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Research Paper

Noise pollution in national parks: Soundscape and economic valuation

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HIGHLIGHTS

- Soundscape-assessment methods and economic valuation were merged in a national park.
- Outdoor anthropogenic noises degrade the park soundscapes.
- Visitors refer to annoyance by human-made noises.
- Visitors are willing to pay for the noise reduction.

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ABSTRACT

In this study a national park soundscape characterisation was contrasted with an economic estimation of the impact of noise pollution on the park visitors' perception. The main noise sources were identified and the noise-pollution levels were assessed along a pathway that is highly frequented by hikers in a natural park in the mountains of central Spain. The results showed noticeable soundscape degradation during the visitors' leisure experience (sound pressure levels increased approximately 4.5 dB from natural ambient levels). Visitors' voices and conversations were as great of a nuisance to themselves as were aircraft overflights and road traffic. Using the contingent valuation method, the willingness to pay for the financing of a programme aimed at mitigating noise in the park was estimated. The results showed that visitors would be willing to pay an entrance fee of approximately 1 euro if this noise-reduction programme were to be implemented in the park.

1. Introduction

Protected-areas management encompasses diverse aspects in the ways it relates to, for instance, nature conservation and the management of tourism and the public use of places that are supposedly unaltered or slightly altered by humans (Arnberger, Eder, Allex, Sterl, & Burns, 2012; Juutinen et al., 2011). The natural and cultural heritages of a territory compose two of the multi-dimensions of the landscape, as referred by the European Landscape Convection (Council of Europe, 2000). Although most landscape studies are based on visual information, the combination of visual experience with the acoustic environment enhances people's perception and their understanding of nature (Matsinos et al., 2008). Sounds emanate from landscapes and reflect ecosystem processes and human activities over space and time (Krause, Gage, & Joo, 2011; Pijanowski, Farina, Gage, Dumyahn, & Krause, 2011; Raimbault & Dubois, 2005). This collection of sounds makes up the 'soundscape', a term that was first defined by Schafer (1977), the acoustic footprint of a landscape (Farina, Pieretti, & Piccioli, 2011). More than a concept, the soundscape is presently also considered an emerging discipline with alternative foci (Brown, Kang, & Gjestland, 2011; Pijanowski, Farina, et al., 2011; Pijanowski, Villanueva-Rivera, et al., 2011; Slabbekoorn & Bouton, 2008). Under this concept, acoustic environments are studied and their threats are assessed to ensure the maintenance of soundscape structure or functions through quality management (NPS, 2006).

The acoustic environment plays a key role as a component of a positive visitor experience in recreational areas. Some researchers and natural resource agencies have begun to recognise soundscape as a resource worth protecting (Dumyahn & Pijanowski, 2011). Unwanted or disturbing sounds (noise) may not only be

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a harmful pollutant to human health as defined by the World Health Organization (WHO) and European Centre for Environment and Health (2011) but may also become a global and growing matter of concern threatening the preservation of natural areas (Lynch, Joyce, & Fristrup, 2011) because of wildlife disturbance, ecosystems degradation, biodiversity loss, etc. (Barber, Crooks, & Fristrup, 2010; Barber et al., 2011; Dumyahn & Pijanowski, 2011; Francis, Ortega, & Cruz, 2009; Francis, Kleist, Ortega, & Cruz, 2012). This degradation could have negative consequences on ecosystems functioning and ecosystems provision of services linked to human well-being (Balvanera et al., 2006). The impacts of ecotourism tend to concentrate in areas of highest natural value (Manning et al., 2004) and tourism activities often cause noise pollution (Zhong, Deng, Song, & Ding, 2011). Therefore, these impacts are becoming an interesting research theme of conflict between recreation and preservation goals in protected areas (Benfield, Bell, Troup, & Soderstrom, 2010; Leung, 2008). In any case, there is a conceptual linkage between tranquillity, environmental quality, and human health that has been correlated with landscape structure (Votsi, Mazaris, Kallimanis, Drakou, & Pantis, 2013) and nature as a provider of restorative experiences for people's well-being (Gidlöf-Gunnarsson & Öhrström, 2007).

