

Institution: University of Reading		
Unit of Assessment: 6 (Agriculture, Food and Veterinary Sciences)		
Title of case study: Evidence-based policy and practice change for improved UK crop pollination.		
Period when the underpinning research was undertaken: Between 2003 and 2017		
Details of staff conducting the underpinning research from the submitting unit:		
Name(s):	Role(s) (e.g. job title):	Period(s) employed by submitting HEI:
Michael Garratt,	Principal Research Fellow, Senior Research Fellow, Research Fellow	January 2011 - present
Deepa Senapathi,	Senior Research Fellow,	April 2010 - present
Tom Breeze,	Research Fellow,	May 2012 - present
Simon Potts	Professor of Biodiversity and Ecosystem Services	March 2002 - present
Period when the claimed impact occurred: Between August 2013 and July 2020		
Is this case study continued from a case study submitted in 2014? No		
1. Summary of the impact		
<p>Research undertaken at the University of Reading has played an important role in steering England's National Pollinator Strategy (NPS) from its conception. Since the NPS was published in 2014, the team's research has closed a significant knowledge gap by quantifying the essential role that wild bees and other pollinating insects play in supporting UK crop production, which has been instrumental in driving the ongoing development and implementation of the NPS.</p> <p>Garratt and colleagues' demonstration of opportunities to increase yield and quality by improving pollination has underpinned engagement with companies that supply approximately 70% of the UK top-fruit market, increasing understanding of the importance of crop pollination across these businesses and leading them to introduce actions to protect and enhance wild pollinator habitats. In addition, the team has supported a leading UK food retailer to meet its sustainability targets, for example by informing the development of a periodic assessment of its growers.</p> <p>The development of the NPS and support for industry practice change complements Natural England's Entry Level Stewardship (ELS) scheme, in which specific management options to promote biodiversity were based on the team's research (e.g. Wild Pollinator & Farm Wildlife Package). In December 2013 over 6,500,000ha of land was covered by ELS agreements, with a significant proportion continuing until December 2019.</p>		
2. Underpinning research		
<p>The key research findings which underpin this case study are:</p> <ol style="list-style-type: none"> 1. For the first time, the specific pollinators providing most of the pollination services to key crops in the UK including apples, oilseed rape, field beans and strawberries have been identified. 2. Methods to quantify the economic value of pollination services to UK crops have been developed and applied. This includes the relative contribution of different pollinators, and the estimation of the extent of sub-optimal pollination and its impact on reduced crop yields. 3. Effective wildlife-friendly farming practices to support crop pollinators on farms have been identified, such as modified hedgerow management, field margins and provision of floral rich habitats. <p>Despite it being well known that many UK and global crops benefit from insect pollination, until recently, the identity of key pollinators and their contribution to crop pollination services were poorly understood. Early research by the Reading team between 2003 and 2007, as part of the Sustainable Arable Farming For an Improved Environment (SAFFIE) research project, quantified the responses of a wide range of plants and invertebrates (except bumblebees and butterflies,</p>		

which was led by the Centre for Ecology and Hydrology) to different field margin types, using several innovative large-scale manipulative field experiments on 29 UK farms [1].

Since 2011, continued research at the University of Reading has provided fundamental insights into the vital role of insect pollinators for agriculture in the UK and beyond. Working with colleagues from across the world, the Reading researchers have helped to establish that wild pollinators provide the majority of crop pollination in Europe and the US [2], and through field surveys of over 100 crop fields they have demonstrated this is also true for the UK [3,4,5]. Furthermore, using national scale data on crop coverage and honeybee hive numbers, the researchers have shown that currently there is a 75% shortfall in honeybee numbers in the UK: they are not sufficient to pollinate all the crops grown. Yet insects contribute an estimated GBP 640,000,000 to UK crop production each year [6]. In fact, by improving both yield and quality through pollination, the Reading team has calculated that wild insects contribute more than GBP 70,000,000 to the farm gate value of four of the UK's most popular apple varieties [4]. They have also identified opportunities to increase production further through effective management of insect pollinators and they were the first group in the UK to identify a significant pollination deficit in a UK crop, showing that pollination deficits of up to GBP 5,000/ha exist in apple orchards [7].

