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# Reversing Insect Pollinator Decline

Pollination by insects enables the reproduction of flowering plants and is critical to UK agriculture.[1] Insect pollinators have declined globally, with implications for food security and wild habitats. This POSTnote summarises the causes for the recent trends, gaps in knowledge and possible strategies for reversing pollinator decline.

## Overview

- Multiple interacting pressures threaten insect pollinators and the pollination services that they provide to agriculture and to wild habitats.
- Clearer evidence describing patterns of change in pollinator populations and services may require a long-term national monitoring programme.
- A lack of evidence on the efficiency of different insects in pollinating different flowering plant species limits the effectiveness of management measures for pollination services.
- Reversing pollinator declines would require co-ordinated action at a landscape level, involving government, industry, land managers and the public. Formal mechanisms for facilitating such co-operation are not yet available.

## Background

Most flowering plants reproduce through the transfer of pollen from one plant to another. This can be achieved by wind, direct contact between floral reproductive structures or by use of a courier, usually an insect. Some plants self-pollinate, though even this can involve insects transferring pollen between flowers of the same plant. A wide variety of insect species provide pollination (Box 1). Some are generalists that visit many types of plant to forage for nectar or pollen, while others are specialists that pollinate a small subset of flowers. Equally some plant species are pollinated by many types of insect and others require a specific species or group of insect. Some generalist pollinators, such as honey bees, are directly managed by humans (Box 1).

Evidence suggests that although a few pollinator species have expanded their range many have declined in the UK and elsewhere.[2,3] Insect pollination is important for both the quantity and quality of crops and wild plants species, and as such, provides an important ecosystem service (POSTnote 378). Pollination services were estimated in 2009 to be worth £510 million in crops per year to the UK.[1] Globally, yields in crops more dependent on pollinators are increasing slower than those that are less dependent.[4]

## Evidence of Declines

There is a range of evidence for declines in the UK and elsewhere.

- The number of bumblebee, solitary bee and hoverfly species in the UK, Netherlands and Belgium has generally declined since 1950, although since the 1990s declines have ceased or reversed for some groups.[2,5,6]
- Two bumblebee species are thought extinct in the UK, and eight have undergone severe range contractions.[7]
- Worldwide, managed honeybees have increased by 45% over 50 years, but have declined significantly in the UK, other European Countries and the US, with parallel declines in the numbers of bee keepers.[8-10]
- A trend across wild pollinator groups is a more pronounced decline of specialist species.[2,5] The consequences of this for the resilience of pollination services are unknown.
- Moths and butterflies make a smaller contribution to wildflower pollination services, but UK butterfly and moth species have declined in abundance and range.[11,12] 62 moth species have gone extinct since the 1960s.[12]

Box 1 Pollinating Insects in the UK

Wild

*Bumblebees* – 25 species in the UK, living in colonies of 20-250 individuals.
*Solitary Bees* – Over 200 species in the UK. They do not live in colonies and many species specialise in pollinating particular plants.
*Hoverflies* – Around 250 species of hoverfly, which increase in importance as pollinators in the north of GB.
*Flies, Moths, Beetles, Butterflies* – The contribution to pollination of both wild and crop plants by these groups is not well understood.

Managed

*European Honeybee* – One species (*Apis mellifera*) is kept in hives by both amateur and commercial beekeepers, with colonies containing around 20,000 individuals.
*Commercial Bumblebees* – Colonies of *Bombus terrestris* are used in greenhouses and polytunnels to provide pollination for fruit crops such as strawberries and tomatoes. The use of non-native subspecies from Europe in England is licensed by Natural England under the Wildlife and Countryside Act 1981.
*Solitary Bees* – The Mason bee (*Osmia rufur*) is increasingly being used both for farming and in gardens.

## Drivers of Declines

The sensitivity of pollinators to different drivers will differ depending on the species and the location. For instance, the pressures associated with agricultural landscapes differ to those experienced in semi-natural habitats. The evidence base for the impacts of some potential drivers, such as invasive alien plants (POSTnote 439) and invasive alien insects is limited. For other drivers, set out below, more substantial evidence exists.