The absence of anthropogenic noise has been valued positively when people visit protected areas (Beal, 1994; Carles, Barrio, & De Lucio, 1999; Cessford, 1999; Saxen, 2008). Starting from the hypothesis that anthropogenic noise degrades landscape quality, whereas natural noise does not, Benfield et al. (2010) analysed the impact of different noise sources in several national parks in the U.S.A. Also, Lynch et al. (2011) analysed noise sources in 43 U.S.A. national parks using different metrics, and Miller (2008) contributed to the discussion of the determination of criteria used to make decisions for national parks soundscape management. Additional research to measure and assess human impacts on soundscapes is needed and recommended (Krog & Engdahl, 2004; Mace, Corser, Zitting, & Denison, 2013; Pijanowski, Villanueva-Rivera, et al., 2011). Moreover, undesired human-made sounds may reduce recreationist welfare or detract from having a quality experience in the wilderness (Barber et al., 2011; Brown, Reed, Dietz, & Fristrup, 2013; Mace, Bell, & Loomis, 1999; Mace et al., 2013; Pilcher, Newman, & Manning, 2009). The study of soundscapes is a complex task, and no single method is able to completely study the complexity of soundscapes or receivers' response to noise (Brown et al., 2011; Job & Hatfield, 2001; Kariel, 1990; Mace et al., 2013); spectrograms or single metrics from SLM data logged alone are not enough (Barber et al., 2011; Lynch et al., 2011). Diverse fields of practice, techniques and methodological approaches have been proposed (Davies et al., 2013; Farina & Pieretti, 2012; Farina et al., 2011; Lynch et al., 2011; Matsinos et al., 2008; Raimbault, Lavandier, & Bérengierc, 2003) bearing also in mind land spatial patterns or working-scale considerations (Iglesias Merchan & Diaz-Balteiro, 2013; Votsi, Drakou, Mazaris, Kallimanis, & Pantis, 2012).

Nevertheless the implementation of noise-mitigation measures for soundscape management may be restricted by social-economic factors (Arenas, 2008) demanding the complementing environmental studies dealing with economic assessment of visitors' welfare. Some authors have modelled the monetary impact of noise on urban ecosystems (Barreiro, Sanchez, & Viladrich-Grau, 2005; Bjørner, 2004; Dekkers & Van der Straaten, 2009; Fosgerau & Bjørner, 2006; Xie, Liu, & Chen, 2011), but we do not know of similar studies in national parks. Among the possible methods to assess the benefits that could be obtained from noise reduction are those based on stated preferences (Matos, Flindell, Le Masurier, & Pownall, 2013), such as the Contingent Valuation method (CVM).

The main objective of this work is to evaluate the soundscape in a protected natural area and assess the visitors' willingness to pay for a noise-mitigation programme after their own visiting experience. Four hypotheses have been defined in this study:

H1. Anthropogenic noise exists in the park. Our initial hypothesis was that anthropogenic noise exists in the park. We proceeded to characterise the acoustical conditions in two ways (Lynch et al., 2011; Miller, 2008): identifying audible sounds (audibility) and assessing noises intrusion with dB readers (sound energy).

H2. Visitors are able to identify noise sources. While taking measurements, we identified a set of anthropic sources, which does not necessarily mean that all of the sources act simultaneously or that visitors were able to perceive and identify them. We have no common hypothesis for the sources of all of these anthropogenic noises, but our hypothesis is that visitors perceive and are able to identify noise sources measured in the soundscape characterisation. This hypothesis was tested using an acoustic-experience survey of park visitors.

H3. Noise negatively impacts visitor experience. The initial hypothesis is that the noise prevents full satisfaction of the park experience, as demonstrated in several studies (Mace et al., 2013). This hypothesis was tested using a visitor survey conducted in the park.

H4. Visitors are willing to pay money to combat noise pollution. Previous experiences in transport economics invite us to predict that visitors would be willing to accept a required payment to combat noise annoyance (Fyhri & Klæboe, 2006; Lera-López, Faulin, & Sánchez, 2012; Navrud, 2002; Östberg, Hasselström, & Håkansson, 2012). Like the previous hypothesis, this hypothesis was tested using the visitor survey.

2. Methods

2.1. The study area

The study was conducted in Peñalara Natural Park (PNP) and its Socioeconomic Influence Area (SIA) that covers almost 15,000 ha under park authorities' management, which are located in the Lozoya valley (Spain). It is part of the recently declared Sierra of Guadarrama National Park. The SIA is crossed by the M-604 road, a 60 km/h limited-speed regional road that has an annual average daily traffic (AADT) of approximately 850 vehicles (more than 2000 in the summer holidays). Aircraft flyover occurs randomly and is unpredictable because it depends on weather conditions at Madrid-Barajas international airport (located at 55 km to the southeast), which determine changes in taking off or approaching operations and routes.

