SPECIAL ISSUE: Shaping the Future of Pollinators in Farmed Landscapes

A PRACTITIONER'S PERSPECTIVE ON WHAT WE KNOW ABOUT SAFEGUARDING POLLINATORS ON FARMLAND

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Abstract—Farmers understand the general importance of pollinators, and through their management of cropped land and non-cropped areas on the farm they have the potential to do more than any other group to help provide habitat and food for pollinating insects. Pollinators are a continually topical issue for the media and policymakers, and against this challenging background it is not always clear what the best approaches are for farmers or land managers to take to protect and increase pollinators. What do we know about the state of pollinator populations on farmland in the UK? To what extent can the use of agri-environment measures, the maintenance and creation of other habitats, and the management of pesticide use, help protect and increase pollinator populations? This paper explores these questions by providing a farming perspective on the evidence in these areas; reflecting on what the knowns and unknowns are, and identifying where there are still gaps in the evidence that need to be plugged to better conserve and manage pollinators on farmland.

Keywords—Farming perspective, pollinator biodiversity, pesticide impacts, habitat loss and fragmentation, agri-environment measures, IPM

- OPINION PAPER -

Insect pollinators are important, not only in terms of crop pollination but also for the pollination of wild plants within the wider countryside (Ollerton et al. 2011), much of which falls under the management of farmers and growers in the UK. The National Farmers' Union for England and Wales (NFU) has been leading the representation of farmers on the issue of bee health and pollinators for nearly fifteen years.

In 2014, I produced an NFU "Farming for bees" leaflet as a simple introduction to pollinators and what farmers could do to help them (Hartfield 2014). Its messages reflected those in the National Pollinator Strategy (Defra 2014) – focusing on providing wild pollinators with habitat and food. The leaflet also discussed taking particular care when using insecticides, and how to provide good apiary sites for managed honeybees. This paper reflects on the 2014 leaflet and asks "what has changed?" A huge volume of pollinator research has been done in the last eight years and we know a lot of new detail. But what do we know now that we can advise UK farmers about, beyond top-line messages about providing more habitat and food, and taking care with pesticide use? What actions can they take that are supported by a weight of evidence and are relevant to the UK farming context and will have a clear measurable impact benefitting pollinators in and around farmed fields? Or what evidence-based actions can they take to improve the ecosystem services that pollinators provide?

The NFU will be revisiting the "Farming for bees" resource to provide an updated overview of evidence-based actions farmers can take to benefit pollinators, and to signpost where more detailed information can be found. This paper provides a farming perspective on the evidence, sets out issues to consider when updating the "Farming for bees" resource, and invites researchers and other stakeholders to input to this process.

WHAT DO WE KNOW ABOUT POLLINATOR NUMBERS ON UK FARMLAND?

The starting point is that we do not know much about pollinator trends on UK farmland specifically. Until 2017, when the UK Pollinator Monitoring Scheme became the first in the world

to collect systematic data on the abundance of bees (Carvell et al. 2020), hoverflies and other flower-visiting insects at a national scale, there had been no widespread pollinator monitoring looking at pollinators as a group on UK farmland. The Pollinator Monitoring Scheme includes assessments of pollinator activity in different habitats, like gardens, parklands, farm crops or grassy pasture, and grassland with wildflowers. Analysis of the first five years of data 2017-2021 shows fluctuating pollinator numbers, with no clear trends (UK Pollinator Monitoring Scheme 2023). Going forward, this monitoring scheme will give us detailed data collected in a standardised format showing pollinator abundance over time, and tell us more about pollinator numbers and diversity in different habitats.

Prior to the UK Pollinator Monitoring Scheme, little systematic data on pollinator numbers (abundance) is available in the UK. Most of the older UK data is based on biodiversity (pollinator species richness) and the distribution of species. The Joint Nature Conservation Committee (JNCC) funded UK Status of Pollinating Insects Indicator (D1c) (JNCC 2022; see https://jncc.gov.uk/our-work/ukbi-d1c-pollinating-insects/#:~:text=The%20indicator%20is%20based%20on for trend figures) is based on distribution and modelled trends for wild pollinator species. Between 1980 and 2017, 19% of the 377 species analysed became more widespread (7% showed a strong increase) and 49% of species became less widespread (24% showed a strong decrease, equating to a decrease in occupancy of 50% over 25 years). Over the short term, a greater proportion of species were increasing between 2012–2017 (46%, with 34% exhibiting a strong increase) than decreasing (43%, with 36% exhibiting a strong decrease).

