service of boats. Some 80 000 to 100 000 visitors come every year on the island of Port-Cros for recreational activities such as diving, snorkeling or simply discovering nature. An underwater trail, with submarines panels submerged, allows visitors to explore the exceptional fauna and flora of the Mediterranean littoral. Visits could be accompanied by professional guides.

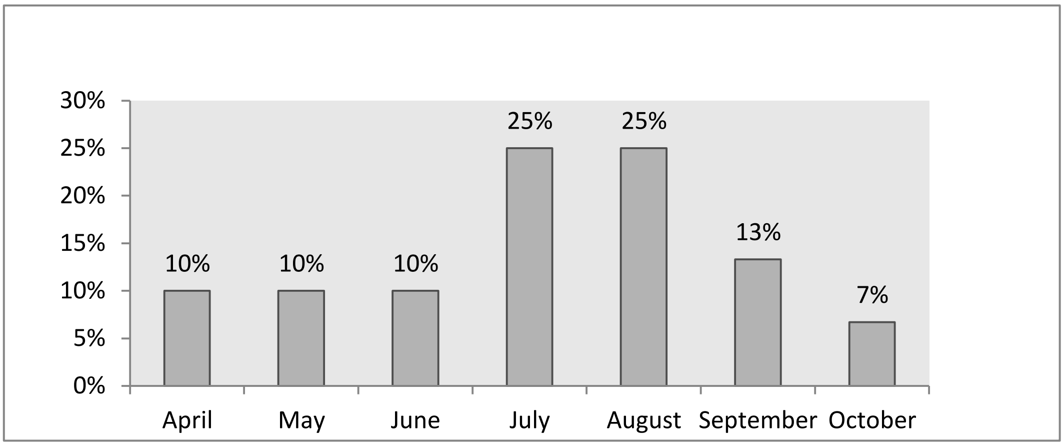
The island of Porquerolles receives some 400 000 to 450 000 visitors each year. The recreational activities appear somewhat different from those offered on the Port-Cros Island since Porquerolles is a less strongly protected area where biking and fishing namely are allowed.

3. Protocol, data and variables

3.1. Data collection

600 surveys of visitors were conducted on-site between April and October 2010. Visitors were intercepted at the Park entrances and at a set of hotspots within the park and on each of the two islands of Port-Cros and Porquerolles. In order to examine all types of visitors, interviews were held on weekend, week, during schooldays and holidays (cf. Figure 3). Interviewers were distributed across the park according to a sampling plan developed with the help of representatives of the Port-Cros National Park in order to ensure that visitors from all origins and using different facilities had a high likelihood of being interviewed.

FIGURE 3: THE DISTRIBUTION OF THE SURVEYS DURING THE YEAR 2010



The questionnaire included questions on the main reasons for the trip, the number of times the respondent had visited the park in the previous twelve months, home location, duration of visit, attractions visited, income bracket, travel steps, travel cost, size and age composition of travel party, and other sites visited during the same holiday.

3.2. Motivation scale

TCM assumes that travel costs incurred to reach a site can be used to approximate the surrogate prices for non-market recreational experiences. A basic assumption is that the travel cost is always incurred for a single purpose recreational trip. In the PCNP, this is not always the case. The difficulty is to allocate travel costs involving multiple destination trips (MDT) and/or multiple purposes in recreational activities. The problem is to allocate joint costs.

Several studies have suggested assuming that travel costs were incurred exclusively to visit a single site. Other authors have excluded the visitors considered as holiday-makers and other non-traditional visitors from the sample. But ignoring MDT visitors decreases the sample size and may result in an underestimate of total benefits of the site. On the other hand, Loomis and al. (2000), using a methodology proposed by Parsons and Wilson (1997) and

Mendelsohn and al. (1992), found that mixing single trip visitors with MDT visitors increases the consumer surplus by about 20%.

Kuosmanen and others (2004), in their evaluation of the Bellenden Kerr National Park in Australia (see also Nillesen and others (2005), used ordinal rankings of the alternative MDT sites as a basis for extracting cardinal cost-shares with which to conduct their TCM. Martinez-Espineira et al. (2008, 2009) adopted a similar approach based on weighting the price variable in order to adjust for the relative importance of the studied site within the multi-destination/multipurpose trip.

In this article, we adopt the same approach. Respondents are asked to state the influence of our single studied site on the decision to take the trip. The purpose is to quantify the weight of the Islands of Port-Cros/Porquerolles in the choice of their destination. Individuals were asked to rate on a scale from 0 to 10 the weight of site of PCNP on their choice of destination.

On average, the weight factor is 7.82 (Cf. Table 1) which indicates the strong attractiveness of the site among the regional recreational opportunities. This attractiveness is supported by the high variable "mileage (highway mode A/R)." Indeed, the average distance to and from road to get to the site of the PCNP stands at 1050 kms. This high value coincides logically with very significant transportation costs, of around € 300 on average per consumption unit (CU), with a median value around € 250.

Visitors come to the Port-Cros national Park using cars, planes or boat. Expenditure patterns of visitors to the PCNP were broken down into two categories, the approach expenditures and the localized expenditure.

The approach expenditures are those incurred to go from the main residence to the holiday residence. Localized expenditure, are expenditure incurred after that visitor have taken their holiday residence.

The approach expenditures were weighted using the weighting stated by the non local visitors, while the localized expenditures were always weighted 10. For visitors living in the region, all expenditures were weighted 10, since if they decide to visit the Park, it is on a on day trip without any other stop.

3.3. Brief description of the sample

Within the sample, 30% of the visitors were less than 34 years old, 36% are between 35 and 54 years old, and 34% were over 55 years. Visitors come from all around the world, but they are mostly European. 89% are French, 4% are Italian, 3% are Suisse, 2% are Belgian, 1% are German, and the 1% left come from other countries. 35% of the French visitors are local visitors, i.e. from the PACA region; about 20% come from the Paris and its neighborhood.

