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Assessing the impact of biodiversity on tourism flows: A model for tourist behaviour and its policy implications

Giulia Macagno^{*a}, Maria Loureiro^b, Paulo A.L.D. Nunes^c and Richard Tol^d

Abstract¹: This analysis provides an example of how biodiversity can be measured by means of different indicators, and how the latter can be used to assess the influence of the biodiversity profile of a region on the tourism flows towards it. Previous studies have considered environmental amenities as one of the determinants of tourism destination choice. The central hypothesis of this paper is that the destination's biodiversity profile can be considered as a key component of environmental amenities. The main objective of this study is to propose a different perspective on this topic, considering the role of biodiversity on tourists' choice of destination and duration of stay. Domestic Irish tourist flows have been chosen as a case study. The first step of the analysis required the construction of biodiversity indicators suitable for developing a biodiversity profile of each Irish county. Subsequently, a model was developed so as to explain the total number of nights spent in any location as a function of a set of explanatory variables including information about the socio-demographic characteristics of respondents, biodiversity and the landscape profile of the county of destination and features of the trip. Results show that most of the biodiversity and landscape indicators included in the analysis turn out to be statistically significant in determining tourists' choices regarding the duration of their trip. As a result, policies pursuing biodiversity conservation appear to have a positive impact on the revenue of regional tourism.

Keywords: species diversity, habitat fragmentation, landscape diversity, trip demand, indicators, ecosystem services, human well-being

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1. Introduction

Previous studies that have analysed tourism demand have dealt with understanding the reasons underpinning tourists' attitudes towards a particular destination (Rugg, 1973; Seddighi et al, 2002). The traveller's choice of destination and duration have been described applying the classical framework of the consumer demand theory, according to which any commodity possesses certain characteristics which, in turn, generate utility for the consumer. However, a traveller does not derive utility from "consuming" his travel destination, but rather from staying in a particular destination for some period of time, thus enjoying the destination's attributes (Rugg, 1973).

Environmental amenities can be considered as one of the determinants of tourism destination choice. The type and the extent to which environmental resources surrounding a site have been proven to be closely linked to the profitability of the tourism sector and environmental quality is widely used as a basis for a marketable tourism attraction (Marcouiller and Prey, 2004). While the decision to make a trip depends greatly on the needs of the traveller, the choice of the destination is largely dependent on the features of the destination itself, such as sunshine, beaches, availability of sport and leisure facilities or the opportunity to enjoy a natural environment (Klenosky, 2002). In terms of competition with other destinations, either domestic or international, a larger supply of environmental amenities might give the destination site a competitive edge or advantage (Huybers and Bennet, 2003).

The central hypothesis of this paper is that the destination's biodiversity profile can be considered as a key component of environmental amenities. Biodiversity is defined as "*the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems*" (MEA, 2005). The need to quantify status and trends of biodiversity is widely recognised. In order to assess the conditions and trends of biodiversity completely it would be necessary to measure the abundance of all organisms over space and time, using the number of species, the species' functional traits and the interactions among species that affect their dynamics and functions. However, biodiversity is too complex an issue to be fully quantified using scales that are policy-relevant and its assessment can only be done by means of indicators. Against this background, this analysis provides an example of how biodiversity can be

measured by means of different indicators, and how the latter can be used to assess the influence of the biodiversity profile of a region on the tourism flows towards it. The remainder of this paper is organised as follows: section 2 provides a literature review regarding tourism demand analysis; section 3 deals with the description of data sources; the data treatment process is explained in section 4. Finally, sections 5 and 6 focus on the application of the developed methodology to a specific case study, the Republic of Ireland, presenting a description of the biodiversity profile and tourism flows as well as the econometric model explaining such flows. Comments about the performance of biodiversity indicators as explanatory variables of the model conclude the analysis.

2. Background and literature review on tourism demand modelling

According to the existing literature, tourism flows can be explained by means of demand function specification, although modelling tourism demand is not a straightforward task. In fact, there is no universally accepted measure of tourism flows; however, the majority of previous studies adopt the number of visitors, the number of nights spent or tourism expenditures (Lim, 1997). It must be noted that each of these variables presents a number of shortcomings when used to characterise tourism demand for a specific location, since none of them is able to encompass all the relevant aspects. A literature review indicates tourism expenditure as the most appropriate measure of tourism demand; nonetheless, its adoption is often hindered by data scarcity (Proença and Soukiazis, 2005; Ledesma Rodriguez *et al.*, 1999).

As far as explanatory variables are concerned, a wide range of potential factors can be found and the choice among them depends mainly on the type of data and the objectives of the research. In the literature it is possible to identify a set of widely used categories of tourism demand determinants. To begin with, socio-economic factors, such as income, household characteristics, cost of the trip, type of accommodation, mode of transportation and period of the year in which the trip takes place, are present in almost all the studies. Secondly, relative prices, exchange rates and security in the country of destination are usually deemed important when dealing with international travel (Lim, 1997; Proença and Soukiazis, 2005). Furthermore, the specific features of the destination, determining its attractiveness, such as climate, culture, history and natural environment are also receiving remarkable attention (Crouch, 1995; Lim, 1997; Song and Li, 2008; Witt and Witt, 1995). Here we focus on the effect of the natural environment, and more specifically of biodiversity, on tourism. There is a substantial literature on nature and recreation (Brander *et al.* 2007; Shrestha and Loomis, 2001, 2003). The difference between tourism and recreation is that the former involves at least one overnight stay. Recreation is therefore more

focused, while tourism is more of a package deal: a holiday may entail nature, culture, entertainment, and relaxation. The impact of nature on tourism is therefore more diffuse than the impact of nature on recreation. However, the sample of tourists used in this study is representative of the population, while typical recreation studies suffer from selection bias.

Another aspect to take into consideration is the choice of the type of econometric model. Since the temporal horizon of statistical data and the specification of tourists' choice mechanisms are often limited and incomplete, many studies apply a panel data approach. This choice turns out to be suitable for analysing cross section data, characterised by a large number of observations and short time series. Finally, as a general rule, studies adopting the number of nights spent, the number of trips or the number of visitors as a dependent variable mostly apply count data models, so as to correct results for truncation and self selected bias effects (Hellström, 2002, Nunes and Van den Bergh, 2002).

The present study is consistent with the cited literature in that it considers the duration of stay as a count variable and it includes the previously described categories of explanatory variables. In addition, however, it seemed important to consider information on the travelling group, to account for individual, couple and family trips. Since the focus of this analysis is on domestic tourism, factors like relative prices, exchange rates and security situations have been deemed irrelevant. As far as the choice of the model is concerned, a GLS regression with correction for random effects and, subsequently a Poisson regression, were performed, since the available data were both cross section and count data.

Previous studies of tourism in Ireland focused on foreign visitors (Barry and O'Hagan, 1972; Hannigan, 1994; O'Leary and Deegan, 2005; Walsh, 1996) while research on Irish tourists is limited to outbound tourism (Gillmor, 1995; Lyons *et al.*, 2007, 2008). This is the first study on Irish tourists in Ireland.

3. Description of data sources

3.1 Travellers' socio-demographic characteristics and trip information

Data about tourism has been taken from the Household Travel Survey, published by the Irish Central Statistics Office (CSO) on a quarterly basis. The purpose of the Household Travel Survey

(HTS)² is to measure domestic and international travel patterns involving overnight stays and associated details, including expenditure, purpose of trip and type of accommodation used by Irish residents. The HTS is a random stratified sample. Each quarter, almost 13,000 households, approximately 1% of all private households, is randomly selected from the Electoral Register, where the selection is stratified by District Electoral Division. Tourism expenditure includes purchases of consumer goods and services inherent to travel and stay, purchases of small durable goods for personal use, souvenirs and gifts for family and friends. Purchases for commercial purposes, capital type investments and cash given to relatives or friends during the trip are excluded. The HTS households are sampled from the Electoral Register and are subjected to a postal survey. Data used in this paper refer to the period 2000-2003, due to the need to match the time horizons of the information regarding both tourism and biodiversity. The dataset includes both international and domestic tourism; however, for the purposes of this study, only the latter is considered. Since this survey does not include data about respondents' income, this information has been retrieved from the County Income and Regional GDP, also published by CSO.

