ENVIRONMENTAL VALUATION AND MANAGEMENT OF WILD EDIBLE MUSHROOM PICKING IN SPAIN

Pablo de Frutos[a1], Beatriz Rodriguez-Prado[b], Joaquín Latorre[c], Fernando Martínez-Peña[d]

[a] *University of Valladolid. Facultad de Ciencias Empresariales y del Trabajo, 42002, Soria, Spain.*
[b] *University of Valladolid. Facultad de Ciencias Económicas y Empresariales, 47011, Valladolid, Spain.*
[c] *European Mycological Institute EGTC-EMI, 42003 Soria, Spain*
[d] *Agrifood Research and Technology Centre of Aragon CITA, Montañana 930, 50059 Zaragoza, Spain*

Abstract

Applying environmental valuation techniques to improve environmental management is a strategy re- commended by the leading international organisations. The present research applies the zonal version of the travel cost method to estimate the intertemporal demand functions for wild edible mushroom picking in various regulated areas in Castilla y León (Spain) through the sale of permits. Using data on the sale of picking permits issued by the managing authority (Micocyl), taken from their on-line sales platform, between 2013 and 2016, the corresponding demand functions for picking are estimated. Interpreting these functions, and calculating col- lector surplus, shows how management of this resource may be improved by providing valuable information that can be used by decision-makers in the various management areas. The main conclusion to emerge is that, based on the features of price elasticity of demand, adjusting the fees for the picking permits can help to manage the resource for purposes beyond merely raising revenue. The price control thus implemented might help to adapt the number of permits sold to the real situation of each area's harvest demand function and, therefore, to manage the harvesting pressure exerted on said resource, taking the amount actually picked as a real base. As a result, said management policies should not be approached in isolation from other public policies given the shift in mushroom picker profiles, which seem to be increasingly related to recreational aspects and less concerned with self-consumption of what is picked.

Key Words: Wild edible mushroom; management; travel cost method

JEL classification: H41, Q26, Q58

[1] Corresponding autor: Tel +34975129318; fax +34975129201.
E-mail addresses: pablof@ea.uva.es (Pablo de Frutos), bprado@eco.uva.es (Beatriz Rodriguez-Prado). jlatorremi@gmail.com (Joaquín Latorre) fmartinezpe@cita-aragon.es (Fernando Martínez-Peña).

ENVIRONMENTAL VALUATION AND MANAGEMENT OF WILD EDIBLE MUSHROOM PICKING IN SPAIN

1. Introduction

Environmental valuation has become one of the main tools at a global scale for environmental management. The United Nations Organization considers one of its three key lines of action in ecosystem management to involve helping countries to include the value of the environment in their environmental planning and policy-making decisions (United Nations, 2017).

In a similar vein, the Organisation for Economic Co-operation and Development also feels that countries' investment policy design should embrace environmental valuation techniques in order to include these values in the cost-benefit analyses required when implementing such policies. This would send out clear signals to investors, producers and consumers alike and point society along the road towards green growth, leaving aside the concept of brown growth (OECD, 2016).

Yet, actually getting managers to transform these general lines of action into specific environmental policies proves somewhat more complex, a gap which strong lines of work currently being pursued are seeking to bridge. One prominent example is the work of the European Commission through its project **"**Reflecting the Value of Ecosystems and Biodiversity in Policy-Making" coordinated by the Foundation for Ecology and Economy whose goal is to provide national and local support on how these recommendations may be included when drawing up environmental policy. Its report specifically defends the role to be played by valuation when creating markets in order to preserve biodiversity and ecosystem services (TEEB, 2010).

In the agroforestry sector, applying these techniques is also seen as an option for improving management policy since they can provide indicators that help improve the sector's chain of value, including non-timber products (TEEB, 2015). Recent years have seen significant changes in developed countries in the use of forest ecosystems. We have witnessed a shift from models based on the market management of timber products towards another more multifunctional model, where management of non-timber products has taken on greater relevance (Sisak *et al*., 2016). Within this group, wild edible mushrooms have become a driver of development in rural areas, due both to the importance of the sale of harvested products in markets in terms of generating revenue and employment (Alexander *et al*., 2002; Cai *et al.*, 2011; Bonet *et al*., 2014) as well as through the emergence of other uses more focused on recreation and tourism [Frutos *et al*., 2012; Büntgen *et al.,* 2017).

This diversification in the use and enjoyment of mycological resources has led in recent years to the worldwide appearance of a range of regulatory experiences of wild edible mushrooms that are of socioeconomic interest. This form of managing the resource has sought to safeguard the interests of the various types of picker, reconciling them with the long-term protection of those species that are most valuable and under the greatest pressure from pickers. In most countries, this protection has been applied, with varying degrees of success, through regulatory systems based on imposing restrictions on the use of certain species, amounts, sizes, etc. Prominent in this regard are the regulatory procedures undertaken in the United States (McLain, 2008), Spain [Mátinez-Peña *et al*., 2017; Górriz-Mifsud *et al*., 2017a), Italy (Secco *et al*., 2010) or Nepal (Thapa *et al.*, 2014), grounded on establishing some kind of permit that grants access to the resource depending on certain features of the pickers.

However, insufficient policy manager knowledge of how the demand function for harvesting actually works has tended to lead to the sale price of permits not being established efficiently enough to ensure that the markets issuing the permits function correctly. As a result, studies dealing with the valuation of demand for wild edible mushroom picking at an international scale are few and far between (Frutos *et al*., 2009; Martínez de Aragón *et al.,* 2011). In addition, those that do exist tend not to separate the valuation of mushroom resources from other forest products and uses (Starbuck *et al*., 2004; Mogas *et al.*, 2005). Some of the studies that have perhaps provided most information aimed at addressing such a shortcoming are those published by Frutos *et al.* (2016) or Gorriz *et al.* (2017b). While the former studies model willingness to pay for permits to pick wild mushrooms in Andalusia (Spain) and explore their explanatory variables, the latter examine the relation between picking, forest ownership and management in regulated areas of Cataluña (Spain).

But, in neither case, nor in the years during which the studies were carried out, were the areas in question regulated areas in which permits were actually sold for picking wild edible mushrooms by those managing the areas. In other words, they were merely valuations of what the value should, hypothetically, be if the areas were regulated. This means that comparisons cannot be drawn between supply and demand, and that possible imbalances between them cannot be explored, nor any analysis be conducted of efficiency criteria when managing the area. Moreover, in most of the studies, the information provided with regard to the maximum willingness to pay for a picking permit does not reflect what would be needed as a guide to calculate what the actual price should be for issuing the licence. One example of a limitation concerns the failure to calculate net consumer surplus, discounting the expenses actually incurred by pickers during their day's picking, such that it is not possible to calculate the maximum willingness to pay for a hypothetical licence that would be increased by the cost of getting to the regulated area. This leads to the values being clearly overestimated for them to be of any use to managers as a guide when establishing fees for picking.

As a result, the present paper seeks to ascertain whether a particular management experience in mycological regulation actually proves efficient. The case study is the *www.micocyl.es* (Martínez-Peña *et al*., 2017) system for selling picking permits, run by the Regional Government of Castilla y León (Spain). Using the zonal version of the travel cost method as an environmental valuation tool, an estimation is provided of pickers' net consumer surplus, comparable to their maximum willingness to increase payment for engaging in the activity. One of the principal novelties of the study involves the use of panel data, drawing on information from different mycological management areas over the period 2013-2016. An attempt is thus made to respond to the criticisms levelled at this method based on the problem of stability of surplus measures estimated using longitudinal data (Cooper and Loomis, 1990; Hellerstein, 1993).

