

Institution: University of Sussex		
Unit of Assessment: 5 – Biological Sciences		
Title of case study: Protecting pollinators: Influencing policy and retail to reduce and remove harmful pesticides		
Period when the underpinning research was undertaken: 2013 – 2020		
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:
Dave Goulson	Professor of Biology	2013 – present
Period when the claimed impact occurred: Aug 2013 – Dec 2020		
Is this case study continued from a case study submitted in 2014? N		
1. Summary of the impact <p>Sussex research on neonicotinoid pesticides has influenced government policies and retail practices relating to their use and harm to insects. The research underpinned Michael Gove's decision to reverse UK policy and back an EU total ban on outdoor use of neonicotinoids, and was key to campaigns by groups including Friends of the Earth (FoE), Greenpeace and Avaaz. Together these impacts contributed to the establishment of an EU-wide ban in 2018. The research also showed that 70% of plants labelled 'bee-friendly' in major garden centres were contaminated with toxic quantities of neonicotinoids leading: FoE to persuade ten of the UK's biggest garden centres (869 stores) to remove neonicotinoids from their plants by 2019; the National Botanic Garden of Wales to convince 22 major nurseries in Wales to remove all synthetic insecticides from their products; and the Royal Horticultural Society to revise its labelling scheme.</p>		
2. Underpinning research <p>The impact of pesticides, including neonicotinoid insecticides, on bees is the subject of considerable public interest and ongoing concern. In 2013, the EU banned use of neonicotinoids on flowering crops, in part because of Goulson's pre-Sussex research indicating that bumblebee colonies are likely to be significantly harmed if they feed upon a crop of oilseed rape treated with a neonicotinoid. With significant funding from Biotechnology and Biological Sciences Research Council (BBSRC) (BB/J014753/1, BB/K014579/1) and Department for Environment, Food and Rural Affairs (DEFRA) (PS2372), subsequent research focussed on understanding the environmental fate of these chemicals, and routes of exposure of pollinators. Goulson collaborated with Hill (Sussex Environmental Chemistry) who developed novel mass spectrometry methods for chemical characterisation of trace pesticides, and together they discovered that the ban on the use of neonicotinoids on flowering crops did not prevent bees from being exposed. They discovered that these systemic pesticides were contaminating and accumulating in farm soils, and from there were being drawn up by the roots of wildflowers and woody hedgerow plants growing in field margins next to treated crops, so entering their pollen and nectar [R1]. Thus, it was demonstrated for the first time that neonicotinoid exposure of bees was likely to be higher and more prolonged than previously thought. Through placement of experimental beehives in agricultural areas, it was possible to collect and systematically identify the origin of pollen harvested by foraging bees. This demonstrated that, even after the 2013 ban, pollen collected by free-flying bumblebees and honeybees were contaminated with a mixture of pesticides, including fungicides, which act synergistically with neonicotinoids [R2] and that field margin plants can contain concentrations of neonicotinoids that are known to be lethal to a range of non-target insects, not just bees [R3].</p> <p>To investigate the effectiveness of the EU-wide 2013 moratorium banning the use of neonicotinoids on flowering crops, bee-collected pollen and nectar was analysed from</p>		

bumblebee colonies in Scotland and England showing that neonicotinoid exposure had declined for rural bees post-ban. However, the risk of exposure to neonicotinoids for bees in peri-urban habitats remained largely the same between 2013 and 2015, indicating that contamination of flowering plants in urban areas remains an important route of insecticide exposure [R4]. This led to an investigation of pesticide load in flowering plants sold as 'bee-friendly' at garden centres, therefore demonstrating the potential impact of pesticides on wildlife beyond agricultural settings. In this work [R5], the team analysed 'bee-friendly' ornamental plants sold by major UK retailers and found that most contained at least one pesticide and some individual plants contained mixtures of up to 10 agrochemicals. The neonicotinoids thiamethoxam, clothianidin and imidacloprid and the organophosphate chlorpyrifos were present in pollen at concentrations that overlap with those known to cause harm to bees. This study revealed, for the first time, the potential of garden centre plants sold in the UK to contribute to pesticide contamination of urban areas.