When combined into an average trend across all species, occupancy or distribution declined by 30% between 1980 and 2017 and the pollinator indicator was therefore assessed as declining over this period. In the shorter term, between 2012 and 2017, average occupancy declined by 2%, and the short-term trend was assessed as "little change".

As individual pollinator species become more or less widespread, the communities in any given area become more or less diverse, and this may have implications for pollination as more diverse communities are, in broad terms, more effective in pollinating a wider range of crops and wildflowers (Winfree et al. 2018; Senapathi et al. 2021).

The indicator includes separate occupancy indices for bee and hoverfly species. The wild bee index fluctuates over the long term, but in 2019 it was estimated to be 9% lower than in 1980, with a larger proportion of bee species decreasing than increasing (37% decreased and 24% increased). Over the short term, 40% decreased and 42% increased. There was a decline in the bee index from 2007 to 2014.

With hoverflies, the index shows a gradual decline between 1987 and 2000. In 2000, the index was approximately 74% of the value in 1980. The trend was relatively stable up to 2009, before declining again and ending 41% lower than the value in 1980. A greater proportion of hoverflies have declined than increased in occupancy over both the long and short term (1980 to 2017 - 55% decreased and 15% increased; 2012 to 2017 - 49% decreased and 44% increased). It is not clear why hoverflies show a different trend to bees, but given differences in the ecology of these two taxa different trends can be expected.

It is clear that in terms of occupancy, the long-term trend is that UK pollinator communities in any given area are becoming less diverse (Biesmeijer et al. 2006; Carvalheiro et al. 2013), with less common species becoming even less common, and common species becoming more common (Carvalheiro et al. 2013). This is a concern because while common species may be effective at providing the majority of pollination services (Kleijn et al 2015; Hutchinson et al. 2021), we recognise the risks in relying on a few species to deliver pollination service to crops and wildflowers. To buffer environmental shocks, we need to build resilience in pollination services , and that means a diverse community of pollinators.

The data used in the JNCC model starts in 1980. Carvalheiro et al. (2013) looked at the UK biodiversity of bees, hoverflies and other pollinators in the decades before 1980, in one of the most important studies looking at changes in pollinators. The study shows the most dramatic declines in pollinator biodiversity between the 1950s and 1980s in Britain, Belgium and the Netherlands. In Britain, declines in bumble bee biodiversity have slowed since 1990, but even

more encouragingly the biodiversity of other wild bees (the majority of our species) has shown some signs of recovery in recent decades, with species richness increasing at finer spatial scales.

While biodiversity in Britain will likely continue to bear the marks of past declines for a long time, this work illustrates that biodiversity loss has slowed or even shown signs of recovery in recent decades for many bees (and wildflowers). The researchers also suggested the slowing of losses and signs of recovery have happened since 1990 because of conservation work and the agri-environmental management done by farmers and growers to encourage biodiversity. This study was a positive message for conservation, for bees and other pollinators, and the wild plants they depend on. It showed the declines we are all so concerned about have slowed significantly in the last couple of decades. Yet this study was little reported. I think it failed to get much attention from the media when it was published because it did not fit the mould of "insectageddon".

Even in the many research papers published since, I commonly see references to the study by Biesmeijer et al. (2006) as the "go to" study showing declines of pollinators, yet the later, directly related work by Carvalheiro et al. (2013), which shares many of the same co-authors, rarely gets referenced. It does not neatly fit the popular narrative about declines.

I have heard the biodiversity situation being described by some researchers as "the grand challenge that hasn't changed for decades". I question this because clearly the challenge still exists, but hasn't the scale of it changed? While concern about pollinator declines has never been greater – is what we are dealing with now a legacy of significant historic biodiversity losses, and while different species are either stable, improving, or declining, are current declines, relatively speaking, at a significantly slower rate compared to what has happened historically?

