Land Use Policy 71 (2018) 355–362

Contents lists available at ScienceDirect

Land Use Policy

journal homepage: www.elsevier.com/locate/landusepol

Measuring public perception and preferences for ecosystem services: A case study of bee pollination in the UK

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ARTICLE INFO

Keywords:
Valuation
Ecosystem services
Bees
Pollination
Willingness to pay

ABSTRACT

There is concern that insect pollinators, such as bees, are currently declining in abundance, and are under serious threat from factors such as increased use of certain pesticides, land use changes, competition from invasive alien species, pathogens, parasites and climate change. Using the contingent valuation (CV) method, this paper evaluates how much public support there would be in preventing further decline to maintain the current number of bees by estimating the willingness to pay (WTP) for a theoretical bee protection policy in the UK. We apply the CV method as an estimation of public perception and preferences for pollination services. The mean WTP to support the bee protection policy was approximately £43 per household per year. Based on the 30.6 million taxpayers in the UK, this is equivalent to £842 million per year. This value can provide a means of illustrating the total value of public support for maintaining pollination services to policy makers and stakeholders.

1. Introduction

Pollination is a keystone biological process in both managed and natural terrestrial ecosystems. Without pollination many inter-connected species inhabiting, and processes functioning within, an ecosystem would collapse (Kearns et al., 1998; Nabhan and Buchmann, 1997). As an ecosystem service, pollination directly or indirectly provides multiple benefits, for example, aiding in genetic diversity, contributing to ecosystem resilience and nutrient recycling, supporting our survival and quality of life (Daily, 1997), as well as the more obvious economic benefit of increasing the productivity of agricultural crops (Nabhan and Buchmann, 1997; MA, 2005; Ollerton et al., 2011).

The majority of agricultural crops depend on animal pollination (Klein et al., 2007; Aizen et al., 2009) and pollination services are provided by a variety of wild and commercially managed animal species including bees, moths, beetles, wasps, flies, birds, butterflies and bats (Ollerton et al., 2011). Globally, it is estimated that 84% of the approximately 300 commercial crops are insect pollinated (Williams, 1996), with fruits, vegetables, oilseeds, legumes and fodder, mostly pollinated by bees (Free, 1993). In the UK, at least 39 crops grown for fruit or seed are insect pollinated, with a further 32 crops requiring insects for propagation of seed production (Williams, 1994).

Bees play a major role in pollination of a wide range of fruit, vegetable and arable crops in the UK (Breeze et al., 2011). In particular, honeybees have historically been regarded as the most economically important group of pollinators (Free, 1993; Williams, 1994, 1996; Kremen et al., 2007; NRC, 2007) although subsequent data concerning wild bees and other insects has emerged, challenging the relative importance of honeybees (e.g. Winfree et al., 2008; Garibaldi et al., 2011, 2013).

Over the past few decades, there have been significant declines in the number of feral and managed bees globally (Biesmeijer et al., 2006; NRC, 2007; Potts et al., 2010; Carvalheiro et al., 2013). The decline is attributed to a number of factors such as increased use of certain pesticides (VanEngelsdorp et al., 2009; Whitehorn et al., 2012; di Prisco et al., 2013; Goulson, 2013), land use changes (Winfree et al., 2009; Osgathorpe et al., 2011), introduction of invasive species (Sugiura et al., 2013), pathogens and parasites (Vanbergen et al., 2013) and climate change (Potts et al., 2010; vanEngelsdorp and Meixner, 2010; Franzen and Ockinger, 2012). In the UK the pollination of crops by honeybees has been reported to be in decline, with decline in colony numbers being linked with use of particular insecticides (Budge et al., 2015).

To support the protection of bees, it is important that the economic value of the services they provide to society is established. This requires a brief discussion of the different types of values of pollination services.

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https://doi.org/10.1016/j.landusepol.2017.11.045
Received 10 April 2017; Received in revised form 22 November 2017; Accepted 22 November 2017

Based on the total economic value (TEV) concept (Perman et al., 2011), the economic value conferred by pollination services can be classified into three main components: (1) use values, (2) option values, and (3) non-use values. Use value reflects the direct use of the pollination services. Option value reflects the value individuals place on a future ability to use the resource. Non-use value is a value placed on an environmental good and which is unrelated to any actual, planned or possible use of the good (Perman et al., 2011). These values can further be categorised as having market and non-market values. Market values consist of the contribution they make to the production of a range of agricultural crops (Ricketts et al., 2004; Gallai et al., 2009; Kasina et al., 2009; Bauer and Wing, 2010). Non-market values arise from the utility which individuals derive from seeing pollinators (i.e. use value) or simply knowing that they exist and the aesthetic value of wild flowers which require pollination (non-use or existence values) (Hanley et al., 2015).

There are a number of economic approaches that can be used to estimate the value of pollination services including (Bauer, 2014): (1) the estimation of the value of crop production that can be attributed to insect pollination, (2) estimation of changes to producer and consumer surplus—using a production function, (3) the replacement cost method, and (4) contingent valuation and choice modelling. Some of these methods provide a theoretically consistent measure of consumer and producer surplus (e.g. production function) while others lead to approximations (e.g replacement cost).[1] Note that these valuation methods measure different aspects of the value of pollination services and are appropriate at different scales. A more detailed discussion of these methods can be found in a number of reviews and guidelines (see Mburu et al., 2006; Hein, 2009; Kasina et al., 2009; Winfree et al., 2011; Bauer, 2014; Hanley et al., 2015). In this paper we focus on the estimation of non-market values of pollination services.