The study area comprises a 2.6 km hiking trail called The Water Pathway (TWP). This trail is a hikers' "there and back" route, supposed to be completed in only 2 or 2.5 h (Fig. 1), that is used by approximately 70,000 people per year (20,000 on weekdays and 50,000 on the weekends) according to data provided by the park managers'. The more demanded recreational activity is to hike along TWP. It ranges from an easy hike through a Scots pine forest that starts at the park visitors' centre (1850 m in altitude) with the goal of resting by the glacier lagoon of Peñalara (2020 m). TWP Fewer visitors are able to continue climbing to the mountain peak of the same name (2428 m).

2.2. Soundscape evaluation

Fieldwork was conducted on different dates from August 2011 to February 2012. The first monitoring station (MS-1) was located close to TWP, and a second (MS-2) was situated by the lagoon (Fig. 1). These two locations were selected to summarise the two extremes of the most common visitor experiences based on

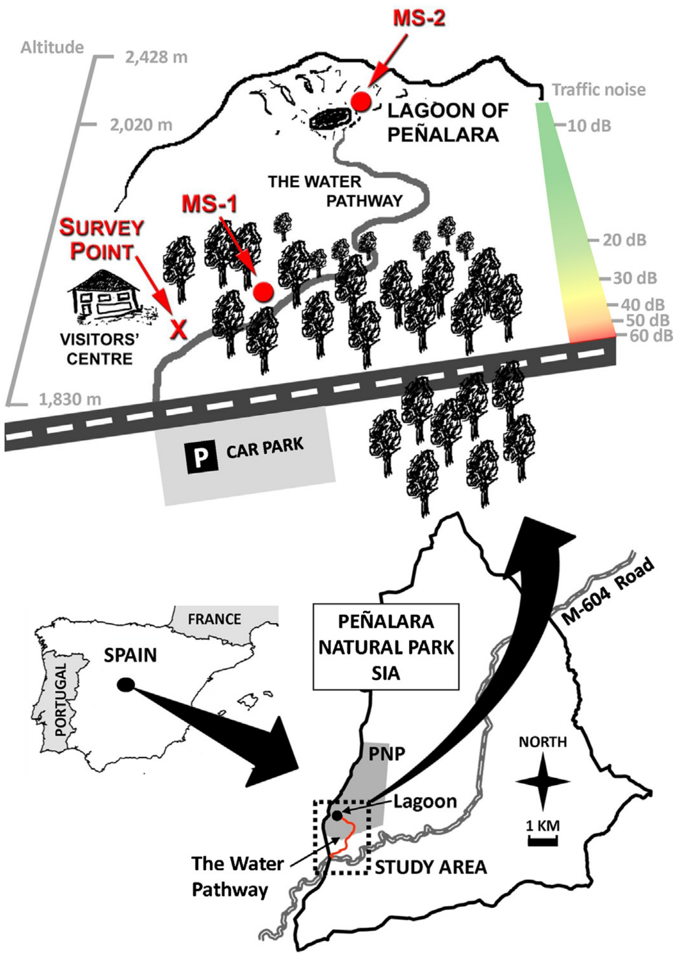

Fig. 1. Study area location and monitoring stations (MS) emplacement with road traffic sound pressure levels scale for an average day period.

soundscape association with landscape structure, composition and distance to roads (Joo, Gage, & Kasten, 2011; Votsi et al., 2012). Sound pressure levels (SPLs) on the surroundings from the road M-604 noise maps (Iglesias Merchan & Diaz-Balteiro, 2012) for an average day period are summarised in Fig. 1.

A professional "A" frequency weighting sound-level meter (SLM) type II with a windscreen was employed. The meter was calibrated before and after every recording period, and records were only accepted if the calibration reading deviations were lower than ± 0.5 dB. Temperature, humidity and wind speed during the measurements at both MSs were also monitored to meet the devices' weather-thresholds specifications or methodological requirements. A digital voice recorder was connected to the SLM for sound capture and noise-source deskwork verification. The SLM was situated at approximately 1.5 m above the ground and collected data each second during the recording periods.