This is important because in the UK I often see today's farmers being blamed for a current "insectageddon" or "insectinction" that is presented as never having been worse. However, in terms of rate of biodiversity decline, this is not strongly supported by the evidence.

We can argue that following dramatic declines between the 1950s and 1980s, we've entered an alternate state for pollinator biodiversity in the UK, where there is still fluctuation, but far less overall change. However, having arrived here, we still must question whether this alternate state applies for different taxa, whether we have lost significant functionality, and what actions do we need to take to address the situation.

This all raises a critical question about what exactly we are trying to achieve when helping our insect pollinators. Beyond providing food, a home, and a mate, there aren't any clear detailed collective aims in the UK, particularly in the context of what can happen on farmland. What exactly is it that we want to protect and improve? Is it the abundance of common species that appear to be doing okay and doing the heavy lifting in terms of crop pollination service? Or the less common species that are not doing so well? Or is it both – to create resilience?

Less common pollinator species tend to be more specialist, with specific habitat requirements. So, we need to think about how realistic it is to provide such specific habitat and increase their numbers in heavily managed agricultural landscapes where the primary function is to produce food and other crops.

If it is the case that current populations of pollinators within farmed landscapes are not sustainable, there is then a question about what level of action is needed to rectify this situation.

In summary, the abundance and biodiversity of pollinators on UK farmland remains a concern - there are pollinator species that are not doing well, but the extent of that, and whether or not species on farmland are at some tipping point between sustainable and unsustainable populations, is unclear. There is also evidence that something has happened in recent decades that has resulted in a significant slowing of pollinator declines. Taken together, I do not think the evidence justifies insectageddon headlines or insectinction campaigns, or the accompanying blame often laid on current farming practices.

With farmers managing around 70% of the landscape in the UK, the focus should be on positively engaging with them to help provide solutions that will deliver measurable benefits for

pollinators. We should also be developing simple ways to sample and monitor pollinators and other beneficial insects on farm. Farmers and their advisors monitor other resources on farm, like soil health and nutrition, and they monitor insect pests. It will be a step-change in understanding and valuing beneficial insects when farmers are able to efficiently measure levels of pollinators, predators and parasitoids in and around crops. There is exciting work being done looking at DNA barcoding of pan trap samples (Carvell et al. 2020), and at monitoring of flying insects using visual and acoustic sensors, and radar. Research has shown there is a willingness from farmers and advisers to monitor crop pollinators and pollination services, but farmers are time-poor, and need training, support, and efficient techniques and tools for this to work (Garratt et al. 2019).

What do we know about what is driving changes in pollinator populations on farmland?

There are several significant reviews assessing the drivers of changes in pollinator populations (Vanbergen et al. 2014; IPBES 2016; Steele et al. 2019). Drivers include land use change (including habitat loss and fragmentation, and chemical use within different landscapes), climate change, invasive alien species, and pests and diseases of pollinators. There appears to be higher levels of certainty around the impacts of habitat loss on pollinators, however these reviews have not been able to rank or prioritise the different drivers. Dicks et al. (2021) used an expert elicitation process to assess the relative importance of drivers of pollinator decline in different global regions. For Europe, pesticides were considered less important than land management, and land cover and configuration. While this is the state of the evidence, it does not feel this way for UK farmers. Media and press coverage shows a heavy bias towards the impact of pesticides on pollinators. This still includes a significant focus on neonicotinoid insecticides, even though in the UK and EU there have been widespread restrictions on their use on flowering crops for nearly 10 years, and widespread restrictions on use on outdoor crops since 2018. Following these restrictions, UK farmers are still struggling to control key pests, and this then impacts their decisions about which crops to grow (AHDB 2021).

The evidence base shows some neonicotinoid insecticides are a high risk to bees and can have negative sub-lethal impacts on bees. But reviews to date show there is no clear or compelling weight of evidence that neonicotinoids are a primary cause of widespread declines in pollinator populations. Steele et al. (2019) states that "The impact of neonicotinoid exposure on bee populations remains unclear".

I think the greatest loss in this situation is that no-one has evidently looked for, or found, any direct positive impacts on pollinator trends resulting from restrictions on neonicotinoid use. Huge amounts of research, policy time and resource have been put into the issue of neonicotinoids, yet despite high levels of certainty among the media, members of the public engaged in campaigns, and politicians, that neonicotinoids are the cause of declines in bee populations, we have not yet been able to evidence that widespread restrictions on their use have resulted is any measurable benefit for pollinators.