3.2 Biodiversity and landscape indicators

Since this investigation focuses on Ireland as a case study, the *Natura 2000* database has been considered as a useful source of information in the indicator-building process. In view of implementing the requirements of the Council Directive 92/43/EEC on the Conservation of natural habitats and of wild fauna and flora and of the Council Directive 79/409/EEC on the conservation of wild birds, the European Commission has established a standard format for the collection of relevant information from member countries. They are in fact required to report on the physical characteristics of each site, as well as the number and conservation status of protected species and habitats. The data form can be found in Annex III.

The information contained in the database appears to be extremely detailed and, due to simplification requirements, it seems necessary to select the most relevant aspects in order to construct biodiversity indicators. It is worth recalling that the *Natura 2000* database provides a sort of "snapshot" of the biodiversity profile of European countries. In order to be able to evaluate trends and changes in those profiles, data should be available for a long time span for all countries and for all protected species and habitats.

² The survey is one of several Central Statistics Office (CSO) tourism surveys conducted to comply with the requirements of the Council Directive 95/57/EC of 23 November 1995 concerning the collection of statistical information in the field of tourism.

As far as fauna and flora are concerned, six taxa, namely amphibians and reptiles, birds, fishes, invertebrates, mammals and plants, are assessed separately. Member states must provide information about size and density of the populations present in each site with respect to the population living on the national territory as a whole, along with conservation status and the degree of isolation of each population with respect to the natural range of its species.

It also seems important to account for the landscape profile in describing the environmental characteristics of a region. Once again the *Natura 2000* database was considered as a useful source of information, since the distribution of protected habitats could be interpreted as a proxy of the landscape features of a region. Habitats are classified according to a three level hierarchical sorting, which appeared excessively detailed to be taken completely into consideration. For the purposes of this analysis the higher and most aggregated level seemed to provide sufficient information. The habitat types considered are therefore: coasts, dunes, freshwater habitats, wetland low vegetation, Mediterranean dryland vegetation, grassland, bogs mires and fens, rocks and caves and forests.

4. Data treatment and construction of a biodiversity metrics

4.1 Review of existing indicators

Since biodiversity is too complex to be fully quantified, its assessment can only be done by means of indicators. The need for biodiversity indicators is widely recognised and various attempts to classify and describe potentially suitable indicators have been carried out. Different institutions have provided their own definitions; however, though the formulation may be different, there is substantial agreement on the relevant aspects to be taken into account in the description of biodiversity. The indicators proposed in this paper have been developed following the path traced by the United Nations and the European Union.

The United Nations Convention on Biological Diversity (CBD) acknowledges the role of indicators as information tools that summarise data on complex environmental issues and indicate the overall status and trends of biodiversity. The convention highlights seven focal areas in which the development of indicators seems to be necessary: 1) status and trends of the components of biological diversity, 2) threats to biodiversity, 3) ecosystem integrity and ecosystem goods and services, 4) sustainable use, 5) status of access and benefit sharing, 6) status of resource transfers and use and 7) public opinion.

The European Biodiversity Strategy (European Commission, 1998) was developed in the context of the CBD, and it calls for the development of a set of indicators corresponding to these focal

areas. A report by the European Environmental Agency (EEA, 2007) provides a more detailed description of these indicators.

Within the scope of this study it has been chosen to focus on indicators related to status and trends of the components of biological diversity. The EEA presents a set of headline indicators to specify the content of this broad category. The remainder of this section therefore focuses on the advantages and shortcomings of these headline indicators, since they have been the starting point of the construction of regional biodiversity profiles.

To begin with, trends referring to abundance and distribution of selected species are thought to be relevant. The EEA considers abundance and distribution of selected species. Species abundance can be defined as the number of individuals of a population living in a particular area. Populations and species constitute one of the most essential components of biodiversity and viable populations indicate the presence of healthy habitats and ecosystems. This indicator can be easily aggregated and it is cost-effective, since most of the data are collected by professionals making it possible to enlarge data availability with little extra cost. However, long time series would be necessary to assess these trends appropriately.

Even though the EEA report does not consider species richness as a possible indicator of these trends, it seems important to review it, since it is the most intuitive and easy to compute. It can be defined as the number of different species recorded in a particular site and it can be expressed either per unit area or per habitat type. The main shortcoming of this indicator lies in the fact that it does not take into account that processes of abundance reduction can take place long before a change in the number of species. Moreover, it is largely dependent on the geographical scale considered. Finally, the indicator needs to be assessed for a large number of species, implying significant costs (Ten Brink, 2000).

The second headline indicator is related to changes in the status of protected species, including both Red List species and species of European interest, with a specific reference to the *Natura 2000* protected species. This indicator is policy-relevant and can be viewed as a measure of the success of protection policies. In our analysis, this indicator is represented by the degree of species conservation, calculated from the assessment contained in the *Natura 2000* database.

The third headline indicator refers to trends in the extent of selected biomes, ecosystems and habitats. The ability of an ecosystem to provide goods and services highly depends on the extension it covers, since a highly fragmented habitat could be less resilient and have reduced ability of recovering after a shock. Data is widely available since land cover change is the main driver of this indicator and this information is well mapped across a large number of countries. It is cost effective and easily aggregated from smaller to larger spatial scales.

Nonetheless, it does not deliver information on the conditions of the remaining ecosystems. For instance, habitat loss could be halted, but other drivers, such as direct exploitation, invasive species and pollution could still cause a decline of species and populations. In order to solve this problem, it could be interesting to add an indicator accounting for the habitats' degree of conservation. For this reason, the EEA report includes status of habitats of European interest within this headline indicator. Finally, as already explained for species, a habitat richness indicator was added to the ones considered by the EEA since it could provide information about the number of habitats present in a specific region, with respect to the number of protected habitats recorded at a national level.

As far as genetic diversity is concerned, the EEA considers livestock genetic diversity, defined as the share of breeding female populations between introduced and native species. However, this definition excludes crops and trees from the analysis. Here we explore the possibility of using the degree of isolation of a population with respect to the geographical range of its species, as a genetic diversity indicator. In fact, a population living at the margins of its species geographical range has higher probabilities of being more genetically diverse. The calculation is done taking advantage of the species isolation assessment provided by the *Natura 2000* database. Finally, the coverage of protected areas is taken into account, both as nationally designated under European directives and as part of the *Natura 2000* network. The indicator does not describe the quality of management or whether the areas are protected from incompatible uses.

Table 1 shows the linkages between the headline indicators proposed by the EEA and the ones developed for the purpose of this study.

Introduce Table 1 about here

It seems important to underline the fact that, in the reviewed literature, no examples were found of the use of biodiversity indicators as explanatory variables in a model describing tourist economic behaviour. This, therefore, represents one of the most remarkable innovative aspects of this study.

4.2 Construction of biodiversity and landscape profiles

Bearing in mind the suggestions given by the EEA (Table 1), it has been necessary to further specify relevant indicators in order to define regional biodiversity and landscape profiles. Since all information was retrieved from the *Natura 2000* database, all indicators have been first computed at the site level and then aggregated at a regional level. Furthermore all indicators are related exclusively to species and habitats that are protected according the Habitats and Birds Directives. The database originally presents qualitative assessments of most of the relevant aspects, based on

a scale ranging from A to C, therefore it has been necessary to attach a numerical value to each of the rankings.

The species richness indicator was computed as the ratio between the number of species present in each site and the total number of species living on the national territory. The indicator was first calculated separately for each of the six taxa considered in the database and then averaged so as to obtain a single value for each site. The idea underpinning this operation is the so-called “inter-species democracy”, implying that all species are considered equally important.