There are many studies regarding ecological effects of noise pollution (Cham & Blumstein, 2011) that are usually based on very short records (González-Oreja, de la Fuente-Díaz-Ordaz, Hernández-Santín, Bonache-Regidor, & Buzo-Franco, 2012; Lengagne, 2008; Patón, Romero, Cuenca, & Escudero, 2012; Summers, Cunnington, & Fahrig, 2011) compared to those other works designed to develop a full soundscape inventory in U.S.A. national parks (Miller, 2008; NPS, 2013). The European legislation on environmental noise (Directive, 2002/49/EC, 2002) was considered, although this Directive excludes the noise from the exposed person itself and its neighbors. Taking also into account the recommendations on principles and methods stated in ISO 9613-2, a generalized well accepted methodology to assess outdoor noise exposure from a variety of sources (Brittain, 2004), as well as the study purposes (records limited to daily periods of recreational visitation), the soundscape sample consisted of 21 noise measurements and sound records that were taken in 7 different monitoring periods. Each monitoring period consisted of 3 measuring and recording intervals 5 min long (logging in slow response mode, every 1 s) alternated with 5-min interval breaks between records. The data collection resulted 1 h and 30 min of data logs and audio recorded files that fulfilled atmospheric requirements.

The main components of the biophony, geophony and anthrophony were manually identified and quantified in spectrograms using the software Audacity 2.0.3. The more common descriptive environmental noise metrics (L_{eq}, L_{max}, L_{min}, L_{10}, L_{50}, L_{75} and L_{90}) were also calculated to give approximate indications of the maximum, intrusive, median and background sound levels (Barber et al., 2011; Zhong et al., 2011). This analysis was also complemented with the sound exposure level (SEL) in singular episodes to provide a complete description of the acoustic scenario.

2.3. The survey

After characterising the soundscape in the park, on-site soundscape-perception surveys were conducted to assess recreationists' park experience. The survey was supervised and authorised by PNP Direction and technical staff. Respondents were approached at an information hut located close to the visitor centre at TWP start point (Fig. 1). A total of 327 self-reported questionnaires were collected by the park staff (correctly identified) from July 4th to October 17th 2012. The sampling procedure consisted of interviewing visitors who were exiting the park after their visit to TWP. There is a hidden automatic people counter in TWP, and the number of hikers on non-working days is approximately 2.5 times the number of visitors received on weekdays, according to data provided by the park managers. Therefore, the sampling design consisted of interviewing two visitors on weekdays and five visitors on non-working days, with the visitors randomly selected by the park staff located at the information hut.

The survey consisted of 22 questions structured according with the following three main parts. The initial part was focused on visitors' motivations and their visit duration. In the second part, visitors were surveyed about their perception of noise pollution with regard to nature conservation and their soundscape experience while visiting the park. A variety of sounds were detected during the field work although some individual and sporadic events were only recorded in one of the MSs. Therefore visitors were asked in two senses in this part of the survey: if different noise sources were audible during their visit and if the noise disturbed them respectively related with hypothesis H2 and hypothesis H3. Finally visitors were confronted with a contingent valuation exercise in the third section of the survey. They were asked to pay an entrance fee to the park for a noise-mitigation programme after their own visiting experience (hypothesis H4). This part included socio-demographic questions and visitors were also asked about their difficulty to understand the questionnaire and their own perception regarding the survey usefulness.

2.4. Economic valuation of noise

A contingent valuation analysis was performed to estimate the visitors' demand for a noise-reduction programme in the park domains. The respondents were confronted with a prospective scenario in which visitors would pay an entrance fee to contribute to mitigating the noise levels of the valley (hypothesis H4). In CVM (Carson, 2000), the individual *i* chooses between two options: the status quo, which represents the outcome that would occur in the absence of any intervention, and a noise-reduction programme at an additional cost to the individual. To identify the value of this policy change to individuals, a variety of elicitation formats have been proposed (Bateman et al., 2002; Mitchell & Carson, 1989). In this study, the payment card (PC) format was applied in the range {€0.5, €1, €1.5, €2, €2.5, €3, €3.5, €4, €4.5, €5, €5.5, €6}. The resulting interval that bounds the respondent's WTP can be modeled using the analytical approach developed for the payment card (Cameron & Huppert, 1989).

The following valuation question was used (the complete questionnaire is available on request from the authors): "In order to adopt measures to mitigate the noise pollution of the Valley, a financial contribution from visitors (through an entrance fee) might be requested. On the next payment card, please mark the maximum amount that you would be willing to pay (through a daily entrance fee per person) for a similar visit as today. Please note that this payment is real and those euros could not be devoted to other tasks."

3. Results

3.1. Soundscape experience

The main aspect of the TWP visitors' acoustic experience is the whole dominance of anthropogenic noises in spectrograms (road traffic and hikers' voices or footsteps at MS-1 and human conversations at MS-2). Singular noisy episodes are represented by people shouting, motorcycles accelerating, vehicle horns, aircraft overflights, etc. For approximately 50–60% of the audible time, it is possible to identify sounds from the biophony (mainly birdsongs). Geophony phenomena, such as the noise of wind through vegetation or rain noise, was minimised because the data were recorded under wind speeds lower than 0.8 m/s on days that were not rainy.