Sussex research has helped to inform understanding of the extent of insect declines; Goulson was an author of a much-cited paper which used longitudinal analysis of standardised trapping data to show a 76% decline in biomass of flying insects in Germany over a 27 year period [R6]. Sussex research on pesticides [R1-R5] feeds directly into wider understanding of the causes of these declines, and has influenced public policy and opinion regarding the use of neonicotinoid insecticides.

This research is based on a collaboration between Goulson (5 – Biological Sciences) and Hill (8 – Chemistry) with ecological and entomological expertise complementing environmental chemistry. The research presented here represents a series of experiments that were able to trace and quantify pesticides through an ecological system from soil to plant to pollinator to colony – research that would not have been possible without this interdisciplinary collaboration.

3. References to the research

- R1. Botías, C., David, A., Horwood, J., Abdul-Sada, A., Nicholls, E., Hill, E., & **Goulson, D.** (2015). Neonicotinoid residues in wildflowers, a potential route of chronic exposure for bees. *Environmental Science & Technology*, 49(21), 12731-12740. <https://doi.org/10.1021/acs.est.5b03459> (256 citations)
- R2. David, A., Botías, C., Abdul-Sada, A., Nicholls, E., Rotheray, E. L., Hill, E. M., & **Goulson, D.** (2016). Widespread contamination of wildflower and bee-collected pollen with complex mixtures of neonicotinoids and fungicides commonly applied to crops. *Environment International*, 88, 169-178. <https://doi.org/10.1016/j.envint.2015.12.011> (218 citations)
- R3. Botías, C., David, A., Hill, E. M., & **Goulson, D.** (2016). Contamination of wild plants near neonicotinoid seed-treated crops, and implications for non-target insects. *Science of The Total Environment*, 566-567, 269-278. <https://doi.org/10.1016/j.scitotenv.2016.05.065> (120 citations)
- R4. Nicholls, E., Botias, C., Rotheray, E.L., Whitehorn, P., David, A., Fowler, R., David, T., Feltham, H., Swain, J.L., Wells, P., Hill, E.M., Osborne, J.L., **Goulson, D.** (2018) Monitoring Neonicotinoid Exposure for Bees in Rural and Peri-urban Areas of the UK during the Transition from Pre- to Post-moratorium, *Environmental Science & Technology*, 52(16), 9391-9402. DOI: [10.1021/acs.est.7b06573](https://doi.org/10.1021/acs.est.7b06573) (19 citations)
- R5. Lentola, A., David, A., Abdul-Sada, A., Tapparo, A., **Goulson, D.**, & Hill, E. M. (2017). Ornamental plants on sale to the public are a significant source of pesticide residues with implications for the health of pollinating insects. *Environmental Pollution*, 228, 297-304. <https://doi.org/10.1016/j.envpol.2017.03.084> (43 citations)
- R6. Hallmann, C.A., Sorg, M., Jongejans, E., Siepel, H., Hofland, N., Schwan, H., Stenmans, W., Müller, A., Sumser, H., Hörrn., T, **Goulson, D.**, & de Kroon, H. (2017). More than 75 percent decline over 27 years in total flying insect biomass in protected areas. *PlosONE* 12(10): e0185809. <https://doi.org/10.1371/journal.pone.0185809> (1439 citations)

Citations from Google Scholar

4. Details of the impact

Impact on UK Government policy

Widely-disseminated research by Goulson and Hill has proved beyond doubt that neonicotinoid exposure from non-target flowering plants poses a significant risk to bee health. The findings [R1, R2] on the persistence of neonicotinoids and their detection at high concentrations in wildflowers were widely cited by UK NGOs including the Game and Wildlife Conservation Trust, The Pesticide Action Network, Buglife and Greenpeace [S1]. Friends of the Earth (FoE) and the Soil Association used the work [R1] to campaign for the extension of restrictions on the use of neonicotinoids in crops [S1a, S1b].