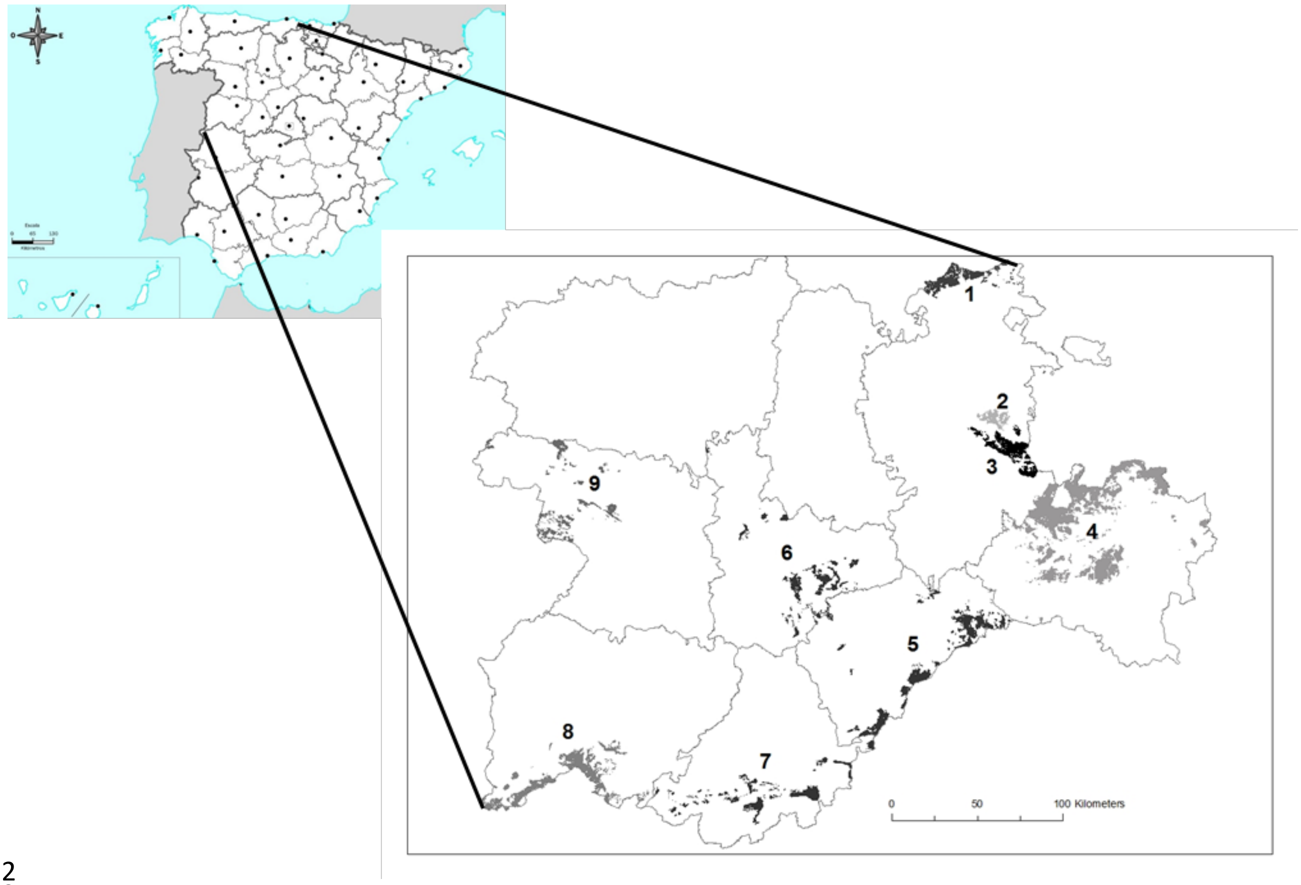
The results obtained are then compared to the sale price for permits in the various mycological management areas, studying the relation between what is actually paid and what pickers would be willing to pay. This comparison allows for an estimation of how much room for manoeuvre managers have when increasing the fee for picking. An analysis is also carried out of the causes of possible deviations and, therefore, of which variables might be impacting on willingness to pay and which could be used in the system managers' decision-making process, whether joint management of mycological areas should be considered or whether the present individual system should be continued. This research thus emerges as a tool for generating *a priori* information designed to help authorities in their decision-making process at the start of each mycological season.

2. Materials and Methods

2.1 Study area

The Autonomous Community of Castilla y León is located in the centre of Spain (Figure 1). It is the largest region in the country, covering 84,226 km^2 (18.6% of the whole country) and the third largest European NUTS-2 administrative area, being similar in size to countries like Bulgaria, Hungary or Portugal.

Figure 1: Study site



Source: Micocyl
(*) Numbers correspond to locations listed in table 1

Castilla y León has a wide variety of forest habitats and, consequently, a wide variety of wild mushrooms, estimated at some 2,744 species. The most representative genera are *Agaricales* (42%), *Russulales* (8%), *Polyporales* (6%) and *Boletales* (6%). Of these species, around fifty taxa are of commercial interest due to their high market value. The average gross annual production of wild edible mushrooms, excluding truffles, is 34,000 tons, equivalent to some 80 million euros (Martínez-Peña et al. 2011). The harvesting of a wide range of edible mushroom species, including *Boletus edulis* Bull., *Lactarius deliciosus* (L.) Gray, *Amanita caesarea* (Scop.) Pers and *Cantharellus cibarius* (Fries), has been attracting greater attention among local populations since the 1950s.

The system governing the harvesting of wild mushrooms in the region of Castilla y León (Spain), a system known as Micocyl, has been in place since 2003. It is one of the most advanced models for managing the forest use of wild edible mushrooms currently in existence. This joint bottom-up governance model today includes over 360 public forest owners (mainly local rural municipalities), and covers more than 430,000 regulated hectares belonging to over 760 forest holdings spread throughout the region, split into 245 municipalities (Figure 1 and Table 1). This regulatory system is grouped and organised into nine collecting areas managed with common aims and tools whilst also taking into account the specific features of each particular area.

Based on sustainability and organisational criteria, the Micocyl system (Martínez-Peña *et al*., 2017) must decide for each picking area both the total number of collecting permits that can be issued as well as the type and cost. These decisions are taken depending on aspects such as each area's capacity (maximum number of permits per km^2), the relation between the picker and the municipality which owns the forest where the activity is to be undertaken, why the mushrooms are to be picked (whether for commercial, recreational or research purposes) or the length of time the activity will take place.

Micocyl has succeeded in bringing together all forest owners in a sophisticated common platform that provides information and online sales of picking permits (www.micocyl.es) connected in real time with the forest agents and security forces responsible for overseeing good practices in the use of the mycological resources the permits provide for. Each collecting area establishes its own sale price for the permits as well as the different types available (daily, weekend, seasonal, recreational, commercial, for locals, and for outsiders). The owners' association, the body governing each collecting area, adjusts the prices intuitively with the social justification of generating a minimum revenue for use of mushrooms that will enable management of the available mycological resources to be maintained and improved in a sustainable manner. Prices are also established following the criterion of favouring local pickers and mycotourism. To achieve this, symbolic prices ranging between 3 and 10 euros per year are applied for pickers registered as residents in the towns and villages that form part of the Micocyl system. This is coupled with reasonable prices for the majority of mycotourists, and range between 5-10 euros per day and recreational use.

Of the revenue generated, 14% is dedicated to covering the structural costs involved in running the system, 15% to the reserve fund for improving the forests, 21% for value added tax, with the remaining 50% going to a fund for undertaking joint action that is decided by each collecting area. Activities such as boosting surveillance, cleaning up rubbish from areas, providing training courses for pickers, promoting and improving the use of mushrooms by organising markets, fairs and conferences, have all been financed through the fund.

Table 1. MICOCYL mycological regulatory system: main features (2013-2016)

Collecting area	L	Province	RF	NO	M	Hectares	PS
Las Merindades	1	Burgos	50	27	5	28,400.69	10,922
Montes de Oca	2	Burgos	37	29	12	12,461.44	3,713
Demanda-San Millán	3	Burgos	31	19	12	29,69375	3,092
Montes de Soria	4	Soria	262	90	60	163,118.70	157,225
Montes de Segovia	5	Segovia	107	38	36	50,397.97	22,784
Torozos-Mayorga-Pinares	*6*	Valladolid	57	32	28	32,486.52	34,333
Norte de Gredos	7	Avila	57	39	37	31,475.37	10,621
Sierras de Francia, Béjar, Quilamas y el Rebollar	8	Salamanca	89	47	39	54,129.29	8,336
Montes de Zamora	9	Zamora	79	47	16	29,968.41	2,726
TOTAL			769	368	245	432,132.14	253,752

L: location on the map, RF: regulated forests, NO: number of owners, M: Municipalities, PS: permits sold
Source: own elaboration

2.2 Methodological framework

The travel cost method has been widely used by international organisations such as the World Bank as a tool to evaluate the cost-benefit analysis of their investment projects (Bolt *et al.*, 2005; Silva and Pagiola, 2003). It is particularly recommended by the United Nations Organization for valuations that involve the movement of people for recreational reasons (UNEP, 2014). Its suitability in this sense has led to it becoming the most widely applied environmental valuation technique for valuing ecosystem facilities in forests (TEEB, 2010).

In this regard, the strong recreational component of the activity studied evidences the appropriateness of adapting the proposed method to the case study in question. Only 6% of the permits sold in collecting areas in the four years studied were for commercial purposes, with the rest being for recreational purposes (table 2). These were mostly recreational pickers, who were either local season pickers or others from outside the area who were there for the weekend, and so on. Recent studies support the idea that the recreational component is becoming increasingly important in wild edible mushroom picking (Büntgen *et al.*, 2017). This is backed up by the evidence to emerge from the conclusions of the present study, and which confirm the notion of the strong recreational element involved in the activity, based on the estimated values of the income elasticity of demand for picking and, therefore, the suitability of the method chosen in this study, following the recommendations of the World Bank. This method has also been widely applied to calculate consumer surplus in other activities linked to the extractive use of natural resources such as fishing or hunting (Balkan and Kahn, 1988; Buchli *et al.*, 2003) in which there is also a strong element of self-consumption of the resource in question.

This technique stems from a request made to several economists by the United States National Park Service, which sought suggestions concerning how to measure the economic benefits of the existence of its parks. Hotelling (1947) responded with a simple letter containing the basic procedural ideas that were subsequently developed by Clawson and Knetsch (1966). Its widespread application has given rise to a large number of variations of the model that may be applied depending on the goals pursued and data availability (Riera, 2000).

This method is based on the relation of complementarity between public and private goods within the consumer utility function. This relation occurs when the use of an environmental good requires individuals' participation in another market through the consumption of other goods without which enjoyment of the first would not be possible. Specifically, picking wild edible mushroom involves getting to the regulated areas, which entails the corresponding cost for pickers. Observing the demand function of this private good allows us to obtain, through an integration process, the corresponding expenditure function with which it is possible to determine the implicit price of the environmental good, in other words, consumer willingness to pay for it.

