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Value of wild mushroom picking as an environmental service

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ABSTRACT

Among the environmental services provided by Mediterranean forests, wild mushroom picking is particularly appreciated. Where access to the forests is free, and when the property rights to the products that can be picked from the ground are not clearly assigned, forest owners bear a cost, in the form of forest damage by pickers, and receive no benefit. These owners therefore have little incentive to provide the public with more or better forests, however socially desirable this would be. If the value of this environmental service to society was known, an appropriate policy could be applied. The first step in assessing this value (evaluation) is illustrated here in a case study in central Catalonia, Spain. A travel cost method was applied to a sample of mushroom pickers over three years. The results show an estimated recreational surplus of €39 per journey. The second step (policy) was explored by asking mushroom pickers for their views on various different payment schemes. The results suggest that paying for this environmental service would be supported to varying degrees depending on how the policy is designed.

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1. Introduction

Natural ecosystems provide society with environmental and recreational services (Bingham et al., 1995; Costanza et al., 1997; De Groot et al., 2002; Ehrlich and Kennedy, 2005). For instance, they control the hydrological cycle, fix carbon dioxide (Tyndall, 1863; Arrhenius, 1896), shape the landscape, and offer opportunities to enjoy the natural environment and engage in recreational activities. The recreational use of forests has increased considerably (de Frutos et al., 2009).

Many people go mushroom picking in the forests as a recreational activity (Camarasa et al., 1993), and some also sell the mushrooms they collect in local markets. However, the influx of mushroom pickers to Solsonès county (Catalonia, Spain) forests generates an environmental impact cost. Mushroom pickers can have a negative impact by overharvesting the mushrooms or by damaging the habitat, e.g. compacting the soil and impairing its quality. Severe impact may decrease the abundance of mushrooms (Egli et al., 2006). This situation has increased the interest of forest owners and the administration for regulations, bearing in mind that the property rights of the mushrooms are not well defined – the term “property rights” being used here in its economics or de facto sense.

On the other hand, mushroom pickers obtain a benefit due both to the recreation experience and the product collected. The amount of

this benefit is generally unknown, making policies based on social welfare difficult to design. Estimating environmental benefits can help in this regard.

A number of valuation techniques can be applied to estimate the social benefits obtained from environmental services. Some of these techniques are based on stated preferences (Mitchell and Carson, 1989; Bateman and Willis, 2002; Hensher et al., 2005) and others on preferences revealed in a market (Freeman, 2003). Among the latter, the Travel Cost Method (TCM) is often used to evaluate recreational services obtained from the environment (Hotelling, 1947; Kopp and Smith, 1993; Zawacki et al., 2000; Haab and McConnell, 2002). The first description of TCM was that of Hotelling (Hotelling, 1947), who put forward this method to estimate the recreational value of the natural parks in the USA. The applications of Clawson (Clawson, 1959) and Clawson and Knetsch (Clawson and Knetsch, 1966), who evaluated the recreational activity in Yosemite National Park, gave rise to numerous TCM applications in the 1960s. Further methodological developments of the method have kept it in the forefront for recreational evaluation (Bhat et al., 1996; Shrestha et al., 2002; Bockstael and McConnell, 2007). Typically, TCM is used to estimate the consumer surplus for the enjoyment of local goods.

Mycological tourism is a long-established activity in Catalonia, a region in the North-East of Spain, where it attracts many people every autumn. This study includes a TCM evaluation of the mushroom picking activity in Solsonès County, in central Catalonia, in the foothills of the Pyrenees (Fig. 1).

The main objectives of this work are (i) to estimate the recreational benefits of mushroom picking in Solsonès County, and

