Institution: University of East Anglia

Unit of Assessment: 5 – Biological Sciences

Title of case study: Safeguarding natural pollination services through informing evidence-based government interventions and stimulating global policy development

Period when the underpinning research was undertaken: 2010 - 2018

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:
Professor Andrew Bourke	Professor of Evolutionary Biology	2006 – present
Dr Lynn Dicks	NERC Independent Research Fellow & Reader	2016 – present

Period when the claimed impact occurred: 2015 - 2020

Is this case study continued from a case study submitted in 2014? No

1. Summary of the impact

Insect pollinators, especially bees, benefit food security and biodiversity worldwide, with an annual economic value measured in hundreds of billions of dollars. Yet many bee species, including 9% of Europe's bees, are threatened or declining. UEA research has led to impact to prevent or reverse such declines through two approaches. **Bourke**'s research provided a key part of the evidence base for the UK Government's Countryside Stewardship agri-environment scheme for pollinators in England. **Dicks**'s research contributed to a set of global policy recommendations on pollinators for governments, which were then incorporated into a formal decision of the United Nations' Convention on Biological Diversity, in turn stimulating the European Union's Pollinators Initiative and national pollinator strategies in up to 30 countries across the world.

2. Underpinning research

Animal pollination, to which bees are major contributors, is worth USD235-577,000,000,000 (12-2016) to annual global crop production and its loss would reduce production by 5-8%. Pollinating bees comprise wild bees and managed populations of honeybees. Both contribute essential natural pollination services, and both are experiencing declines from a broad set of causes. These declines are most severe in wild bees, with 9% of European species assessed as Threatened. Hence research on how best to prevent or reverse wild bee declines is widely recognised as urgently needed. **Bourke** and **Dicks** have conducted empirical, field-based studies and large-scale data syntheses that have provided the evidence for government interventions and stimulated global policy development to aid wild bees and other pollinators.

Providing evidence for UK Government interventions to aid pollinators: A frequently-used government intervention to aid pollinators within agricultural landscapes is to pay land managers to plant strips of flowers along arable field margins to provide floral resources for pollinators. However, little evidence existed to demonstrate the effectiveness of such agri-environment schemes or to guide the scale over which they should be implemented. **Bourke** was Joint PI on a major collaborative project under the UK's Insect Pollinators Initiative [Grant A] designed to address these questions. This large-scale project investigated the spatial ecology of bumblebees (*Bombus* species; see image), which form the main group of wild bee pollinators in temperate countries. The team used a novel combination of field ecology, remote sensing, DNA analysis and landscape modelling to determine the relationship between bees' use of space and the siting of floral resources in five representative bumblebee species [R1-R3]. The study area was in arable

farmland experimentally planted with floral margins for pollinators based on the UK Government's existing agri-environment scheme for England [R1].

By measuring workers' colony-specific foraging distances (average distance flown by workers from a given nest to flower patches), the research showed that workers forage more closely to their nests in areas with greater coverage of semi-natural vegetation, including planted floral margins [R2, R3]. This suggested that planting these margins helps bee populations by reducing the energy workers spend on foraging longer distances [R2]. In the first analysis of its kind, the research also showed that bumblebee nests within 250-1,000m of high-quality floral resources are significantly more likely to have daughter queens surviving to the following spring [R3]. Overall, the findings both confirmed the value of agri-environment schemes for pollinators and indicated the spatial and temporal scale of the floral resources required for such interventions to be effective [R1-R3]. In particular, the team's research allowed it to estimate the proportion of agricultural landscape (1-3%) that would need to contain flower-rich habitat for the foraging distances of bumblebee workers to be maintained at or below their species averages [R2].

Stimulating global policy development to aid pollinators: **Dicks** was a Co-ordinating Lead Author of the UN's Inter-governmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) thematic assessment on pollinators, pollination and food production [S4]. By synthesising results and data from hundreds of scientific studies, this international collaboration produced the largest ever global assessment of pollinators. **Dicks** led the team producing the chapter on policy responses [S4], key findings of which were published in [R4]. Based on the information thereby acquired on the benefits provided by pollinators, the scale of their global declines and the threats they face, **Dicks** then led the development of 10 specific global policy recommendations for pollinators. These were developed through consultation with the scientific advice body (Subsidiary Body on Scientific, Technical and Technological Advice, SBSTTA) to the Convention on Biological Diversity, which is the UN's international treaty on biodiversity arising from the 1992 Rio Earth Summit. The 10 policy recommendations were published by **Dicks** and co-authors in [R5] and were to: *"1. Raise pesticide regulatory standards. 2. Promote integrated pest management (IPM). 3. Include indirect and sublethal effects in GM crop risk assessments. 4. Regulate movement of managed pollinators. 5. Develop incentives, such as insurance schemes, to help farmers benefit from ecosystem services instead of agrochemicals. 6. Recognize pollination as an agricultural input in extension services. 7. Support diversified farming systems. 8. Conserve and restore 'green infrastructure' (a network of habitats that pollinators can move between) in agricultural and urban landscapes. 9. Develop long-term monitoring of pollinators and pollination. 10. Fund participatory research on improving yields in organic, diversified, and ecologically intensified farming"* [R5].

