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Surveys

A stated preference valuation of the non-market benefits of pollination services in the UK

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ABSTRACT

Using a choice experiment survey this study examines the UK public's willingness to pay to conserve insect pollinators in relation to the levels of two pollination service benefits: maintaining local produce supplies and the aesthetic benefits of diverse wildflower assemblages. Willingness to pay was estimated using a Bayesian mixed logit with two contrasting controls for attribute non-attendance, exclusion and shrinkage. The results suggest that the UK public have an extremely strong preference to avoid a status quo scenario where pollinator populations and pollination services decline. Total willingness to pay was high and did not significantly vary between the two pollination service outputs, producing a conservative total of £379M over a sample of the tax-paying population of the UK, equivalent to £13.4 per UK taxpayer. Using a basic production function approach, the marginal value of pollination services to these attributes is also extrapolated. The study discusses the implications of these findings and directions for related future research into the non-market value of pollination and other ecosystem services.

1. Introduction

Pollination, the transfer of pollen within and between flowers by insect vectors is a key ecological function facilitating reproduction in 78% of temperate flowering plants (Ollerton et al., 2011). These plants underpin the function of a range of ecosystem services, such as food crop production (Klein et al., 2007), soil quality, pest regulation (Sarrantonio, 2007) and improving landscape aesthetics (Lindemann-Matthies et al., 2010). At present, populations of both wild and managed pollinating insects within the UK have experienced substantial long-term declines (Potts et al., 2010; Carvalheiro et al., 2013), raising concerns about the stability of pollination services. As a regulatory, or intermediate, ecosystem service (Fisher et al., 2009), pollination has typically been valued as a component of the final benefits it provides (but see Allsopp et al., 2008). To date only the benefits to crop markets have been economically quantified to assess the value of production changes resulting from pollination services to crops (e.g. Winfree et al., 2011). Unlike crop production, other final benefits of pollination services are not directly traded on markets and are often public (they are not owned by anyone exclusively) and non-excludable (people cannot be prevented from using them) (Cooke et al., 2009). Furthermore, there may be intrinsic values attached to the existence of pollinators (e.g. Mwebaze et al., 2010). As valuation is often used to underpin decision making, an exclusive focus on market benefits will neglect the broader impacts such decisions can have on wider stakeholders.

In order to redress the failure of markets to capture the benefits of non-market ecosystem services, economists have exploited a range of techniques, broadly categorised as revealed or stated preference methods. Revealed preference methods utilise existing market or experimental data to estimate previously uncaptured benefits arising from ecosystem services (e.g. hedonic price models used to value the benefits of proximity to natural habitat on house prices; Hanley et al., 2007). Stated preference methods create a hypothetical market for environmental goods/services using a questionnaire or interview and ask respondents to state preferences for bundles of these goods/services. Costs attached to each bundle act as a price within the market, allowing estimation of the respondents' willingness to pay (WTP) to acquire or maintain the goods/services or their willingness to accept (WTA) compensation for their degradation of the goods/services if the costs are negative (Bateman et al., 2002). Stated preference methods allow a wide range of respondent factors to be modelled and compared and, unlike revealed preference techniques, are theoretically applicable to any ecosystem service (Hanley et al., 2007). Stated preference methods are based upon random utility models which assume that respondents are rational, self-serving

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utility maximisers who will express preferences that optimise their utility (Train, 2003). However, recent research has questioned these assumptions particularly for complex or unfamiliar goods and non-market goods. Subsequently, respondents may express lexicographic preferences, whereby they are unwilling to trade away any quantity of the good (Spash et al., 2009), and a number of biases which may obscure their true preferences. In particular when respondent awareness of the hypothetical nature of the study affects their response (hypothetical bias — e.g. Ivehammar, 2009) or where respondents avoid the risks of change even if they disapprove of the status quo (status quo bias — e.g. Boxall et al., 2009).

Stated preference surveys have been used to value a range of ecosystem services such as water quality (Zander and Straton, 2010), recreation (Christie et al., 2007) and carbon sequestering (MacKeron et al., 2009). However, while final services, those with distinct end products that are directly consumed (Fisher et al., 2009), such as water quality, are more tangible and comprehensible to respondents who interact with them, intermediate services (those which enhance the production of end products), such as pollination, are often complex ecological concepts that the public find difficult to attribute value to. This can make valuations for ecosystem services difficult to elicit accurately with stated preference methods, due to the limited information available to respondents (Christie and Gibbons, 2011). This in turn increases the probability of respondents using decision simplifying strategies rather than fully considering all the information presented when expressing their preferences, further biasing the results (Meyhoff and Liebe, 2009). Nonetheless, if carefully developed, stated preference studies can be used to capture aspects of ecosystem service benefits that are not included in existing valuation studies.