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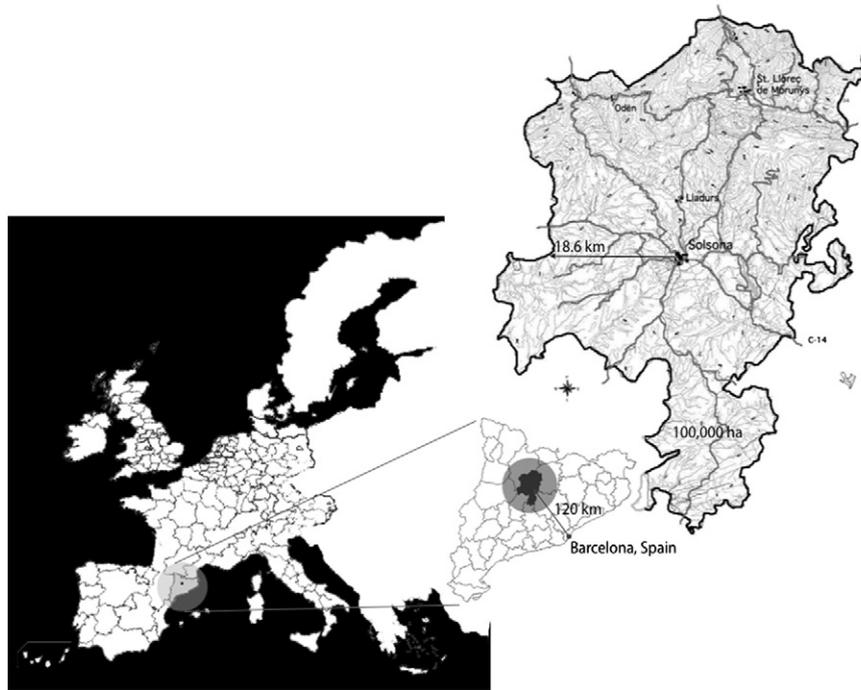


Fig. 1. Solsonès County location map.

(ii) to record opinion on various policy instruments designed to internalize this forest externality.

2. Study site

Solsonès County is approximately 100,000 ha in size, 65% of which is forested. *Pinus nigra* Arnold, *P. sylvestris* L. and *P. halepensis* Mill. are the dominant trees in the area. The southern part of the county is relatively flat, and is dominated by Mediterranean forest, while the north is mountainous, mostly with sub-Mediterranean forests. Nearly 85% of the forest area is private property. There are many small property owners, most of the properties being under 25 ha in area (Piqué, 2004).

The forests host a large variety of animal, plant and fungal species. More than 250 species of mushrooms have been identified in pine forests (Martínez de Aragón et al., 2007). The mushrooms growing in the autumn are mostly strict mycorrhizal fungi (Llimona and 31 authors, 1990; Dahlberg, 1991). The main mushroom species collected are *Cantharellus lutescens*, *Lactarius deliciosus*, *L. sanguifluus*, *L. semisanguifluus* (saffron milk-cap), *Hygrophorus latitabundus*, *H. eburneus*, *H. Russula*, *Hydnum repandum*, *Suillus luteus*, *Tricholoma portentosum* and *T. terreum*. These are also the most highly valued for their gastronomic value. The saffron milk-cap varieties are the most popular, probably because they are easy to identify by their orange-reddish latex, and are unlikely to be confused with poisonous species.

A decade of mushroom data collection in the pine forests of Catalonia shows a wide-ranging yield (2–124 kg per ha per year), with an estimated average autumn yield of 41 kg per ha. This dispersion is mainly due to differences in rainfall each autumn. More water in the soil during the months of September and October increases wild mushroom production (Martínez de Aragón et al., 2007).

3. Methodology

A questionnaire was drawn up to survey a sample of mushroom pickers in Solsonès. The questionnaire was designed to serve two main purposes. One was to collect data for a TCM exercise, and the other to determine mushroom pickers' opinion on various different

policy instruments. In addition, information was collected on the number of mushroom pickers, the amount and species they picked, and the commercial prices at which mushrooms were traded.

3.1. The Travel Cost Method

The Travel Cost Method (TCM) estimates the consumer surplus or difference between the maximum willingness to pay for the good (demand function) and the actual expenditure (price) (Bockstael and McConnell, 2007). Recreationists are assumed to behave as utility or welfare maximizers.

Going to the forest incurs a cost for the harvesters (TC), through the money and time they invest in the activity. Thus the utility (V) that a harvester (i) obtains from going out to collect wild mushrooms in a given place (j) depends on what it costs (TC_{ij}), on what the other goods cost (p_x), on the characteristics of the place (z_j), and on the income (y_i) and other socioeconomic characteristics of the harvester (S_i), as expressed in the equation:

$$V = v(TC_{ij}, p_x, z_j, S_i, y_i).$$

If each mushroom harvester adjusts the number of journeys to the utility they provide, the number of journeys (journeys_{ij}) and their cost (TC_{ij}) will define their demand function $\text{journeys}_{ij}(TC_{ij})$.