Dicks and collaborators also published a research report for the Convention on Biological Diversity that synthesised evidence for the value of pollinators beyond their agricultural value (e.g. ecological, cultural, financial, health, human and social value) [R6]. **Dicks** contributed an entire section (Section 5.4, amounting to c. 10%) of this extensive report. **Dicks** conducted her work on global policy development for pollinators both before and after joining UEA in 2016 [Grant B], having previously been at the University of Cambridge from 2008, with the underpinning outputs [R4-R6] having been published when at UEA.

Image: Garden Bumblebee (*B. hortorum*) worker with pollen load; *Credit*: Andrew Bourke

3. References to the research

Underpinning research: Six key outputs report the underpinning research - five papers in competitive, international, peer-reviewed journals and one report for an external body [R6] (citations numbers are from Google Scholar; UEA author names are in bold):

R1 Dreier S, Redhead JW, Warren IA, **Bourke AFG**, Heard MS, Jordan WC, Sumner S, Wang J, Carvell C (**2014**) Fine-scale spatial genetic structure of common and declining bumble bees across an agricultural landscape. *Molecular Ecology* 23: 3384-3395. DOI: 10.1111/mec.12823 [36 citations]

R2 Redhead JW, Dreier S, **Bourke AFG**, Heard MS, Jordan WC, Sumner S, Wang J, Carvell C (**2016**) Effects of habitat composition and landscape structure on worker foraging distances of five bumblebee species. *Ecological Applications* 26: 726-739. DOI: 10.1890/15-0546 [68 citations]

R3 Carvell C, **Bourke AFG**, Dreier S, Freeman SN, Hulmes S, Jordan WC, Redhead JW, Sumner S, Wang J, Heard MS (**2017**) Bumblebee family lineage survival is enhanced in high quality landscapes. *Nature* 543: 547-549. DOI:10.1038/nature21709 [115 citations]

R4 Potts SG, Imperatriz-Fonseca V, Ngo HT, Aizen MA, Biesmeijer JC, Breeze TD, **Dicks LV**, Garibaldi LA, Hill R, Settele J, Vanbergen AJ (**2016**) Safeguarding pollinators and their values to human well-being. *Nature* 540: 220-229. DOI:10.1038/nature20588 [573 citations]

R5 **Dicks LV**, Viana B, Bommarco R, Brosi B, Arizmendi MDC, Cunningham SA, Galetto L, Hill R, Lopes AV, Pires C, Taki H, Potts SG (**2016**) Ten policies for pollinators. *Science* 354: 975-976. DOI: 10.1126/science.aai9226 [122 citations]

R6 Aizen MA, … **Dicks L**, and 16 other authors (**2018**) *Review of pollinators and pollination relevant to the conservation and sustainable use of biodiversity in all ecosystems, beyond their role in agriculture and food production.* CBD/COP/14/INF/8. 10 November 2018. Published at: https://www.cbd.int/conferences/2018/cop-14/documents

Funding: Funding of the research has come from competitive, peer-reviewed sources, i.e. the Insect Pollinators Initiative (IPI), a UK initiative funding nine competitively selected projects [Grant A] and a NERC Independent Research Fellowship [Grant B]: Grant A: PIs (joint): C Carvell, UK Centre for Ecology & Hydrology, Wallingford (lead); **A Bourke**; the late W Jordan (Institute of Zoology, Zoological Society of London); Co-Is: M Heard (CEH, Wallingford; now National Trust); S Sumner (IoZ, ZSL; now UCL); J Wang (IoZ, ZSL). Title: *Investigating the impact of habitat structure on queen and worker bumblebees in the field*. Funder: Insect Pollinators Initiative (funded by BBSRC, NERC, Defra, Scottish Government and Welcome Trust). Project dates: 1 November 2010 – 31 October 2013. Total value: GBP666,105 (UEA GBP13,138). Grant B: PI: **L Dicks**. Title: *Towards 'crop-pollinating' landscapes: quantifying pollen supply and demand to manage wild pollinators for their benefits to food production*. Funder: NERC Independent Research Fellowship. Project dates: 28 September 2016 – 27 September 2021. Grant value: GBP555,266.