The Reading researchers have shown that a number of farm management practices can help support pollinators and the pollination services they provide. For example, protecting non-cropped areas such as hedgerows can support beneficial species [8], and conservation practices, such as establishing field margins, can boost biodiversity [1] and, more specifically, populations of common crop pollinators [2,9].

3. References to the research

This research resulted from multiple competitive, peer-reviewed funding awards, including the DEFRA *et al.* GBP 3,500,000 (GBP 639,000 to Reading) SAFFIE project (2003-2007), the GBP 405,000 'Sustainable pollination services for UK crops' project, LWEC Insect Pollinators Initiative ([BBI000348/1](#) between 2011 and 2014) and the GBP 295,000 'Sustainable Management of Orchard Pollination Services' project, BBSRC Industry Partnership Award ([BB/P003664/1](#) between 2017 and 2020). It is published in peer-reviewed, internationally recognised journals and it provides new and important knowledge of international significance and applies these findings in ways that are of relevance and interest to the wider scientific community.

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4. **Garratt, M. P. D., Breeze, T. D.**, Boreux, V., Fountain, M. T., McKerchar, M., **Webber, S. M.**, **Coston, D. J.**, Jenner, N., **Dean, R.**, Westbury, D. B., Biesmeijer, J. C. and **Potts, S. G.** (2016). 'Apple pollination: demand depends on variety and supply depends on pollinator identity'. *PLoS ONE*, **11** (5). e0153889. DOI: <https://doi.org/10.1371/journal.pone.0153889>

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6. **Breeze, T.D.**, Vaissière, B.E., Bommarco, R., Petanidou, T., Seraphides, N., Kozák, L., Scheper, J., Biesmeijer, J.C., Kleijn, D., Gyldenkerne, S., Moretti, M., Holzschuh, A., Steffan-Dewenter, I., Stout, J.C., Pärtel, M., Zobel, M. and **Potts, S.G.** (2014). 'Agricultural Policies Exacerbate Honeybee Pollination Service Supply-Demand Mismatches Across Europe'. *PLoS ONE*. **9**(1): e82996.1. DOI: <https://doi.org/10.1371/journal.pone.0082996>
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4. Details of the impact

The research outlined in this case study has changed policy and practice at the national, company and individual grower level. It has provided key stakeholders across the UK fruit industry and beyond with a greater understanding of the essential role that wild pollinators play in supporting UK crop production and what they can do to protect them.

Shaping national policy to support crop pollination: The Reading team's research on managing field margins to enhance biodiversity has provided the evidence to support incentives for supplementing crops with wildflowers as part of Natural England's Entry Level Stewardship (ELS) scheme. In particular, the team's evidence led to the development and inclusion of specific options within the ELS Wild Pollinator & Farm Wildlife Package. This includes option EK1, which takes field corners out of management and requires that no fertilisers be applied and stipulates reduced cutting to promote the growth of plants that provide large scale architectural diversity. The Reading team's evidence is also part of the evidence base underpinning options EE4, EE5 and EE6 on the management of buffer strips, as described in the team's 2014 REF impact case study. **A total of 48,200 ELS agreements were in place in December 2013, covering an area of 6,514,000ha. Approximately one third of the area under this scheme was covered by ongoing ELS agreements up to December 2019** [E1]. Impact on land management for boosting biodiversity has continued with management options from ELS retained under the new national scheme, including nectar flower mixtures, flower-rich margins and buffer strips. This has allowed habitats created under ELS to be managed under new Countryside Stewardship agreements as well as incentivising the creation of new habitats to further boost biodiversity, which is central to the implementation of England's National Pollinator Strategy (NPS) [E2, paragraphs 14-21].

