Estimating the amenity value of Irish woodlands

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Abstract
During the last decade, as the population of Ireland has become increasingly urbanised, there has been an increase in demand for outdoor recreational pursuits. Increased affluence, mobility and changing values have also brought new demands with respect to landscape, conservation, heritage and urban land use. Forests in Ireland are seen by the general public as potential destinations to fulfil their outdoor recreation requirements. We estimate an urban fringe forest recreation demand function and use it to investigate the value of urban woodland space, in terms of public-good provision to local residents. Through the estimation of a travel cost model, the study derives the mean willingness to pay of the average outdoors enthusiast using two urban fringe forests in Co Galway as €12.33, of which the travel cost comprised €7.36, with the balance the consumer surplus of €4.97. The results indicate a high value of urban woodland in Ireland from a recreational perspective.

Keywords
Recreation, urban woodland, travel cost model, negative binomial distribution.

Introduction
It has been well established (Tyrväinen et al. 2005) that urban forests greatly improve the local landscape and environment, provide a wide variety of recreational and educational activities for all ages, play a role in improving air quality and in carbon sequestration, provide a buffer to integrate mixed development and land uses and help to create an attractive green landscape, which encourages inward investment, employment and tourism.

In an Irish context, as a result of the growth in the urban population, significant increases have taken place in outdoor recreation participation throughout the 1990s and into the early 2000s. The widely documented Celtic tiger has brought increased wealth and disposable income to a greater proportion of the Irish population, giving rise to increased car ownership and extended leisure time, enabling people to partake in a range of outdoor recreational pursuits (Fitzpatrick and Associates 2005).

With over 60% of the Irish population now living in cities and in towns with populations in excess of 10,000, urban forests can provide important opportunities for people to recreate. In a review of forest research of non wood benefits of Irish forestry, Cregan and Murphy (2006) point out that urban forestry has the potential to provide green space for active and passive recreation. The authors also highlight the fact that urban forests may provide an increased level of social cohesion in the community, and can be important in terms of maintaining natural functions and biodiversity in urban areas.

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Urban forests have also been found to add value to house prices (Morales et al. 1980, Anthon et al. 2005).

To date, few studies have explored whether urban forests in Ireland contribute to the well-being of nearby communities. However, a number of studies have been carried out in Europe and elsewhere in this regard (Bennett et al. 1995, Lockwood and Tracy 1995, Tyrväinen and Miettinen 2000, Tyrväinen 2001, Anthon et al. 2005, Chaudhury 2006).

Urban forestry in Ireland

The importance of urban forestry[1] in Ireland has been highlighted for many decades, although according to Johnston (1997) it was not until the beginning of the 1990s that it began to be properly recognised in Ireland[2]. A 12-month project initiated by the NGO Crann, during 1988 - *Crann sa Chathair* - had the objective to establish woodland in city areas. One thousand trees were planted in each of ten areas of Dublin City, with the impetus coming from local communities (Crann 2008).

More recent urban woodland initiatives include the Forest of Limerick project established in 1991[3], the Terryland Forest Park initiative in Galway City (begun in 2000 and still expanding) and the urban forestry programmes of ECO, ECO UNESCO[4] and the Tree Council of Ireland. According to Johnston (1997) not only did ECO develop the beginnings of a national urban forestry network, it also did much to gain international recognition for developments in the Republic of Ireland. The interest in urban forest research is also evident from the fact that there were three national urban forestry conferences during the 1990s (1991, 1996 and 1998). The year 2000 also saw the holding in Dublin of the research seminar *Planting the Idea, The role of Education in Urban Forestry* by COST Action E12[5].

As the importance of urban forestry grew in Ireland, grant aid became available for its development. In 1995 the Forest Service launched the Urban Woodland Scheme. Its main aim was to support the establishment or development of urban woodland by local authorities, for the specific purpose of recreational use by the public (DAFF 2007). The scheme was co-funded by the EU under the Operational Programme for Agriculture, Rural Development and Forestry.

[1] According to international definitions (COST E12, IUFRO) the urban forest is the entire tree and woodland population within an urban area (including street trees, trees in public spaces, private gardens and woodland), and urban forestry is the multi-disciplined integrated approach towards the management of this overall resource. This study focuses on the urban woodland component of the overall urban forest resource.