The principal problem to emerge is that it is not known to what extent expenditure on the private good is a function of the level of the environmental good consumed. It is therefore necessary to establish a series of initial hypotheses known as weak complementarity conditions (Mäler, 1974). Weak complementarity between the private and the environmental good (and therefore the implicit price) is said to exist if the marginal utility provided by the environmental good is zero, when the amount demanded of the private good is zero. There is an exclusion price of the private good that makes its demand zero and, therefore, that of the environmental good. Moreover, at that price any improvement in the environmental good does not increase demand for it, as it would continue to be zero. If these conditions are met, specifically the latter, it means that by using this technique we can only reflect use values. Once these assumptions have been taken into account, the demand function of the environmental good would then be estimated with regard to any changes in access or use cost, a variable that would act as a "proxy" of the environmental price, given this relation of complementarity.

A number of discrepancies and disagreements have arisen amongst researchers when applying the travel cost method, particularly as regards the initial assumptions that must inevitably be made in order to apply the method (Hanley and Spash, 1993). Given below is a summary of the most important of these and how they have been dealt with in the present study.

2.2.1 Dependent variable

The first group of hypotheses is linked to the choice of the dependent variable. Many approaches have been adopted to estimate demand functions using this method. These include demand equation systems (Burt and Brewer, 1971), gravity models (Cesario, 1975), variable parameter models (Vaughan and Russel, 1982) or the hedonic travel cost method (Brown and Mendelsohn, 1984). Put simply, a distinction tends to be drawn between two principal variations when applying this method, zonal (ZTCM) and individual (ITCM). When applying the ZTCM, the area around the attribute being valued is divided into several zones. Each is allocated a mean access cost related with the distance to the asset. The rate of visits per zone over a given period can be estimated using the cost of the average trip. Many authors have applied this version to estimate the demand function of a recreational site (Englin and Bowker, 1996; Bateman *et al*., 1999; Bennear *et al*., 2005; Tourkolias *et al.* 2015; Jones *et al.,* 2017).

In contrast, the ITCM is applied using data from surveys conducted amongst individual visitors in an effort to relate demand to the environmental asset, in the number of visits over a given period, to a series of explanatory factors. These include questions such as the distance people are willing to cover to enjoy the place, the journey time, the cost of the trip and expenses incurred at the actual site, the level of income and other socioeconomic variables. This variable is based on conventional methods used by economists to estimate economic values centred on market prices and on what individuals actually do and not what they would do in a hypothetical situation (Bell and Leeworthy, 1990). This version is preferred by many researchers conducted it depends on more consistent consumer behaviour than is applied in the zonal version (*Bhat et al*., 1998; Nillesen *et al*., 2005), yet in no instance has economic theory shown that individual models are a superior approach to zonal ones (Fletcher *et al*., 1990).

In this regard, empirical studies have yielded conflicting results. Whilst the zonal version is deemed more appropriate to estimate consumer surplus when visits are evenly distributed, the individual version adapts better to situations that generate multi-purpose trips (Cook, 2000). Moreover, the zonal approach uses sufficiently robust demand models which, given certain research objectives, may be achieved in the same way as individual ones (Hellerstein, 1995). Given the availability of data, the features of the database used, picker profiles and the manner in which the study has been set out, the zonal version is deemed appropriate for reaching the goals posited in the research considering the previously mentioned aspects. Furthermore, it is still a variation widely used in valuing natural assets that attract large numbers of visitors (Loomis, 1999; Weber *et al.,* 2012).

2.2.2 Travel cost

The second group of hypotheses concerns how access cost is measured. A decision must be taken regarding which costs should be included and which should not. The most conservative option is to include only so-called unavoidable costs, in other words, those resulting strictly from getting to and from the chosen site. The most common procedure is to estimate a certain cost per kilometre. This might also vary significantly depending on which expenses are included (fuel, car insurance, vehicle depreciation and maintenance, parking cost, tolls, etc.). Seller *et al.* (1985) recommend using only fuels costs since they are the most easily recognised by travellers as relevant costs that determine the decision to undertake the trip. In the present instance, the price of the compulsory picking permit would have to be added to these unavoidable costs. The travel cost from province i to regulated area j in year t, using only fuel cost ($TCop_{ijt}$) is thus defined as:

$$TCop_{ijt} = \frac{PP_{ijt}}{n_{ij}} + 2 * \frac{D_{ij} * SP_t}{2.03}$$

where PP_{ijt} is the mean price of the permits sold to pickers in province i in regulated zone j in mushroom season t. n_{ij} is the estimated number of days picking in regulated zone j by pickers in province i, approximated with visit frequency data depending on the distances travelled by pickers in similar studies (Martínez-Peña *et al.*, 2015). D_{ij} is the distance between province i and mycological unit j measured in kilometres of road from provincial capital i to the main population nucleus in regulated zone j. SP_t is the real expense per kilometre in fuel (Transport&Environment protocol) in year t of an average vehicle, calculated in terms of fuel cost and the features of the fleet of vehicles in Spain (types of fuel, engine and vehicle age). Other forms of access are not taken into account because it is virtually the only way of getting to the regulated areas. To correct this variable with the number of occupants in the vehicle, the value 2.03 is used (Frutos *et al.*, 2009). As an alternative variable, $TCfcrc_{ijt}$ is used, which includes all the car-related expenses incurred during the trip, where SP_t is replaced by SF_t, which includes all the unavoidable costs previously cited resulting from the trip (full car running cost) following European Motorists Associations.

Further to this are the discretional costs that may or may not be incurred, and which may include specific equipment used in picking (boots, baskets, knives, etc.), or which may vary substantially depending on individuals, such as food and overnight stays. Including these latter costs adds a specific utility component that is very hard to model, since for many people the higher the costs the greater the satisfaction derived from the trip. As a result, it is impossible to objectively value the cost of the trip for all visitors, since only the individual is able to do so. Whether or not the time spent in the day's picking is to be included or not must also be decided. Including it or not is based on the fact that time is a scarce asset and, therefore has an implicit price or opportunity cost resulting from the possibility of being able to engage in other activities (Cesario, 1976). In any case, its inclusion would only prove appropriate if a person were able to freely choose their working day and leisure time, such that the salary/hourly wage (or a proportion thereof) would be a good approximation to this cost (Parsons, 2003). Although it is still common to include it in valuation studies (Voltaire *et al*., 2017) it was decided here not to do so for two reasons. Firstly, because of the extensive discussion in the literature as to how and indeed whether it should be considered (Bockstael, *et al.*, 1987; Larson, 1993) and, secondly, because it is not recommended in applications based on the zonal version of the method, as is the present case.

Finally, there is the question of scaling access costs depending on whether we are dealing with so-called multi-purpose trips. There is ample literature on the subject (Smith, 1971; Ulph and Reynolds, 1981; Mendelshon *et al*., 1992). The problem proves particularly important when long distances are involved that increase the likelihood of such trips. In this case, the hypothesis is that the picker's main (and virtually only) motivation is to look for and find wild edible mushrooms. This is considered a totally different motivational profile from that of other visitors to natural areas who are more likely to engage in other substitute activities. During their trip, pickers only pick. Expert opinion backs up this view, such that no correction in access costs has been made nor has any alternative form of estimation been considered to include this type of trip.

2.2.3 Econometric specification

The third and final group of hypotheses is related to the choice of econometric specification when estimating the demand function (Adamowicz, 1998).

Traditional ZTCM studies use continuous functional forms, such as ordinary least squares (OLS), to estimate the recreation demand equation. This can be explained because the dependent variable is expressed as the number of visits per 1000 population from a given zone around the site. OLS regression, however, stands in direct contradiction to two main characteristics of trip demand: recreation trips are non-negative and only occur in discrete integer quantities (Hellerstein, 1991, Voltaire *et al*. 2017). An alternative is to use count data models, such as Poisson and negative binomial (NB), which recognize both the integer and non-negative features of trip demand.

In our case, we also incorporate longitudinal information and use a panel count data specification to estimate the demand function of picking permits. The advantage of this approach is that the panel data model is able to control for unobserved zone-specific factors which are difficult to account for in the cross-section model (Hellerstein, 1993). More precisely, under the conventional ZTCM model, the demand function of a collecting area establishes the statistical relationship between visit rate and a set of explanatory variables as follows:

$$lnVR_{it} = X'_{it}\beta$$

where VR_{it} is the visit rate from zone i at time t. X'_{it} includes the independent variables explaining the rate and β is a vector of coefficients. In order to operationalize the model in the count data model, we use $VR_{it} = {}^{Y_{it}}/_{Pop_{it}}$, where Y_{it} is the number of permits issued in zone i at time t and Pop_{it} is the population of zone i at time t. Moreover, after writing out the specific independent variables included in X'_{it}, the longitudinal ZTCM becomes:

$$lnY_{it} = lnPop_{it} + \beta_0 + \beta_1 lnGDP\_pc_{it} + \beta_2 lnTC_{it} + \beta_3 lnRain_t + \mu_i$$

where β_0 is a constant, $lnGDP\_pc_{it}$ is the GDP per capita (in log) for zone i at time t; $lnTC_{it}$ is the average travel cost (in log) from zone i at time t; $lnRain_t$ is the rainfall (in log), in litres per square metre, at time t in the collecting area as a determinant variable of the fruit-bearing capacity of the wild mushrooms (Büntgen *et al*. 2015; Taye *et al.,* 2016), and therefore influencing the sales of permits in that year. Thus, this time-variant factor accounts for the quality of the collecting area. Finally, μ_i represents the zone-specific time-invariant factor of zone i that is not captured in any other explanatory variable. For example, this factor could include the cultural tradition of picking for each single travel zone.