The average monthly income per consumption unit (CU) of the respondents was 2146 €. It is 20% higher than the average income of the French population. The average number of CU was 1.69, while it is 1.60 at the national level, which means that the park is a family attractive site.

79,50% of the visitors are tourists staying at least one night near the park, and the remaining 20,50% are visitors on a one day trip coming from the neighboring region of PACA.

Other statistics of interest are reported in table 1.

TABLE 1: SAMPLE DESCRIPTIVE STATISTICS (565 obs.)

Variables		Mean	SD	Median
Number of visits		2,01	2,76	1
Weight Factor		7,82	3,22	10
Distance to access (road – Two ways - km)		1050,09	820,83	991
Transportation Cost (Two ways - €)		296,52	327,84	247,41
Opportunity cost of time (Two ways - €)				
	Terra	56,34	52,96	45,14
	Boîteux	165,56	134,75	144,51
Monthly Income by consumption unit (€)		2146,35	1101,98	1785,71
Age		46,56	16,30	50
Number of Consumption Unit by household		1,69	1,08	1,50
			Fréquence	
Male			63%	
Female			37%	
Resident			20,54%	
Nearby trip			69,70%	
Step on trip			9,76%	
Retired			23,82%	
Student			5,78%	
Skilled Worker			4,62%	
Employee			22,63%	
Higher managerial and professional occupations			16,59%	
Lower managerial and professional occupations			18,49%	
Intermediate occupations			7,29%	
Unemployed			0,78%	

On average, people come twice a year with a median value of one. Costs they face to get on the site PCNP are relatively high.

4. Estimation strategy

4.1. Valuing the various components of the travel costs

The Travel Cost Method (TCM) requires assessing all costs related to the visit of Port-Cros National Park. It is now conventional to distinguish between the cost of transportation itself and the cost of travel. Indeed, the latter introduces elements such as the accommodation cost, expenses on the site (catering, fishing, cycling,…) but also the opportunity cost of time.

4.1.1. The determination of transport costs

For the reasons explained in paragraph 3 (cf. the weight factor), we distinguish in the distance to the National Park two components: an approach trip and a nearby trip. For the former, users can use one of the following modes: train, plane, car and motorcycle. For public transport modes, we use the information provided by individuals on ticket prices. For road trips, we use the scale given by the tax administration for the year 2010 (cf appendix 1). For the latter, users can use the shuttle boat, hired boat or private boat (sail or motor). The first two modes do not imply any difficulties in terms of assessment of their cost: we retain the values provided by the individuals. For private boat, assessing the true cost of ownership is more ambiguous. We consider that the cost of renting a boat, under certain assumptions, can be used as proxy variable of private boat using cost. We use the rates for weekly rentals of various boats for a period of 9 hours of daily use[4] (cf. appendix 2). We also incorporate in the cost of travel expenses incurred to park the vehicle.

Finally, it should be noted that all the costs mentioned in this paragraph are weighted by the weight factor.

4.1.2. The opportunity cost of time

Since Cesario (1976), it is no longer any doubt that it is necessary to valuing the time spent to access to the recreational site. So the issue is how to value the opportunity cost of time[5]. For a long time, the values of time, derived from a work-leisure tradeoff models, have been used. These values were obtained from studies (cf. Beesley (1965), Quarmby (1967), …) of time-money tradeoffs in urban commuter mode choice: they stand between 20% and 50% of wage rate. Although the values used are questionable, it still seems that taking into account the opportunity cost of time in the Travel Cost Method (TCM) significantly improves the results. According to McConnell and Stand (1981, 1983), the most critical aspect of the methodology proposed by Cesario is that it uses values of time obtained in another context

---

[4] Weekly rental rates for ships are from 15 to 20% lower than the rates for daily rental. Also, calculate the hourly cost of using a private boat based on the rental rate for a life of 9 hours per day further reduces cost. We can with this method estimate that the hourly cost of using a private boat is about 30% lower than a rental boat of similar size.

[5] Bishop and Heberlein (1979) have shown that total consumer surplus is nearly four times as large when time costs was valued at one-half the median income and when time was omitted from the model. Indeed, omit the cost of time overestimate the effect of a price change and so underestimate the consumer surplus relative to a price changes.

(mainly, studies of modal choice for commuting) and is applied without any restrictions at the recreational aspect. Moreover, these values of time are estimated for a sample of individual different from those involved in the study of recreational demand. McConnell and Strand (1981) provide a method of estimating the opportunity cost of time in the demand for recreation context. Their methodology has the advantage of being implemented in conjunction with the Travel Cost Method and only requires collecting the hourly wage rate or income of respondents. In any case, it does not use an exogenous estimated value for the opportunity cost of time. For example, in their study relative to sport fishing, they find an opportunity cost of time around 60% of the average income of individuals. They also specify that "this value is applicable only to our sample. However, by estimating it directly from observations on individual behavior we have eliminated the need for ad hoc and arbitrary valuation of the opportunity cost of time". It nevertheless true that the methodologies developed based on the work-leisure tradeoff model which presents very restrictive limits: in particular, for this model, individual can freely choose the number of worked hours. Bockstael and al. (1987) develop a behavioral recreational demand model incorporating theoretical advances of the labor market literature. Consideration of situations other than those corresponding to the extreme case (perfect substitutability between worked hours and leisure, or on the contrary fixed working hours) allows authors to achieve interesting results: for any interior solution on the labor market, the wage rate represents the individual's value of time because work and leisure can be traded at the margin ; but for corner solution on the labor market, as for example unemployment or fixed worked hours, we can't use the wage rate as proxy of individual's value of time. The authors emphasize in this latter case, the individual's opportunity cost of time is not zero either, it is just equal to an unobservable parameter. The work of Bockstael and al. (1987) gives theoretical foundation in the valuation of individual's value of time but leads to indeterminacy on a practical viewpoint in certain cases (i.e. corner solutions on labor market). In his paper, Shaw (1992) suggests that alternative way in determining the opportunity cost of time is the use of certain contingent valuation techniques such as stated preferences or more generally discrete choice experiments. To do this, the economists drop the use of work-leisure tradeoff models for the benefit of time allocation models such as that developed by DeSerpa in 1971. In the same line with DeSerpa's model, individuals maximize their utility in triple constraints: a standard budget constraint, a constraint of total available time and a constraint of minimal time consumption. It is then possible to distinguish two kinds of activities: (i) activities for which individuals do not saturate their minimum time consumption constraint and for which they are not willing to pay to save a unit of time spent on these activities. Typically, these are activities which belong to final consumption including recreational activities. (ii) activities for which consumers are already at the minimum time requirement and for which they are willing to pay to save a unit of time spent in these activities. These are activities that have characteristics of intermediate consumption and which are usually the case of transport activities. For these activities, the willingness to pay to save a unit of time is equal to the marginal rate of substitution between time spent in the activity and money. Formally, we get: $WTP_i = \frac{\frac{\partial V}{\partial t_i}}{\frac{\partial V}{\partial p_i}}$, where the subscript i represents the activity, t_i the time spent in the activity i, and p_i the price of the activity i.