[2] Having said this, Massey Woods near Killakee in the Dublin mountains was laid out primarily as an urban recreational woodland in the 1930s under the guidance of the then Director of the Forestry Division, Otto Reinhardt.

[3] A pilot project initiated by the Forest Service, it led to the establishment of the first state grant aid scheme for urban woodland

[4] ECO-UNESCO is Ireland's national environmental organisation for young people specialising in environmental education.

[5] See Collins (1996), Collins (1998) and Collins and Konijnendijk (2000) for further information on these conferences.

The Urban Woodland Scheme ceased in late 1999, and was replaced by the NeighbourWood Scheme. The NeighbourWood Scheme offers support to local authorities, community groups, environmental NGOs and private woodland owners to work in partnership to develop woodland amenities in and around villages, towns and cities, and has led to many new projects being developed. It is administered by the Forest Service, Department of Agriculture, Fisheries and Food and until recently was co-funded under the Regional Operational Programmes of the National Development Plan by the State and the EU. The NeighbourWood Scheme, involving public, private and voluntary sector organisations, continues to contribute to the development of urban forestry[6]. Local authorities and the Office of Public Works own and provide much of the urban woodland available for recreation in Ireland. Coillte, The Irish Forestry Board is the largest owner of urban (and peri-urban) woodland in Ireland, particularly in and around the fastest growing towns.

With the expansion of city suburbs into rural areas, some former rural woodlands can now be considered as urban green spaces. The two sites used in this study are two such examples: Barna Woods and Renville forest park were 20 years ago in rural locations, but with the growth of Galway City and Oranmore village, they now lie on the edge of these settlements, respectively.

The valuation of pubic good provision in Irish forestry

There have been a number of valuation studies of Irish forestry, using both stated and revealed preference techniques, but none relating specifically to non-market goods provision in urban forestry[7]. Work was undertaken by Ní Dhubháin et al. (1994), as part of a larger study to determine the social and economic impacts of forestry on rural development in the Republic of Ireland, Northern Ireland and Scotland. Forest recreation was valued using both the travel cost method (TCM) and the contingent valuation method (CVM). The work showed that the willingness to pay (WTP) for a single day-visit to a forest, varied from €1.02 to €2.73 (1992 prices) and estimated the value of recreational activities associated with forests at €15.9 million annually.

Clinch and Convery (1995) carried out an extensive review of the levels and trends of forest recreation in Ireland using existing data at that time. Clinch (1999) expanded this work by carrying out a public goods valuation study on Irish forestry; estimating that there were 8.5 million visits made to Irish forests annually. Clinch (1999) used a contingent valuation method (CVM) approach to account for the willingness to pay for landscape, wildlife and recreational benefits from Irish forests.

[6] For a discussion relating to the development of urban forestry in Northern Ireland see Johnston (1998).

[7] Economic valuation techniques usually fall into two distinct categories: stated preference (SP) techniques (e.g. the contingent valuation method (CVM)) and revealed preference (RP) techniques (e.g. the hedonic price method and the travel cost method). The stated preference method asks users directly to state their WTP for the opportunity to use an environmental amenity (Hanley et al. 2000). The revealed preference technique aims to deduce WTP from observed evidence of how users behave in the face of real market choices, so as inferences can be drawn on a related non-market good (Pearce and Ozdemiroglu 2002).

Results indicated that in 1999 the net present value of Irish forests amounted to £129 million.

Bacon and Associates (2004) updated Clinch's visitor estimates, presuming a growth rate of 3% per year, indicating a total of 11 million visitors in 2004. Adopting a model used in the UK, Bacon and Associates (2004) were able to calibrate a model for Irish forests and estimate a willingness to pay of €3.34 per visitor based on 2003 prices.

A more recent report (Fitzpatrick and Associates 2005), commissioned by Coillte, used primary data from 640 on-site interviews and 3,000 household surveys, in a contingent valuation study, to measure the non-market value of forest recreation in Ireland. Value was estimated at €97 million per year, a substantial increase from the €16 million estimated in 1990 when Coillte carried out a similar valuation exercise (Fitzpatrick & Associates 2005). This Fitzpatrick & Associates study also highlighted the importance of proximity to home in terms of use and the popularity of general recreational pursuits that are typical of urban woodland.