4. Details of the impact

Providing evidence for UK Government interventions to aid pollinators: **Bourke**'s research has had impact through informing public policy with research evidence. This had led to changes in government regulations to enhance pollination services and biodiversity, so aiding pollinators and thereby benefiting agricultural practitioners and the environment.

In 2015 the UK Government launched a new version of Countryside Stewardship, its agri-environment scheme for England, to run to 2020 [S1]. Countryside Stewardship provides financial incentives to farmers, foresters and land managers to care for and improve the environment, including wildlife habitats. Via regular dialogue between the team and contacts in Natural England/Defra, the research of **Bourke** and collaborators [R1-R3] provided a key component of the evidence base for Countryside Stewardship's pollinator-focused actions. In particular, the team's finding [R2] that a coverage of 1-3% of agricultural landscape by flower-rich habitat would allow bumblebee workers to forage at or below their species-average foraging distance directly informed the Wild Pollinator and Farm Wildlife Package within Countryside Stewardship. This Package is the set of farmland management options, including the planting of floral margins alongside arable fields, designed to benefit wild pollinators and other farm wildlife. Specifically, the finding defined the minimum area threshold for option coverage within the Package, i.e., at least 3% total area to be planted with floral margins, this threshold being mandatory for the scheme's Mid-Tier version or higher [S1]. It also informed the package's advice to select a combination of options and to distribute them spatially within farms [S1]. Evidencing this, the Countryside Stewardship Manual stated, *"Recent evidence suggests that applying the right combination of options over 3 to 5% of the arable, temporary grass or permanent grass included in an application will deliver meaningful benefits to farm wildlife"* [S1]. In addition, as Natural England's Nature Recovery Team stated, *"The research findings of the IPI bumble bee project team helped to set*

the 3% minimum threshold for option coverage in the CS Wild Pollinator and Farm Wildlife Package" [S2]. Moreover, the package has *"helped in an overall increase in the delivery of land management options such as flower-rich grass margins and pollen and nectar mixes, which are crucially important in helping to provide the year-round life cycle needs of pollinating insects"* [S2]. Although it is too early to determine if any interventions since 2015 have increased UK bee numbers, a 2019 study concluded that, against general trends for pollinators, crop-pollinating bees increased by 12% in Britain between 1980 and 2013 and that this could be due to previous agri-environment schemes, which were similar in kind if not in scale to those implemented by Countryside Stewardship [S3].

Stimulating global policy development to aid pollinators: **Dicks**'s research has had a suite of primary and downstream impacts stimulating and influencing the policy and practice of governments and international agencies as regards safeguarding pollinators and pollination services, so benefiting agricultural practitioners and the environment on a global scale.

The primary impact has been that the UN's multilateral treaty body for biodiversity, the Convention on Biological Diversity, agreed two formal decisions that draw heavily on the work of the global IPBES pollinator assessment [S4] and outputs [R4-R6] co-authored by **Dicks** [S5]. This followed an approach to **Dicks** and co-authors by the secretariat of the Convention [S5]. As a UN treaty, this Convention has 196 party countries and 168 signatories. Its Decision XIII/15 [S6], taken at the Convention conference in Mexico in late 2016 (COP13), formally endorsed the key messages of the assessment [S4] that were included and further developed in [R4] and [R5]. It also listed specific actions for Governments to follow, and these included all 10 policy recommendations in [R5]. In short, each policy recommendation in [R5] by **Dicks** and collaborators has been incorporated into a formal decision of a UN treaty body [S6]. As the Deputy Executive Secretary of the Convention on Biological Diversity stated, *"… I approached a number of the authors* [of the IPBES assessment]*, including Dr. Dicks, for scientific inputs in drafting policy recommendations for Governments with a view to including these in a draft SBSTTA* [Subsidiary Body on Scientific, Technical and Technological Advice to the Convention] *recommendation. … At the same time, Dr. Dicks led the development of a scientific paper published as* [Dicks et al. 2016 *Science*, R5]*. The thinking behind the paper informed the development of the SBSTTA policy recommendations, and indeed, the policy recommendations in the* Science *paper and the SBSTTA recommendations are very closely aligned. The paper* [R5] *also helped … give added scientific weight to the Convention's draft recommendations, helping their formal adoption by Governments at the thirteenth meeting of the Conference of the Parties* [COP13]*. With only minor changes, the policy recommendations were subsequently adopted by the COP as decision XIII/15 in December 2016"* [S5].