Regarding SLM measurements, the TWP's L_{eq} is 6 dB(A) higher than by the lagoon (41.6 dB in TWP and 35.5 dB by the lagoon). The L_{90} is usually regarded as the background noise level without any discrete events. This value corresponds to 35.7 dB in TWP and less than 30 dB by the lagoon. Lynch et al. (2011) established the desired condition for natural ambient as a metric (L_{nat}) that is an estimate of what the median ambient sound levels for a national park would be in the absence of all extrinsic (or anthropogenic) sources. A less-conservative metric has been adopted as a reference for the natural ambient in this work (L_{75}) because it was obviously not possible to do any field work to characterise visitor's experiences in the absence of these sources. The anthropic noise is assumed to be affecting this recreational area by increasing the SPL approximately 4.5 dB over the natural ambient in both places. This change can be considered as a noticeable impact because it means that the sound energy more than doubled; these values together with the percentage of time that anthropogenic noise is audible lead to the acceptance of hypothesis H1.

In addition, the SPL exceeded 44.2 dB in the TWP (and 37.8 dB by the lagoon) for 10% of the measurement period. However, some discrete episode SEL values (motorcycles accelerating, shouts, sneezes or aircraft overflights) clearly exceeded L_{75} and L_{eq} values during the monitored periods (Table 1). Therefore, repetitive events such as overflights or accelerating vehicles are able to cause a very significant environmental impact on the natural soundscape. Human shouts or loud voices are also particularly significant in quantitative terms of energy.

A total of 327 on-site visitor soundscape-perception self-reported questionnaires were collected by the park staff. Regarding audible noises during the period of visit (hypothesis H2), the results (Fig. 2) reveal that the majority of perceived noises were from visitors' voices (51%) and aircraft overflights (42%).

Table 1
Noise metrics at monitoring stations (MS-1: TWP; MS-2: Lagoon) and singular events sound exposure levels (SEL)[a].

Metric dB(A)	TWP	Lagoon	Bike	Shout	Sneeze	Aircraft
L_{eq}	41.6	35.5	–	–	–	–
L_{max}	59.5	50.3	–	–	–	–
L_{min}	33.1	27.7	–	–	–	–
L_{10}	44.2	37.8	–	–	–	–
L_{50}	39.2	32.9	–	–	–	–
L_{75}	37.3	30.9	–	–	–	–
L_{90}	35.7	29.7	–	–	–	–
SEL	–	–	45.7	59.9	45.7	39.0

L_{eq}, the equivalent continuous sound pressure level (SPL); L_{max}, maximum SPL period value; L_{min}, minimum SPL period value; L_n, level of noise exceeded for n% of the specified measurement period.

[a] Instrumentation: PCE-322 sound level meter type II (from 31.5 Hz to 8 kHz); PCE-SC41 calibrator type II (1 kHz sine wave at 94 dB); Olympus VN-85000PC digital voice recorder.

Therefore the second hypothesis was accepted: human-made noises are perceived by the park visitors. Transport vehicles reached annoyance values ranging from 2.65 to 3.38 on a scale with a maximum of 5.0 (Fig. 2), which could be considered as a disturbing noise detracting visitors from having a quality park experience, confirming our hypothesis H3. Music could also be considered almost disturbing, and other devices such as cell phone ringtones, range under half of the maximum values (2.5). The rest of the noises (dogs and hunters) were assessed as not very disturbing sources.

3.2. Contingent valuation results

A total of 321 collected questionnaires were considered fully valid and relevant to the CV question; six visitors were removed from the sample because they did not reply to the CV question. On average, the interviewed visitors were 42 years old, and 96% of them had Spanish nationality. Most of the visitors (85%) live in near municipalities located in the region of Madrid, mainly in Madrid city (42% of the respondents). An environmentalist affiliation (mountaineers, ecologist groups, etc.) was reported by 21% of the interviewed visitors. The percentage of respondents with college degrees was 63% which is much higher than the current percentage of people with higher education in Spain. Regarding