In another study, Scarpa et al. (2000) used the CVM approach to calculate the WTP of users of forest attributes in Irish forests. The study found that the presence of a nature reserve in a forest significantly increased visitors WTP. A random utility model was used to calculate the welfare gains from the presence of a nature reserve. A new nature reserve was found to generate almost half a million pounds of welfare per year accruing to visitors. Thus, provision of forest attributes and facilities, such as nature reserves, have been shown to significantly increase the returns from forest sites to the recreational users. In a study dealing with similar issues, Mill et al. (2007), calculated the personal and social mean willingness to pay (MWTP) for conservation of an Irish forest. The study found a positive correlation between the personal MWTP and the rankings of forest types by forest managers, suggesting that public use forests have been reasonably efficient in providing facilities that reflect visitor MWTP.

Research into the non-market valuation of urban forestry in Ireland is limited. Collins (1994) conducted a study that examined the potential to develop woodland in West Dublin. This study undertook a review of urban forestry and its development in Ireland and set out a case study of the development of an urban forest in the Finglas suburb of Dublin, based on a detailed community survey and site evaluation.

Johnston (1997, 1999) contains an in-depth review of the development of urban forestry in the Republic and Northern Ireland. The 1997 paper reviewed the organisations primarily responsible for the development of urban forestry in Ireland and criticised the Department of the Environment and Local Government for not playing any significant role in this development process; Johnston speculated that it may have been due to "continuing misconceptions regarding the broad scope of urban forestry and a lack of awareness that it is primarily a local authority function."

In a recent review of forest recreation research needs in Ireland, Cregan and Murphy (2006) highlighted the fact that there is "a limited understanding of the role and value of woodlands in urban settings in Ireland." Who uses urban woodland in

Ireland and what value do they bring to urban communities are two areas of research that Cregan and Murphy (2006) believed required particular attention.

This study addressed these issues by having the overall objective of estimating the recreational value of urban woodland by assessing recreational activity of local residents in two urban woodlands in Co Galway.

To put the work reported here in context, much research evaluating other benefits of urban forests is being conducted abroad, examining aspects such as urban regeneration, public health, tourism, sustainable urban planning/development, sustainable transport corridors, as well as direct environmental benefits such as cooling effects and savings in air conditioning.

Materials and methods

On-site, in-person interviews were undertaken at two urban forest sites in Ireland, between June and August 2006. Both forests are managed by Galway County Council and are in close proximity to residential populations. Barna Wood is located in the western suburbs of Galway city, and covers 10.5 ha, while Renville Forest Park is located on the outskirts of Galway City, adjacent to Oranmore village, and has a forested area of 18.5 ha. Barna Wood, just 5 km from the city centre, comprises native oak woodland with walks, trails and picnic facilities. Renville Forest Park meanwhile has walks, a playground and picnic and barbeque facilities. There are many other examples of urban fringe woodland across Ireland, Brackloon near Westport, Co. Mayo and Trespan Rock Park on the outskirts of Wexford Town being just two others.

The two forest sites in this study are not tourist destinations in their own right but nevertheless are used heavily by the local urban communities as recreational amenities. The frequency of visits is quite high, with a significant number of people visiting the sites on a daily basis. The forests cater for a wide range of uses, from walking, nature walking, dog walking, cycling and picnicking. A breakdown of the main activities pursued by the sample of visitors at the two forests is provided in Table 1.

On-site interviews were conducted during both week and weekend days, as well as during all daylight hours. The format of the survey questionnaire followed

Table 1: Main reasons given for visiting the forests in the study.

Activity	*Renville Forest*	*Barna Wood*	*Total*
Walking	120	46	166
Dog Walking	39	15	54
Cycling	4	3	7
Picnic/Barbeque	15	0	15
Other	25	2	27
Total	203	66	269

standard guidelines for the design of valuation survey instruments (Bateman et al. 1996). Survey respondents were provided with some background information on the study and were then asked to outline how they use the forests for recreation. Finally, socio-economic, demographic and attitudinal data was collected from respondents.

Model specification and empirical estimation

Valuation of recreation or environmental goods attempts to estimate the economic value, in monetary terms, which members of society receive from the use of natural resources. Due to their public good characteristics, such as being non-rival and non-excludable, they cannot be efficiently allocated through markets Yet, walking in a forest or on upland commonage or kayaking on a river can provide an economic benefit to the individual even if a formal market does not exist to recognise this. It is a benefit for which the consumer would, if he/she had to, pay (perhaps a parking or access fee). The fact that they do not have to pay (in most cases), results in the recreationalist retaining, therefore, a consumer surplus as extra income.