Over time, research on the valuation of the opportunity cost of time in recreation demand models have continued and have always been built around these two main axis: work-leisure tradeoff versus time allocation models (cf. McConnell (1992), Larson (1993a, 1993b), McKean and al. (1995), Shaw and al. (1999) and Larson and al. (2004)).

More specifically, in the French case, we find again these two main approaches. However, the technical notes of the Department of Ecology, Sustainable Development and Spatial Planning suggest using the wage rate as an estimate of the opportunity cost of time. More precisely, expert recommendations (Terra, 2005) lead to retain the following formula for the opportunity cost of time in recreational demand:

$$Cost\ of\ Time = 2 \times \frac{1}{3} \times \frac{Travel\ Time}{60} \times \frac{Monthly\ Income}{135} \qquad (1)$$

So this formula holds as the opportunity cost of time a ratio equal to one third of the hourly wage rate. Indeed, 135 accounts for the monthly legal work of a French employee. Travel time (in minute) is accounted for one-way trip, which requires the inclusion of a multiplicative factor of 2 in the formula.

There is, moreover, a study (Boîteux, 2001) on behalf the *Commissariat Général du Plan* based on optimal time allocation models. This study is known as Boîteux Report. In this report, the estimated values of time for personal travel outside of working hours and a rule for updating the values are provided for the reference year (1998). Reassessed values for year 2010 for various transport modes are shown in the following table:

TABLE 2: 2010 BOÎTEUX REPORT REASSESSED VALUES OF TRAVEL TIME (€/h)

Transport Mode	distance<150 km	150 km $\leq$distance $\leq$ 400 km	distance> 400 km
Car	14,52	1,191×(d/10+50)/6,56	16,32
Train 2nd class	12,74	1,191×(3d/10+445)/6,56	14,65
Train 1st class	32,63	1,191×(9d/10+1125)/6,56	38,47
Plane	/	54,43	54,43

From the perspective adopted by Boîteux (2001), the opportunity cost of time is differentiated by mode of transport and distance. This is not the case if one adopts the Terra's approach (eq(1)). These two approaches lead to substantially different valuations of the opportunity cost of time, with a clampdown in the gap when the monthly income of individuals increases. These differences lead us to retain the two approaches and to discriminate between the two based on econometric results.

It should be stressed that only journeys that represent intermediate consumption for the users, are be dressed in an opportunity cost of time (approach routes). Local routes and the time spent on the site of the natural park, which are similar to final consumption for the users, are not taken into account in the valuation of opportunity cost of time.

4.1.3. Other expenses to consider

The main expenses and costs incurred by visitors (other than the transport itself) are accommodation, marine travel companies, and activities' expenses. For 56% of the visitors, the accommodation is chargeable, the other 44% stays in friends or family apartment. The average length of stay is 9.9 nights. 19% stays in hotel, 11% in camping, 14% in a rent apartment, 2% in rural "Gite", 3% in a "Chambre d'hôte", 16% on a boat and 35% for other answers.

Once on site, unless they rent a boat, visitors have to take a marine travel companies (the "*navettes*" or shuttle) from the seashore to reach the islands.

Visitors may also need equipments to practice a recreational activity. On both island, there are stores for equipment renting. Stores for rent a boat rent a bike; rent a suite for diving etc.

4.2. The econometric models of recreational demands

In this section, we present the various kinds of econometric models that are suitable with the transport costs method. The latter is particularly suitable for the estimation of recreational demand. Recreational demand reveals in fact a small number of specificities to be taken into account in the estimation process if one wishes to obtain a high goodness of fit: discrete nature of the dependant variable, a preponderance of zeros and small values.

4.2.1. The Poisson model

The Poisson model allows the estimation of the probability of an event from a count process. Let y_i be the dependent count variable representing the number of visits made to the national park by an individual i in the past twelve months. The Poisson model specifies that each y_i is drawn from a count Poisson distribution of parameter λ_i, which depends on the vector of explanatory variables x_i. The probability given by the Poisson distribution for the number of visits to the site over the past twelve months is equal to k (any non-negative integer) is given by:

$$\forall\, k \geq 0,\ \forall\, i = 1, \dots, n \qquad Prob\{y_i = k \,/\, \boldsymbol{x_i}\} = e^{-\lambda_i} \frac{\lambda_i^k}{k!} \tag{2}$$

In most cases, the parameter of the distribution λ_i gets a semi-logarithmic formulation, as following:

$$\lambda_i = e^{(x_i \beta)} \tag{3}$$

With β is a vector of parameters to be estimated.