With the widespread use of neonicotinoids restricted, research funders and some researchers have shifted focus to other pesticide issues, such as the impacts of glyphosate, fungicides, pesticide combinations or co-formulants. An important part of such work would be to identify whether or not changes in the use of such products could actually result in positive impacts on pollinator populations.

There are some significant knowledge gaps around the impact of pesticides on pollinators, which do not attract much research interest, for example - recovery - the ability of pollinators to detoxify, clear and recover from chemicals following exposure. Negative effects of pesticides on pollinators are often presented as effects from which there is "no return", however, studies show recovery can happen for honeybees and for bumble bees following exposure to neonicotinoids (Laycock & Cresswell 2013; Cresswell et al. 2014; Holder et al. 2018; Mulvey & Cresswell 2020). While there has been an explosion of work on ecotoxicology to show the negative impacts of insecticides and other pesticides on insect pollinators, there are very few studies on recovery. Our knowledge for pollinators appears limited to the impact or symptoms of the causal agent being studied. This contrasts starkly with the way we

operate in other areas like animal or human health, where we identify the causal agent, understand the symptoms it causes, how long they will last, whether there will be recovery, what recovery looks like, and what any long-term effects might be. The lack of long-term studies of the impacts of pesticides on pollinators is a major shortfall of current research. Just focussing on short-term effects could mean we are missing the bigger picture.

Much of this recent ecotoxicology work has focussed on the "toxicology", with the "ecology" often forgotten. We have relatively little understanding of what bees and other pollinators are doing within the farmed landscape, their actual exposure in pesticide treated fields, or their dietary usage of pesticide contaminated food.

Much of the focus around pesticide impacts on pollinators has been on detecting negative sub-lethal effects and showing these effects occur at environmentally relevant doses. But we still have a relatively poor understanding of how this relates to real fields, how pollinator behaviour and dietary usage influence levels of actual exposure, or what the recovery rate of various pollinators is.

What do we know about measures that will benefit pollinator populations on farmland?

Reviews show that the greatest body of evidence identifies habitat loss and fragmentation as the most well-established driver of change – with the highest confidence levels in the evidence showing the negative impacts of habitat loss on pollinator populations (Vanbergen et al. 2014; IPBES 2016; Steele et al. 2019).

In 2016, Nowakowski & Pywell published a book on "Habitat Creation and Management for Pollinators", which detailed how to create and manage the right habitats in the right places for pollinators. The book sets out to show how to balance profitable farming with practical conservation, with wildlife habitat creation being funded through agri-environment support payments. Knowing how important habitat is, and knowing the actions we can take to create and manage such habitats – has this knowledge made a difference to pollinator populations and if not, why not?

The greenest of farming businesses need to be profitable, and I believe the gear-shift moment will be when we can show a farmer that the return from improved ecosystem services, in terms of enhanced yield, quality or other benefits, is more valuable than the agri-environment input costs incurred to generate those benefits. Being able to demonstrate a net benefit would create a significant increase in the uptake of agri-environmental measures benefiting pollinators. It seems we have a handful of case studies indicating this, but we still lack a general compelling overview.

The economic value of pollination and opportunity to address deficits has been demonstrated for some crops in the USA (Blaauw & Isaacs 2014), the UK (Garratt et al. 2022) and for small farms (Garibaldi et al. 2016). But for many other crops, varieties and situations there are still many unknowns around the level of insect pollination dependency, whether there are deficits or excess pollination, and whether measures to address sub-optimal pollination are cost-effective. Many of the world's crops depend on pollinators, so their declines clearly raises concerns about food and nutritional security. However, the degree to which pollination is limiting current crop production, and the opportunity to cost-effectively address any potential deficits, is not well understood (Reilly et al. 2020).