Species abundance was obtained taking information on population size and density as a starting point. In this case, the rankings reflect what share of each species’ national population is living in each particular site. “A” stands for a share from 100% to 15% of the total population, “B” from 15% to 2% and “C” from 2% to 0%³. In the case of species conservation, “A” means an excellent conservation status, “B” a good one and “C” an average one. Finally, as regards species isolation, “A” represents almost complete isolation, “B” suggests that the population is not completely isolated but lives at the margins of the distribution range while “C” implies that the population lives within an extended distribution range.

Amid the habitat-related information supplied by the database, it has been chosen to take into account habitat relative surface that represents a habitat area in each site with respect to the area covered by the habitat at a national level. In this case “A” stands for a percentage from 100% to 15%, “B” from 15% to 2% and “C” from 2% to 0% of the habitat surface at a national level. This information has been used to calculate the habitat abundance indicator.

Habitat richness has been calculated as the ratio between the number of habitats found in a site and the number of habitats recorded at a national level. The degree of conservation of habitat structure, functions and restoration possibilities was computed taking advantage of the database assessment. “A” stands for excellent, “B” for good and “C” for average conservation status, as previously explained for species.

In order to treat all this information in a homogeneous way and consistently with the definitions provided by the database itself, it has been decided to attach a value of 100 to ranking “A”, of 15 to ranking “B” and of 2 to ranking “C”. As a result, habitat and species indicators have been computed according to the following formula:

³ These thresholds are provided by the Natura 2000 database and have been taken as a starting point for the computation of the values of each indicator. Narrower intervals would be useful in order to provide a more precise measure of biodiversity; however, considering the extreme difficulty in achieving reliable data, the information contained in the database was deemed to be sufficiently detailed.

$$Indicator = \frac{(No. "A" \times 100 + No. "B" \times 15 + No. "C" \times 2)}{No. habitats\ or\ species\ per\ site} \quad (1)$$

Unlike the previous indicators, coverage of protected areas provides the percentage of land covered by *Natura 2000* sites, which of course depends on the geographical scale considered. When focusing on one country it seems appropriate to choose administrative regions as a unit of analysis. All indicators can be subsequently aggregated at a regional level by calculating the mean of the values obtained by the sites belonging to each region. Values range from 0 to 100.

As far as the landscape profile is concerned, information regarding the surface covered by different habitat types at site level was retrieved from the database. Then these areas have been expressed as a share of protected area at a regional level; this result was assumed as a proxy of a region's land cover composition and landscape profile. The outcome of this indicator-building process has been the creation of a dataset encompassing relevant biodiversity and landscape diversity information.

5. Impact of biodiversity and landscape profiles on Irish tourism flows

5.1 Irish biodiversity and landscape profiles

The remainder of this paper deals with the empirical application of this protocol to a specific case study, namely Ireland. Results show that indicators are not only a useful tool for assessing trends and status of biodiversity in a specific region, but they can also find direct application in the assessment of biodiversity impacts on human well-being. This section provides a description of the values attained by biodiversity and landscape indicators at a county level. Subsequently, this information is merged with data from the Irish Household Travel Survey, in order to analyse the impacts of these indicators on tourism flows.

The Republic of Ireland has been chosen as a case study on the grounds of broad data availability and of the fact that in the Irish context, natural and cultural heritage is deemed to be a major cornerstone of the tourism industry, both at a local and at a national level (McManus, 1997). The first category of indicators refers to trends in abundance and distribution of selected species, encompassing species richness, abundance and conservation. The scores, presented in Table 2, do not show a remarkable performance in any of the counties. The highest scores are attained by the species conservation indicators in all counties, achieving the best results in the Leitrim and Carlow counties. Values for species richness are too close to zero to be detectable in the graph. As far as genetic diversity is concerned, the Sligo and Kildare counties show a higher average level

of species geographical isolation. However, since the maximum value attained is 6.03, it seems that the contribution of any of the populations present in each site to the genetic patrimony of its species is, in general, relatively low.

When considering habitat-related indicators, abundance, richness and conservation, Table 2 shows that County Cavan has by far the highest value for the fragmentation indicator and County Dublin shows the lowest value. However, all counties show a low degree of habitat fragmentation. Scores recorded are considerably higher for habitat conservation, while values for habitat richness are all virtually zero.

The last category of indicators deals with the coverage of protected areas. The values have been calculated by summing up the surface covered by each site belonging to a county and then dividing this result by the total surface of the county under consideration. Results show a very different percentage of protected areas in the counties, where some of them, including Kerry, Clare, Galway and Mayo, have a substantial portion of their territory protected under *Natura 2000*, while others like Monaghan, Kilkenny, Kildare, Limerick and Meath designated less than 1% of their territory to *Natura 2000* sites. Table 2 shows the values attained by each indicator in each county.

****Introduce Table 2 about here****

As regards landscape characteristics, analysis of the data contained in the *Natura 2000* database reveals that the most common habitat type across Irish counties is represented by freshwater habitats, followed by low wetland vegetation and coastal habitats, while the rarest ones are Mediterranean dryland vegetation, grasslands and forests. Table 3 shows the surface covered by each of these habitat types.

****Introduce Table 3 about here****

On the other hand, Table 4 shows the composition of different habitat types across the different Irish counties, thus providing a snapshot of each county's landscape variety. County Carlow's protected areas appear to be dominated by bogs, mires and fens, since no other protected habitat is recorded in the region. By contrast, Donegal, Galway, Limerick, Offaly and Roscommon show remarkable landscape diversity, since all the nine habitat classes can be found in these counties. Cork, Dublin, Kerry, Louth, Mayo and Sligo are also very diverse, recording eight out of nine habitat categories. Table 4 provides a graphical representation of this result.

****Introduce Table 4 about here****

5.3 Socio-demographic characteristics and travel specific features

As regards the travellers' socio-demographic characteristics, it is possible to say that the mean number of family members is slightly less than four, while on average the number of participants to a trip is two. The average traveller's age is of about 34 years and the average number of children participating in each trip appears to be nearly one. 47% of the travellers are men and the average disposable income amounts to 16,664 euros per capita.

As far as the specific features of the trip are concerned, it turns out that the average number of repeated trips to the same destination is nearly two and the average total cost of each trip is of 229.42 euros per person, in the period 2000-2003. The months in which the majority of journeys take place are the summer ones, from June to August. The accommodation categories chosen by the majority of travellers are hotels (41%), SC/rental (14%) and guesthouses (13%). Table 5 shows summary statistics for socio-demographic and trip-specific characteristics.

****Introduce Table 5 about here****

6. Demand for tourism

6.1 Econometric model specification

The duration of stay of tourists in a particular destination has been considered as the dependent variable to be explained as a function of a set of independent variables that can be grouped into socio-demographic variables (X_1), cost of the trip (X_2), biodiversity and habitat profile (X_3), landscape profile (X_4), modes of transportation (X_5), month of departure (X_6), region of destination (X_7), accommodation category (X_8) and recreation group (X_9). To begin with, a GLS regression was performed and it has been chosen to introduce a correction factor for random effects adopting the household identification number as group variable. However, since the available data was retrieved from a survey in which only travellers have been interviewed, the econometric model specification and estimation method needs to be corrected for self-selection bias. Therefore, we estimate a Poisson count data model, correcting for both truncation and self-selection. This gives rise to model specification

$$\text{Prob}(V = j) = F_p(j) = e^{(-\lambda)\lambda^j} / j! \quad (2)$$

with⁴

$$\lambda = e^{\beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9} + \varepsilon \quad (3)$$

Here j denotes the possible values for the number of days spent on the trip ($j=1, 2 \dots$), $F_p(\cdot)$ the cumulative distribution function of the standard Poisson probability model, and λ (non-negative) Poisson parameter to be estimated.