It can be shown that for this type of model, the mean and variance of the numbers of visits per period are equal to the distribution parameter λ_i. So we get:

$$E\{y_i/\boldsymbol{x_i}\} = Var\{y_i/\boldsymbol{x_i}\} = \lambda_i = e^{(x_i\beta)} \tag{4}$$

However, in data on recreational uses, the variance is often greater than the mean, which results in an over-dispersion. This over-dispersion leads to an underestimation of the standard deviations of the estimated coefficients from the Poisson model, and frequently leads to the rejection of the null hypothesis of no significance of the β coefficients: the estimated coefficients are often falsely significant. There are two non-exclusive causes usually given for the presence of over-dispersion in count data: the non-independence of the observations and the presence of heterogeneity not captured by the model. In the latter case, the over-dispersion phenomenon can be significantly reduced by using more appropriate variables. It should be noted that over-dispersion doesn't introduce any bias in the values of estimated coefficients β, but underestimates the standard errors: we may therefore conclude wrongly the role of a variable to explain the number of visits. These factors argue for the use of the negative binomial model.

4.2.2. The negative binomial model

The negative binomial model drops the assumption of equality of the mean and the variance of the number of visits to the site during the previous year. To do this, we introduce an individual heterogeneity term in the conditional mean of the Poisson model.

In the negative binomial model, the probability that the number of visits to the site over the past twelve months is equal to k (any non-negative integer) can be written as:

$$\forall\, k \geq 0,\ \forall\, i = 1, \dots, n \qquad Prob\{y_i = k\ /\ \boldsymbol{x_i}\} = \frac{\Gamma\left(k+\frac{1}{\alpha}\right)}{\Gamma(k+1)\Gamma\left(\frac{1}{\alpha}\right)} \cdot \left(\frac{\frac{1}{\alpha}}{\frac{1}{\alpha}+\lambda_i}\right)^{\frac{1}{\alpha}} \cdot \left(\frac{\lambda_i}{\frac{1}{\alpha}+\lambda_i}\right)^{k} \tag{5}$$

with Γ denoting the Gamma distribution and $\lambda_i = e^{(x_i\beta)}$.

The mean and variance are given by the following relations:

$$E\{y_i/\boldsymbol{x_i}\} = \lambda_i = e^{(x_i\beta)} \tag{6}$$

and

$$Var\{y_i/\boldsymbol{x_i}\} = \lambda_i(1 + \alpha\, \lambda_i) \tag{7}$$

The α parameter can be interpreted as an over-dispersion parameter. If $\alpha = 0$, the negative binomial model reduces to the Poisson model (cf. eq(2)). If $\alpha > 0$, we conclude to the presence of an over-dispersion phenomenon and the Poisson model must be rejected in favor of the negative binomial model.

Beyond this over-dispersion problem, we face another problem in relation with the data collection process. Indeed, choosing an on-site study results in one hand, the inability to sample non-visitors and also by the fact individuals who frequently visit the natural park have more likely to belong to the sample. The first difficulty is leading to a truncation at zero of the number of visits, while the second refers to a problem of endogenous stratification. The generalization of the results obtained on the sample to the general population therefore requires taking into account both the inherent difficulties related to the on-site data collection. This is precisely the aim of the research developed by Shaw (1988) for the Poisson model and Englin and Shonkwiler (1995) for the negative binomial model. Haab and McConnell (2002) have shown that the corrected density for the phenomenon of endogenous stratification also includes the correction for the truncation at zero.

4.2.3. Endogenous stratification and truncation at zero correction models

In the case of a Poisson model for a single site, Shaw (1988) shows that the density correction can be written as:

$$\forall\, k \geq 1,\ \forall\, i = 1, \dots, n \qquad Prob\{y_i = k \,/\, \boldsymbol{x_i}\} = e^{-\lambda_i} \frac{\lambda_i^{k-1}}{(k-1)!} \tag{8}$$

The mean and variance of the number of visits are then given by the following equations:

$$E\{y_i/\boldsymbol{x_i}\} = \lambda_i + 1 = e^{(x_i\beta)} + 1 \tag{9}$$

$$Var\{y_i/\boldsymbol{x_i}\} = \lambda_i = e^{(x_i\beta)} \tag{10}$$

The estimate of the Poisson model, adjusting simultaneously the phenomenon of endogenous stratification and of the truncation at zero, is obtained using the same process as those used for the Poisson model using as dependent variable the number of visits minus one.

The problem of over-dispersion of the data does not disappear with this process and one must use a negative binomial model. Englin and Shonkwiler (1995) generalize the Shaw's solution to the case of a negative binomial model. It then corrects simultaneously over-dispersion, the truncation at zero and endogenous stratification. The probability density of such a model is written as:

$$\forall\, k \geq 1,\ \ i = 1, \dots, n \qquad Prob\{y_i = k \,/\, \boldsymbol{x_i}\} = \frac{k \cdot \Gamma\left(k+\frac{1}{\alpha}\right)}{\Gamma(k+1)\Gamma\left(\frac{1}{\alpha}\right)} \cdot \left(\frac{\frac{1}{\alpha}}{\frac{1}{\alpha}+\lambda_i}\right)^{\frac{1}{\alpha}} \cdot \left(\frac{1}{\frac{1}{\alpha}+\lambda_i}\right)^{k} \cdot \lambda_i^{k-1} \tag{11}$$

In this model, the mean and variance of the number of visits is equal to:

$$E\{y_i/\boldsymbol{x_i}\} = \lambda_i + 1 + \alpha\lambda_i \tag{12}$$

$$Var\{y_i/\boldsymbol{x_i}\} = \lambda_i\left(1 + \alpha + \alpha\lambda_i + \alpha^2\, \lambda_i\right) \tag{13}$$

When performing on-site data collection, it is these models that should be used.

5. Econometric results and economic implications

5.1. The choice of explanatory variables

The variables used to explain the number of visits (*VISITS*) to the site of PCNP during the last twelve months can be divided into two categories: quantitative variables and qualitative variables. Among the quantitative variables, we use of course the variable of total travel cost (*TTC*). This variable includes all costs described in section 4.1 weighted by the weight factor. The weights used are different for each kind of visitors and are weighted or not by the number of consumption unit (*NCU*) of the household[6]. Since income is related to household and several expenses differ according to the number of persons involved, it appears relevant to weight their costs according to consumption units and not directly with the number of persons.