Methods of valuing non-market goods (recreation or environment) are usually categorised as stated or revealed preference approaches. In the former, respondents are asked to directly state their willingness to pay for recreational opportunities in the context of hypothetical changes in the supply or quantity of these opportunities. The Contingent Valuation Method (CVM) is an example of a stated preference approach and its use in the valuation of urban forestry can be seen in Bennett et al. (1995) and Tyrväinen (2001). Revealed Preference (RP) models are the main alternative to Stated Preference (SP) techniques for modelling recreation. The RP methods of valuation are based upon data drawn from observations of behaviour in real markets from which inferences may be drawn on the value of a related non-market good. Previous studies that have used the Hedonic Price RP method for urban forest valuation include Tyrväinen and Miettinen (2000) and Anthon et al. (2005), while Lockwood and Tracy (1995) and Chaudhury (2006) have used the Travel Cost Method (TCM) to estimate the value of urban forest resources from a recreational viewpoint.

The travel cost model (TCM) is widely used by economists to estimate user benefits from visits to recreational areas. There have been problems with using the TCM in urban areas because travel costs may not be a major determinant of visitation (Curtis 2002), as travel time is not a key factor in determining recreation demand. Tyrväinen et al. (2005) describe how the TCM is problematic in urban settings because there are usually no, or only small costs involved in travelling to the site. However, in our case the two sites can be considered a regional recreation resource, with a significant number of people travelling between 10 and 45 minutes to visit them, with the majority of visitors travelling by car.

Tyrväinen et al. (2005) say: *the TCM method is useful in a setting where large urban forests within city limits are scarce and people have to travel further to reach the areas.* There is at present no large urban forest within the city of Galway (although Terryland Forest Park is under development) or in Oranmore. Residents of both areas have to travel to the outskirts of the suburbs of each area, usually by car, to reach Barna Woods and Renville forest. Therefore there are time costs involved that make the TCM an appropriate valuation option.

Chaudhury (2006) used the TCM to estimate the recreational value of an urban woodland site as the author had previously found that respondents in CVM studies had a tendency not to reveal actual income on record which led to poor results in using CVM analysis.

TCM is, therefore, an indirect valuation technique which uses expenditure in travelling to a site as a surrogate measure for the price paid by an individual visitor. The price faced by recreationalists is the cost of access to the urban forest site (mainly the time and money costs of travel from home to site), while the quantity demanded per year is the number of recreational trips made to the (urban forest) site. A demand equation can then be estimated, from which consumer surplus can be derived. Economic value (consumer surplus) of a particular output of a public good such as urban forest site recreation can be found by estimating the consumer demand curve for that output. It is important to note that the consumer surplus figure is a measure of the user value of the urban forest site only, and does not measure the site's environmental or intrinsic value (McKean and Walsh 1986).

Travel cost should reveal itself as being the critical driving factor behind the demand for trips to the urban forest area. Demographic factors such as gender and age generally have less dramatic impacts on demand, but can be important in explaining why different groups respond differently to changes in price or income (McKean and Taylor 2000). Variation among recreationalists in travel cost from home to the urban forest sites (i.e. price variation) creates the urban forest recreation demand function.

Travel Cost Count Data models are typically estimated based on either the Poisson or negative binomial distributions. Such an approach is consistent with the discrete nature of the dependent variable, that is, the annual number of trips. The number of trips taken in any given year is reported as a discrete, non-negative integer value. Thus, application of the standard distributional assumptions (e.g. normality) is inappropriate because the dependent variable in the TCM cannot take on a continuous range of values. This is evident from the histogram in Figure 1 where it can be seen that a discrete probability distribution would result in a better model specification.

The Poisson model has been criticised because of its implicit assumption that the conditional mean of T (in this study T is the expected number of trips to the urban forest area demanded) equals the variance of T (Greene 1993). Therefore, if a Poisson model is fitted to the urban forest data, a mean-variance equality restriction is imposed on the estimation; effectively requiring the variance to be less than it really is. As a result, the true variability of the data is underestimated. This leads to underestimation of standard errors, and so the overestimation of the level of precision of the coefficients (Cameron and Trivedi 1986).