Within the first set it has been chosen to consider number of members of the household, (county average) disposable income per person, age of the respondent and a dummy variable representing repeat visitors to the same destination. As far as species and habitat diversity characteristics are concerned, only species abundance and habitat fragmentation have been included in the model, since all the computed indicators were highly correlated with one another and the two selected indicators are deemed to be highly telling ones according to reviewed literature.

The share of protected area respect to the total county surface is generally considered a biodiversity indicator; however in this model it has been listed as a separate explanatory variable, since it appears to be a policy response indicator, rather than a biodiversity indicator. In addition, it seemed important to include variables describing landscape features of the destination. For this reason, the habitat categories specified above have been included in the model, with the exception of bogs, mires and fens which was dropped due to multicollinearity. The area covered by each habitat type has been expressed as a share of the total *Natura 2000* protected surface per county.

The remaining variables included in the model are a set of dummy variables constructed so as to represent different features of the trip. As far as the modes of transportation are concerned, it has been chosen to consider air transportation, land transportation, including rail, buses, bicycle and cars, and other means. Furthermore a set of twelve dummies, representing the months of departure has been added. The region of destination has also been deemed relevant for the analysis, therefore eight dummies standing for the NUTS 3 regions, namely South-west, South-east, Midwest, Midlands, Mideast, Dublin, West and Border, were incorporated into the model. The type of accommodation chosen by travellers was also thought to play an important role in determining the number of nights spent at the destination. The Household travel survey classifies them into camping sites, guesthouses, holiday homes, hotels, house rentals and visits to relatives; hence a dummy has been inserted for each of these categories.

⁴ The Poisson model has been formally tested against negative binomial models as can be seen from Table 7. The chi-squared value associated to the Likelihood ratio test of alpha = 0 is 3.3e+04, therefore suggesting that in this specific case the Poisson model better fits the data.

Finally, the characteristics of the travel group were considered and three dummies corresponding to single, couple and groups of more than three people were introduced. In addition the number of children taking part to the trip was inserted as an explanatory factor.

6.2 Estimation results

Results show that biodiversity and land cover characteristics are highly significant. As can be seen from Tables 6 and 7, the results of the two regressions performed are quite similar as far as the signs of the coefficients and the level of significance are concerned. In order to interpret the results of the Poisson regression and to quantify the influence of the different explanatory variables on the dependent variable, incidence rate ratios were computed.

When considering the respondents' socio-demographic characteristics, three of the four variables turn out to be statistically significant. Disposable income per person and the age of respondent are positively correlated with the duration of stay, reflecting the fact that larger income availability allows larger travel expenditures and that older people tend to stay longer in their destination. Older people may also be wealthier, but unfortunately we cannot capture this effect because we do not have micro-data on income. However, these variables have a very low impact on the number of nights, increasing the probability of the tourist spending an additional day by 1.4% and 0.1% respectively.

By contrast, trips by repeat visitors tend to be 12% shorter than first trips; this could be explained considering that frequent journeys to a site decrease the probability of long stays. It is worth noting that tourists' socio-demographic characteristics are likely to play a limited role in determining the duration of the trip, with respect to other variables.

The cost paid for the trip has a negative impact on its duration, as can be expected. For every 1% increase in costs, the number of nights decreases by 0.2%. Land transportation is positively correlated to travel duration. A possible explanation can be found in that this category of means of transportation, including private or hired vehicles, rail, buses or bicycles generally requires a longer time span to reach the destination, thus increasing the probability of overnight stays by 70%.

Another important factor in determining the number of nights is the period of the year in which the journey takes place. As can be expected, the summer months, from June to September are positively correlated and statistically significant, most probably due to larger time availability during the summer vacations, higher temperatures and favourable weather conditions, with a 26.5% probability of spending an additional day in June, 84.7% in July and 54.7% in August. On

the contrary, January, February and November have a negative and significant impact on trip duration.

It is possible to interpret the results for different accommodation categories on the grounds of lower costs. Camping sites, holiday homes and home rentals appear to be positively correlated with trip length, increasing the probability of an additional day by 6.1%, 31.8% and 9.5% respectively. On the other hand, stays in hotels, guesthouses and visits to relatives turn out to have 28.8%, 28.8% and 14.3% probabilities of shorter duration. An interesting result is related to the regions of destination, since all of them are negatively correlated, although only the coefficient obtained for the South-East, Midwest, Midlands and Mid-East regions are significant.

Furthermore, trips taken by couples tend to have a shorter duration, with a reduction of the number of days by 3.3%, while those undertaken by groups of more than three people are likely to be longer; in fact the probability of spending an additional night increases by 15.1%. The number of children taking part in the trip is negatively related to trip duration, meaning that a larger number of children is likely to reduce the probability of staying an additional day by 4.1%.

Finally, it is important to analyse results for the impacts of the destination's biodiversity and landscape profiles on the probability of observing longer trip lengths. The extent of protected areas in the region of destination is negatively correlated with the duration of stay, implying that trips towards a county with a higher share of protected areas out of the total surface are more likely to be shorter with respect to trips to other destinations. This result can be explained by the fact that a higher degree of protection of natural areas can limit the potential for tourist visits to the sites.

As far as species and habitat diversity are concerned, results show that both species abundance and habitat abundance are positively correlated and significant. Such an outcome is consistent with the hypothesis that higher species abundance increases the possibility of observing wild animals, exerting a positive impact on the probability of spending an additional day in the destination, increasing it by 12,2%. When it comes to habitat diversity, a higher habitat relative surface is here considered as a measure of endemism. This can be defined as the degree to which a habitat is native or confined to a particular region. From the tourist's perspective, this may be a factor increasing travel enjoyment, since it could imply the opportunity to see unique or rare habitat patches in their destination.

To conclude, the landscape profile can be analysed in order to identify which environmental features are able to influence the tourist's choice about duration of stay. It turns out that coastal habitats are positively correlated to trip length, as well as wetland vegetation, Mediterranean dryland vegetation, rocky habitats and forests. A wider presence of these habitat and land cover types in the region of destination is likely to increase the probability of spending an additional

night by 14.4%, 27.2%, 11.2%, 26.5% and 10.8%, respectively. By contrast, dunes, freshwater and grassland habitats show a remarkable negative correlation with trip length. It seems important to underline that these landscape categories have been developed exclusively on the basis of the *Natura 2000* protected habitats, and are therefore limited in that they only refer to protected sites. Nonetheless, considering the noteworthy level of detail achieved by the *Natura 2000* database, it was decided to use this information as a proxy of the different counties' real landscape features.

Introduce Tables 6 and 7 about here

7. Policy discussion

7.1 Economic valuation of the welfare impact of a marginal change in the values of biodiversity indicators

In April 2002, the Parties to the Convention on Biological Diversity committed themselves to achieve a significant reduction in the current rate of biodiversity loss at a global, regional and national level by 2010. At the European level, EU Heads of State or Government agreed in 2001 “to halt the decline of biodiversity in the EU by 2010” and to “restore habitats and natural systems”. A Biodiversity Strategy was adopted in 1998 and related Action Plans in 2001 (European Commission, 2006). In addition, biodiversity has been integrated into a whole set of European Union internal policies, such as the Lisbon Partnership for growth, jobs and environmental policy, the Common Agricultural Policy and the Common Fishery Policy.