Steele et al. (2019) assesses the effectiveness of habitat management and policy for pollinators, and Cole et al. (2020) analyses the potential of ecological focus areas to support pollinators on farmland. Flower strips, margins and extensively managed grassland can result in local increases in pollinator numbers. But we do not know whether these high-quality habitats are actually increasing overall populations in the wider area, or just locally concentrating pollinators by drawing them in from elsewhere. It is also unclear how high-quality habitats next to fields affects exposure to any pesticides used in-field. Studies indicate that at least four years of monitoring is required to be able to demonstrate bee population responses to changes in agricultural land management (Blaauw & Isaacs 2014; Iles et al. 2018).

In terms of unknowns, we are only just getting to the point with collecting systematic data on the abundance of UK pollinators which will potentially allow us to assess population-level impacts of management actions on pollinators.

Even with high quality UK Pollinator Monitoring Scheme data, showing direct attribution of a population effect to a management action will be extremely difficult.

For habitat creation to be successful in supporting pollinators – it needs to be the right type and quality of floral resources, in the right place in the landscape, at the right time, and it needs to happen at a large enough scale to have an impact.

The factor of scale appears to be the main sticking point – we have a good idea of what measures will help support pollinators, and where to put these measures and how to manage them. What is not really clear, is exactly how much we need within a landscape to make a difference to pollinator populations – there are high levels of uncertainty in this area (Dicks et al. 2015), or information is only available for specific crops (Eeraerts 2023). But there is some consensus that what we have currently, particularly through agri-environment schemes, is not at sufficient scale, or appropriately targeted to make a difference. So, there is a question about how much area of habitat do we need to provide for pollinators to make a difference. Alongside this there needs to be more work done about how these measures can be supported within a financially sustainable farming business.

One thing we are beginning to understand is that pollinator species known to be declining are mostly habitat or diet specialists - half of the declining English wild bee species associated with farmland are specialised in their diet (Steele et al. 2019). So, while there is an opportunity to tailor agri-environment measures to support these species, there is also a need to establish what realistically is achievable within fields, where the primary focus is food production.

Studies comparing "land sharing" and "land sparing" approaches (Phalan et al. 2016; Balmford 2021) suggest there will be a point where it is simply not feasible to support sustainable populations of some of these species by taking a land sharing approach within a farmed landscape – it is never going to meet their needs. What is that tipping point, and how many pollinator species does this apply to? For specialist species, the focus would need to be on land sparing to provide sufficient areas of the specialist habitat or diet they require. Agri-environmental measures, margins and appropriate hedgerow management will then have a role to play in providing the corridors to connect such habitat patches. Bateman and Balmford (2023) highlighted how the yield lowering effect of land sharing presents an additional challenge, which would add to further offshoring of the UK's food production, and the implications this has for food security and global biodiversity. I think we need to find a way to safeguard pollinators and deliver environmental improvements in the UK, while at the same time delivering yield increases to increase domestic food production.

The final area to mention with respect to measures that will benefit pollinator populations on farmland, is the careful and responsible use of pesticides. The UK and the EU have one of the strictest pesticide regulatory regimes in the world. In the UK we also have world leading industry schemes (e.g. National Register of Sprayer Operators, National Sprayer Testing Scheme, BASIS training) ensuring best practice in pesticide use, through the use of professional advisors, training of spray operators, and regular testing of application equipment to ensure it is fit for purpose.

There is also industry-wide support for the increased uptake of Integrated Pest Management, which aims to reduce the risks associated with pesticide use. The challenge is that we are not currently able to measure the extent to which the reduction in risk results in benefits for pollinator diversity, abundance and health on farmland.

Conclusion

I have aimed to present a farming perspective of the knowns and unknowns around protecting and increasing pollinators on UK farmland, and as part of the process welcome input and challenge from researchers and other stakeholders. As an organisation representing farmers in England and Wales, the NFU position on pollinators, and our "Farming for bees" guidance, needs to be based on all the important evidence, not just a particular slice.

In the area of policy development, and implementation of actions to protect and increase pollinators on farmland, we need to make sure

future actions are underpinned by evidence and deliver measurable benefits for pollinators. Poor evidence or a lack of knowledge about actions is likely to result in them being viewed by farmers as too high risk to undertake. We need to consider what the costs and benefits of taking actions are for the farmer, and our ability to do this will depend on the quality of available evidence.

I believe farming can offer solutions to protect and increase UK pollinator populations, but to do this effectively we need clarity on the problem to solve, and confidence the solution will deliver benefits.

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