This mean-variance equality has proven problematic since data frequently exhibit over-dispersion: where the conditional variance is greater than the conditional mean. Take recreationalists at an urban forest site for example; the average number of trips

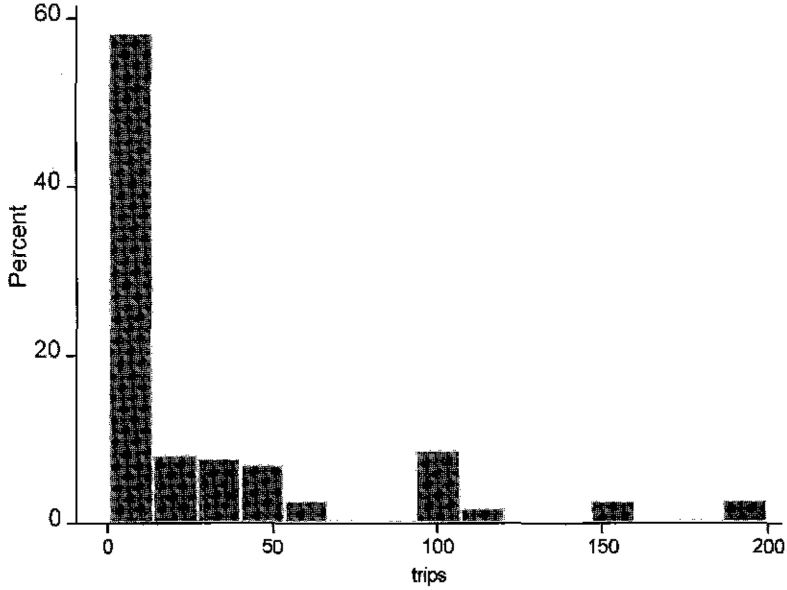

Figure 1: Frequency distribution of recreational trips to forests in the study.

taken to the urban forest in one year was 32.5 but the variance was over 68 times that at 2,228. Following the work of Creel and Loomis (1990) and Grogger and Carson (1991), however, the Poisson distribution can be generalised to take over-dispersion into account. The generalisation most often used in the literature is the negative binomial probability distribution (Grogger and Carson 1991, Englin and Shonkwiler 1995, Curtis 2002) where an individual, unobserved effect is introduced into the conditional mean.

Having taken into account the foregoing, one remaining issue needed to be addressed: there were no observations for individuals who made no trips to urban forest sites. The survey dataset only reflected the behaviour of individuals who took at least one trip to the study areas. This has important implications for the empirical specification of the TCM. Exclusion of individuals who chose not to make a trip implies that the data were systematically truncated. If not recognised, the resulting parameter estimates will be biased in terms of inferences drawn about the population of potential beneficiaries of urban forest recreation in the future. Bias will extend to the estimates of consumer surplus that are derived from these parameters. To address this issue the negative binomial distribution was modified to reflect the fact that T_i is only observed when $T_i > 0$. Following Grogger and Carson (1991), the negative binomial probability distribution was adjusted for truncated counts. The revised probability model can be written as:

$$\Pr(T_i) = f(T_i) = \frac{\Gamma(T_i + 1/\alpha)}{\Gamma(T_i + 1)\Gamma(1/\alpha)}(\alpha\lambda_i)^{T_i}(1+\alpha\lambda_i)^{-(T_i+1/\alpha)}[1 - f(0)]^{-1} \qquad (1)$$

where there are $i = 1, 2, \ldots, n$ observations, Ti is the number of trips to the forest for individual i and λi is some underlying rate at which the number of trips occur, such that we expect some number of trips in a particular year, i.e. the mean of the random variable T_i, $(E(T_i|X_i))$ is given by λ_i and $\lambda_i = \exp(Xi'\beta)$. The variance of y_i $(var(T_i|X_i))$ is given by $\lambda_i(1 + \alpha\lambda_i)$. The vector X_i represents the set of explanatory variables reported for each individual i. It is a 1 by k vector of observed covariates and β is a k by 1 vector of unknown parameters to be estimated. The scalar α and the vector β are parameters to be estimated from the observed sample. Γ in equation (1) indicates the gamma function that distributes λ_i as a gamma random variable. Finally, α is a nuisance parameter to be estimated along with β. α is a measure of the ratio of the mean to the variance of the number of trips to the forest site. Larger values of a correspond to greater amounts of over-dispersion. The model reduces to the Poisson when $\alpha = 0$, as $E(T_i \mid X_i)$ is again equal to $var(T_i \mid X_i)$). The truncated probability function differs from the standard probability function by the factor $[1 - f(0)]^{-1}$. Since $f(0)<1$, multiplication of the usual probabilities by $[1 - f(0)]^{-1}$ inflates them, accounting for the unobserved zeros. Estimation of the resulting truncated negative binomial model relies on standard maximum likelihood techniques. The log-likelihood function for the truncated model can be written as follows:

$$\ln L = \sum_{i=0}^{N} \ln\Gamma(T_i + 1/\alpha) - \ln\Gamma(1/\alpha) + T_i \ln(\alpha\lambda_i) - (T_i + 1/\alpha)\ln(1 + \alpha\lambda_i)$$
$$- \ln[1 - (1 + \alpha\lambda_i)^{-1/\alpha}] \tag{2}$$

where N corresponds to the size of the truncated sample. The conditional mean and variance of this model is given by:

$$E(T_i \mid X_i, T_i > 0) = \lambda_i[1 - f(0)]^{-1} \tag{3}$$

and
$$var\,(T_i \mid X_i, T_i > 0) = \frac{E(T_i|X_i, T_i > 0)}{f(0)^\alpha}\{1 - [f(0)]^{1+\alpha} E(T_i|X_i, T_i > 0)\} \tag{4}$$

For comparison purposes, the demand model was also estimated under the less restrictive assumptions imposed by use of the untruncated negative binomial distribution. A truncated Poisson distribution is also used to model the data generating process that underlies the discrete, nonzero values observed in the sample. Although this model can be somewhat easier to estimate, it once again imposes the restriction that the conditional mean of the dependent variable λ, is equal to the conditional variance.

Results

During the course of this study, 269 on-site personal interviews were carried out in Barna Wood and Renville Forest Park. In order to correct for respondents who replied with a very high number of trips taken, the approach taken by Morey et al.

(1993) was followed and the analysis was confined to respondents who stated that they had made 200 or less trips in the previous year. This reduced the sample to 235 observations, of which 62% were female, 64% were in full-time employment and 60% had third level education. Renville Forest accounted for 75% of the sample.

The average annual number of visits to the forest sites was 32, one-way distance travelled was 9.6 km and time spent at the site was just under an hour (53 minutes). The short average distance travelled and the high average frequency of trips taken, indicate the level of usage of the facilities by local residents in particular. Indeed, the furthest distance travelled was 145 km. Table 2 provides a detailed summary of some of the key variables for the sample.

Table 2: Summary urban forest visit statistics.

Variable	*Mean*	*Std. dev.*	*Min*	*Max*
Annual number of trips	32.5	47.2	1	200
Distance travelled from home to forest site (km)	5.95	9.36	0.5	90
Travel cost (€)	67.02	68.03	0.5	321.75
Income (€)	46,979	26,726	0	120,000
Travel time from home to forest site (minutes)	13.0	15.8	1	150

Parameter estimates for the urban forestry TCM are presented in Table 3. Four alternative specifications of the demand equation were estimated: the Poisson, the negative binomial model, the truncated Poisson and the truncated negative binomial model. Although these alternative models gave results similar in magnitude (and with the same signs), the Poisson was rejected in favour of the negative binomial model. The value of the maximized log-likelihood was -933 for the chosen truncated negative binomial model, whereas it was -4476 for the truncated Poisson model indicating that the truncated negative binomial model is a better fitting model for our data.

In the chosen truncated negative binomial model[8] α, the over-dispersion parameter is 3.15. It is positive and significant, indicating that the data were over-dispersed. In order to test the hypothesis that $\alpha = 0$ (and therefore indicating that the Poisson model would be more appropriate) a likelihood ratio-test is performed. The χ^2value of 7985 asserts that the probability that one would observe these data conditional on $\alpha = 0$ is virtually zero, i.e. conditional on the process being Poisson. This indicates that the negative binomial distribution is more appropriate. The model's estimate of the mean number of urban forest recreational trips demanded is 24.8. This is slightly lower than the actual mean of 32.5 trips observed in the sample.