Against this background, a further step to complement the results of this analysis has been the economic valuation of the welfare impact of a policy aimed at reducing biodiversity loss. In order to do this it has been decided to attach a monetary value to the three biodiversity indicators considered in the model. To be able to do this, the score of each indicator in each county has been multiplied by the impact coefficient obtained from the Poisson regression and by the average individual expenditure in the county, according to the equation:

$$Monetary\ value_j = Expenditure\ per\ night_i * \hat{\beta}_j * \overline{biodiversity\ indicator\ score}_i$$

(4)

The degradation of the biodiversity status would produce an economic loss that can be assessed using the revenues of the tourism sector. Any environmental protection policy would aim at reducing or mitigating this impact; therefore benefits deriving from protection can be interpreted

as foregone costs. In order to estimate this amount in monetary terms, a scenario of policy inaction has been assumed, considering that, if no protection measures were adopted, a 10% decrease in the score of the species abundance indicator would be observed. This scenario is a purely hypothetical one and it aims at showing the welfare impact of a marginal change in the level of the biodiversity indicators.

The monetary value of this change has been computed applying the previously explained procedure. Finally, this result has been multiplied by the average number of days spent and the number of visitors in each county and then divided by the number of years over which the tourism survey was conducted.

$$Annual\ welfare\ change = \frac{Monetary\ value\ of\ changes_{biodiversity\ indicator} * No.\ visitors_{county\ i} * No.\ nights_{county\ i}}{No.years} \quad (5)$$

In the case of species abundance, the policy objective should be the maintenance of the current number of individuals of a species living in a particular area. Since species abundance appears to be positively correlated with trip duration, the policy's annual welfare impact can be interpreted as the foregone cost deriving from the maintenance of the current level of species abundance. As far as habitat abundance is concerned, the policy objective should be the prevention of habitat loss. Considering that also habitat abundance is positively correlated with trip duration, the annual welfare change has been computed according to the same procedure followed for species abundance.

The policy discussion is somehow different when it comes to the coverage of protected areas. In this case, since the indicator is negatively correlated with the number of days the tourist spends in his destination, the computation of the annual welfare change due to a 10% increase in its value produced negative results. This can be interpreted as the need to maintain the current extension of protected areas, which is not in contrast with the results obtained for the species and habitat abundance indicators. In fact, there are a number of policy options suitable for preventing biodiversity loss by improving the status and degree of conservation of species and habitats without increasing the share of protected areas.

It is worth noting that these monetary values can differ significantly across counties, therefore it has been decided to rank counties according to these values. This is particularly relevant if the objective is providing information to the policy-maker, who needs to decide where to allocate resources for environmental protection. Assuming that the costs of protection are fixed across counties, from a cost-benefit point of view, the policy-maker is not indifferent about where and what to protect. Table 8 presents the results for annual welfare changes produced by a 10% change in the scores of biodiversity indicators.

Among the three indicators considered, species abundance is by far the one that produces a higher annual welfare change. This can be explained by remembering that the starting point of this economic valuation has been tourism expenditure and that species abundance may be the component of biodiversity that is more directly perceived by recreationists. Therefore, policy options focusing on the preservation of species abundance in particular are likely to have a higher positive welfare impact in terms of tourism expenditures.

****Introduce Table 8 about here****

7.2 Further discussion

In addition to the aforementioned results, ranking counties according to the annual welfare change produced by a variation in the indicators provides useful insights and hints for further discussion. In the econometric estimation exercise biodiversity richness indicators proved not to be statistically significant; nonetheless, it is possible to explore the role of this scientific information in the ranking of the counties from a cost-benefit point of view, analysing the economic efficiency in the allocation of limited financial resources to environmental protection. In order to do this, both the magnitude of the monetary estimate as well as the information regarding the counties' individual profile with respect to species and habitat richness were taken into account.

There turned out to be a direct correlation between both species and habitat abundance and richness; in fact, counties in which a 10% change in species and habitat abundance indicators has a higher monetary value are also characterised by higher scores in species and habitat richness indicators. Table 9 and 10 display these results.

****Introduce Table 9 and 10 about here***

Another interesting application of ranking counties is the possibility of exploring in deeper detail the link between changes in species abundance and annual welfare changes. So far the species abundance indicator has always been considered as encompassing five different taxa, namely birds, fishes, invertebrates, mammals and plants. However it is reasonable to expect that a higher abundance in each of these taxa with respect to the others would produce different impacts in terms of welfare changes. In order to address this point the ranking of counties according to the annual welfare change for species abundance has been analysed jointly with species abundance of each taxon.

The logarithm of the annual welfare change was computed and it has been regressed against bird, fish, invertebrates, mammals and plants species abundance indicators, as well as against their cross products, in order to investigate any complementarity or substitution effect among them.

Results show that all taxa, individually considered, are positively correlated with the annual welfare change except fish which are negatively correlated. However, when taking into account the cross products of the indicators, it can be shown that a high joint fish and mammal species abundance is positively correlated with the annual welfare change, thus mitigating the negative impact of fish species abundance alone. This result reflects the fact that the presence of fish and mammal species is complementary in consumption, implying that it positively influences the welfare change in terms of tourism expenditure.

On the contrary, the cross products between bird and mammal species abundance and between invertebrates and mammal species abundance are negatively correlated with the welfare change. This signals substitutability between mammals and birds and mammals and invertebrates. Table 11 displays the results of this analysis.

**Introduce Table 11 about here*

8. Concluding remarks

The overall goal of this paper was to analyse the potential impact of biodiversity on tourists' decisions about the duration of their stay. The use of indicators as assessment tools of the status of biodiversity is widely acknowledged, however it can be difficult to define a protocol and to retrieve sufficient data to construct them. The first objective achieved by this paper is the use of an existing database, *Natura 2000*, as a basis for the indicator-building process. Different sets of indicators can be created, therefore it seems very important to carefully select the most relevant ones to be included in the analysis. In this specific case, since impacts on tourism were to be investigated, species abundance and habitat fragmentation were employed but different information could be needed in a different analysis.

The second objective attained is the empirical use of biodiversity indicators as explanatory variables in the analysis of tourism flows, assessing their influence on trip duration. As explained in the previous section, the results lead to the conclusion that, in the considered case study, the species and habitat diversity profiles can exert a positive influence on tourists' choices regarding the number of nights spent at the destination. Results are particularly satisfactory for species abundance and habitat fragmentation indicators, which increase the probability of spending an additional night by 12% and 7% respectively.

Another aspect that has been highlighted is related to land cover types. Following the classification provided by *Natura 2000*, it has been proven that the presence of different habitat types can cause a different impact on tourist choices. Tourists seem to prefer longer trips in regions characterised by coastal, low wetland vegetation, Mediterranean dryland vegetation, rocky habitats and forests. The probability of spending an additional night in such regions is respectively

14%, 27%, 11%, 26% and 10% higher. Since in many regions tourism is an important economic sector, giving a strong contribution to the well-being of the local populations, the results of this study can provide useful hints to policy-makers, when taking decisions regarding biodiversity protection.

The results of this analysis allow the description of a number of characteristics of Irish domestic tourists and their behaviour with respect to the choice of destination and length of stay. The present study is consistent with the tourism economics literature as far as the choice of explanatory variables is concerned. Environmental quality is often regarded as a relevant factor in describing tourist behaviour. However, unlike most previous studies, this analysis considers biodiversity and landscape profiles of the destination as a measure of environmental quality.

Therefore, an extensive work of elaboration of these profiles has been a necessary initial step. The outcome has been the creation of a set of eight indicators, which have been subsequently introduced as explanatory variables in the model. Nonetheless, only three of them have been maintained in the final model specification, since all of them turned out to be highly correlated among themselves. This depends mainly on the fact that these indicators are intended to measure different aspects of the same phenomenon, and exert considerable reciprocal influence on one another, since ecosystem health conditions directly affect species living conditions. As a result, only species abundance and habitat fragmentation have been included in the final model, due to their stronger explicative power and lower correlation score.

It would have been desirable to include species and habitat richness in the model, however, they have been considered as providing limited additional information. Nonetheless, it seemed interesting to use them to describe regional biodiversity profiles. Conservation indicators were excluded, since in this case, the evaluation provided by the *Natura 2000* database, was considered much too subjective, being carried out by authorities managing the protected site. However, the role of this kind of indicators is important and further research would be necessary to develop a more scientifically sound measure of species and habitat conservation status.