To estimate the proposed econometric model, we can utilize either the Poisson model or the negative binomial model depending on the assumption of the dependent variable's distribution. The Poisson model specifies the probability function of the dependent variable as:

$$f(Y_{it}) = \frac{e^{-\lambda_{it}} \lambda_{it}^{Y_{it}}}{y_{it}!}$$

where $\lambda_{it} = E({}^{Y_{it}}/_{X'_{it}}) = Var({}^{Y_{it}}/_{X'_{it}})$ is both the mean and the variance of the distribution. A common problem with travel cost models in practice, however, is that data are not equidispersed, such that the observed variance and mean may differ. In such cases of over-dispersion in data, an alternative distributional assumption may be required. While several alternatives exist, a common approach is to use the negative binomial model which derives from the Poisson distribution through the introduction of a parameter α that may vary randomly allowing for inter-zone heterogeneity (Cameron and Trivedi, 2013). This model has a variance $Var({}^{Y_{it}}/_{X'_{it}}) = \lambda_{it}(1 + \alpha\lambda_{it})$, where α (the dispersion parameter) is a measure of the degree to which the conditional variance exceeds the conditional mean (Cameron and Trivedi, 2013). If $\alpha > 0$, then overdispersion exists and the Poisson model should be rejected in favour of the negative binomial. The probability function for the negative binomial is given by:

$$f(y_{it}) = \frac{\Gamma(y_{it} + \alpha^{-1})}{\Gamma(y_{it} + 1)\,\Gamma(\alpha^{-1})} \left(\frac{\alpha^{-1}}{\alpha^{-1} + \lambda_{it}\upsilon}\right)^{-1} \left(\frac{\lambda_{it}\upsilon}{\alpha^{-1} + \lambda_{it}\upsilon}\right)^{y_{it}}$$

where $\Gamma(\cdot)$ is the gamma probability density function evaluated at $(\cdot)$ and $\upsilon > 0$ is an independent and identically distributed random variable with density $g(\upsilon/\alpha)$ (Cameron and Trivedi, 2013). This collapses to the standard Poisson distribution when $\alpha = 0$. We estimate both Poisson and negative binomial models by directly maximizing the full log likelihood function, including the group specific constants, μ_i.

In order to estimate the net Marshallian consumer surplus (NMCS), i.e. the difference between what the picker would be willing to pay and what they are actually required to pay (Pascoe *et al.* 2014), we assume that travel cost increases until visits from the zone are depressed to zero. This maximum cost is called the choke cost. Based on economic principles and the specification of our ZTCM, the estimated net NMCS per picker for travel zone *i* at time *t* can be calibrated as follows (Chotikapanich and Griffiths, 1998):

$$\widehat{NMCS}_{it} = \frac{-1}{\widehat{\beta_2} + 1} e^{(\widehat{\beta_0} + \widehat{\mu_i})} TC_{it}^{\widehat{\beta_2}+1}$$

where $\widehat{\beta_2}$ should be less than -1.

As a result, assuming the hypothesis that the cost of accessing each regulated area may be used as an approach to the price that pickers are willing to pay to use mycological resources, the demand function of the resource would be inversely related to said access cost and, therefore, to the number of days picking. Net consumer surplus values, estimated by integrating the demand function expressed into the above formula and displayed in Table 4, could be interpreted as the maximum increase pickers are willing to accept in the cost they are currently paying for their permit: in other words, the rise in the price of the licence that would make the picker indifferent towards applying for their licence and so decline to go picking.

2.3 Data collection

Data were gathered for several mycological seasons, where each spans from mid-September in one year to mid-July the following year. Specifically, data were gathered from 19 September 2013 to 3 July 2017, corresponding to four mycological seasons (2013, 2104, 2015 and 2016). Longitudinal travel cost models based on inter-temporal data are important to understand the change of value and when testing for the stability of model results (Cooper and Loomis, 1990; Hellerstein, 1993). Due to the unobservable nature of NMCS estimates, these are only ordinally measurables [Stoeckl and Mules, 2006). The intertemporal analysis of these ordinal estimates is expected to provide an analysis of the stability of economic values. As a result, the longitudinal travel cost method offers several advantages, such as control for unobserved factors (Hellerstein, 1993). For example, Loomis (1999) used a fixed-effect zonal travel cost model to analyse the impact of use in United States national forests and parks. Weber *et al*. (2012) applied a similar model to control for time-varying factors at a single site and also evidenced how demand can change over time. A data panel model is thus a suitable approximation to test the stability of NMCS measure estimates through the picker demand function over time.

Various sources of information were taken into account when gathering data. Data concerning the number of permits issued and their price during the period studied in the different collecting areas were provided by the managing agency (Micocyl), which has a database linked to the online platform that handles the sales of permits and which contains information regarding the number, type and payment per picking permit, as well as information such as the picker's home town (www.micocyl.es). Because it has only recently been set up, it was decided to remove the Montes de Oca collecting area from the analysis. The decision was taken on account of the small number of permits sold and the impossibility of completing the data panel. The profile of the various types of picker with regard to the kinds of permits sold in each regulated area (as a percentage of the total) may be seen in Table 2.

Table 2: Sales permits (SP) by types and collecting areas in percentages (2013-2016)

Collecting area	Recreational				Commercial (all season)			Total
	All season			1-2 days weekend				
	Local	Relating[a]	Others		Local	Relating[a]	Others	
Las Merindades	14	18.6	7.0	59.5	0.9	0	0.02	100
Montes de Oca	28.9	16.4	15.6	38.9	0.1	0	0	100
Demanda - San Millán	14.2	14.7	3	55.7	12.4	0	0.04	100
Montes de Soria	29.2	10.6	0.2	52.2	7.7	0.13	0.01	100
Montes de Segovia	61.6	20	6.1	7.4	4.9	0.006	0.01	100
Torozos-Mayorga-Pinares	88.4	3.5	2.1	4.5	1.6	0	0	100
Norte de Gredos	42.8	15.3	11.2	25.7	4.4	0.06	0.59	100
Sierras de Francia,…	57.6	14.8	5.9	16.8	3.7	1.20	0.01	100
Montes de Zamora	11.1	1.9	4.3	26.8	54.9	1.14	0	100
Total	**40.25**	**10.99**	**1.97**	**40.02**	**6.58**	**0.13**	**0.03**	**100**

(a): if the picker is in some way linked to the regulated municipalities other than through being a local resident
Source: own elaboration

Weather data were gathered as means of the values recorded at the weather stations in the National Meteorology Agency, part of the Spanish Government Ministry of Agriculture, Fisheries and Environment, and located inside the boundaries of the collecting areas. Population, per capita income, fuel cost and vehicle feature data were obtained from the National Institute of Statistics, part of the Spanish Government Ministry of Economy, Industry and Competitiveness. Finally, data concerning distance were gathered from the CartoCiudad System ("CityMap System"), part of the Spanish Government Ministry of Infrastructure.

Table 3 shows the principal statistics of the variables of the models, disaggregated into regulated areas. Specifically, we report the mean, standard deviation, minimum and maximum of the variables of interest along with the number of observations. These figures show that the largest number of permits sold by province and year, on average, is for the regulated area of Montes de Soria, followed by Torozos-Mayorga-Pinares. As for travel cost, in terms of average values, as expected there are no major variations between the regulated areas, with the least accessible tending to be, on average, that of Montes de Zamora, and the most accessible that of Montes de Segovia (highest and lowest mean access costs, respectively). With regard to rainfall, this was more abundant during the study period in the regulated area of Sierras de Francia, Bejar, Quilamas y el Rebollar, with the lowest amount of rainfall being recorded in the area of Torozos-Mayorga-Pinares. Finally, mean GPD per capita is the same for all the regulated areas, since it considers all the Spanish provinces.

3. Results

Table 4 shows the results of the models estimated for the regulated areas chosen for the period 2013-2016, using a Poisson distribution as opposed to a negative binomial. All of them display a good fit and prove significant as a whole both for model 1, which uses the travel cost calculated only with fuel as a proxy variable of price (TCop), and for model 2, which includes all the vehicle expenses incurred (TCfcrc). In all instances, the estimation based on the negative binomial is more suited than through the Poisson distribution, since the parameter measuring overdispersion ($\ln\alpha$) is significant in all cases and the AIC and BIC statistics are smaller, implying a better goodness of fit.

With regard to the variables in the model, both travel cost and per-capita GDP are significant in all of them, added to which they also display a high level of significance (in most cases above 99%). All of them also predict the correct relation, in line with economic theory, with the dependent variable, this being negative in relation to the travel cost variable and positive for per-capita GDP. In the case of the climate variable, it is significant in 50% of the models estimated and in all of them also displays the expected sign. As a result, the greater the rainfall the better the fruit yield, and therefore the higher the expectation of a good crop and so the greater the number of visits and, consequently, the number of permits sold. This relation proved negative in around 30% of the models estimated, although in none was it significant.

The estimations of net Marshallian consumer surplus are shown in table 5. It was decided to estimate these values using the models based on the negative binomial distribution due to its greater explanatory power resulting from its better goodness of fit statistics, as mentioned previously. In the case of model 1 (only fuel) the highest surplus values correspond to the regulated area of Montes de Zamora with a value for the estimated period of 79.64€ per picker and season compared to the minimum value found for the area of the Norte de Gredos, with 18.53€. For this model, the mean value is 46.76€ per picker and season. As regards model 2 (expenses generated by the vehicle), values are noticeably lower, with the highest corresponding to the regulated area of Torozos-Mayorga-Pinares with 18.44€ per picker and season, and the lowest to Montes de Segovia with 6.22€. In this model, the mean value is 9.03€ per picker and season.