This study uses a choice experiment survey to assess respondents stated willingness to pay to conserve pollinators in order to prevent marginal losses in two previously unvalued final benefits of pollination services; the relative availability of UK grown produce and the diversity of aesthetic wildflowers. Presently, many key insect pollinated fruits are largely supplied by imports, while by contrast the UK is largely self-sufficient in wind-pollinated cereal crops (DEFRA, 2013). Consumer concerns regarding pollution, accountability and local economic impacts involved in food imports, have prompted a growing preference for locally produced foods (Chambers et al., 2007; Brown et al., 2009). As such, even if produce can be substituted with imports, loss of UK pollination services will reduce the availability of this preferential characteristic. Insect pollinated wildflowers can provide significant welfare benefits through enhancing the aesthetic quality of landscapes (Soini and Aakkula, 2007), habitats (Lindemann-Matthies et al., 2010; Junge et al., 2011) and road verges (Akbar et al., 2003). This aesthetic quality has substantial impacts on perceptions of landscapes (Natural England, 2009) and socio-cultural values associated with connectivity with nature (Kellert, 1996). Subsequently, destabilisation of plant-pollinator networks and the consequent loss of flowering species may diminish these benefits. Based upon this information, this study expects that respondent willingness to pay for pollinator conservation will rise in relation to the improving quality of these final goods.

2. Methods

2.1. Experiment Development and Sampling

This study evaluates respondent willingness to pay (WTP) to prevent losses in multiple pollination service end products using a choice experiment questionnaire. Choice experiment surveys present respondents with several bundles of goods and services with different attributes and ask them to indicate their preferred bundle. By attaching a cost to each choice and taking several choice sets per individual, choice experiments can be used to assess respondents' willingness to pay for marginal changes in each attribute rather than just the bundle as a whole.

2.1.1. Design

Typically, attributes are derived from policy, prior preferences elicited or scientific predictions, however quantitative relationships between pollinator populations, pollination service levels and end production are difficult to extrapolate in an easily comprehensible manner. The attributes selected for this choice experiment were aesthetic wildflower diversity, the relative availability of UK produce and price. Attribute levels were specified identically as changes in current levels compared to now from no change to −30% in a linear incremental scale (Table 1) to elicit respondent willingness to pay to avoid losses in these pollination service benefits. These seemed sufficient to incentivise changes between options. The attributes were confirmed as suitable by a focus group, which considered the use of tax as payment vehicle (the hypothetical means by which payment would be collected) and the attribute levels to be comprehensible and believable. The cost attribute was framed as a possible future taxation to maintain realism (Ivehammar, 2009) and presented as both a monthly and annual increase. The cost attribute levels were modified after a 90 household pilot survey, so as to increase the variation in choices as most pilot respondents picked only the most expensive options.

Values ascribed to these attributes do not directly represent a valuation of pollinators. For simplicity, bees were chosen as a focal species because of their widely recognised importance as pollinators (Klein et al., 2007) and recent UK media coverage of declining populations. A measure of bee populations was considered as an attribute in the initial design however focus group discussions indicated difficulty in placing values on percentage changes in bee populations in relation to other attributes, indicating instead that it was the secure existence of the taxa and the services that they provide that mattered. Furthermore, such a variable could complicate the scenario by creating choice sets where bees decline but their services remain, which although plausible, many participants found hard to comprehend. Alternatively, other ecosystem functions may compensate for lost pollination services (Bommarco et al., 2013) however this introduces complex, multiple ecosystem service concepts into the scenario. The presence of a "do nothing" status quo option, whereby there is no additional effort is made to preserve bees in the UK, instead allows for some estimate of the intrinsic value respondents attach to the continued existence of bees by statistically analysing the impact of "non status-quo" options on WTP.

30 choice sets were initially developed with attribute balanced (i.e. attribute levels of each attribute appear across all choice sets the same number of times), D-optimal design algorithms, which aim to produce more statistically robust choice sets by minimising the standard error or standard deviations of the parameter estimates using initial assumptions about parameter signs and magnitudes.

Table 1
Choice attribute levels.

Attribute	Levels
1. UK grown fruit and vegetables available in local shops compared to now	−30%*, −20%, −10%, same as now
2. Variety of wildflowers in local green spaces compared to now	−30%*, −20%, −10%, same as now
3. Monthly tax increase to you	£0*, £0.5, £1, £1.5, £2, £2.5, £3, £3.5, £4

* = Status quo attribute levels.