[8] All results discussed in this section are based on the parameters from the truncated negative binomial model (column 4 in Table 3).

Table 3: Model parameter estimates.

	Poisson	*Negative binomial*	*Truncated Poisson*	*Truncated negative binomial*
Travel cost	-0.272	-0.142	-0.281	-0.201
	(-19.65)**	(-3.84)**	(-19.95)**	(-3.81)**
Travel cost to substitute site	-0.32	-0.254	-0.33	-0.299
	(-15.36)**	(-4.34)**	(-15.03)**	(-4.01)**
Forest code (Renville = 0, Barna = 1)	-0.748	-0.645	-0.753	-0.784
	(-24.15)**	(-3.22)**	(-24.31)**	(-2.77)**
Dog walking	0.831	0.882	0.83	0.97
	(31.93)**	(3.86)**	(31.85)**	(2.99)**
Cycling	-0.975	-0.758	-0.982	-0.856
	(-8.58)**	(-1.6)	(-8.64)**	(-1.34)
Picnic/barbeque	-1.68	-1.713	-1.69	-2.134
	(-14.78)**	(-4.69)**	(-14.56)**	(4.46)**
Other forest activity	-1.234	-1.114	-1.255	-1.425
	(-17.97)**	(-3.79)**	(-17.97)**	(-3.69)**
Gender (1=female)	0.102	0.236	0.102	0.323
	(3.94)**	(1.31)	(3.93)**	(1.29)
Married	-0.186	-0.266	-0.184	-0.28
	(-6.23)**	(-1.17)	(-6.16)**	(-0.89)
Retired	0.773	0.772	0.774	0.912
	(17.74)**	(2.35)*	(17.71)**	(2.06)*
Income	0.00002	0 .00003	0 .00002	0 .00003
	(19.90)**	(3.32)**	(20.19)**	(3.34)**
Age greater than 34	0.287	0.145	0.288	0.064
	(9.24)**	(0.67)	(9.24)**	(0.22)
Constant	4.502	4.27	4.519	4.209
	(77.24)**	(10.95)**	(77.34)**	(7.46)**
α (over dispersion parameter)		1.36		3.15
Log-likelihood	-4484	-973	-4475	-933

(Absolute value of z statistics in parenthesis)

*** significant at the $p \leq 0.05$ level*

** significant at the $p \leq 0.01$ level*

The marginal effect of covariates on mean urban forest trips taken is given by:

$$\frac{\partial E(T \mid X)}{\partial x_i} = (1+\alpha)\lambda_i \beta_j \qquad (5)$$

where λi is the predicted number of trips taken (24.8), β are parameters estimated from the observed sample and α is the over-dispersion parameter.

For every €0.50 increase in the travel cost of a trip, the number of trips per year demanded fell by 13. This suggests that the demand for recreational pursuits at urban forests is extremely elastic. This may be due to availability of a number of substitute recreational options close to both sites.

The estimated coefficients for both travel costs and income are negative and are significant at the $p \leq 0.05$ level. The income coefficient is significant and positive but is very small at 0.0000255. While this result is unexpected, it is not uncommon to encounter small (and in some cases counter-intuitively negative) income effects in recreational travel cost demand models (Chakraborty and Keith 2000, Curtis 2002).

Whether an individual was retired or not also had a significant impact on the demand for urban forest recreation. Retired individuals were likely to make 94 more trips per year than their working counterparts. Compared to the base case of walkers, dog walkers made significantly more trips per year to the forest sites, while cyclists, individuals who used the forests for picnic/barbeque activities and other forest users made significantly less trips. Women were likely to make 33 more visits per year than men. Individuals older than 34 were more likely to partake in recreational activities in urban forests, compared to those under the age of 34.

As stated, the overall aim of the study was to use the urban forest travel cost model to calculate the economic value of urban forest recreation. Consumers' surplus (estimated following McKean and Taylor (2000) and Hellerstein and Mendelsohn (1993), was used to calculate consumer utility (satisfaction), subject to an income constraint, and where trips were a nonnegative integer. Hellerstein and Mendelsohn show that the conventional formula to find consumer surplus for a semi-log model also holds for the case of the integer-constrained quantity demanded variable. They show that the expected value of consumer surplus, E(CS), derived from count models can be calculated as $E(CS) = E(T_i|x_i)/\beta_p) = \hat{\lambda}_i|(\beta_p)$ where $\hat{\lambda}_i$ is the expected number of trips, and β_p is the price (travel cost) coefficient. Consumers' surplus per-trip ($E(CS)$) is simply equal to $1/{-\beta_p}$.