Finally, table 6 shows the results corresponding to the mean prices paid per year for a picking permit in the various collecting areas and its relation to the net Marshallian picker surplus in the form of a percentage over the price (also based on the negative binomial specification). This value can thus be interpreted as the margin available to the managing authorities for increasing the fees; in other words how much they would have been able to raise the price of the picking permit in percentage terms that year until exhausting the number of permits, making the demand for them zero in that regulated area. Given that the aim is to put forward recommendations for management, in order to calculate the percentages it was decided to use the most conservative surplus values based on those estimated using travel cost that includes all the vehicle's expenses. In this case, these percentages vary between 26% in the regulated area of the Merindades for 2015 to 180% in 2016 for Torozos-Mayorga-Pinares.

4. Discussion

The consumer surplus estimated values shown in table 5 do not differ substantially from the willingness to pay reported in other valuation studies related to mushroom picking, and generally fall within the range set out in the results. Using the individual version of the travel cost method, Starbuck *et al*. (2004) estimate a 30$ consumer surplus for picking fruit and wild edible mushrooms in the Gifford Pinchot National Park in the state of Washington (USA). Using the same version, Martínez de Aragón *et al.* (2011), calculate this value to be 39€ per visitor who picked in the area of Solsones (Cataluña, Spain). Using the zonal version, Frutos *et al.* (2009) obtain mean valuations for the period 1997-2005 that are far more conservative than the previous ones; specifically, 10€ per picker visiting the Pinar Grande (Soria, Spain). Applying a choice experiment, Mogas and Riera (2003) calculate the willingness to pay for picking wild mushrooms in future repopulated areas of Cataluña (Spain) to be 5.77 euros per year. However, given the circumstances in which the study was framed, estimations of the willingness to pay do not respond to the aim of establishing a market price for picking. Perhaps the closest reference to what this value should be is the pilot contingent valuation study carried out by Frutos *et al*., 2016 in the forests of Andalusia (Spain), where the willingness to pay for a picking permit is estimated to be 23€ per picker.

Moreover, all the estimated values evidence stability over the period studied. This means they can be considered stable references with which to work when taking decisions on possible changes in fees in regulated areas. In this regard, a very important variable that managers should take into account in this process concerns the features of price demand elasticity. In all the models estimated, the demand functions present price demand elasticity values approaching one. This means that an increase in the sale price of permits would lead to the same proportional drop in the number sold. This behaviour would ensure that the revenue derived from the system would remain constant. Yet in most cases, these values tend to be slightly above one, which would advise against applying a substantial rise in fees aimed at increasing revenue since it might spark quite the opposite effect. Proceeding in this way might yield the expected results were regulations designed to relieve the pressure on mushroom collecting, discouraging people from picking in regulated areas that might be affected by problems of overexploitation (Egli *et* al., 2006; Parladé *et al.*, 2017). Specifically, the price elasticity values estimated for the various regulated areas (in absolute value) are in the range 1.026-1.485. They are thus slightly above what tends to be found in the tourist activity sector, where these values oscillate in the range 0.5-1 (Álvarez *et al.*, 2015). These higher elasticity values might be linked to the high level of substitutability that exists between regulated areas since nearly all of them have another area relatively close by that offers very similar possibilities for mushroom picking. One additional explanation might be due to the emerging provision of specific facilities for pickers in regulated areas, which are still insufficient for any distinction to be made between them, and which would make regulated areas more difficult to substitute. Price would thus be playing a more important role in pickers' decisions as there would be no other way to distinguish between the different areas available.

In any case, it can be considered that there is a significant margin of price variation, whatever aim the management policy might be pursuing. Clearly, the greatest tolerance in percentage terms is to be seen in regulated areas where the lowest priced permits are found such as in Montes de Soria. There is thus an inverse relation between price and net surplus, as posited by economic theory. In contrast, there are regulated areas such as Las Meridandes which have virtually used up all the Marshallian consumer surplus in their pricing system for collecting wild edible mushrooms.

With regard to income elasticity values, these are always positive, indicating that the activity is considered normal. In addition, with the exception of two regulated areas (Norte de Gredos and Torozos-Mayorga-Pinares) these values are significantly above one. This indicates that an increase in picker income would raise the amount of the activity in demand more than in proportional terms. It might therefore be an activity considered a luxury that would gain weight in pickers' consumption budget as their income increased. Moreover, this behaviour would be very closely linked to that of other activities related to leisure enjoyed by people with a certain level of spending power (Heilbrun and Gray, 1993) and very similar to that of other visitor profiles such as people who engage in rural tourism (Santeramo and Morelli, 2015) or cultural tourism (Vicente y Frutos, 2011) activities. These authors found income elasticity values between 1.4 and 1.8, respectively, very similar to those reported in the present study.

5. Conclusions

The present research has shown that environmental evaluation methodologies can provide valuable and useful information for dealing with ecosystems, as defended by the leading international institutions. Specifically, we have seen how the travel cost method can be a tool to help establish prices for issuing picking permits for a much prized forest resource, namely wild edible mushrooms. Such a system might help achieve other management objectives beyond what is merely collecting revenue since an understanding of demand elasticity may help managers to respond more accurately to demand when facing changes in pricing. The high values found highlight the fact that the strategy of each collecting area setting its prices independently might not be so wise and that they should tend towards a common management system for establishing fees. These major differences in prices and the link to their margins of variation, calculated through an estimation of net Marshallian consumer surplus would seem to point in this direction. This proposal is also supported by the significant substitution effects via prices that appear to exist between regulated areas, due to the strong correlation between travel costs for neighbouring areas. This tends to increase the harvesting pressure on those mycological areas that offer the lowest prices permits, an issue that could easily be dealt with by correct management of prices due to price elasticity demand. Another question concerns the possible social response in areas that traditionally have lower prices and that display a strong local presence of pickers based on historical and sociocultural aspects. Further research focusing on this aspect is required prior to implementing any price merging strategy.

Another finding that may also be deemed very important, and which is extremely significant in terms of managing the asset in question, concerns the income elasticity of the estimated demand. The high values found support the idea that mushroom picking seems to respond more to leisure and recreational aspects than to mere self-consumption of what is picked. As a result, management of both the environmental aspect as well as that of what is considered a primary asset should be combined with a tourist policy by adequately controlling the flows of pickers similar to visitors coming for other reasons such as natural area and heritage tourism, etc. The substantial growth expected in this activity, related to more developed societies than to other more traditional ones, might bring with it problems of overcrowding and overexploitation of the asset if the economic boom of modern-day societies continues at its current rate. Possible conflicts of interest that might emerge between different types of pickers when accessing the resource in question is another matter that should not be overlooked. Once again, addressing the issue of prices might help to alleviate this problem. In this regard, the evidence found supports the idea that the current pricing system, which distinguishes between different types of picker, is an appropriate tool for dealing with duality in picker profile.

In the long run, the important link between the sale of permits and the productivity of the collecting areas supports the idea that the regulatory system should be grounded on environmental policy (Frutos *et al*., 2019). The competent authorities must be able to adopt the measures required to safeguard this productivity by applying the appropriate forestry management techniques. Should they fail to do so, sales of permits would be affected as would the regulatory system itself. As has been amply highlighted throughout the present research, issues concerning regulatory control of picking and environmental management should not be approached separately. Several authors have shown that careful collection of fungal species fruit bodies (carpophores) need not affect future production (Egli *et* al., 2006; Parladé et al., 2017). However, in line with the principle of prudence, access and collection limits have been established in many regions, together with awareness-raising campaigns in order to educate society on good collecting practices and reduce the collecting pressure in mushroom-producing forests. It is therefore useful to develop mushroom collecting control models, and other monitoring indicators that provide insights into the future consequences of such activities. As a result, it may be concluded that efficient handling of prices based on reliable and correctly interpreted information can help to achieve the various goals related to the management of wild edible mushroom picking.

Finally, the study presented has not been able to determine the importance of the role played by the harvest collected or self-consumption in satisfying pickers when measured by estimating picker surplus. We feel that it is extremely difficult to separate the utility for pickers of merely being able to pick wild edible mushrooms from the utility they derive from being able to consume or give away what they pick, etc. Both components should form part of their decision when stating their maximum willingness to pay in the estimated demand functions. Regardless of whether or not this value is included in the maximum willingness to pay, we feel that it should not invalidate applying the method, although fresh research would be needed, using more appropriate techniques applied in other areas of knowledge such as consumer behaviour, in order to ascertain what motives and motivations drive recreational pickers and how these may tie in with other socioeconomic variables.