The case of species isolation is somehow different in that it appears to have stronger objectivity; however the degree of geographic isolation of a species may not be easily perceived by tourists. Notwithstanding this, it seems useful to further develop and apply this indicator to other contexts or different case studies. When considering the landscape profile, eight out of nine habitat classes were included in the final model and performed very well, allowing some conclusions to be drawn on the attractiveness of different habitats. Alternatively, it seems possible to construct landscape indicators from land cover data, which are generally well mapped across a large number of countries. This possibility could also account for agricultural and anthropogenic landscapes that could enhance a destination's attractiveness. All in all, more work is needed to understand the

complex role played by biodiversity on tourism flows, although this study represents a first valid approximation.

Table 1: Streamlining of biodiversity indicators

CBD Focal area	EU headline indicators	EU proposed indicators	Variables created in this application	Variables retrieved from <i>Natura 2000</i>	
Status and trends of biodiversity indicators	Trends in the abundance and distribution of selected species	Abundance and distribution of selected species	Species abundance	Species abundance	
			Species richness	No. species per site	
	Change in status of threatened and/or protected species	Red List Index of European species	Species of European interest	Species conservation	Species conservation
			Ecosystem coverage	Habitat abundance	Habitat relative surface
	Trends in the extent of selected biomes ecosystems and habitats	Habitats of European interest	Livestock genetic diversity	Habitat richness	No. habitats per site/ No. habitats at country level
				Habitat conservation	Habitat conservation
	Trends in genetic diversity	Nationally designated protected areas	Sites designated under the EU Habitats and Birds Directives	Species isolation	Species isolation
				Coverage of <i>Natura 2000</i> protected areas	Site area

Source: EEA (2007), own elaboration

Table 2: Values of biodiversity indicators across Irish counties

County	Habitat Abundance	Habitat Richness	Habitat Conservation	Species Richness	Species Abundance	Species conservation	Species Isolation	Cover age of protect ed area
Carlow	1.54	0.05	9.55	0.11	4.14	17.82	2.32	25.39
Cavan	7.57	0.06	19.69	0.02	0.64	11.94	0.40	7.56
Clare	2.72	0.03	15.87	0.03	1.26	7.36	1.83	44.30
Cork	3.54	0.04	29.79	0.04	1.54	13.62	0.53	6.98
Donegal	4.27	0.05	31.15	0.03	2.31	15.70	1.57	29.38
Dublin	1.25	0.03	16.64	0.03	2.41	10.37	0.63	11.58
Galway	4.51	0.05	32.13	0.03	1.63	10.08	0.98	39.23
Kerry	4.16	0.05	29.84	0.05	3.29	13.82	1.90	44.32
Kildare	4.13	0.03	12.40	0.04	1.94	9.69	5.91	0.32
Kilkenny	2.00	0.02	15.00	0.00	0.07	0.43	0.07	0.15
Laois	2.94	0.03	12.17	0.01	1.78	3.42	4.40	3.16
Leitrim	4.82	0.06	63.17	0.02	1.40	21.00	0.53	5.26
Limerick	3.94	0.03	8.00	0.02	1.23	2.25	1.28	0.35
Longford	3.96	0.05	24.19	0.02	0.86	6.86	0.36	25.05
Louth	4.16	0.04	8.03	0.03	1.36	7.59	0.44	26.35
Mayo	4.31	0.04	26.30	0.03	2.56	13.82	2.38	35.78
Meath	3.08	0.04	5.25	0.01	0.10	0.75	0.10	0.49
Monaghan	2.00	0.05	10.67	0.03	0.40	0.40	0.40	0.04
Offaly	2.79	0.03	16.98	0.01	1.30	4.19	2.93	2.19
Roscommon	4.52	0.03	35.06	0.02	0.63	6.64	1.24	3.78
Sligo	4.84	0.05	31.50	0.04	2.08	11.69	6.03	23.93
Tipperary	1.97	0.04	23.64	0.00	0.15	3.57	0.15	2.21
Waterford	2.14	0.05	22.26	0.05	1.21	11.81	0.57	10.06
Westmeath	2.19	0.02	20.28	0.02	1.34	5.88	0.33	4.83
Wexford	3.26	0.05	19.89	0.03	1.91	9.16	0.56	27.56
Wicklow	3.51	0.04	16.62	0.01	1.86	5.92	0.69	26.73

Source: Natura 2000 database, own elaboration

Table 3: Surface covered by protected habitats per county (km²)

County	Coastal	Dunes	Freshwater	Wetland vegetation	Mediterranean dryland vegetation	Grassland	Bogs, mires and fens	Rocky	Forests
Carlow							8797.13		
Cavan			4837.27				5.85		284.86
Clare	19980.79	1.34	1381.10	42319.65	7.82	92.02	15.37	7814.50	125.93
Cork	11705.19	2983.58	921.64	1429.31	0.20	3035.56	5771.46	452.86	77.99
Donegal	5831.53	8608.12	40121.22	1507.83	143.02	400.03	11664.42	4666.96	954.74
Dublin	182.52	5.02	2445.62		33.82	144.84	48.60	4666.96	24.29
Galway	11848.97	8283.25	90870.49	9212.49	232.81	64.93	7086.46	2847.25	4478.27
Kerry	16147.02	22509.76	3849.44	61324.69		2458.84	2032.34	76.18	17037.08
Kildare						54.97	34.78		13.13
Kilkenny			10.02	27.60		156.79	0.08	10.92	3.34
Laois	3638.07	59.05		150.72			48.91		14.73
Leitrim	2357.89	785.96		1292.46			2377.98		
Limerick	35.27	72.66	74.89	94.14	3.58	26.21	9.01	6.92	0.24
Longford	11026.89	861.30		23.47			127.59	69.01	
Louth	155.00	2.62	5587.72	248.00		558.77	3.8	2108.04	137.21
Mayo	674.46	1844.01	16278.64	5773.15		1740.81	1746.21	24959.66	1858.49
Meath			299.70	9.68			567.10		
Monaghan			4.04	4.61	2.31		1.73		
Offaly	270.43	36.05	237.30	630.10	3.87	0.42	579.25	52.79	9.14
Roscommon	519.79	144.58	807.27	893.61	34.82	162.71	724.46	3.88	102.45
Sligo	9001.66	97.17	708.64	961.24		27.01	3495.99	63.17	7277.79
Tipperary	3202.09	33.79		526.97	18.77	360.11	19.71	18.73	0.07
Waterford	13150.36			526.97		164.01	30.11		
Westmeath	2601.52	8.26		16.70			215.57		3.01
Wexford	5133.76		16700.28	17.83			7515.42	0.49	15.20
Wicklow			53.10				12581.63		7.96

Source: Natura 2000 database, own elaboration

Table 4: Coverage of protected habitats per county (share of protected areas)