A number of studies have analysed the economic value of pollination services at the national level, mostly focussed on developed countries e.g. Australia (Gordon and Davis, 2003), UK (Carreck and Williams, 1998; Smith et al., 2011), USA (Southwick and Southwick, 1992; Morse and Calderone, 2000), and a few developing countries such as South Africa (Allsopp et al., 2008) and Kenya (Kasina et al., 2009). There have also been attempts to analyse the value of the pollination service at the global level (e.g. Costanza et al., 1997, 2014; Gallai et al., 2009; Bauer and Wing, 2010). However, these studies used different approaches, resulting in different economic values of pollination services being published. For example, the value provided by the pollination service to US agriculture was estimated to be US$6 billion per year by Southwick and Southwick (1992) and US$ 14 billion per year by Morse and Calderone (2000).

Focussing on major UK crops, Carreck and Williams (1998) used the level of insect pollination dependency to estimate the production value of bees to be £172 million per year (equivalent to US$219 million) for outdoor crops and £30 million per year (US$38 million) for glasshouse crops. The same approach was used in the UK's National Ecosystem Assessment (UK NEA) to estimate the economic value of pollination for all UK crops in 2007 (Smith et al., 2011). The value of the pollination service to UK agriculture was estimated to be £430 million per annum (equivalent to US$548 million). However, these studies estimate the contribution of insect pollination service within agriculture, but do not evaluate the non-market values for pollination services.

Kleijn et al. (2015) assert that the "delivery of crop pollination services is an insufficient argument for wild pollinator conservation". Their analysis of global crop production showed that wild bees contribute (US$3251 per ha) a similar amount to honey bees (US$2913 per ha). The public support for pollinators is also largely missing from the economic literature. By definition, this public support reflects the values attached to the existence of pollinators (Breeze et al., 2015). Notwithstanding, there are few published studies of the non-market benefits of pollination services.

This study evaluates how much public support there would be in preventing further decline in order to maintain the current number of bees in the UK. Economists have developed a number of methods for estimating non-market values, broadly categorised as revealed and stated preference methods (e.g. Hanley and Barbier, 2009; Freeman et al., 2014). Revealed preference (RP) methods have the advantage of relying on actual market behaviour but they can only be applied to measure 'use' values (e.g. Kasina et al., 2009). Stated preference (SP) methods are applicable to a wide range of ecosystem goods and services and typically they are the only option available for estimating non-use values of the pollination service (Hanley et al., 2015; Breeze et al., 2015).[2] Stated preference techniques use information provided by respondents to questionnaires asking about their WTP for an environmental improvement in a hypothetical market (Mitchell and Carson, 1989; Bateman et al., 2002; Hanley and Barbier, 2009). The questions may be based on contingent valuation (CV) or choice modelling (CM).

However, SP methods also have their limitations, including hypothetical bias (Murphy et al., 2005), embedding effect and insensitivity to scope (Kahneman and Knetsch., 1992).[3] The main challenge in assessing the non-market values of pollination services using SP methods is the extent of public knowledge on pollination services (Mburu et al., 2006; Hanley et al., 2015).[4] If respondents in a CV survey are not aware of the importance of the goods that they are being asked to value, they may not reveal a strong preference and the good may be undervalued (Christie et al., 2006). However, strategies are available to reduce this problem. For example, it has been shown that providing additional information about a public good before estimating the WTP for it can lead to a significant increase in values of the respondents (LaRiviere et al., 2015).[5]

This paper applies the CV method to measure the WTP for a theoretical bee protection policy in the UK. With the limitations of SP in mind, we apply the CV method as an estimation of public perception and preferences for pollination services. Moreover, a good understanding of how the public perceives ecosystem benefits can facilitate better valuation of ecosystem services and influence policy. This article contributes to the scarce literature on evaluating the non-market values of pollination services. The results can provide a means of illustrating the overall value of conserving pollination services to policy makers and other stakeholders, in addition to setting priorities among competing conservation goals (de Groot et al., 2012; Hanley et al., 2015).

[1] Consumer surplus and producer surplus are welfare measures commonly used in economics. The consumer surplus (CS) is the difference between the willingness to pay (WTP) for a good or service and actual expenditure while the producer surplus (PS) is the difference between the revenue received for a good or service and the costs of provision of the good or service (Tietenberg and Lewis, 2015). Economic surplus is the sum of consumer surplus and producer surplus.

[2] For example, SP methods have been used to value other ecosystem services such as water quality, recreation and carbon sequestering (Ninan, 2014).

[3] A scope test is recommended as a way to test the validity of CV studies (Arrow et al., 1993). It examines whether respondents are willing to pay more for a good that is larger in scope, either in a quantity or quality sense. However, there are many reasons for the failure to pass a scope test, including diminishing marginal utility, substitution and socio-psychological factors—all of which are consistent with economic theory (see Heberlein et al., 2005). The authors conclude that, 'by itself, the scope test is neither a necessary nor sufficient condition to invalidate a CV study' (Heberlein et al., 2005). The scope test was not conducted in this CV study.

[4] For example, surveys in the UK suggest that the public does not relate easily to the concept of ecosystem services. But they appreciate the benefits of provisioning services, such as the supply of food and clean water, regulating services, and cultural services including recreation and urban green space (UK NEA).

[5] Another strategy is to use the 'learning design contingent valuation' method developed by Bateman et al. (2008). Here respondents are provided with opportunities for learning by repetition and experience. It allows for learning and experience in the valuation tasks and for the opportunity to 'discover' preferences within the duration of the survey. The authors assert that it is the last response in a series of valuations which should be attended to rather than the first. However, this strategy could not be implemented in this study due to budget constraints.