*Land Use Change and Intensity of Agriculture*
Intensive farming has resulted in a significant loss of natural and semi-natural habitats; with 70% (17.12m ha) of the UK's land is now devoted to agriculture.[13] The resultant loss of food and nesting resources for pollinators has been a leading driver in wild pollinator declines.[3] Since the 1930s, 97% of the UKs wildflower meadows have been lost.[14] The number of species of flowering plants found across the UK has generally declined since the 1950s, including 76% of bumblebee forage plants.[2,15] The remaining suitable habitat is fragmented, restricting the movement and population size of pollinators.

Modern practices of using herbicides to remove weeds on which pollinators feed, and the planting of crops as monocultures, result in habitats poor in food sources for pollinators. The nutritional needs of individual pollinator species and supporting a diversity of pollinators requires a variety of plant species that flower at different times of year. Monocultures like oilseed rape flower en masse for a short time only and their flowers are not accessible to some specialist species. Insecticides applied to crops to kill insect pests can also affect insect pollinators. Neonicotinoid insecticides are the most widely used globally and have been the focus of recent debate on the role insecticides might play in pollinator losses (Box 2).

*Pests and Disease in Honeybees*
Pest and diseases are a serious threat to honeybee colonies. The parasitic mite *Varroa destructor* has spread throughout hives in the UK since its arrival in 1992 and has developed resistance to chemical treatments.[16] It feeds on adult bees and larvae, and transmits several harmful viruses, ultimately causing the loss of hives. The fungal pathogen *Nosema ceranae*, which infects the bee gut, has also emerged as a serious threat to honey bee health in the past decade.[17] Two distinct bacterial infections, European Foulbrood and American Foulbrood, are serious widespread honeybee diseases in the UK. Both infect and kill developing bee larvae. In England and Wales suspected cases must be reported to the Food, Environment and Research Agency for inspection. Hives infected with American Foulbrood are always destroyed whereas European Foulbrood may be treated depending on the severity of infection.[18]

*Pest and Disease in Wild Pollinators*
Disease risks to wild pollinators are much less understood, but there are risks that pathogens may 'spill over' from managed pollinators into wild populations.[19] The honeybee parasite *Nosema ceranae* has been found in bumblebee populations in England, and evidence indicates it is more deleterious to bumblebee health than in honeybees.[20] A survey of bumblebee colonies imported to England in 2011 and 2012 that were cleared as disease free, found 77% were carrying diseases, some of which could also infect honeybees.[21] The decline of some bumblebee species in Japan, Canada and US has also coincided with the introduction of diseases from imported commercial bumblebee colonies.[22,23] Almost nothing is known about effects on solitary bees.

*Climate and Weather*
Evidence from butterflies shows that climate change could facilitate an expansion in range for pollinators that have ranges restricted by temperature.[24] Changes in seasonal weather patterns and increased extreme weather events can affect both managed and wild pollinators by limiting their ability to forage. Long wet winters and late springs have been suggested as a particular problem for UK honeybees.[25] Warmer temperatures may also cause a mismatch between the flying period of pollinators and flowering events, which could potentially result in less food for the pollinators and disrupted pollination services.[26]

Box 2. Neonicotinoids

Neonicotinoids are a class of insecticide that kills insect pests by disrupting neurological function (POSTbox, Neonicotinoid Insecticides September 2013). They are also toxic to non target-insects and aquatic invertebrates, but are far less toxic to vertebrates.[27] Developed in the 1990s, they can be applied as a spray, but are mostly applied as a seed coating that is absorbed into the growing plant, providing protection against insect pests throughout its life. Pollinating insects may be exposed to the active ingredients when they feed on the nectar and pollen of treated plants. Several laboratory studies have shown that neonicotinoids have negative effects on both honey bees and bumble bees, at the individual and colony level.[28-31] Field studies have suggested that the levels of exposure in the wild are not sufficient for negative consequences, but to date there has not been an experiment of sufficient scale or replication to understand theseeffects.[32] In 2013, the European Food Safety Authority concluded that the current risk assessments of three different neonicotinoids (imidacloprid, thiamethoxam, clothianidin) were insufficient.[33-35]