Since its conception, the NPS has been guided by the Reading team's research through advice and technical input [E2, paragraphs 2-12]. This underpinned the publication of the original NPS in 2014, a statement of collaborative action and cooperation between Government, industry, NGOs and researchers to protect and sustain pollinators. Furthermore, the Reading team has been one of five academic members of the Pollinator Advisory Steering Group since it was established in 2014. Through PASG, the Reading team has steered and contributed to the development, and

subsequent publication, in December 2018, of the *NPS Implementation Plan, 2018-2021* [E3]. **DEFRA acknowledges the importance of the Reading research to the evolution of the NPS since 2014, in highlighting the key role of wild insects and their value to UK crop pollination**, and how this supports the department in explaining the economic case for policy interventions to support pollinators and pollination services [E4]: *“The team’s research highlighting the key role of wild insects in pollinating UK crops supports our decision to include these insects in the NPS. Tom Breeze’s work to value UK crop pollination services also supports us in explaining the economic case for policy interventions to support pollinators and pollination services. We cite this work regularly and it has played a role in DEFRA decisions, for example to fund the [Pollinator Monitoring and Research Partnership].”*

Nature Strategy Team Lead (Pollinators, UK coordination), DEFRA

Guided by University of Reading findings, strengthening the evidence base continues to be one of four ‘action areas’ underpinning the NPS implementation plan [E3], aimed primarily at a better understanding of trends in pollinators and their impact on pollination. Furthermore, the Reading team has been leading three out of nine new activities listed within the evidence action area: (1) establishing a pollinator monitoring and research advisory group, (2) mapping pollinator natural capital, and (3) knowledge exchange. This is **the first time that there has been a long-term commitment from the UK Government to support pollinator monitoring**. In addition to these three activities, the Reading team contributed to the ‘*NPS: Evidence statements and Summary of Evidence*’, which was externally reviewed by stakeholders and published by DEFRA in January 2019. The Reading team led a critical review of the evidence on ‘*Pollination services and pollinator dependent crops*’ and ‘*Values of pollinators*’ for the report and their research features prominently, with 11 of the 22 and 14 of the 33 papers cited in each section respectively (45% in total). In its introduction to the document [E5], DEFRA stated: *“These Evidence Statements provide up-to-date information on what is known (and not known) about the status, values, drivers of change, and responses to management of UK insect pollinators. This document has been produced to inform the development of England pollinator policy, and provide insight into the evidence that underpins policy decision-making.”*

Supporting the UK fruit industry: Reading research has changed the way the industry and growers think about crop pollination. Garratt and colleagues have actively engaged with commercial growers since 2011, co-developing multiple projects aimed at sustainably managing and boosting pollination services in fruit crops. For example, this includes seven studentships and a BBSRC/NERC Industrial Partnership Award (GBP 800,000 – 10% industry cash contribution and considerable in-kind support) co-funded by Worldwide Fruit Ltd (WFL), Avalon Produce Ltd and Syngenta UK [E6]. In conjunction with these partners, as part of this project the Reading team has established high quality wildflower plots as well as bee nesting areas across 18 apple orchards in Kent. Through their ongoing partnership with WFL, and particularly their findings on the value of wild pollinators and opportunities to improve crop quality, this research has raised greater awareness that pollination is a key input to WFL’s supply chain. As a direct result, in 2018, WFL, representing 40 top fruit producers, carried out a supply chain risk assessment focussed on pollination to understand the opportunities and vulnerabilities of the sector to declining pollinators: *“We found that many of the crops we supply are highly to moderately pollinator dependent, so pollination is a crucial ecosystem service for our producers. Based on this increased understanding of the critical role wild pollinators have in underpinning crop quality and economic output for our suppliers we have been working with our UK growers to establish flower rich habitats for these valuable pollinators. We are also encouraging growers to leave a proportion of their landholdings uncultivated to provide forage and nesting habitats for pollinators as well as other biodiversity and environmental benefits. To date nearly 20% of our growers have introduced flower rich habitat on their farms and 90% of the farmers we have surveyed had 10% of their holdings protected from cropping; we are actively working with them to maintain this.”* Technical Manager, WFL Ltd. [E7]