A limitation of the TCM procedure is that it analyses decisions based on expectations rather than on the actual trip experience. Since mushroom hunters may enjoy a higher or lower utility than anticipated, the validity of the TCM results is linked to the degree of coincidence with the actual enjoyment.

3.2. Policy instruments

Various different policy instruments can be considered when attempting to internalize the externalities caused by mushroom pickers. They can be based on direct governmental intervention or be the initiative of some of the parties involved (Baumol and Oates, 1988). Taxes and quantity regulation, including prohibitions, are

probably the most prominent governmental policy instruments. Private initiatives require the clear assignment of property rights to one of the parties, in this case forest owners or mushroom pickers. Access payment is an example of initiatives that forest owners can take, if in possession of the property rights.

This study empirically considers both types of policy instruments, governmental and private. From the governmental side, an annual and a daily payment were each proposed to mushroom pickers. This instrument was chosen because it was under public discussion at the time, and now already in place in Castilla y León (Martínez et al., 2003) (North-Central Spain), as will be discussed in Section 6. From the private side, the instrument emulated the way hunting and fishing reserves are managed, with some limited mycological experience in Huesca (North-East Spain) and Navarra (Gómez, 2009) (North Spain).

The attitudinal analysis will be performed using frequencies of responses in the survey.

4. Application

To estimate the consumer surplus, a survey of mushroom pickers in Solsonès County was made. To calculate the number of mushroom pickers, the vehicles parked at forest entrances were counted on selected days. The quantities of mushrooms picked were estimated by appraising the success of the mushroom pickers surveyed. Finally, mushroom prices in the market were recorded.

The study was conducted in September, October, November and December 2001, 2002 and 2003.

4.1. Survey

A sample of 300 persons was surveyed for the TCM exercise, with approximately 100 interviews in each of the three years. Mushroom pickers were randomly selected on exit from different forest locations.

The questionnaire had five separate parts. The first part mainly contained questions on the attitudes and mycological knowledge of the respondents. The second part examined the expenses incurred when going to pick mushrooms in Solsonès County, and the frequency of the trips. The amount harvested was explored in the third part of the questionnaire. The fourth part recorded attitudes toward different policy instruments. The fifth and last part collected socioeconomic data on the respondents.

4.2. Analysis

In the individual travel cost version, the number of trips is accounted for by the cost of the trips and some co-variables, such as the characteristics of respondents. As the number of trips is always a natural number, an econometric count data model was used, which ensures the consistency of the estimators obtained (Creel and Loomis, 1990). The model assumed a Poisson distribution of the number of trips. This is the most widely used model when there is no over-dispersion, as is the case here.

A Poisson model can be expressed as

$$f(\text{journeys}) = e^{(-\lambda)} \lambda^{\text{journeys}} / \text{journeys}!$$

where $\text{journeys}!$ is the factorial product of the number of trips made by the individual in a given period of time, and $\lambda = a + b_1(X_1) + \dots + b_n(X_n)$, with a, b_1, \dots, b_n the coefficients and X_1, \dots, X_n the explanatory variables, such as the travel cost, or some characteristics of the individual.

The variables significant in the estimation were those shown in Table 1. The model was implemented following Kealy and Bishop (1986), using LIMDEP 7.0 software, Econometric Software Australia, Castle Hill (Greene, 2003). The negative inverse of the coefficient of variable TC ($-1/b_{TC}$) yields the consumer surplus associated with the

Table 1
Variables of the travel cost model.

Variables	Description
<i>Dependent variable</i>	
Journeys	Number of trips made by an individual during a given mushroom season in the Solsonès forests
<i>Explanatory variables</i>	
TC	Expense of the trip by the individual, in Euros of 2003
Species	Number of edible mushroom species that the individual can recognize
Quantity	Amount of kilograms of mushrooms the individual expected to harvest when deciding to take the trip
Age	Age of the respondent

probability of making an additional trip to pick mushrooms in Solsonès County.

4.3. Number of trips

A total of 80 km of roads giving access to the forests were monitored for cars likely to be related to mushroom pickers. The route was covered 66 times, counting, on every sampling day, the number of cars parked near the entrances of the forests that produce mushrooms. The total number of cars was calculated. This number was then multiplied by the mean occupancy obtained from the survey of mushroom pickers to estimate the total number of pickers.