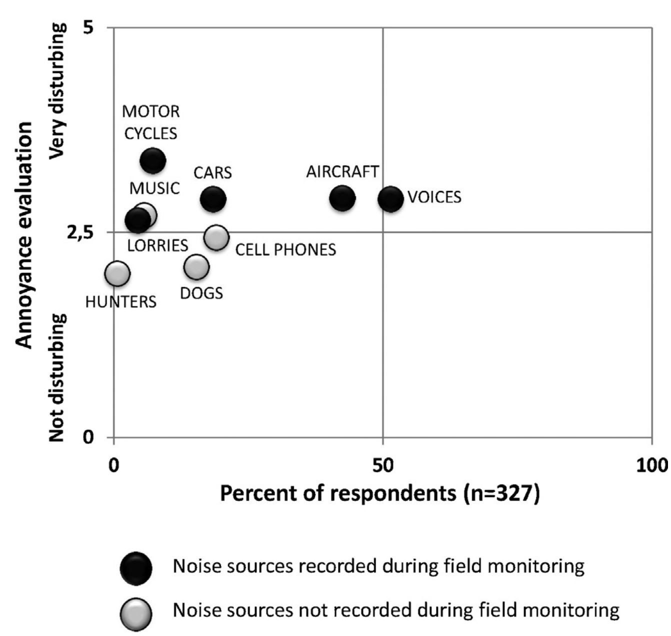

Fig. 2. Noise sources inventory and visitors' perception.

the household composition, the reported households consisted of an average of 3 individuals, and 62% of the households do not have any children (under 16 years). The surveyed households' average net monthly income is 1500–2000 euros, while the personal average income ranged between 1000 and 1500 euros. Finally 80% of respondents appreciated that questionnaire contents were appropriate and only 2.75% of the surveyed visitors rated as useless this work.

In this study, we have estimated two behavioural models (simple and expanded). For each model, the analytical median ($-\alpha/\beta$) and the nonnegative mean ($-\ln(1+\exp(\alpha))/\beta$) values of WTP were estimated (Table 2), where α represents the "grand constant" (i.e., the sum of the products of the means of the explanatory variables times their associated coefficients) and β is the coefficient associated with the bid amount. The 95% confidence intervals for the average WTPs were estimated using the Krinsky and Robb (1986) approach with 1000 replications.

The simplest model considers that preferences are only influenced by the bid. The results from this model show a negative relationship between the bid amount and the probability of saying 'yes' to the programme. The median WTP is €0.84, and the mean is €0.94 per individual, i.e., the results show a positive and significant WTP for the noise-reduction programme.

In addition to considering the bid amounts, it is usual to incorporate some degree of individual heterogeneity into the analysis. In this sense, the expanded model shows that there could be several individual variables (Table 3) with a significant influence on WTP. The results show that people visiting the park for the first time (FIRST) were less willing to contribute to the noise-reduction programme. Nevertheless, those visitors for whom, one of the main reasons for their visit was to know the park (KNOW) were more willing to pay for this programme. Noise perceptions had an intense effect on visitors' preferences. In this sense, those who perceived that noise bothered them a great deal during their visit (NUISANCE) or that noise levels were very high in the valley (NOISE) or who were bothered very much by the noise of cell phones (PHONE) were more likely to support the noise reduction-programme. In addition, individuals with higher incomes (INCOME) were also more willing to support policies aimed at improving the noise conditions of this protected area. Lastly, the mean WTP from the expanded model was €0.96 and the median was €0.87 per individual. The simple and expanded model confirm hypothesis H4.

4. Discussion

4.1. Natural soundscape degradation

Anthropogenic SPLs from visitors activities and transport infrastructures are degrading leisure experiences, including the natural soundscape, in PNP. Noise pollution represents an expanded threat that is limiting opportunities to experience human-made noise-free intervals over the years (Lynch et al., 2011; Mace et al., 2013). Pilcher et al. (2009) studied respondents acceptability of park's visitor-caused sounds and their results were plotted in a social norm curve where the neutral point of the acceptability scale was situated at 37 dB(A). This value indicates an almost permanent unacceptable anthropogenic impact on the natural soundscape of TWP and a noticeable level of singular events at the lagoon that would reaffirm the first hypothesis H1, as was observed in the results.

Noise pollution from transport infrastructures represents an increasingly challenging environmental problem on sensitive areas (Dumyahn & Pijanowski, 2011; Mace et al., 2013; Miller, 2008). Feasible road traffic noise mitigation measures could include aspects related to traffic management, noise-reducing road surfaces or even sound barriers construction but it could be a cause of additional environmental impact (Arenas, 2008). We agree with Lynch et al. (2011) that the regional and national scales of these noise sources require noise-mitigation planning efforts and policy coordination at the highest agency levels. Although such collaboration happens only in very few cases (Holm et al., 2013), transdisciplinarity becomes strategic to handle the complexity of environment components (Tagliafierro, Longo, Van Eetvelde, Antrop, & Hutchinson, 2013).