For individuals who return at night in their principal residence (called “resident” hereafter), we get:

$$TTC_{resident} = 2.\left\{\frac{TC_{approach}}{NCU} + \frac{TC_{nearby}}{NCU} + COT_{approach}\right\} + \frac{\{CAct.+Cpark.\}}{NCU} \quad (14)$$

For individuals who stay temporarily near (called “near” hereafter) or are a step on a journey (called “step)” hereafter), we get:

$$TTC_{near} = \frac{2\times WF}{10}.\left\{\frac{TC_{approach}}{NCU} + COT_{approach}\right\} + \frac{2\times TC_{nearby} + WF\times Accommo.+\{CAct.+Cpark.\}}{NCU} \quad (15)$$

$$TTC_{step} = \frac{2\times WF}{10}.\left\{\frac{TC_{approach}}{NCU} + COT_{approach}\right\} + \frac{2\times TC_{nearby} + WF\times Accommo.+\{CAct.+Cpark.\}}{NCU} \quad (16)$$

In expressions (14), (15) and (16), *TTC* is the total cost of the trip, *TC* is the transportation cost, *COT* represents the opportunity cost of time, *NCU* is the number of consumption unit, *CAct.* is the cost of the activities on the site of PCNP, *Cpark.* represents the cost of parking,

[6] The Number of Consumption Unit (*NCU*) is an indicator used by the French National Institute of Statistics (INSEE) to compare households of various sizes. The first adult of the household gets a weight of one. The other household members have a weight of 0.5 if they are more than 14 years old and 0.3 otherwise.

WF is the weight factor, and *Accommo.* is the cost of the accommodation on the site or nearby.

We also introduce in the model the household monthly income per number of consumption unit (*INCNCU*), the age of respondent (AGE), and the budget holidays of the household (*HOLBUD*).

The qualitative variables included in the model are the gender of the individuals (*GENDER*[7]), and dichotomous variables in relation with each kind of visitors (*NEAR*, *RESID*[8]).

Moreover, the activities made by visitors on the site are a priori significant factors explaining the number of visits. We made four groups of activities[9]. The group 1 (*GROUP1*) brings together five activities: water sports, scuba/snorkeling, swimming, fishing trail submarine. The group 2 (*GROUP2*) consists in exhibitions and the visit of the fortified castles. Discover the island on foot, mountain biking and nature are in group 3 (*GROUP3*). Finally, the group 4 (*GROUP4*) consists in five activities: beach, relaxing and relaxation, shops, restaurants and island tour by boat. These groups are not mutually exclusive. There is therefore no need to create a reference group. In addition, we also checked that the correlation between groups is low. The *GROUP1* variable takes the value 1 if any of the activities of the group 1 was performed and 0 otherwise. The same goes for other groups.

In order to obtain consumer surplus by activity, it is necessary to introduce into the model, interaction terms between group activity and the total travel cost variable (*TTC*). *INTER1*, *INTER2*, *INTER3* and *INTER4* variables correspond to the following interactions:

$$INTER1 = GROUP1 \times TTC \quad (17)$$

$$INTER2 = GROUP2 \times TTC \quad (18)$$

$$INTER3 = GROUP3 \times TTC \quad (19)$$

$$INTER4 = GROUP4 \times TTC \quad (20)$$

Finally, we created a dummy variable for each occupation and social class in the sample, eight in total. Table 3 summarizes the variables used in the model with a brief description.

---

[7] The *GENDER* variable is coded as follows: 0 if the respondent is a male, 1 otherwise.

[8] These dummy variables are introduced to capture the effect of each kind of visitors on the number of visits made to the site over the past twelve months. Thus, the variable *NEAR* is equal to 1 if the individuals interviewed are temporarily staying close and 0 otherwise. Similarly, the variable RESID equals 1 if the respondent is an individual who returns in the evening in his principal residence and 0 otherwise. The category of individuals who make a step on a path is used as the reference category: no dummy variable associated with it to avoid problems of multicollinearity.

[9] We first tested each activity separately but the results were inconclusive.

TABLE 3: MODEL VARIABLES AND BRIEF DESCRIPTION

Variables	Brief description
VISITS	Number of visits to the PCNP over the past twelve months.
TTC	Total Travel Cost of the trip. The weights used for each kind of visitors are different (*resident*, *near* and *step*).
TC	Transportation Cost. We distinguish two kind of path (*approach* and *nearby*).
NCU	Number of Consumption Unit of the household.
COT	Cost of time. We use two different valuations (*Terra* and *Boîteux*).
CAct.	It is the expenditures made by the respondent on the PCNP site, for leisure activities.
Cpark.	This variable represents the cost of parking the vehicle on the site.
WF	It's the weight factor. This variable is an important one for multi-destination and multi-purpose trips.
Accommo.	Cost of accommodation on the site or nearby.
INCNCU	The monthly income of the household per number of consumption unit.
AGE	The age of the respondents.
HOLBUD	The amount spent on holiday by the household.
GENDER	Dummy variable equals to 1 if the respondent is a female, 0 otherwise.
NEAR	Dummy variable equals to 1 if the individuals interviewed are temporarily staying close and 0 otherwise.
RESID	Dummy variable equals to 1 if the respondent is an individual who returns in the evening in his principal residence and 0 otherwise.
GROUP1	Dummy variable for the following activities: water sports, scuba/snorkeling, swimming, fishing trail submarine.
GROUP2	Dummy variable for the following activities: exhibitions and the visit of the fortified castles.
GROUP3	Dummy variable for the following activities: Discover the island on foot, mountain biking and nature.
GROUP4	Dummy variable for the following activities: beach, relaxing and relaxation, shops, restaurants and island tour by boat.
INTER1	Dummy variable for the interaction term between *TTC* and *GROUP1*.
INTER2	Dummy variable for the interaction term between *TTC* and *GROUP2*.
INTER3	Dummy variable for the interaction term between *TTC* and *GROUP3*.
INTER4	Dummy variable for the interaction term between *TTC* and *GROUP4*.