County	Coastal	Dunes	Freshwater	Wetland vegetation	Mediterranean dryland vegetation	Grassland	Bogs, mires and fens	Rocks and caves	Forests
Carlow	0.00	0.00	0.00	0.00	0.00	0.00	38.66	0.00	0.00
Cavan	0.00	0.00	33.11	0.00	0.00	0.00	0.04	0.00	1.95
Clare	14.33	0.00	0.99	30.36	0.01	0.07	0.01	5.61	0.09
Cork	22.48	5.73	1.77	2.75	0.00	5.83	11.08	0.87	0.15
Donegal	4.10	6.05	28.21	1.06	0.10	0.28	8.20	3.28	0.67
Dublin	1.71	0.05	22.94	0.00	0.32	1.36	0.46	43.77	0.23
Galway	4.91	3.43	37.67	3.82	0.10	0.03	2.94	1.18	1.86
Kerry	7.68	10.70	1.83	29.16	0.00	1.17	0.97	0.04	8.10
Kildare	0.00	0.00	0.00	0.00	0.00	10.00	6.33	0.00	2.39
Kilkenny	0.00	0.00	3.14	8.66	0.00	49.21	0.03	3.43	1.05
Laois	67.02	1.09	0.00	2.78	0.00	0.00	0.90	0.00	0.27
Leitrim	28.23	9.41	0.00	15.47	0.00	0.00	28.47	0.00	0.00
Limerick	3.72	7.66	7.89	9.92	0.38	2.76	0.95	0.73	0.03
Longford	40.34	3.15	0.00	0.09	0.00	0.00	0.47	0.25	0.00
Louth	0.72	0.01	25.86	1.15	0.00	2.59	0.02	9.76	0.64
Mayo	0.35	0.95	8.43	2.99	0.00	0.90	0.90	12.92	0.96
Meath	0.00	0.00	25.93	0.84	0.00	0.00	49.07	0.00	0.00
Monaghan	0.00	0.00	7.00	8.00	4.00	0.00	3.00	0.00	0.00
Offaly	6.16	0.82	5.41	14.36	0.09	0.01	13.20	1.20	0.21
Roscommon	5.40	1.50	8.39	9.29	0.36	1.69	7.53	0.04	1.07
Sligo	20.48	0.22	1.61	2.19	0.00	0.06	7.95	0.14	16.56
Tipperary	33.66	0.36	0.00	5.54	0.20	3.79	0.21	0.20	0.00
Waterford	71.17	0.00	0.00	2.85	0.00	0.89	0.16	0.00	0.00
Westmeath	30.54	0.10	0.00	0.20	0.00	0.00	2.53	0.00	0.04
Wexford	7.92	0.00	25.76	0.03	0.00	0.00	11.59	0.00	0.02
Wicklow	0.00	0.00	0.10	0.00	0.00	0.00	23.25	0.00	0.01

Source: Natura 2000 database, own elaboration

Table 5: Summary statistics of socio-demographic and trip-specific characteristics

Variable	Description	Mean	St. deviation
Household population	Number of household members	3.96	1.60
No. trips	Number of trips taken by the household members	1.93	1.46
No. nights	Number of nights spent on the trip	4.36	4.94
No. persons	Number of participants to the trip	2.30	0.77
No. adult	Number of adults taking part to the trip	2.50	1.07
No. children	Number of children (>18 years old) taking part to the trip	1.14	1.31
Age	Age of the respondent	34.39	20.12
Gender	Gender of the respondent	0.47	0.50
Disposable income	Average disposable income in the county of residence	16,664.36	2,114.99
Cost paid in advance	Amount of money paid before departure	64.11	75.32
Total cost	Total cost of the trip	229.42	2,853.59
Coverage of protected areas	Share of county surface covered by Natura 2000 protected areas	26.93	15.64
Species richness	Number of species per site	0.03	0.01
Species abundance	Share of specimen living on the national territory recorded in each site	1.92	0.82
Species conservation	Degree of conservation of species	10.74	3.68
Species isolation	Degree of geographic isolation of species present in each site	1.29	1.08
Habitat richness	Number of habitat per site	0.04	0.01
Habitat abundance	Share of habitat existing on the national territory recorded in each site	3.57	1.02
Habitat conservation	Degree of conservation of habitat	24.95	7.66
Air	Travel by airplane	0.01	0.11
Land	Travel by train, car, bus or bicycle	0.02	0.12
Other	Travel by boat or other means	0.97	0.16
January	Month of departure	0.04	0.19
February		0.06	0.25
March		0.09	0.29
April		0.08	0.26
May		0.07	0.26
June		0.12	0.32
July		0.14	0.35
August		0.19	0.39
September		0.07	0.25
October		0.06	0.24
November		0.04	0.19
December		0.04	0.21
South-East	NUTS III region of destination	0.28	0.45
South-West		0.20	0.40
Midwest		0.11	0.31
Midlands		0.02	0.14
Mid-East		0.03	0.18
Dublin		0.05	0.22
West		0.21	0.41
Border		0.09	0.29
Camping	Accommodation category	0.10	0.30
Guesthouse		0.14	0.34
Holiday home		0.06	0.24
Hotel		0.42	0.49
Home rental		0.15	0.35
Visiting relatives		0.10	0.30
Other		0.04	0.19
Single	One person participating to the trip	0.19	0.39
Couple	Two people participating to the trip	0.32	0.47
Group (>3)	Group of more than three people participating to the trip	0.49	0.50

Source: Natura 2000 database, CSO (2007)

Table 6: GLS regression results

	No. Nights	Coefficient	Std.Err	P> z
	(constant)	1.868	0.492	0.000***
Household socio-demographic characteristics	Household dimension	0.021	0.025	0.279
	Disposable income (county average)	0.079	0.018	0.000***
	Age of respondent	0.004	0.001	0.000***
	Repeat visitor	-0.533	0.050	0.000***
Cost paid for the trip	Cost	-0.005	0.000	0.000***
Coverage of protected areas	Protected areas	-0.022	0.006	0.000***
Species and habitat diversity indicators	Species abundance	0.453	0.101	0.000***
	Habitat abundance	0.283	0.076	0.000***
Protected habitats (landscape)	Coastal	0.511	0.228	0.025*
	Dunes	-1.551	0.326	0.000***
	Freshwater	-1.027	0.279	0.000***
	Wetland vegetation	0.860	0.315	0.006**
	Dryland vegetation	0.444	0.117	0.000***
	Grassland	-0.674	0.233	0.004**
	Rocky	1.313	0.378	0.001***
	Forests	0.610	0.201	0.002**
Modes of transportation	Air	0.280	0.242	0.172
	Land	2.405	0.215	0.000***
Month of departure	January	-0.506	0.182	0.005**
	February	-0.217	0.166	0.133
	March	-0.152	0.157	0.233
	April	0.017	0.162	0.636
	May	0.069	0.159	0.461
	June	0.787	0.153	0.000***
	July	3.201	0.153	0.000***
	August	1.914	0.148	0.000***
	September	0.330	0.158	0.037*
	October	-0.217	0.143	0.089*
	November	-0.170	0.157	0.193
NUTS 3 regions of destination	South-west	-0.310	0.415	0.316
	South-east	-0.955	0.463	0.039*
	Midwest	-1.022	0.448	0.023*
	Midlands	-1.139	0.477	0.017*
	Mideast	-0.834	0.394	0.035*
	West	-0.509	0.439	0.171
	Border	-0.987	0.454	0.030*
Accommodation categories	Camping	0.573	0.152	0.000***
	Guesthouse	-1.414	0.138	0.000***
	Holiday home	2.038	0.179	0.000***
	Hotel	-1.462	0.131	0.000***
	SC/rental	0.586	0.144	0.000***
	Visiting relatives	-0.731	0.143	0.000***
Recreationist group	Couple	0.099	0.069	0.106
	Group (>3) children	1.157	0.089	0.000***
	children	-0.223	0.046	0.000***

GLS regression with correction for random effects. Group variable (i): household. R^2 within = 0.11; R^2 between = 0.19. Wald $\chi^2 = 3582.60$. Prob > $\chi^2 = 0.0000$