This led to significant impact on UK Government policy where, in July 2017, [R1] was one of seven key UK studies reviewed in a House of Commons Parliamentary briefing paper informing politicians and the public about the environmental persistence and toxicity of neonicotinoids [S2]. Following this, in October 2017, the Expert Committee of Pesticides (Department for Environment, Food and Rural Affairs, DEFRA)) recommended, based on [R1, R2], further restrictions on the use of neonicotinoid insecticides in the UK [S3a]. This expert advice was cited in November 2017 by Michael Gove, the Environment Secretary, in a government announcement [S3b] and piece in *The Guardian* [S3c] as the main reason for overturning the previous UK position and backing further restrictions on neonicotinoid pesticides by the EU and in the UK post-Brexit. This prompted Friends of the Earth to celebrate the fact that “Michael Gove listened to the experts” in *The Telegraph* [S3d]. In 2019, DEFRA cited the research [R1-R3, R5] as evidence in its report on the ~1500 pollinating insect species in the UK [S4a] which has been used to inform the National Pollinator Strategy Implementation Plan, 2018-2021 [S4b].

Goulson and Hill’s findings further influenced national debate when the South West Wildlife Trusts – an alliance of 9 wildlife trusts in South West England – commissioned Goulson to write the report *Insect declines and why they matter* which cited Hill and Goulson’s work [R4] and argued that we “stop all routine and unnecessary use of pesticides” [S5a]. Published in November 2019, this received national media attention (e.g. *The Telegraph*) [S5b] and led the Wildlife Trusts, an alliance of all 46 UK wildlife trusts, to commission Goulson to write a further report *Reversing the Decline of Insects* (July 2020) which set out ambitious targets for government, industry and the public to halt unnecessary pesticide use [S5c]. Again, this received national media attention, e.g. *The Independent* hailed it as a “major report” [S5d]. These reports were central to the Wildlife Trusts’ flagship campaign “Action for Insects” in 2019 and 2020 which included petitions, lobbying and improving practice with land managers and farmers [S5e].

Impact on policy internationally

In 2013, the EU enacted a partial ban on neonicotinoids, with restrictions only applying to certain crops. The Sussex research [R1-R3] clearly showed the presence of neonicotinoids in plants beyond their initial application, pointing to a need for an EU total ban. Avaaz (a non-profit organisation promoting global activism on social and environmental issues) commissioned an OpEd from the Sussex researchers to support its campaign for an EU total ban. This featured in the media across Europe, e.g. *Le Monde* and *Der Tagesspiegel* [S6a], with the associated Avaaz petition achieving over 5,000,000 signatures [S6b]. In April 2018, the EU held a vote with member states, including the UK (its position informed by Sussex research [R1, R2] as above), approving a total ban on the outdoor use of neonicotinoids [S3d].

The Sussex research has contributed evidence towards scrutiny of the USA Environmental Protection Agency’s (EPA) proposed registration of neonicotinoid insecticides. In January 2017, the EPA published a ‘Preliminary Pollinator Assessment to Support the Registration Reviews of Clothianidin and Thiamethoxam’. In its response, the Center for Food Safety (a USA NGO) raised several concerns including that the assessment failed to adequately assess risks to bees from field-realistic exposures. They cited Sussex work [R1, R2 and R4] as supporting evidence that exposure to contaminated wildflower and crop pollen arising from seed-treated crops had not been considered [S7a]. In addition, in April 2017, several NGOs, together with the Center for Food Safety, raised a citizen’s petition calling on the EPA to close a regulatory loophole allowing seeds coated with neonicotinoids to be used on nearly 150 million acres across the US [S7b]. Sussex research [R1-R3] was used as evidence of the risk of exposure to insecticides arising

from planting of seed-treated crops. In response, in January 2020, the EPA published a Proposed Interim Registration Review Decision on neonicotinoids which included an environmental risk assessment of neonicotinoid exposure from seed-treated crops and proposed mitigations for the use of treated seeds including new labelling, reinforcing best practice, and educating farmers [S7c].