5.2. The results of the econometric process

Due to the on-site method for data collection, it is natural to focus on models with correction for truncation at zero and endogenous stratification. Therefore, we estimate the Poisson model of equation (8) (TSP) and the negative binomial model of equation (11) (TSNB) incorporating this corrections.

Firstly, we have to settle the problem of under or over-dispersion data. The estimation of the TSNB model leads to a parameter α that cannot be considered significantly different from zero. This is also confirmed by the likelihood ratio test between TSP model and TSNB model[10]. These elements argue for the rejection of the over-dispersion data hypothesis and lead us to use a Poisson model with truncation at zero and endogenous stratification (TSP). The TSP model is estimated for both versions of the opportunity cost of time, used in the study (cf. 4.1): the Terra approach versus the Boîteux approach. Only the variables significant at the 10% level are retained in the model. The results of the econometric estimation process are given in the following table:

TABLE 4: ECONOMETRIC RESULTS OF THE TSP MODEL ESTIMATION

	TSP Boiteux			TSP Terra		
Variables	**Coeff.**	**z**	**P>$\|z\|$**	**Coeff.**	**z**	**P>$\|z\|$**
TTC	-0,0036831	-6,24	0,000	-0,0042676	-6,14	0,000
GENDER	-0,5121419	-5,03	0,000	-0,5090386	-5,00	0,000
INCNCU	-0,0002078	-3,98	0,000	-0,0002136	-4,08	0,000
AGE	0,0191678	4,37	0,000	0,0189514	4,31	0,000
INTER2	0,0008171	5,60	0,000	0,0007796	5,15	0,000
INTER3	0,0003122	2,49	0,013	0,0002785	2,12	0,034
INTER4	0,0034763	6,02	0,000	0,0041061	6,00	0,000
GROUP2	-0,4303129	-2,03	0,042	-0,3410494	-1,68	0,094
GROUP3	-0,9168376	-8,61	0,000	-0,8923713	-8,50	0,000
RESID	1,102971	10,94	0,000	1,116604	11,32	0,000
Retired	0,4734736	2,72	0,006	0,4829557	2,78	0,005
Student	0,9376623	4,55	0,000	0,9167475	4,46	0,000
Employee	0,2862258	1,88	0,061	0,2828463	1,85	0,064
Higher managerial	0,5969723	3,40	0,001	0,5997578	3,42	0,001
Intermediate occupations	1,171026	6,79	0,000	1,179633	6,85	0,000
Intercept	-0,3366292	-1,41	0,158	-0,3449175	-1,45	0,148
Log L (intercept only)	-1205,46			-1205,46		
Log L (full model)	-938,92			-942,91		
R^2_{IRV}	0,2211			0,2178		
R^2_d	0,7420			0,4390		

For both models estimated, the Total Travel Cost (*TTC*) has a negative effect on the number of visits and satisfies the hypothesis underlying the transport cost method. The variables *GENDER* and *INCNCU* have also a negative influence on the number of visits. It means that the probability of visiting the PCNP decreases when the person is a woman and when the monthly income per consumption unit of the household increases. In most other studies on the recreational value of natural areas, the income variable is often not significant. The negative sign of this variable is more difficult to interpret since we are dealing with a recreational demand. In fact, we have to interpret the negative sign in relative terms: for individuals who come on the site, the probability of coming frequently decreases when the income of the individuals increases. *GROUP2* and *GROUP3* variables have also a negative

[10] The estimation results of the TSNB model are not provided in the paper. There are available on request upon the authors.

coefficient: these activities do not affect attraction beyond the first visit. Finally, the *AGE* of individuals has a positive effect on the number of visits.

Regarding the goodness of fit, depending on whether one uses indicators based on the comparison of log-likelihood or deviance based indicators, the two models are not of similar quality. The TSP Boîteux model outperforms rather widely the TSP Terra one, on the basis of R_d^2.

5.3. Valuing the welfare of the visitors

The travel cost method allows, from previous estimates, to calculate the recreational value of Port-Cros National Park. To do this, it is necessary to go through an intermediate step, which is to estimate the surplus of the visitors (consumer surplus). We calculate the surplus by consumption unit and by visit, but also the annual surplus, using the following formulas:

$$\widehat{CS}_i^{Visit} = -\frac{1}{\beta_{TTC}} \quad (21)$$

$$\widehat{CS}_i^{Annual} = -\frac{\hat{\lambda}_i}{\beta_{TTC}} \quad (22)$$

However, the use of relations (21) and (22) is based on the hypothesis that income effects are minimal. If income effects play an important role, alternatives measures of consumer welfare must be used in order to calculate economic benefits: it is the compensating variation and the equivalent variation. So, we get:

$$\widehat{CV}_i = \frac{1}{\beta_{INCNCU}} ln\left(1 + \hat{\lambda}_i \frac{\beta_{INCNCU}}{\beta_{TTC}}\right) \quad (23)$$

$$\widehat{EV}_i = -\frac{1}{\beta_{INCNCU}} ln\left(1 - \hat{\lambda}_i \frac{\beta_{INCNCU}}{\beta_{TTC}}\right) \quad (24)$$

It is also possible to determine surplus by activity. This requires, however, introducing an interaction term into the econometric model. When the interaction term and the term associated to the group are significantly different from zero, it is then possible to estimate the surplus by activity as follows:

$$\widehat{CS}_{Act_j}^{Visit} = -\frac{1}{\beta_{TTC}+\beta_{INTER_j}} \quad (25)$$

$$\widehat{CS}_{Act_j}^{Annual} = -\frac{\hat{\lambda}_{Act_j}}{\beta_{TTC}+\beta_{INTER_j}} \quad (26)$$

Given the econometric results provided in table 5, we are able to calculate the surplus by activity only for activities of group 2 and 3.