Avalon Produce Ltd, representing 50 growers and 35% of the UK top fruit industry, are also well-established partners of the University of Reading and are stakeholders in current BBSRC- and Horizon 2020-funded pollinator projects. The Chief Technical officer at Avalon Produce has indicated that research by Garratt *et al.* on pollinators (including [4,7]) has progressed their understanding *“beyond the importance of honeybees and highlighted the important role that wild pollinators have”*. He indicated that wildflower strips that were planted in orchards as a result of

joint research projects have been positively received by the grower community with growers reporting increases in ground nesting bee numbers since introducing pollinator habitats. Speaking about the significance of the team's research into the value of pollinators for yield and quality, he added: "[it] has changed the way we think as an industry about pollination" and "thanks to research by the team from Reading, growers are now refocussing on the importance of pollinating insects in their orchards and paying particular attention to how they can enhance the environment to assist with this," [E7]. Typical of grower engagement with the Reading research, one grower, who established a 1ha wildflower plot on his 90ha farm said: "As a result of these actions I have seen a noticeable increase in bee numbers and types of both solitary and others. We have also seen an increase in butterflies and other insects. The general public have also greatly appreciated the side effects of this project and it is widely spoken about in my village," [E7].

Increasing awareness among UK farmers, suppliers and retailers: Since 2014, the research group has actively engaged with a broad spectrum of UK farmers, suppliers and retailers with over 130 engagement activities associated with the UKRI 'Sustainable Pollination Service to UK Crops' (BB/I000348/1) and the 'Sustainable Management of Orchard Pollination Services' (BB/P003664/1) projects [E8, E9]. These include more than 20 events at which the Reading researchers engaged directly with the agri-food sector, for example 'grower days' for Waitrose, Avalon Ltd and NIAB/EMR. They have also disseminated their research findings as invited speakers to key farming advisory groups such as the Association of Independent Crop Agronomists, the Vegetable Growers' Association and the Institute of Agricultural Managers, in all reaching approximately 1,000 people.

The Reading team has been a key partner helping Waitrose to meet their sustainability targets. Consultancy provided by the team supported the development of the 'flagship' Waitrose Farm Assessment scheme. In 2015, over 1,000 farms had been included in this periodic assessment and the results were critical to help Waitrose to understand where their farms stood on sustainability and guided training provision. In addition, online materials and training videos on pollinator and pollination management, developed by the Reading team, are a requirement for Waitrose growers as part of their sustainability training [E10]. Garratt and colleagues have also presented their research at Waitrose annual Science Days every year since 2013. These have been regularly attended by over 100 growers and suppliers as well as the Waitrose Agronomy Group (comprising 12 suppliers), who use this forum to be updated on current research to underpin new activities and innovation.

Summary: The Reading team's research has been fundamental to shaping national pollinator policy, particularly on the role of pollinators for crop production, helping DEFRA to implement and update its National Pollinator Strategy. By engaging directly with leading fruit suppliers, including Worldwide Fruit Ltd and Avalon Produce Ltd, Reading research on the role and value of insect pollinators has had a direct impact on pollinator management of suppliers who represent 70% of UK top fruit production. More broadly the researchers have increased awareness among UK farmers, suppliers and retailers of the importance of wild pollinators for sustainable crop production (not just fruit), and the risks and opportunities for managing pollinators more effectively for optimum quality and yields.

5. Sources to corroborate the impact

- [E1] Tables 10.5 and 10.6 from [Agriculture in the United Kingdom 2017](#) and [2019](#).
- [E2] [Supporting document: additional background material on the proposed National Pollinator Strategy](#), DEFRA March 2014.
- [E3] [National Pollinator Strategy Implementation Plan 2018-2021](#).
- [E4] Testimonial from Nature Strategy Team Lead (Pollinators, UK coordination), DEFRA.
- [E5] [National Pollinator Strategy: for bees and other pollinators in England, Evidence statements and Summary of Evidence](#), DEFRA January 2019.
- [E6] [Sustainable Management of Orchard Pollination Services](#) project homepage.
- [E7] Testimonials from representatives of the UK top fruit industry.
- [E8] Researchfish summary for BBSRC project [BB/I000348/1](#).
- [E9] Researchfish summary for BBSRC project [BB/P003664/1](#).
- [E10] Testimonial from former Waitrose Technical Manager Agronomy.