Impact on the retail sector

The Sussex research has also led to a reduction in the use of pesticides in the ornamental flower industry. Gardening for wildlife has become popular in recent decades, and garden centres promote certain plants with 'bee-friendly' or 'perfect for pollinator' logos. Sussex research [R5] showed that 70% of 'bee-friendly' plants on sale in major retail outlets contained significant levels of neonicotinoid insecticides. This shocking finding led to considerable coverage in the national newspapers including the *Daily Mail*, *The Telegraph*, *The Times*, *The Irish Times* and *The Independent* [e.g. S8a], as well as scientific media [e.g. S8b], highlighting the harm that well-meaning gardeners may be doing and the inadequacies of the industry's labelling schemes.

These results were shared in advance with Friends of the Earth (FoE) and, as a direct result, they launched a new campaign to coincide with the publication of R5. They commissioned a YouGov poll in May 2017 which found that 78% of the public agree that garden centres should not sell plants grown with pesticides that are harmful to bees [S9a]. The campaign received broad coverage in the media, and pressure on the retailers was increased by a "public action" in which approximately 18,000 emails were sent to retailers asking them to cease using neonicotinoids [S9a]. By August 2017, nine of the UK's top ten garden centres had announced that they would be banning the use of neonicotinoids on their plants (including Wyevalle, Dobbies, B&Q, Notcutts, Squires, and Aldi) [S9]. Homebase followed suit in 2018, so that by 2019 all plants sold in major UK garden centres were free of neonicotinoid insecticides [S9d].

FoE confirms that "In 2016 we learnt from Goulson of a forthcoming study ... demonstrating the presence of a number of pesticides, including the neonicotinoids clothianidin, imidacloprid, and thiamethoxam, in the majority of garden centre plants labelled as 'bee-friendly'. We were alarmed at this contradiction and we now had direct evidence (from Goulson and Hill) that members of the public, who were motivated to help pollinators, were being misled by the horticultural industry and were purchasing plants that were harmful to pollinators" [S9a]. The garden centre ban on neonicotinoid use marked "the end of a highly successful campaign which introduced a significant change in industry attitudes and practice, influencing 869 garden centres in total. This successful campaign was only possible because of the direct evidence from Goulson and Hill, that pesticides were present in garden centre plants" [S9a].

The Royal Horticultural Society (RHS) rebranded its 'Perfect for Pollinators' scheme in May 2018, saying "after research found that some labelled plants contained traces of pesticides ... we are changing the name to Plants for Pollinators ... We are also eager to continue to work with the horticultural trade and Government to establish how assurance schemes and supply chains can be improved to help buyers and gardeners make informed decisions" [S10a].

In July 2020 the National Botanic Garden of Wales (NBGW) launched the Saving Pollinators Assurance Scheme which supports Welsh nurseries to produce bee-friendly plants without the use of synthetic insecticides. NBGW said the Sussex research was "critical and central" [S10b] to the new scheme, and of the five non-NBGW papers they cite, three are from Sussex [S10c]. Already the Saving Pollinators scheme includes 22 Welsh nurseries that have signed up to not use synthetic insecticides on labelled plants [S10b].

5. Sources to corroborate the impact

S1. a. Three quarters of public agree government should support tougher action on bee-harming chemicals. Friends of the Earth. 2 October 2017. [PDF]; b. New research exposes secret cocktail of toxic pesticides in hedgerows and wildflowers. Soil Association. January 2016. [PDF]; c. Position statement on Neonicotinoids. Game and Wildlife Conservation Trust accessed 8 March 2021. [PDF]; d. Soil Association scientific briefing reveals new data on impact of Neonicotinoids on Pollinators. The Soil Association. 28 April 2016. [PDF]; e.