Acknowledgements: This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Table 3: Descriptive statistics of variables of the demand functions of picking permits of zonal travel cost data panel model by collecting area: 2013-2016

Variable	Obs	Mean	Std. Dev.	Min	Max
Demanda-San Millán					
Y	188	16.44681	79.55829	0	734
TCop	188	42.86281	21.28431	5.599817	95.54134
TCfcrc	188	172.7918	86.69997	20.39249	350.2027
GDP_pc	188	21114.28	4502.388	15167	34391.95
Rain	188	789.85	244.2308	397.4	1023.2
Las Merindades					
Y	188	58.09043	303.9575	0	3073
TCop	188	45.59331	22.69952	9.494783	99.40751
TCfcrc	188	181.7866	90.56475	38.2668	371.4153
GDP_pc	188	21114.28	4502.388	15167	34391.95
Rain	188	591.575	96.08114	484.8	730.6
Montes de Segovia					
Y	188	121.1915	738.9092	0	6494
TCop	188	36.09076	17.12343	6.236143	80.80549
TCfcrc	188	150.053	70.1596	28.5761	305.0006
GDP_pc	188	21114.28	4502.388	15167	34391.95
Rain	188	479.55	37.98681	449.9	543.5
Montes de Soria					
Y	188	835.3404	2749.731	0	22788
TCop	188	38.16843	20.29538	3.225199	91.6146
TCfcrc	188	161.5366	84.32864	13.18761	352.9447
GDP_pc	188	21114.28	4502.388	15167	34391.95
Rain	188	612.3875	141.7005	481.2	819.2
Montes de Zamora					
Y	188	14.49468	79.04947	0	660
TCop	188	47.37688	21.77598	6.723784	103.3675
TCfcrc	188	194.1242	86.98135	27.55429	384.7046
GDP_pc	188	21114.28	4502.388	15167	34391.95
Rain	188	725.65	173.7245	493.65	931.4
Norte de Gredos					
Y	188	56.4734	283.7086	0	2265
TCop	188	39.12721	17.50246	4.214253	84.59646
TCfcrc	188	158.0227	67.72534	17.49747	313.7477
GDP_pc	188	21101.89	4515.677	15167	34391.95
Rain	188	443.15	62.07515	363.8	503.8
Sierras de Francia. Béjar. Quilamas y el Rebollar					
Y	188	44.32979	262.2442	0	2129
TCop	188	44.85582	19.47434	6.682413	103.6636
TCfcrc	188	189.2627	79.43559	29.62616	391.1231
GDP_pc	188	21114.29	4502.38	15168.22	34391.95
Rain	188	814.45	168.6053	597.6	985.4
Torozos-Mayorga-Pinares					
Y	188	182.6117	1270.571	0	10599
TCop	188	37.92757	18.74339	2.623142	82.37614
TCfcrc	188	155.7169	75.3668	10.77421	305.8005
GDP_pc	188	21114.29	4502.38	15168.22	34391.95
Rain	188	314.4125	64.57032	227.45	392.3

Source: own elaboration. Y: permits issued per province; TCop: Travel cost (only fuel) in euros; TCfcrc: Travel cost (full car running cost) in euros; GDP_pc: GDP per cápita in euros; Rain: rainfall in litres per square metre

Table 4: Estimation results from the demand function of picking permits of zonal travel cost data panel models

	Demanda-San Millán		Las Merindades		Montes de Segovia		Montes de Soria		Montes de Zamora		Norte de Gredos		Sierras de Francia		Torozos-M-Pinares	
	Model 1: Travel cost fuel only															
	Poisson	NB	Poisson	NB	Poisson	NB	Poisson	NB	Poisson	NB	Poisson	NB	Poisson	NB	Poisson	NB
ln*TCop*	-1.026***	-1.023***	-1.117***	-1.084**	-1.159***	-1.054***	-1.485***	-1.056***	-1.289***	-1.032***	-1.139***	-1.106***	-1.237***	-1.051***	-1.039***	-1.045***
	(0.126)	(0.160)	(0.231)	(0.394)	(0.137)	(0.255)	(0.065)	(0.260)	(0.172)	(0.220)	(0.063)	(0.140)	(0.104)	(0.181)	(0.063)	(0.154)
ln*GDP_pc*	2.781***	3.194***	1.672**	2.120**	1.274***	1.165**	1.855***	1.043*	2.463***	2.438***	0.591**	0.477*	2.309***	2.140***	0.857*	0.882*
	(0.773)	(0.788)	(0.704)	(0.712)	(0.370)	(0.517)	(0.480)	(0.563)	(0.385)	(0.526)	(0.275)	(0.277)	(0.312)	(0.546)	(0.467)	(0.482)
ln*Rain*	0.411**	0.429**	0.670**	0.675**	-0.532	-0.429	0.312*	0.365***	0.272	0.209	-0.204	-0.215	0.039	0.026	0.537*	0.523**
	(0.134)	(0.131)	(0.239)	(0.225)	(1.082)	(0.511)	(0.175)	(0.044)	(0.301)	(0.211)	(0.377)	(0.225)	(0.324)	(0.148)	(0.282)	(0.208)
Constant	-27.319**	-31.632***	-17.275**	-21.958**	-0.255	0.315	-9.406*	-10.977**	-21.901***	-22.123***	-0.688	0.405	-18.691***	-17.585**	-8.353	-8.515
	(8.335)	(8.469)	(8.006)	(8.075)	(0.402)	(0.872)	(5.500)	(5.170)	(4.237)	(5.266)	(3.586)	(6.232)	(3.863)	(5.590)	(5.341)	(8.631)
Ln*α*		-2.063***		-0.987**		-1.550***		-1.338***		-1.260***		-1.723***		-1.548***		-0.789*
		(0.768)		(0.471)		(0.500)		(0.253)		(0.471)		(0.580)		(0.482)		(0.410)
N	188	188	188	188	188	188	188	188	188	188	188	188	188	188	188	188
Chi2	91.6	97.9	57.4	112.9	157.2	112.7	1044.9	22493.0	72.7	55.4	335.1	208.4	166.0	56.5	270.6	108.4
p-value	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
AIC	237.2	234.5	288.9	270.7	332.8	321.4	986.7	778.9	315.3	302.6	391.6	387	391.9	380.9	307	282.9
BIC	247.1	246.9	299.8	284.2	344.5	336	999.6	795.1	326.7	316.9	403.7	402.1	403.9	395.9	318.1	296.7
	Model 2: Travel cost full car running cost															
ln*TCfcrc*	-1.362***	-1.181***	-1.396***	-1.174**	-1.311***	-1.147***	-1.259***	-1.101***	-1.323***	-1.150***	-1.111***	-1.120***	-1.270***	-1.174***	-1.019***	-1.101***
	(0.319)	(0.098)	(0.148)	(0.389)	(0.134)	(0.252)	(0.061)	(0.138)	(0.142)	(0.202)	(0.053)	(0.096)	(0.086)	(0.169)	(0.056)	(0.172)
ln*GDP_pc*	4.963***	4.041***	1.371***	1.983**	1.093***	1.095**	1.824***	1.301*	2.497***	2.486***	0.425*	0.443*	2.281***	2.260***	0.739*	0.831*
	(1.013)	(0.536)	(0.385)	(0.647)	(0.305)	(0.470)	(0.467)	(0.711)	(0.363)	(0.501)	(0.232)	(0.268)	(0.287)	(0.514)	(0.447)	(0.474)
lnR*ain*	0.385**	0.347*	0.637*	0.671**	0.31	0.329	0.249*	0.302***	-0.036	-0.041	-0.298	-0.298	-0.04	-0.039	0.337*	0.334*
	(0.123)	(0.212)	(0.344)	(0.221)	(0.900)	(0.473)	(0.136)	(0.045)	(0.268)	(0.180)	(0.340)	(0.211)	(0.283)	(0.149)	(0.203)	(0.196)
Constant	-46.634***	-37.890***	-13.890**	-21.277**	-0.613	0.426	-11.519**	-0.116*	-20.842***	-21.545***	0.413	0.266	-18.522***	-18.802***	-7.242	-7.795
	(11.074)	(6.043)	(5.270)	(7.589)	(0.901)	(1.023)	(5.415)	(0.061)	(3.779)	(5.028)	(3.105)	(5.442)	(3.499)	(5.330)	(5.213)	(8.342)
Ln*α*		-0.689**		-1.273**		-1.796***		-1.416***		-1.597**		-2.037*		-1.855***		-0.884**
		(0.348)		(0.545)		(0.580)		(0.241)		(0.825)		(1.061)		(0.558)		(0.425)
N	188	188	188	188	188	188	188	188	188	188	188	188	188	188	188	188
Chi2	265.3	105.4	136.0	251.2	179.5	860.1	1256.2	27620.4	96.8	752.8	448.3	588.0	237.4	627.3	335.5	287.5
p-value	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
AIC	287.9	270.5	278.5	266.9	324.5	318.4	960.4	756.5	301.9	295.8	385	383.7	380	373.9	302.3	280.9
BIC	300.9	286.7	289.4	280.5	336.2	332.9	973.4	772.7	313.3	310.1	397.1	398.8	392	388.9	313.4	294.7

Notes: in parentheses robust standard errors. *indicates p-value<0.10, ** p-value<0.05, *** p-value<0.01.