4.4. Production and prices

The quantities of mushrooms picked were first estimated from direct observation of the volume the interviewed individuals were carrying on exit. Two further indicators of production were obtained. One was the total production of the County, which was estimated by systematically collecting mushrooms from randomly selected locations. The other was a survey of the local markets. This was done to estimate the importance of commercial activity among mushroom pickers.

Price trends were also obtained from the local markets. They were preferred to the Barcelona central market because they are not exposed to the effects of international trade on prices, and because all the identified commercial collectors at Solsonés sold at the local market.

5. Results

5.1. Mushroom pickers

The survey showed that mushroom pickers made an average of 4.56 trips to the forests of Solsonès County during the mycological autumn season. These individuals also made an average of 1.71 trips to other mushroom production locations.

All the interviewed individuals traveled by car. The average reported car occupancy was 2.7 persons per vehicle. In the three years of the study, 6692 cars were estimated to be related to mushroom picking. The number of cars changed depending on the year, mainly due to the different lengths of the mushroom seasons (Fig. 2). In 2001, the season lasted 7 weeks (early October to mid-November), in 2002, 13 weeks, from early September to late November, and in 2003 14 weeks, although 1 week was adversely affected by bad weather.

From the number of cars sampled and the mean occupancy, the total number of mushroom pickers was calculated. For the three seasons, it was estimated that some 18,000 ($18,069 \pm 637$) trips per season were made by mushroom pickers to the Solsonès forests. The number varied widely for the three seasons considered. As shown in Fig. 3, the number of mushroom pickers in 2001 was relatively low, this being a year of exceptionally low production. The 2002 and 2003 seasons were more representative. The number of trips made in 2003

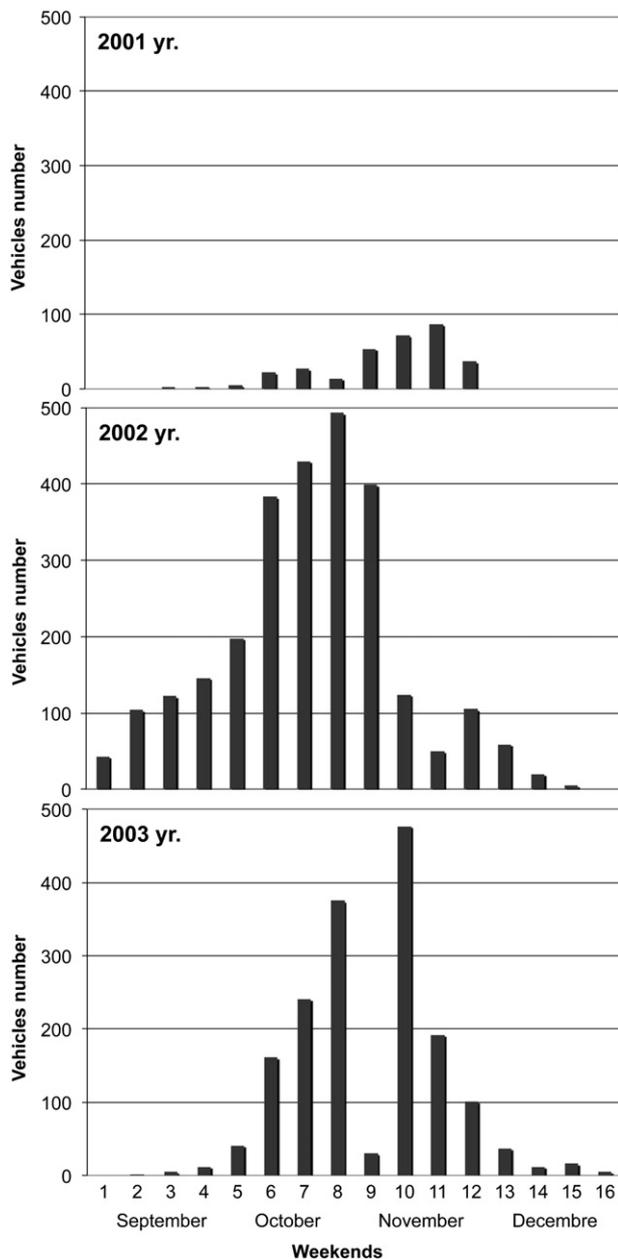


Fig. 2. Number of vehicles counted in relation to mushroom picking in Solsonès County.