Persistence of neonicotinoids and widespread contamination. Pesticide Action Network UK - Bee Factsheet 9. Published 3 Mar 3, 2017. [PDF]; f. Neonicotinoids Pose Toxic Risk to Animals in Field Margins and Hedges. Buglife. October 2015; g. Pesticides and bee health. An evaluation of the application of the 2013 European Food Safety Authority bee guidance document as a mechanism to protect bees from agricultural pesticides. Greenpeace. January 2019. [PDF]

S2. Bees and neonicotinoids. House of Commons Library briefing paper. Number 06656. 20 July 2017. Page 4. [PDF]

S3. a. UK Expert Committee on Pesticides (ECP) Advice to Departments. DEFRA. October 2017, p4,5 and Annex. [PDF]; b. Environment Secretary backs further restrictions on neonicotinoid pesticides, DEFRA, 9 November 2017. [PDF]; c. The evidence points in one direction. *The Guardian* 9 Nov 2017. [PDF]; d. European countries ban 'bee-harming' pesticides, *The Telegraph* 27 April 2018. [PDF]

S4. a. Management and drivers of change of pollinating insects and pollination services. National Pollinator Strategy: for bees and other pollinators in England: Evidence statements and Summary of Evidence. Department for Environment, Food and Rural Affairs. January 2019. pages 46,47,60,68,80,86,89. [PDF]; b. National Pollinator Strategy: Implementation Plan, 2018-2021, DEFRA, December 2018. [PDF]

S5. a. Insect declines and why they matter, South West Wildlife Trusts, November 2019. [PDF]; b. Will gardeners turn over a new leaf in 2020? Here are the trends to look out for, *The Telegraph*, 4 January 2020. [PDF]; c. Reversing the Decline of Insects, The Wildlife Trusts, July 2020. [PDF]; d. 'An alarm bell we must not ignore': Major report calls for huge pesticide reductions to halt collapse in vital insect populations, *The Independent*, 8 July 2020. [PDF]; e. Action for Insects, The Wildlife Trusts. [PDF]

S6. a. Es ist Zeit, das Pestizid-Karussell zu stoppen, *Der Tagesspiegel*, 21 March 2018. [PDF]; b. Save the Bees Petition, Avaaz. [PDF]

S7. a. Comments from the Center for Food Safety on the EPA's Preliminary Pollinator Assessment to Support the Registration Reviews of Clothianidin and Thiamethoxam 24 July 2017. Pages 5 and 7. [PDF]; b. Citizen Petition to The United States Environmental Protection Agency. April 2017. pages 17,18 21. [PDF]; c. Proposed Interim Registration Review Decision on neonicotinoids which included an environmental risk assessment of neonicotinoid exposure from seed-treated crops, EPA, January 2020. [PDF]

S8. a. Garden centres selling 'bee-friendly' plants laced with pesticides that harm them, study finds. *The Independent* 13 May 2017. [PDF]; b. Garden centre plants may pose pesticide threat to bees. *Chemistry World* 30 May 2017. [PDF]

S9. a. Testimonial letter from the Friends of the Earth (FoE) 21 October 2020 [PDF]; b. Homebase urged to act after most top garden retailers say no to bee-harming neonicotinoids. Friends of the earth. 22 August 2017. [PDF]; c. B&Q removes Neonicotinoids from flowering plants. B&Q 2018. [PDF]; d. Homebase make sustainable changes to their range. Homebase. 7 February 2019. [PDF]

S10. a. Plants for Pollinators replaces Perfect for Pollinators, Royal Horticultural Society, May 2018. [PDF]; b. Testimonial letter from National Botanic Garden of Wales (NBGW) 13 October 2020. [PDF]; c. Saving Pollinators Assurance Scheme FAQs, NGBW. [PDF]