Using the truncated negative binomial regression, the travel distance was multiplied by €0.42 per km per person, to which was added 25% of the individual's gross hourly wage (taken to represent the opportunity cost of leisure time), to give an estimated travel cost coefficient of -0.201[9]. Consumer surplus (CS) per individual per trip is the reciprocal or €4.97. The population estimate of per-trip consumer surplus is estimated with 95% confidence to be between €3.23 and €10.24. Average trips per

[9] Much of the travel cost literature has argued that the cost of leisure time is below the hourly wage rate. Cesario and Knetsch (1976) are credited with first having suggested approximating the opportunity cost (value) of time as a fraction of an individual's wage rate. The appropriate fraction to choose however is the subject of much debate. According to Parsons and Massey (2003) the recreation demand literature has more or less accepted 25% as the lower bound and the full wage (100%) as the upper bound. Following the literature review, 25% of the hourly wage was chosen, as we believe that individuals could possibly receive disutility from work and more importantly, the 'transit time' in getting to the recreational site produces many joint products. For instance, if the drive is scenic, one derives benefit from this. Such additional benefits or products suggest that using some fraction of the marginal wage rate may be more appropriate.

year in the full 235-person sample were found to be 32.47, giving a total consumer surplus per individual, per year of €161.38.

Conclusions

The mean willingness to pay (mean WTP) of the average recreationalist using urban forest sites in Co Galway was €12.33. The travel cost comprised €7.36, with the balance the consumer surplus of €4.97. This suggests that individuals received a considerable benefit from urban forest recreation.

Mean WTP was more than twice the estimate of €3.53 in Bacon and Associates (2004). In a more recent survey, Fitzpatrick and Associates (2005) estimated the typical value placed by a user on a visit to a trail or forest site was €5.42. This estimate is still lower than our estimate of €12.33 but given the high frequency of visits of urban residents to urban fringe forestry this is not an unexpected finding. Fitzpatrick and Associates (2005) estimated that there were 18 million visits to Irish forests annually, providing a value of €97 million for the total non-market annual value of forest and trail recreation on the Coillte estate[10]. Comparisons between valuation reports are however, difficult to interpret, since methodologies and context vary. Nevertheless, it can be argued that urban forests generate higher welfare estimates than larger forests which are not frequented as often by local residents. However, site value may be overestimated for Renville forest, as it links up with a one mile coastal walk. For some individuals, the forest and the coastal walk may be joint products and not all of the value of the visit is attributable to the forest, and the consumer surplus estimates may have been overestimated.

This study is also limited in the sense that the sample size was quite small. While the results indicate that the value of Irish urban forest recreation is high, further research is necessary on a larger sample. The preferences of recreationalists for alternative forest sites as a function of site characteristics and individual characteristics should also be explored. It would also be interesting to investigate the impacts on welfare and trips of alternative rationing mechanisms, such as the imposition of car-parking fees and measures to increase public access (see for example Shaw and Ozog 1999 and Hanley et al. 2002).

Our estimates of recreationalists' welfare also suffer from many of the generic drawbacks of the travel cost model; for instance, that they do not include non-use values of the urban forest site, and that our values depend on assumptions made about the value of leisure time and what should constitute the marginal cost of visiting. Omission of non-use values may be particularly important for urban forest sites with unique scenic qualities or for sites of high cultural significance and will certainly bias any cost-benefit analysis based solely on recreation use values.

The work has, however, confirmed findings by Clinch and Convery (1995) and Hutchinson and Chilton (1994) that urban woodlands have a high value for local

[10] This study was unable to estimate the total annual usage of the forest sites in question, thus we are unable to calculate a total annual non-market recreational value, for comparison with Fitzpatrick and Associates (2005).

populations. The high welfare estimates for the usage of urban forests combined with their small catchment areas provides a strong case for more resources to be devoted to this land use in the hinterland of Irish cities and towns. Urban residents derive considerable benefit from urban and community-owned forests that are managed by Local County Councils and Local Authorities.

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