Source: own elaboration

Table 5: Estimation of Net Marshallian Consumer Surplus per picker by collecting area 2013-2016 (in €)

	Demanda-San Millán		Las Merindades		Montes de Segovia		Montes de Soria		Montes de Zamora		Norte de Gredos		Sierras de Francia…		Torozos-M-Pinares	
Year	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
2013	76.26	6.96	26.15	7.00	20.94	5.09	46.38	6.15	79.33	8.71	18.29	13.01	46.61	6.65	57.98	18.39
2014	76.34	6.96	26.24	7.00	20.98	5.09	46.49	6.17	79.46	8.71	18.37	13.00	46.71	6.65	58.18	18.44
2015	76.54	7.00	26.45	7.03	21.14	5.12	46.85	6.26	79.78	8.75	18.66	13.06	47.04	6.68	58.55	18.47
2016	76.66	7.00	26.68	7.05	21.24	5.12	47.06	6.31	80.02	8.76	18.81	13.06	47.23	6.69	58.75	18.48
2013-2016	76.45	6.98	26.38	7.02	21.07	5.11	46.69	6.22	79.64	8.73	18.53	13.03	46.90	6.67	58.37	18.44

Source: own elaboration

Table 6: Average price of picking permits (in €) and Net Marshallian Consumer Surplus (as a percentage of price)

Year	Demanda-San Millán		Las Merindades		Montes de Segovia		Montes de Soria		Montes de Zamora		Norte de Gredos		Sierras de Francia…		Torozos-M-Pinares	
2013	16.28	43%	17.74	39%	9.22	55%	5.21	118%	13.87	63%	17.57	74%	5.96	112%	14.81	124%
2014	15.99	44%	18.72	37%	10.06	51%	5.22	118%	12.41	70%	17.93	73%	6.01	111%	12.12	152%
2015	17.49	40%	26.76	26%	9.23	55%	5.12	122%	13.58	64%	15.95	82%	6.41	104%	10.29	179%
2016	18.19	38%	18.10	39%	7.67	67%	5.04	125%	11.72	75%	16.28	80%	6.12	109%	10.24	180%
2013-2016	16.99	41%	20.33	35%	9.05	56%	5.15	121%	12.90	68%	16.93	77%	6.12	109%	11.87	155%

Source: own elaboration

6. References

Adamowicz, W. Behavioral Implications of Non-Market Valuation Models. *Can. J.Agr. Econ.*, 36, 929-939. **1998**. [CrossRef]

Alexander, S.; Pilz, D.; Weber, N.; Brown, E.; Rockweel, V. Mushrooms, trees and money: Value estimates of commercial mushrooms and timber in the Pacific Northwest. *Environ. Manag*. **2002**, 30, 129–141. [CrossRef]

Álvarez, M.; González, M.; Otero, S. Research Note: Estimating Price and Income Demand Elasticities for Spain Separately by the Major Source Market. Tourism Econ. 21(5), 1103-1110. **2015** [CrossRef]

Balkan, E.; Kahn, J.R. The value of changes in deer hunting quality. A travel cost approach. *Appl. Econ*., 20(4), 533-539. **1988**. [Crossref]

Bateman I.; Brainard J.; Lovet A.; Garrod G. The impact of measurement assumptions upon individual travel cost estimates of consumer surplus: a GIS analysis. *Reg. Environ. Change*, 1 (1), 24-30. **1999**. [CrossRef]

Bell, F.; Leeworthy, V. Recreational demand by tourist of saltwater beach. *J. Environ. Econ. Manage.*, 18 (3), 189-205. **1990**. [CrossRef]

Bennear L.; Stavins, R.; Wagner, A. Using Revealed Preferences to Infer Environmental Benefits: Evidence from Recreational Fishing Licences. *J.Regul. Econ.* 28 (2), 157–179. **2005**. [CrossRef]

Bhat G.; Bergstrom J.; Teasley R.; Bowker J.; Cordel H. An ecoregional approach to the economic valuation of land-and water-based recreation in the United States. *Environ. Manage.,* 22 (1), 69-77. **1998**. [CrossRef]

Bockstael, N.; Strand, I.; Hanemann, W. Time and recreational demand model. *American J. Agr. Econ.*, *68*, 293-302. **1987**. [CrossRef]

Bolt, K.; Ruta, G.; Sarraf, M. *Estimating the cost of environmental degradation. A Training Manual in English, French and Arabic*. World Bank. **2005**. http://siteresources.worldbank.org/INTEEI/214574-1153316226850/20781069/EnvironmentalDegradationManual.pdf

Bonet, J.A.; González-Olabarria, J.R.; Martínez De Aragón, J.J. *Mt. Sci.*, 11, 535-543. **2014**. https://doi.org/10.1007/s11629-013-2877-0

Brown, G.J.; Mendelsohn, R. The hedonic travel cost method. *Rev. Econ. Stat*. 66 (3), 427-433. **1984**. [CrossRef]

Buchli L.; Filippini M.; Banfi S. Estimating the benefits of low flow alleviation in rivers: the case of the Ticino river. *Appl. Econ.* 35 (5), 585-590. **2003**. [CrossRef]

Büntgen, U.; Egli, S.; Galvá, J.D.; Diez, J.M.; Aldea, J.; Latorre, J.; Martinez-Peña, F. Drought- induced Changes in the Phenology, Productivity and Diversity of Spanish F. *Fungal Ecol.*, 16, 6-18. **2015**. [CrossRef]

Büntgen, U.; Latorre, J.; Egli, S; Martínez-Peña, F. Socio-economic, scientific, and political benefits of mycotourism. *Ecosphere*, 8(7), 1-13, **2017**. http://onlinelibrary.wiley.com/doi/10.1002/ecs2.1870/abstract

Burt, O.R.; Brewer, D. Estimation of net social benefits from outdoor recreation. *Econometrica*, 39(5), 813-827. **1971**. [CrossRef]

Cai, M.; Pettenella, D.; Vidale, E. Income generation from wild mushrooms in marginal rural areas. *For. Policy Econ*. **2011**, 13, 221–226. [CrossRef]

Cameron A.C.; Trivedi P.K. Regression Analysis of Count Data. Second Edition. Cambridge University Press. New York. **2013.**

Cesario, F. A Combined Trip Generation and Distribution Model. *Transport. Sci*. 9, 211-223. **1975.** [CrossRef]

Cesario, F. Value of time in recreation benefit studies". *Land Econ.*, 52 (1) , 32-41. **1976.** [CrossRef]

Chotikapanich, D.; Griffiths, W.E.. Carnarvon gorge: A comment on the sensitivity of consumer surplus estimation. *Aust. J. Agr. Resource Ec.*, 42, 249-261. **1998**. [CrossRef]

Clawson M.; Knestch J. *Economics of outdoor recreation*. Johns Hopkins University Press for Resources for the Future. Washington. **1966**

Cook, A. Estimation of community values of lakes. A study of lake Mokoan in Victoria, Australia.: a comment. *Econ. Anal. Poli.,* 30 (1), 99-102. **2000**. [CrossRef]

Cooper, J.; Loomis, J. Pooled time-series cross-section travel cost models: Testing whether recreation behavior is stable over time. Leisure Sciences, 12, 161-171. **1990.** [CrossRef]

Egli, S.; Peter, M.; Buser, C.; Stahel, W.; Ayer, F. Mushroom picking does not impair future harvests – results of a long-term study in Switzerland. *Biol. Conserv*. 129, 271–276. **2006**. [CrossRef]

Englin D.; Bowker, J. Sensitivity of whitewater rafting consumer surplus to pecuniary travel cost specifications. *J. Environ. Manage.* 47 (1), 79-91. **1996** [CrossRef]

Fletcher J.; Adamowizc W.; Graham-Tomasi T. The travel cost model of recreation demand: theoretical and empirical issues. *Leisure Sci.,* 12, 119-147. **1990**. [CrossRef]

Frutos, P.; Rodríguez-Prado, B.; Latorre, J; Mertínez-Peña, F. A Gravity Model to Explain Flows of Wild Edible Mushroom Picking. A Panel Data Analysis. *Ecol. Econ*., 156, 164-173. **2019** [Crossref]

Frutos, P.; Martínez-Peña, F.; Aldea, J.; Campos, P. A Model to Estimate Willingness to Pay for Harvest Permits for Wild Edible Mushrooms: Application to Andalusian Forests. *Forests* 7(292), 1-14, **2016** [CrossRef]

Frutos, P.; Martínez-Peña, F.; Esteban, S. Edible wild mushroom tourism as a source of income and employment in rural areas. The case of Castilla y León. *For. Syst*. **2012**, 21, 81–98. [CrossRef]

Frutos, P.; Martínez-Peña, F.; Ortega-Martínez, P.; Esteban, S. Estimating the Social Benefits of Recreational Harvesting of Edible Wild Mushrooms Using Travel Cost Methods. *For. Syst.* 18, 235–246, **2009**. [CrossRef]

Górriz-Mifsud, E.; Marini, V.; Bonet, J.A. What to Do with Mushroom Pickers in my Forest? Policy Tools from the Landowners' Perspective. *Land Use Policy*, 63, 450-460, **2017b**. [CrossRef]

Górriz-Mifsud, E.; Secco, L.; Da Re, R. Pisani, E.; Bonet, J.A. Structural social capital and local-level forest governance: Do they inter-relate? A mushroom permit case in Catalonia. *J. Environ. Manage.*, 188, 364-378, **2017a** [CrossRef]

Hanley, N.; Spash, C.L. *Cost-Benefit Analysis and the Environment.* Edward Elgar Publishing. **1993**

Heilbrun, J.; Gray, C.M. The Economics of Arts and Culture. An American Perspective. Cambridge. Cambridge University Press. **1993**

Hellerstein D. Using Count Data Models in Travel Cost Analysis with Aggregated Data. *Am. J. Agr. Econ.* 73(3) , 860-866. **1991**. [CrossReff]

Hellerstein D. Welfare estimates using aggregate and individuals-observation models: a comparison using Monte Carlo analysis. *Am. J. Agr. Econ.* 77 (3), 620-630. **1995**. [CrossRef]

Hellerstein, D. Intertemporal data and travel cost analysis. Environmental and Resource Economics, 3, 193-207. **1993**. [CrossRef]