European countries lead research on transportation and industrial noise impacts on human health (Seong et al., 2011), but natural soundscape management is still a pending issue in Europe. Some research groups and practitioners have become involved in collective actions or programmes aimed at standardisation in recent years (Axelsson, 2012) although it is still not possible to find references or studies by European agencies like NPS of the U.S.A. These technical and scientific works may assist to correct the gap from policies and public initiatives in this field. Besides, these multiple focuses or findings (like those exposed in the present study and the large number of references listed) may contribute to make evident the transdisciplinarity required by so dynamic and complex issues if every stakeholder doesn't get involved. An example of strategic planning that involves different agencies has been developed by the Australian State of Victoria (SV, 2013) in the case of recreation linked to motorcycle routes, although that programme is too heavily focused on economic and social impacts and does not equally reflect environmental considerations.

Natural soundscape loss or degradation may have a substantial impact on aesthetic and affective visitors' experiences (Benfield et al., 2010), representing a depletion of ecosystem services linked to people's health or psychological well-being in areas of presupposed environmental quality (Gidlöf-Gunnarsson & Öhrström, 2007; Radford & James, 2013; Votsi et al., 2013). According to Marin, Newman, Manning, Vaske, and Stack (2013) and Mace et al. (2013), visitors' motivation management and information on the diverse soundscape experiences offered would affect their acceptance of anthropogenic noises. In this sense, an original educational programme to sensitise visitors to human-caused noise was implemented at Muir Woods (Stack, Newman, Manning, & Fristrup, 2011), and monitored sound levels dropped by almost 3 dB(A) by introducing the soundscape management in the park planning and invoking visitor's consciousness for improving their own experience. Therefore our findings may help stakeholders to promote environmentally responsible behavior of visitors with regard to soundscapes which may positively redound to their own perception and satisfaction during visits (Chiu, Lee, & Chen, 2014) according with the survey assessment by PNP visitors.

4.2. Visitors' soundscape experience

The on-site soundscape survey results reveal that the majority of the perceived anthropogenic noises were from visitors' voices (51%) and aircraft overflights (42%), confirming hypothesis H2. Both of these noise sources are easily visible by receivers, which could suggest significant influence of visual stimuli on respondents' sensitivity and evaluation (Anderson, Mulligan, Goodman, & Regan, 1983; Mace, Bell, & Loomis, 2004). Human voices were not reported as a significant noise source causing impact to soundscapes and were not considered of great management concern by U.S.A. park managers (Dumyahn & Pijanowski, 2011). Nevertheless, because of the high percentage of respondents referring to this disturbance and given our measurement results, we find that the human-voice pollution at PNP is closer to the findings of Pilcher et al. (2009), who observed that loud talking was a good indicator of quality that detracts from the visitor experience, thereby becoming an issue for management to consider.

Table 2
Contingent valuation results.

	Simple model		Expanded model	
	Coeff.	Std. err.	Coeff.	Std. err.
Constant	1.562**	0.176	1.386**	0.218
Bid	−1.861**	0.083	−1.962**	0.086
First	–	–	−0.574*	0.255
Nuisance	–	–	2.692**	0.940
Noise	–	–	3.016**	0.578
Know	–	–	0.570*	0.234
Income	–	–	0.531*	0.221
Phone	–	–	2.023*	0.934
Median WTP (€) (K&R 95% CI)	0.84** (0.70–0.97)	0.067	0.87** (0.73–0.99)	0.064
Mean WTP (€) (K&R 95% CI)	0.94** (0.75–1.11)	0.050	0.96** (0.79–1.12)	0.050
Log likelihood function	677.993		662.265	
Bayesian information criterion	−4.224		−4.126	

* $p < 0.05$.
** $p < 0.01$.

Table 3
Variables and descriptive statistics.

Variable	Description	Mean (%)	Std. dev.
First	This is the first time visiting the Nat. Park (1: yes; 0: no)	30.22	0.460
Nuisance	Likert scale from 1 (null) to 5 (greatly) indicating if the noise has bothered during the visit (1: greatly bothered; 0: other value)	0.62	0.079
Noise	Likert scale from 1 (null) to 5 (very high) describing the perceived noise levels in the valley (1: very high; 0: other rating)	2.49	0.156
Know	One of the main reasons for her/his visit was to know the Nat. Park (1: yes; 0: no)	40.50	0.492
Income	Individual income is more than €1,500 monthly (1: yes; 0: no)	28.97	0.454
Phone	Likert scale from 1 (null) to 5 (greatly) indicating if she/he was bothered by noise of phones during the visit (1: greatly bothered; 0: other rating)	0.93	0.097