Following up, in a further decision on pollinators, Decision 14/6 [S7] taken at the Convention on Biological Diversity's conference in Egypt in 2018 (COP14), the Convention mandated the UN's Food and Agriculture Organisation to implement a joint Plan of Action for the conservation and sustainable use of pollinators. This plan [S7] again included the actions recommended by [R5], and cited [R6] as major support, i.e. **Dicks**'s collaborative research synthesising the contributions of pollinators beyond their agricultural value such as value for society and quality of life.

Prompted by the Convention on Biological Diversity's formal Decision XIII/15, two major, global-scale downstream impacts have also occurred. One is that a collaboration of Governments across the world created "Promote Pollinators, a Coalition of the Willing on Pollinators". With a founding membership (including the UK) of 14 countries in 2016, by 2020 this coalition included 30 countries, each committed to developing its own national pollinator strategy [S8]. Evidencing this, its website states: *"Promote Pollinators was established in December 2016 as the result of deliberations during* [COP13, = Decision XIII/15 conference]*. During this conference, …, fourteen countries decided to unite and collaborate in an international coalition, in order to bring about progress in the protection of pollinating species and their habitats"* [S8]. The other downstream impact is that, in 2018, citing Decision XIII/15, the European Commission launched its own European Union Pollinators Initiative [S9]. This is an EU-wide strategy to address pollinator declines across Europe, which from January 2019 has been implemented in collaboration with the

International Union for the Conservation of Nature and the Institute for European Environmental Policy [S10].

Overall, both the primary and downstream impacts of the work of **Dicks** and collaborators have had a positive and ongoing effect on UN and Government actions for pollinators. As the Deputy Executive Secretary of the Convention on Biological Diversity has stated, Decision XIII/15, [S4] and [R5] *"have fostered increased efforts by Governments and stakeholders on this crucial issue for biodiversity, and the issue of pollinators and pollination is likely to feature explicitly in the post-2020 global biodiversity framework currently in development under the Convention"* [S5].

5. Sources to corroborate the impact

S1 Natural England/Defra (2017) *Countryside Stewardship Manual*. Revised November 2017. [Wild Pollinator and Farm Wildlife Package is in Section 6.3; quote is from p. 53.]

S2 Letter from the Nature Recovery Team, Natural England (28.11.20).

S3 Powney GD et al. (2019) Widespread losses of pollinating insects in Britain. *Nature Communications* 10, 1018. doi.org/10.1038/s41467-019-08974-9. [12% statement is on p. 3.]

S4 IPBES (2016) *The assessment report of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services on pollinators, pollination and food production*. Potts SG, Imperatriz-Fonseca VL, Ngo HT (eds) Secretariat of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, Bonn, Germany. [**Dicks** led the final chapter: **Dicks LV**, Viana BF, del Coro Arizmendi M, Bommarco R, Brosi B, Cunningham S, Galetto L, Lopes A, Hisatomo T (2016) Responses to risks and opportunities associated with pollinators and pollination. pp. 361-477.]

S5 Letter from the Deputy Executive Secretary, Convention on Biological Diversity (18.11.20).

S6 Convention on Biological Diversity, Decision XIII/15 (*Implications of the IPBES assessment on pollinators, pollination and food production for the work of the Convention*, CBD/COP/DEC/XIII/15, 9.12.16). [Includes recommendations 1-10 of **Dicks LV** et al. (2016) [R5] in paragraphs 7m, 7j, 7m, 7h, 7q, 7p, 7b, 7c, 7t and 7y, respectively.]

S7 Convention on Biological Diversity, Decision 14/6 (*Conservation and sustainable use of pollinators*, CBD/COP/DEC/14/6 30.11.18). [Cites Aizen … **Dicks LV** … et al. (2018) [R6] on p. 12.]

S8 Promote Pollinators - a Coalition of the Willing on Pollinators website (accessed 5.9.20). [Quote referencing Decision XIII/15 is on "About" page, page 3.]

S9 European Union Pollinators Initiative: *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: EU Pollinators Initiative*. Brussels, 1.6.2018, COM(2018) 395 final. Document 52018DC0395 [Cites Decision XIII/15 on page 1.]

S10 IUCN website, Pollinators in Europe pages from iucn.org (accessed 5.10.21) [Statement that IUCN and IEEP are helping implement EU Pollinators Initiative is in paragraph 4.]