TABLE 5: ESTIMATED CS, CV, AND EV – GLOBAL AND BY ACTIVITY

Global Welfare (€)		
	TSP Boiteux	**TSP Terra**
CS by visit and by Consumption Unit	**271,51**	**234,32**
CS annual by Consumption Unit	447,99	478,02
Annual CV by Consumption Unit	-428,35	-455,16
Annual EV by Consumption Unit	-470,24	-504,22
Welfare by activity (€)		
GROUP2		
By visit and by Consumption Unit	348,92	286,70
Annual by Consumption Unit	450,11	369,84
GROUP3		
By visit and by Consumption Unit	296,66	250,68
Annual by Consumption Unit	456,86	386,05

A first point is to note that despite the difference in the assumptions allowing calculating CS according to the two approaches of the value of time, the final results are not widely different. Nevertheless, it is worth noting that, on a statistical point of view, the TSP Boiteux model fits best our data (the R_d^2 is equal to 0,742 for the TSP Boiteux, and only 0,439 for TSP Terra).

We also calculate confidence intervals at the 95% level for the surplus by visit and by consumption unit in euros. We get:

$$\widehat{CS}_{Boîteux}^{Visit} \in \ [190{,}25 \quad ; \quad 356{,}77] \qquad (27)$$

$$\widehat{CS}_{Terra}^{Visit} \in \ [159{,}51 \quad ; \quad 309{,}13] \qquad (28)$$

The values obtained for the recreational use of the Port-Cros National Park are consistent with those presented in the recreational valuation literature. From our point of view, the study conducted by Fleming and Cook (2008) on Lake McKenzie is the closest to our. The Lake McKenzie is located on Fraser Island on the East Coast of Australia. The issues raised by the management of the Port-Cros National Park show a lot of similarities with that of other insular protected areas, and especially with Lake McKenzie, since both sites are protected areas and belong to the UNESCO World Heritage List.

In the Lake McKenzie study, the consumer surplus stands between 146 and 339 Australian dollars per visit and per person, or between 118 and 274 € (January 2012 exchange rate). These values are close to ours and this result emphasizes the uniqueness of the site which can be related to the insular situation and the fact that a marine protected area accessible to a large number of visitors remains exceptional. These points are corroborated by the high value of the weight factor (Average *WF*=7.82 in a 0 to 10 scale). Recall that this factor has been introduced to allow respondents to indicate the importance attached to the visit PCNP as part of a multi-purpose trip.

6. Concluding remarks

The paper aimed at valuing the use of the PCNP for recreational activities in order to emphasize its great importance and help the public body in charge of this area to draw more precise information useful for improving its management. From the estimates obtained in this paper, we estimate that the recreational uses of the PCNP may be valued at 75 to 90 million euros per year. To achieve these results, we used a Travel Cost Method with count data models. In this method, we gave particular importance to two points which we considered fundamental: the valuation of the opportunity cost of time on the one hand, and the motivation scale for multi-destination and multi-purpose trips on the other.

For the former, the standard approach based on the use of a value derived from a work-leisure tradeoff model led to the selection of a fraction of the hourly wage rate as opportunity cost of time (Terra approach). It is also possible to use values derived from a monetary and time resources optimal allocation model (Boîteux approach). The comparative study allows us to conclude, in our case, to the superiority of the Boîteux approach.

For the latter, we used a motivation scale to treat properly the particular situations of each kind of visitors (resident, near and step). When the travel is only a local journey, attributing all the related expenses to the cost incurred to visit the Park appears legitimate. However, for visitors from distant places, visiting the Park must be regarded a priori as being only one motivation among others. We therefore introduce a motivation scale on which we asked subjects to indicate the degree of importance of visiting the park in this set of reasons. This factor obviously lowers the weight of distant travelers in the calculation, but its importance remains limited because the park appears as an important reason for their trip to the majority of its visitors.

Finally, results showed high value for the consumer surpluses, consistent with those obtained in the literature for recreational demand for similar high quality natural areas. However, further analysis will be needed to study the specific effect of the particular activities offered by the marine character of the Park since available information did not allow identifying a specific added value.

Acknowledgments

This study was co-funded by the National Parks of France (PNF), the Ministry of Ecology, of Sustainable Development, Transportation and Housing (MEDDTL), the Commissariat Général for Sustainable Development (CGDD) and the Rhône-Mediterranean-Corsica Water Agency.

We are grateful to all members of the steering committee (COPIL) and members of the staff of the Port-Cros National Park (PNPC) who were involved in the study.

Appendix 1

TABLE 6: KILOMETRIC SCALE FOR THE YEAR 2010

Power of the car	Untill 5000 kms	From 5001 to 20000 kms	Beyond 20000 kms
3 CV	d×0,387	(d×0,232)+778	d×0,271
4 CV	d×0,466	(d×0,262)+1020	d×0,313
5 CV	d×0,512	(d×0,287)+1123	d×0,343
6 CV	d×0,536	(d×0,301)+1178	d×0,360
7 CV	d×0,561	(d×0,318)+1218	d×0,379
8 CV	d×0,592	(d×0,337)+1278	d×0,401
9 CV	d×0,607	(d×0,352)+1278	d×0,416
10 CV	d×0,639	(d×0,374)+1323	d×0,440
11 CV	d×0,651	(d×0,392)+1298	d×0,457
12 CV	d×0,685	(d×0,408)+1383	d×0,477
13 CV and more	d×0,697	(d×0,424)+1363	d×0,492
d is the distance traveled during the year			

Appendix 2

TABLE 7: HOURLY COST OF USING OF A PRIVATE BOAT

		Hourly cost		
Type	**Length (m)**	**Others periods**	**July**	**August**
Motor	6,25	31,11	36,67	37,78
	6,35	32,22	36,67	37,78
	6,40	31,11	36,67	37,78
	6,50	32,22	36,67	37,78
	6,50	32,22	36,67	38,89
	7,15	37,78	41,11	43,33
	7,50	37,78	41,11	43,33
	7,50	40,00	44,44	45,56
	8,05	55,56	66,67	72,22
	8,95	66,67	80,56	86,11
	10,85	74,60	90,48	93,65
	11,80	87,30	103,17	106,35
		From 01/01 to 05/06 and from 09/17 to 12/31	**From 05/07 to 07/15 and from 08/20 to 09/16**	**From 07/16 to 08/19**
Sailing	10,30	19,68	26,83	33,97
	11,00	23,02	30,00	39,52
	12,10	31,59	41,11	52,22
	12,90	34,13	39,52	53,96
	13,20	39,52	51,43	66,51

References

Beesley, M. E. (1965), “The Value of Time Spent Travelling: Some New Evidence”, ***Economica***, 32, 174-185.