Hotelling, H. *The economics of public recreation*. The Prewitt report. National Parks Service. Washington. **1947**

Jones, T.; Yang, Y.; Yamamoto, K. Assessing the recreational value of world heritage site inscription: A longitudinal travel cost analysis of Mont Fugi climbers. *Tourism Manage*., 60, 67-78**. 2017**. [CrossRef]

Larson, D. Joint recreation choices and implied values of time. *Land Econ*., 69(3), 270-286. **1993**. [CrossRef]

Loomis, J.B. Do additional designations of wilderness result in increases in recreation use? *Society & Natural Resources*, 12(5), 481-491. **1999.** [CrossRef]

Mäler, K-G. *Environmental Economics: A Theoretical Inquiry.* The Johns Hopkins University Press, Baltimore. **1974**

Martínez de Aragón, J.; Riera, P.; Giergiczny, M.; Colinas, C. Value of Wild Mushrooms Picking as an Environmental Service*. For. Policy Econ*. 13, 419–424, **2011**. [CrossRef]

Martínez-Peña, F.; Picardo, A.; Redondo, C.; Latorre, J. Micocyl.es: El programa de micología de Castilla y Leon. Boletín Micológico de FAMCAL 10:149. **2017**. http://www.micocyl.es/suscripcion-boletin-famcal

Martínez-Peña, F.; Aldea, J.; Frutos, P.; Campos, P. Renta ambiental de la recolección pública de setas silvestres en los sistemas forestales de Andalucía. In Biodiversidad, Usos del Agua Natural Y Recolección de Setas Silvestres en Los Sistemas Forestales de Andalucía; Campos, P., Díaz-Balteiro, M., Eds.; Memorias científicas de RECAMAN. Editorial CSIC: Madrid, Spain**, 2015**; Volumen 2, Memoria 2.3. https://www.researchgate.net/profile/Pablo_Frutos/publication/301338274_Renta_ambiental_de_la_recoleccion_publica_de_setas_silvestres_en_los_sistemas_forestales_de_Andalucia/links/583bf44f08ae3a74b4a17223/Renta-ambiental-de-la-recoleccion-publica-de-setas-silvestres-en-los-sistemas-forestales-de-Andalucia.pdf

McLain, R. Constructing a Wild Mushroom Panopticon: The Extension of Nation-State Control over the Forest Understory in Oregon, USA. Econ. Bot. 62(3), 343-355, **2008** [CrossRef]

Mendelshon, R.; Hof, J.; Peterson, G. Johnson, R. Measuring recreation values with multiple destination trips. *Am. J. Agr. Econ*., 74 (4), 926-933. **1992**. [CrossRef]

Mogas J.; Riera P.; Bennett, J. A comparison of contingent valuation and choice modelling with second order interactions, *J. Forest Econ*., 12, 5-30, **2005**. [CrossRef]

Nillesen E.; Wesseler J.; Cook A. Estimating the recreational-use value for hiking in Belleden Ker National Park, Australia. *Environ. Manage.*, 36 (2), 311-316. **2005**. [CrossRef]

Organisation for Economic Co-operation and Development. *Policy Framework for Investment, 2015 Edition*. OECD publishing, Paris. **2016**. http://dx.doi.org/10.1787/9789264208667-en

Parladé, J.; Martínez-Peña, F.; Pera, J. Effects of forest management and climatic variables on the mycelium dynamics and sporocarp production of the ectomycorrhizal fungus Boletus edulis. *Forest Ecol. Manag*. 390, 73–79. **2017.** [CrossRef]

Parsons, G. . The Travel Cost Model. In *A Primer on Nonmarket Valuation. The Economics of Non-Market Goods and Resources*, **2003**. Edited by Champ, P. A., K. J. Boyle, and T. C. Brown, 269–329. Dordrecht: Kluwer Academic Publishers. https://doi.org/10.1007/978-94-007-0826-6

Pascoe, S.; Doshi, A.; Dell, Q.; Tonks, M.; Kenyon, R. Economic value of recreational fishing in Moreton Bay and the potential impact of the marine park rezoning. *Tourism Manage.*, 41, 53-63. **2014**. [CrossRef]

Riera, A. Valoración Económica de los Atributos Ambientales mediante el Método del Coste del Viaje. *Estudios de Economía Aplicada*, 14, 173-198. **2000.** file:///C:/Users/Usuario/Downloads/Dialnet-ValoracionEconomicaDeLosAtributosAmbientalesMedian-1217244%20(2).pdf

Santeramo, F.; Morelli, M. Modelling tourism flows through gravity models: a quantile regression approach. Current issues in Tourism 19. 1077-1083. **2015** [CrossRef]

Secco, L.; Vidale, E.; Pettenella, D. Comparing Profitability and Governance for Recreational Wild Mushroom Picking in Forest and Timber Production. In Proceedings of the IUFRO International Symposium, Paris, France, 27–29 May. **2010**

Seller, C.; Stoll, J.; Chavas, J. Validation of empirical measures of welfare change. A comparison of nonmarket techniques. *Land. Econ*. 61 (2), 156-175. **1985** [CrossRef]

Silva, P.; Pagiola, S. *A Review of the Valuation of Environmental Costs and Benefits in World Bank Projects*. Environment Department working papers; no. 94 Environmental Economics series. World Bank, Washington, DC**.** **2003**. https://openknowledge.worldbank.org/bitstream/handle/10986/18395/293490EDP010940Valuation01Public1.pdf?sequence=1&isAllowed=y

Sisak, L.; Riedl; Dudik, R. Non-market non-timber forest products in the Czech Republic. Their socio-economic effects and trends in forest land use. *Land Use Policy*, 50, 390-398, **2016**. http://dx.doi.org/10.1016/j.landusepol.2015.10.006

Smith, R. The evaluation of recreational benefits: The Clawson method in practice, *Urban Stud.*, 8 (2), 89-102. **1971**. [CrossRef]

Starbuck, C.; Alexander, S.; Berrens, R.; Bohara, A. Valuing Special Forest Products Harvesting: A Two-step Travel Cost Recreation Demand Analysis. *J. For. Econ*. 10, 37–53, **2004**. [CrossRef]

Stoeckl, N.; Mules, T. A travel cost analysis of the Australian Alps. *Tourism Econ.*, 12(4), 495-518. **2006**. [CrossRef]

Taye, Z.M.; Martínez-Peña, F.; Bonet, J.A.; Martínez de Aragón, J.; de-Miguela, S. Meteorological Conditions and Site Characteristics Driving Edible Mushroom Production in *Pinus pinaster* Forests of Central Spain. *Fungal Ecol*., 23, 30-41. **2016** [CrossRef]

TEEB. *Agroforestry: an attractive REDD+ policy option? The Economics of Ecosystems and Biodiversity***.** **2015**. http://img.teebweb.org/wp-content/uploads/2016/11/FeederStudyAgroforestry_web.pdf

TEEB. *The Economics of Ecosystems and Biodiversity*. Ecological and Economic Foundations. Edited by Pushpam Kumar. Earthscan, London and Washington. **2010**. http://www.teebweb.org/our-publications/teeb-study-reports/ecological-and-economic-foundations/

Thapa, B.; Panthi, S.; Rai, R., Shrestha, U.; Aryal, A.; Shrestha, S.; Shrestha, B. An Assessment of Yarsagumba (*Ophiocordyceps sinensis*) Collection in Dhorpatan Hunting Reserve, Nepal. *J. Mt. Sci.* 11(2), 555-562, **2014**. [CrossRef]

Tourkolias, C.; Skiada, T.; Mirasgedis, S.; Diakoulaki, D. Application of the travel cost method for the valuation of the Poseidon temple in Sounio, Greece. *J. Cult. Herit*., 16 (4), 567-574. **2015**. [CrossRef]

Ulph, A.; Reynolds, I. An Economic Evaluation of National Parks. Australian National University, Centre for Resources and Environmental Studies Press. **1981**

United Nations Environment Programme. *Guidance Manual on Valuation and Accounting of Ecosystem Services for Small Island Developing States Valuation and Accounting of Natural Capital for Green Economy* (VANTAGE). Guidance Manual Series No. 2. Regional Seas Reports and Studies No. 193. **2014**. https://www.cbd.int/financial/monterreytradetech/unep-valuation-sids.pdf

United Nations. UN Environment Annual Report 2016. *Engaging People to Protect de Planet*. United Nations Environment Programme, **2017**. http://www.unep.org/annualreport/2016/index.php?page=12&lang=en

Vaughan, W.J.; Russel, C.S. Valuing a fishing day: an application of a systematic varying parameter model. *Land Econ.,* 58 (4), 450-463. **1982** [CrossRef]

Vicente, E.; Frutos. P. Application of the Travel Cost Method to Estimate the Economic Value of Cultural Goods: Blockbuster Art Exhibitions. *Hacienda Pública Esp*., 196(1), 37-63. **2011**

Voltaire, L.; Lévy, L.; Alban, F.; Boncoeur, J. Valuing cultural heritage sites: an application of the travel cost method to Mont-Saint-Michel. *Appl. Econ*., 49 (16), 1593-1605**. 2017**. [CrossRef]

Weber, M.A.; Mozumder, P.; Berrens, R. P. Accounting for unobserved time-varying quality in recreation demand: An application to a Sonoran Desert wilderness. *Water Resour. Res.*, 48, W05515. **2012**. [CrossRef]