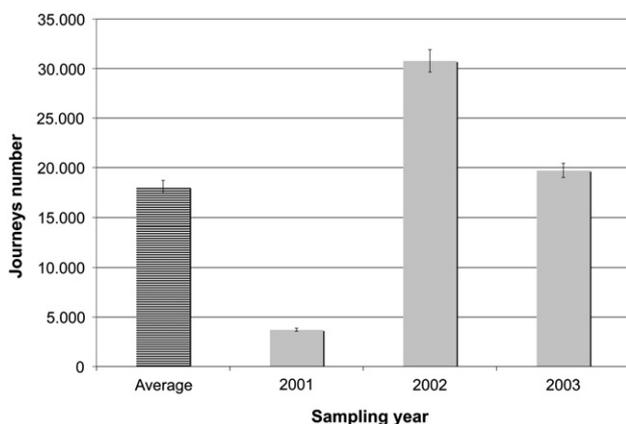


Fig. 3. Number of mushroom picking trips per season to Solsonès County.

was lower than in 2002, even though 2003 was a more productive season. This may have been due to an increased motivation of the mushroom pickers in 2002, after a year of scarcity.

5.2. Production and prices

On average, 37 metric tons of mushrooms was collected every season by mushroom pickers, with a maximum of 88 tons in 2002. The amount of mushroom production that reached the local market in the three seasons followed a similar pattern. In 2001, less than 300 kg were marketed, this figure increasing to 3500 kg in 2002 and 4000 kg in 2003 (Table 2). The disparity of the figures is due to the annual differences in production. The productions observed in the three years of the survey are not abnormal within the 1990s and 2000s period (see Fig. 4).

In general, commercial prices varied as expected with supply abundance (Table 2). On average, the local commercial selling price was almost twice the price paid to the mushroom pickers. The weighted price average for the three years and the different species that commercial mushroom pickers received was 3.5 euros per kg. Local traders sold the mushrooms at 6.46 euros per kg. For 2003, this gave a total trading gain of about 12,000 euros.

5.3. Consumer surplus

Table 3 shows the results obtained from the econometric estimation of the Poisson model. The coefficients of the explanatory variables were significant and the signs were as expected. The cost of the trip (TC) was negatively related to the number of trips. Knowing more mushroom species (SPECIES) and expecting to collect more mushrooms (QUANTITY) increased the probability of making more trips. The same was found for AGE, suggesting that younger people are not as keen pickers as older persons are. Other socioeconomic variables, such as income or gender, were found non-significant, and thus excluded from the final econometric estimation.

As indicated earlier, $-1/b_{TC}$ yields the consumer surplus associated with the probability of making an additional trip to pick mushrooms in Solsonès County. Thus, the consumer surplus was estimated at $-1/-0.0255 = 39.26 (\pm 0.8)$ euros per trip to the Solsonès forests. Taking into account the average number of trips per year, this gave a total surplus or net benefit of about 710,000 euros per mycological season.

The consumer surplus has two components, as individuals base their decisions on the recreational experience they obtain, as well as the products they expect to collect. To estimate the recreational surplus, the product value was deducted from the total surplus. The product value can be estimated by the earnings an individual would obtain in the market by selling the amount of mushrooms harvested at the market price (Table 3).

The average market value of the collected mushrooms per trip was about 7 euros. The recreational surplus was estimated at 32.43 euros per trip, with some 586,000 euros per season for all the mushroom pickers in Solsonès County.

5.4. Policy instruments

Of the three instruments proposed in the survey the two governmental instruments, annual and daily charge, were the least popular, and the private reserve proposal the most acceptable.

Paying an annual charge to the government to be allowed to pick mushrooms was accepted in principle by 15% of the 300 sampled individuals, and explicitly opposed by 54%, the rest not having a clear opinion. However, 33% of the negative answers were of the protest type, for reasons such as *access to forests should be free for everyone, or we pay enough taxes, and we should not have to pay also for picking mushrooms*. A payment per harvesting day was accepted in principle by 24% of the sampled individuals, some 10% more than for the annual payment proposal.

Table 2
Commercialized production (Prod.), evolution of the average annual buying (BP) and selling (SP) prices of different species in Solsonès County (in Euros of 2003).