Bishop, R. C. and T. A. Herbelein (1979), “Measuring Values of Extra-Market Goods: Are Indirect Measures Biased?”, ***American Journal of Agricultural Economics***, 61, 926-930.

Bockstael N.E, Strand I. E. and W. M. Hanemann (1987), “Time and the Recreational Demand Model”, ***American Journal of Agricultural Economics***, 69, 293-302.

Boîteux, M. (2001), “Transports : choix des investissements et coût des nuisances », ***Rapport du Commissariat Général du Plan***.

Cesario, F. J. (1976), “Value of Time in Recreation Benefit Studies”, ***Land Economics***, 52, 32-41.

DeSerpa, A. C. (1971), “A Theory of the Economics of Time”, ***Economic Journal***, 81, 828-846.

Englin, J. and J. S. Shonkwiler (1995), “Estimating Social Welfare Using Count Data Models: An Application to Long-run Recreation Demand Under Conditions of Endogenous Stratification and Truncation”, ***The Review of Economics and Statistics***, 77, 104-112.

Fleming, M. and A. Cook (2008), “The Recreational Value of Lake McKenzie, Fraser Island: An Application of the Travel Cost Method”, ***Toursim Management***, 29, 1197-1205.

Haab, T. C. and K. E. McConnell (2002), “***Valuing Environmental and Natural Resources – The Econometrics of non-market valuation***”, Edward Elgar Publishing Limited.

Kumar, P. ed. (2010), ***The Economics of Ecosystems and Biodiversity. Ecological and Economic Foundations***, Earthscan, London.

Kuosmanen, T., Nillesen, E. and J. Wesseler (2004), “Does Ignoring Multidestination Trips in the Travel Cost Method Cause a Systematic Bias”, ***Australian Journal of Agricultural and Resource Economics Society***, 48, 629-651.

Larson, D. M. (1993a), “Joint Recreation Choices and Implied Values of Time”, ***Land Economics***, 69, 270-286.

Larson, D. M. (1993b), “Separability and the Shadow Value of Leisure Time”, American Journal of Agricultural Economics, ***American Journal of Agricultural Economics***, 75, 572-577.

Larson, D. M., Shaikh S. L., and D. E. Layton (2004), “Revealing Preferences for Leisure Time from Stated Preference Data”, ***American Journal of Agricultural Economics***, 86, 307-320.

Loomis, J., Yorizane, S. and D. Larson (2000), "Testing Significance of Multidestination and Multi-purpose Trip Effects in a Travel Cost Method Demand Model for Whale Watching Trips", ***Agricultural and Resource Economics Review***, 29, 183-191.

Martinez-Espineira, R. and J. Amoako-Tuffour (2008), "Recreation Demand Analysis Under Truncation, Overdispersion, and Endogenous Stratification: An application to Gros Morne National Park", ***Journal of Environmental Management***, 88, 1320-1332.

Martinez-Espineira, R. and J. Amoako-Tuffour (2009), "Multi-destination and Multi-purpose Trip Effects in the Analysis of the Demand for Trips to a Remote Recreational Site", ***Environmental Management***, 43, 1146-1161.

McConnell, K. E. and I. E. Strand (1981), "Measuring the Cost of Time in Recreation Demand Analysis: An Application to Sportfishing", ***American Journal of Agricultural Economics***, 63, 153-156.

McConnell, K. E. and I. E. Strand (1983), "Measuring the Cost of Time in Recreation Demand Analysis: Reply", ***American Journal of Agricultural Economics***, 65, 172-174.

McConnell, K. E. (1992), "On-Site Time in the Demand for Recreation", ***American Journal of Agricultural Economics***, 74, 918-925.

McKean, J. R., Johnson D. M. and R. G. Walsh (1995), "Valuing Time in Travel Cost Demand Analysis: An Empirical Investigation", ***Land Economics***, 71, 96-105.

MEA (Millennium Ecosystem Assessment) (2005), ***Ecosystems and Human Well-being: Synthesis***, Wahington DC, Island Press, 137p.

Nillesen, E., Wesseler, J. and A. Cook (2005), "Correcting for Multiple Destination Trips in Recreational Use Values. An Application to Bellenden Ker National Park, Australia", ***Environmental Management***, 36, 311-316.

Parsons, G. and A. Wilson (1997), "Incidental and Joint Consumption in Recreation Demand", ***Agricultural and Resource Economics Review***, 26, 1-6.

Quarmby, D. A. (1967), "Choice of Travel Mode for the Journey to Work", ***Journal of Transport Economics and Policy***, 1, 273-314.

Shaw, D. (1988), "On-Site Samples Regression - Problems of Non-negative Integers, Truncation and Endogenous Stratification", ***Journal of Econometrics***, 37, 211-223.

Shaw, W. D. (1992), "Searching for the Opportunity Cost of an Individual's Time", ***Land Economics***, 68, 107-115.

Shaw, W. D. (1999), "Possibilities for Including the Opportunity Cost of Time in Recreation Demand Systems", ***Land Economics***, 75, 592-602.

Wittmer, H. and H. Gundimeda, Eds. (2011), The Economics of Ecosystems and Biodiversity in Local and Regional Policy and Management. Earthscan, London.

Terra, S. (2005), “Guide de bonnes pratiques pour la mise en œuvre de la méthode des coûts de transport », DT Etudes-Méthodes-Synthèse, ***Ministère de l’écologie et du développement durable***, mars 2005, France.