Hypothesis H3 has also been accepted. Although road-traffic noise is only audible in the first part of TWP (not from the lagoon), it was considered equally annoying as loud talking and aircrafts by 18% of the visitors. However, motorcycles are the more disturbing noise source according to the respondents. Despite being one of the less commonly heard sources by visitors (7%) and although the SEL values of motorcycles are lower than those of other sources. However, motorcycle touring is a growing trend on weekends, and the drivers profile and park-resources use of these drivers is very different from that of hikers. Subjective noise perception is correlated with psychological phenomena, and reported annoyance levels might be increased when a noise is perceived as unnecessary or it is assumed that the noise producer is unconcerned about the welfare of others (Mace et al., 2004, 2013).

4.3. Visitors' WTP

Two very different scenarios have been defined from both aspects: from the background noise and from the visitors' activities (hiking TWP or resting by the lagoon for a while). Accordingly, visitors were asked about the duration of their visit because it is assumed that stays shorter than 2.5 h correspond to people who did not walk as far as the lagoon. In total, 17.5% of the PNP visitors surveyed had stayed for less than 2.5 h, and therefore, they had only been exposed to the TWP soundscape. Unexpectedly, this issue did not influence the visitors' willingness to pay despite the facts that spatiotemporal changes of soundscape elements influence the perception by people significantly (Liu, Kang, Luo, Behm, & Coppack, 2013) and that opportunities to rest far from the road traffic may positively affect psychological well-being and the valuation of spiritual services in regard to landscape gradients from a less to more natural composition (Gidlöf-Gunnarsson & Öhrström, 2007; Radford & James, 2013).

The results show a projected improvement in the visitors' well-being if a noise-reduction programme were developed in the PNP because visitors are willing to pay nearly €1 per visit, which confirms hypothesis H4. This value may express the monetary benefits that society receives from preserving nature (Tagliafierro et al., 2013) as a provider of restorative experiences for people's well-being (Gidlöf-Gunnarsson & Öhrström, 2007). Several 'soundscape variables', such as being bothered a great deal by the noise of cell phones during the visit, having the perception of very high noise levels in the valley, or being greatly inconvenienced by noise disturbances during the visit, influence the visitors' willingness to pay.

In addition, almost 90% of PNP visitors arrive in their own vehicle. Considering that cell phones and other devices are brought by the visitors, it is possible to affirm that the main noise disturbances referred to by visitors are caused by visitors themselves (except aircraft). This linkage is a challenge in the field of national park soundscape management that overlaps the action field of the park's public-use management, in the context of the findings of Lawson, Manning, Valliere, and Wang (2003) with regard to the carrying capacity in national parks to conserve heritage but also the quality of the visitors' experience. This balance is required even though soundscapes do not have clearly defined boundaries (Dumyahn & Pijanowski, 2011). Public managers could consider the results of such studies to propose specific measures to mitigate anthropogenic noise.

5. Conclusions

This work reveals that noise pollution is indiscriminately impacting nature soundscapes of Peñalara Natural Park at present (H1). Visitors identify unwanted outdoor noises that disturb their soundscape experience when visiting the park (H2). Some of the noise disturbances related by visitors (H3) are caused by the visitors themselves. Transport noise is also deemed as disturbing, although it is a problem outside of the national park manager's jurisdiction. A visitor soundscape-experience survey shows a positive and significant willingness to pay for supporting a noise-reduction programme funded through an entrance fee to the park (H4). Therefore, four hypotheses were tested with significant results in each case.

Educational programmes have been proposed by a variety of authors to maintain or restore natural soundscapes for a satisfactory park experience. Such programmes would be a suitable recommendation because of SPLs and the high audibility of visitor-made noises as well as the annoyance levels referred to and caused by the same visitors. Education may facilitate improvement of respondents' acceptance of anthropogenic noises, but environmental noise management in national parks is not only an educational issue at the park level. Some reasonable road traffic noise mitigation measures have been also commented in parallel with educational programmes, but interagency cooperation at the highest levels would be desirable because these noise-pollution sources are outside the park managers' control and it may cause new environmental impacts in the park. The economic resources available for the design of these mitigation measures and educational programmes may vary according to visitors' WTP.

Lastly, further research of interest would be to expand the number and type of locations of visitor-sampling points in national parks and to conduct automated sound-source recognition coupled with long-term measurements to broadly assess the influence of temporal and spatial dynamics of soundscapes on visitors' preferences while surveying these preferences.

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Appendix A. Supplementary data

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