Species	2001			2002			2003		
	Prod.	BP	SP	Prod.	BP	SP	Prod.	BP	SP
	(kg)	(€/kg)	(€/kg)	(kg)	(€/kg)	(€/kg)	(kg)	(€/kg)	(€/kg)
<i>Lactarius deliciosus</i>	206,5	7,17 ± 0,8	11,8 ± 0,2	1.041	2,46 ± 0,3	5,1 ± 0,5	1.133	3,84 ± 0,4	8,33 ± 0,6
<i>Hygrophorus latitabundus</i>	7	7,5 ± 2,9	13,5 ± 2,9	584	5,64 ± 0,3	9,74 ± 0,6	758	5,35 ± 0,4	9,0 ± 0,7
<i>Tricholoma terreum</i>	39	3,03 ± 0,3	5,67 ± 0,2	31	1,9 ± 0,5	3,46 ± 0,8	322	1,78 ± 0,4	3,4 ± 0,6
<i>Cantharellus lutescens</i>	3	4,5	7,5	1718	1,43 ± 0,1	2,88 ± 0,2	1655	2,97 ± 0,4	4,83 ± 0,5
<i>Hygrophorus eburneus</i>	16,5	5,14 ± 0,7	8,14 ± 1,1	2	3	6	3	3	5
<i>Hygrophorus russula</i>	0	–	–	25	1,8	3,56 ± 0,4	0	–	–
<i>Hydnum repandum</i>	0	–	–	153	1,22	2,52 ± 0,1	139,8	2,7 ± 0,3	4,93 ± 0,6
Weighted annual average		6,42 ± 0,8	10,65 ± 0,6		2,28 ± 0,3	4,38 ± 0,5		3,66 ± 0,4	6,8 ± 0,6

For making a forest management payment, which is how private hunting reserves are administered, the acceptance rate went up to 34%. This private policy was explicitly opposed by 35% of the persons interviewed, while the remaining 31% did not answer or did not express an explicit answer.

The interactions of the responses with the socioeconomic characteristics of the respondents were analyzed using one-way ANOVAs, and the values were compared with a post hoc test (Fischer's protected least significant difference, with $p < 0.05$). No significant correlations were found.

6. Discussion and conclusions

The application of the travel cost method to mushroom pickers in Solsonès County yielded a surplus of about 40 euros per trip, in 2003 values. This gives an average aggregate value of 710,000 euros per autumn mycological season. Some 82% of the surplus corresponded to the recreational experience, while the rest was attributed to the value of the mushrooms collected. Thus, the recreational component of the mushroom picking experience was greater than the product component. In addition, Costanza et al. (1997) and De Groot et al. (2002) found the ecosystem recreational service to be one of the most valued they reported.

The Solsonès County surplus value is higher than the one estimated by de Frutos et al. (2009) in Soria (North-Central Spain), of 10.49 euros per trip. This value was estimated by a zonal variant of TCM and only petrol cost was taken into account. However, the Solsonès surplus value can be compared with the 63 euros per trip estimated by Martínez Peña (2003) in the same study area (Pinar Grande, Soria). The value corresponds to non-local pickers and was estimated by a zonal variant of TCM. Although variations would be expected between regions, the relative similarity of the results may be taken as a consistency sign of the valuation procedure.

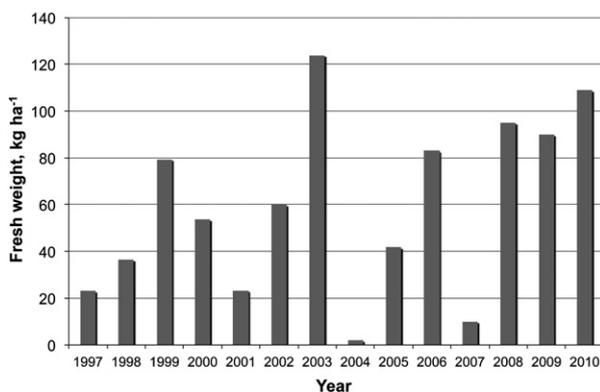


Fig. 4. Mean annual mushroom production in Catalonia forests. Source: Forest Sciences Center of Catalonia (CTFC).

Mediterranean forests are generally considered of low profitability to their owners (Terradas, 2004), mainly due to the low soil productivity, high labor costs, and strong competition from imported wood (Donaire and Gordi, 2003; Vayreda, 2004; Baeza, 2005). Over 23,000 cubic meters of wood were cut from Solsonès forests in 2004 worth 48,000 euros (CFC, 2004). This implies that the market value of the mushrooms commercialized in the same region would be 60% greater than the commercialized wood. Since in practice mushroom pickers share the property rights on the product, the forest owners do not benefit from this commercial activity. This results in lower investment in the forestry sector than is socially desirable.