Table 7: Results of the Poisson regression analysis and incident rate ratios

	No. nights	Impact	IRR	Coefficient	P> z
	(constant)			0.962	0.000***
Household socio-demographic characteristics	Household dimension	0.001	1.001	0.001	0.579
	Disposable income (scale)	0.014	1.014	0.014	0.000***
	Age of respondent	0.001	1.001	0.001	0.000***
	Repeat visitor	-0.120	0.880	-0.128	0.000***
Cost paid for the trip	Cost	-0.002	0.998	-0.002	0.000***
Coverage of protected areas	Protected area	-0.006	0.994	-0.006	0.000***
Species and habitat diversity	Species abundance	0.122	1.122	0.115	0.000***
	Habitat abundance	0.079	1.079	0.076	0.000***
Protected habitats (landscape)	Coastal	0.144	1.144	0.135	0.003**
	Dunes	-0.306	0.694	-0.366	0.000***
	Freshwater	-0.181	0.819	-0.199	0.001***
	Wetland vegetation	0.272	1.272	0.240	0.000***
	Dryland vegetation	0.112	1.112	0.106	0.000***
	Grassland	-0.123	0.877	-0.131	0.004**
	Rocky	0.265	1.265	0.235	0.002**
	Forests	0.108	1.108	0.102	0.013*
Modes of transportation	Air	0.048	1.048	0.047	0.193
	Land	0.701	1.701	0.531	0.000***
Month of departure	January	-0.104	0.896	-0.110	0.002**
	February	-0.059	0.941	-0.060	0.055*
	March	-0.028	0.972	-0.029	0.229
	April	0.038	1.038	0.037	0.151
	May	0.038	1.038	0.037	0.150
	June	0.265	1.265	0.235	0.000***
	July	0.847	1.847	0.614	0.000***
	August	0.547	1.547	0.437	0.000***
	September	0.111	1.111	0.105	0.000***
	October	-0.021	0.979	-0.021	0.334
	November	-0.086	0.914	-0.090	0.008**
NUTS 3 regions of destination	South-west	-0.071	0.929	-0.074	0.261
	South-east	-0.232	0.768	-0.264	0.005**
	Midwest	-0.214	0.786	-0.241	0.008**
	Midlands	-0.249	0.751	-0.286	0.004**
	Mideast	-0.215	0.785	-0.242	0.002**
	West	-0.100	0.900	-0.105	0.161
	Border	-0.200	0.800	-0.223	0.014*
Accommodation categories	Camping	0.061	1.061	0.059	0.029*
	Guesthouse	-0.288	0.712	-0.340	0.000***
	Holiday home	0.318	1.318	0.276	0.000***
	Hotel	-0.288	0.712	-0.339	0.000***
	SC/rental	0.095	1.095	0.091	0.000***
	Visiting relatives	-0.143	0.857	-0.154	0.000***
Recreationist group	Couple	-0.033	0.967	-0.034	0.008**
	Group (>3) children	0.151	1.151	0.141	0.000***
		-0.041	0.959	-0.042	0.000***

Log likelihood = -68197.735; Wald $\chi^2 = 8691.83$ Prob > $\chi^2 = 0.0000$. Statistical significance of 0.1%. 5% and 10% is indicated by ***, **, * respectively. Likelihood-ratio test of alpha= 0: $\text{chibar2}(01) = 3.3\text{e}+04$ Prob>= $\text{chibar2} = 0.0000$.

Table 8: Annual welfare change due to a 10% change in biodiversity indicators

County	Annual welfare change (habitat abundance)	Annual welfare change (species abundance)	Annual welfare change (Coverage of protected areas)
Carlow	€5,568	€23,093	-€6,965
Cavan	€80,402	€10,436	-€6,101
Clare	€268,740	€191,876	-€332,490
Cork	€557,431	€373,197	-€83,463
Donegal	€274,849	€229,271	-€143,646
Dublin	€81,616	€242,272	-€57,327
Galway	€991,090	€553,272	-€655,313
Kerry	€1,053,959	€1,290,072	-€853,775
Kildare	€26,293	€19,058	-€157
Kilkenny	€82,989	€4,272	-€487
Laois	€11,346	€10,612	-€924
Leitrim	€39,023	€17,516	-€3,236
Limerick	€88,870	€42,697	-€605
Longford	€6,588	€2,203	-€3,166
Louth	€39,169	€19,770	-€18,862
Mayo	€393,138	€360,107	-€248,029
Meath	€18,363	€920	-€223
Monaghan	€7,704	€2,379	-€13
Offaly	€19,872	€14,307	-€1,186
Roscommon	€25,054	€5,392	-€1,589
Sligo	€147,206	€97,575	-€55,221
Tipperary	€27,457	€3,304	-€2,335
Waterford	€151,162	€132,487	-€53,996
Westmeath	€22,940	€21,754	-€3,847
Wexford	€428,513	€388,550	-€275,462
Wicklow	€85,298	€69,641	-€49,318
TOTAL	€4,934,640	€4,126,033	-€2,857,739

Source: Natura 2000 database, own elaboration

Table 9: Correlation between monetary value of a change in species abundance and scores for species richness

County	Monetary value of change in species abundance	Monetary value of change in species abundance (% expenditure per night)	Species Richness
Carlow	€3	5%	0.11
Mean	€3	5%	0.11
Dublin	€2	3%	0.03
Kerry	€2	4%	0.05
Mayo	€2	3%	0.03
Mean	€2	3%	0.04
Kildare	€1	2%	0.04
Donegal	€1	3%	0.03
Laois	€1	2%	0.01
Galway	€1	2%	0.03
Sligo	€1	3%	0.04
Offaly	€1	2%	0.01
Westmeath	€1	2%	0.02
Wicklow	€1	2%	0.01
Limerick	€1	1%	0.02
Wexford	€1	2%	0.03
Leitrim	€1	2%	0.02
Cork	€1	2%	0.04
Louth	€1	2%	0.03
Waterford	€1	1%	0.05
Clare	€1	2%	0.03
Mean	€1	2%	0.03
Cavan	€0	1%	0.02
Monaghan	€0	0%	0.03
Longford	€0	1%	0.02
Roscommon	€0	1%	0.02
Tipperary	€0	0%	0.00
Kilkenny	€0	0%	0.00
Meath	€0	0%	0.01
Mean	€0	0%	0.01

Source: Natura 2000 database, own elaboration

Table 10: Correlation between monetary value of a change in habitat abundance and scores for habitat richness

County	Monetary value of change in habitat abundance	Monetary value of change in habitat abundance (% expenditure per night)	Habitat Richness
Cavan	€3	6%	0.056
Mean	€3	6%	0.056
Galway	€2	4%	0.050
Kildare	€2	3%	0.027
Limerick	€2	3%	0.025
Leitrim	€2	4%	0.056
Sligo	€2	4%	0.046
Mayo	€2	3%	0.038
Kerry	€2	3%	0.045
Mean	€2	3%	0.041
Donegal	€1	3%	0.047
Offaly	€1	2%	0.034
Kilkenny	€1	2%	0.017
Louth	€1	3%	0.039
Laois	€1	2%	0.025
Wicklow	€1	3%	0.042
Cork	€1	3%	0.039
Monaghan	€1	2%	0.051
Roscommon	€1	4%	0.034
Westmeath	€1	2%	0.018
Longford	€1	3%	0.046
Meath	€1	2%	0.038
Wexford	€1	3%	0.049
Clare	€1	2%	0.028
Waterford	€1	2%	0.047
Tipperary	€1	2%	0.040
Dublin	€1	1%	0.033
Carlow	€1	1%	0.047
Mean	€1	2%	0.037

Source: Natura 2000 database, own elaboration

Table 11: Results of the regression analysis of annual welfare change against the different components of species abundance and their cross products

Annual welfare change	Coefficient	St. err	P> t
Bird species abundance	0.9876984	0.160787	0.000***
Fish species abundance	-6.194821	3.305607	0.078*
Invertebrate species abundance	0.6121539	0.160101	0.001**
Mammal species abundance	7.374116	2.232583	0.004**
Plant species abundance	0.738841	0.25468	0.010**
Fish*Mammal species abundance	5.739874	2.744486	0.052*
Bird*Mammal species abundance	-1.021129	0.442093	0.034*
Invertebrate*Mammal species abundance	-1.0081	0.441996	0.036*
Mammal*Plants species abundance	-0.5609158	0.336017	0.113

Prob > F= 0.0000; $R^2 = 0.9434$; Adjusted $R^2 = 0.9134$

Source: Natura 2000 database, own elaboration

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