In addition, mushroom pickers may cause damage to forest quality. Egli et al. (2006) show that compacting the soil and trampling of the humus have a negative effect on the production of certain species. This adverse environmental impact, together with the forest externality linked to the mushroom production, justifies policy implementation to improve the quantity and quality of the provision of forests, and thus social welfare.

Three policy instruments to pay for the environmental service were considered in this study: two types of government-administered charges, and private reserves. The acceptance of the three proposals among mushroom pickers varied widely. The most popular measure was the implementation of private reserves, where mushroom pickers would pay the forest owner directly for the mycological activity. Some 34% of the 300 mushroom pickers interviewed agreed in principle with this instrument. It would involve a change in property rights, which would be assigned to the forest owner. A daily governmental tax would be supported, in principle, by 24% of the sampled individuals, while an annual tax would be supported by only 15% of them. The public solution would also imply a change of property rights, assigning them to the public administration in the first place. In both solutions, private and public, the reassignment of property rights (in the economic sense of the term) would not imply a change in the legislation, just in the enforcement based on current regulations. For instance, forest owners could take advantage of the existing legislation to set up the reserves, as in the Huesca case; or the local administration could implement the tax system on their lands, as in Soria.

Several factors can explain this ranking of priorities. Respondents can understand that the private scheme gives an incentive for forest owners to improve the conditions of the forest for mushroom

Table 3
Econometric estimation of the Poisson model.

Variables	Coefficient (b)	Standard error	b/St.Er.	P[– Z > z]	95% Confidence interval
Constant	1.1159	0.1548	7.21	0.000	0.8124, 1.4193
TC	–0.0255	0.0028	–8.98	0.000	–0.0310, –0.0199
Species	0.0528	0.0528	3.21	0.001	0.0206, 0.0851
Quantity	0.1189	0.1189	5.14	0.000	0.0736, 0.1642
Age	0.0053	0.0022	2.43	0.015	0.0010, 0.0095
Pseudo R ² = 0.12			Journeys average = 4.57		
Log L = –620.39			Log L ratio = 172.64		

production, thus benefiting their recreational activity. Several management actions could be taken in that regard, e.g. thinning has a positive long-term effect by reducing stand density and basal area to a level conducive to mushroom fruiting (Martínez de Aragón et al., 2007; Bonet et al., 2008). Another factor is decreased competition to collect mushrooms in the reserves, which could restrict the number of members. Individuals may place lower trust in the government than in private parties, and possibly expect better information and care in general from the latter. This would be consistent with most valuation surveys finding taxes as a payment vehicle to be a large cause of protest answers (Mitchell and Carson, 1989). In any case, private or governmental, property rights would be moved away from mushroom pickers, which could explain why three out of four surveyed individuals did not support a change on the status quo, and why some answers in line with “access to the forests should be free to everyone” were given.

There is some experience of implementing payment schemes for collecting mushrooms in Mediterranean forests, with higher charges from the private estates than government-administered charges, in line with greater opposition to the latter type of solution. On the private side, in Las Paules, in the Spanish province of Huesca, a forest owners association charges 180 euros per season, or between 3 and 9 euros per day for picking mushrooms in their forests. A similar scheme in Gironde, in southern France, charges 121 euros per season or 6 euros per day (Hazera, 2000).

On the governmental side, in Castilla y Leon, Spain, two types of permits are available. Commercial collectors pay from 10 to 60 euros per season, depending on whether they are locals or not. Non-commercial mushroom pickers pay 3 to 18 euros per year depending on their place of residence. For single trips, the charge is 15 euros for everybody. In all the examples, private and governmental, the charge is clearly lower than the mean individual surplus per trip estimated in this study, which suggests that a good portion of mushroom pickers may still engage in this activity, as they do in the forests where a payment scheme is in place.

In summary, the TCM exercise suggests that a considerable amount of welfare is derived from mushroom picking. However, this popular recreational activity involves some negative environmental externalities. If they were to be corrected, the establishment of reserves would encounter less opposition from mushroom pickers than a tax collected by the administration. Finally, the results ought to be taken with care, since they are inferred from a case study based on a survey, and therefore subject to some error. Further research on the topic would be of interest.

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