Box 3. Priorities for Research and Effective Action
Stakeholder workshops have identified several key priorities for research, which include:[36-38]

- the effectiveness of current interventions in rural and urban environments at promoting pollinator populations, diversity, abundance and pollination services
- the importance of managed and wild pollinators for crop yields
- monitoring schemes for wild pollinator populations and their diseases
- establishing the links between pollinator diversity and the resilience of pollination services and crop yield
- identifying the sub-lethal effects of pesticides on different pollinators, and their population level consequences
- a better understanding of the floral resources available to pollinators in the UK landscape and how these are changing
- identifying how the uptake and effectiveness of agri-environment options for pollinators can be increased
- how to train of conservationists, agronomists and land managers in pollinator conservation

### Interactions between Pressures

Pollinators are exposed simultaneously to multiple interacting pressures.[39,40] Research has addressed subsets of two interacting factors, but multiple pressures are likely to be acting on pollinators in field conditions. For instance, pollinator malnutrition due to lack of forage can impair the ability to cope with other pressures, such as weakening their immune system.[41] Exposure to pesticides may also damage immune systems.[42-44] Another example is that climate change may make conditions in the UK more favourable for invasive alien species, which may have negative effects on native pollinators.[45] In addition, studies of butterflies suggest that the fragmented nature of habitats in UK landscapes may disrupt the ability of pollinators to expand their range in response to climate change.[46]

## Addressing Pollinator Declines

### Limited Knowledge

Understanding of pollinator declines and their causes is incomplete. However, priorities for research have been identified and research is ongoing (Box 3).

*Monitoring Pollinators*

The lack of a national pollinator monitoring scheme has been identified as a key priority for research and policy, and a recent House of Commons Environmental Audit Committee report recommended that Defra should fund and co-ordinate a national scheme.[36,47] Evidence for declines in UK populations of wild pollinators is predominantly derived from observations by amateur experts (citizen science) subsequently analysed by scientists.[2,5,11,12] Though invaluable, these data have limitations:

- They are restricted in scope to certain pollinator groups and geographical regions with larger numbers of experts, and can be biased towards insects that are easier to see and identify.[2]
- Most schemes only provide data on the presence of species, not their abundance.

A number of methods are in development that could inform a national pollinator monitoring scheme in the UK (Box 4).

*Protecting Crop Pollination Services*

To safeguard pollination services, the contribution of different insects needs to be understood. This requires data on both the frequency of visits to a given crop by a given insect, and the resulting effects on the quantity and quality of crop yield. For example, solitary bees provide more efficient transfer of pollen between oil seed rape flowers than both bumble and honey bees, resulting in higher yields.[48,49] It is estimated that honeybees could contribute up to a third of all crop pollination services in the UK, but under most scenarios it would be substantially less.[50, 51] Global evidence suggests that wild bees are a much more significant influence on crop pollination.[52] More specific information is required on how effective different kinds of pollinators are at pollinating different types of crops (Box 3).

### Improving Habitats

*Action at the Landscape Scale*

The conservation and creation of natural and semi-natural habitats is an essential tool in preserving both pollinator diversity and services.[3] These habitats provide important refuges for feeding and nesting and the establishment of source populations that facilitate movement across the landscape. Landscapes containing natural and semi-natural habitats, such as nature reserves, support a higher abundance and diversity of insect pollinators.[53-56] Urban areas may also act as refuge habitats, and may rely on pollinators for local food production in urban green spaces and gardens. However, research into urban pollinators is relatively new (Box 5). To be effective local action needs to be connected and co-ordinated within the larger landscape.[39,57] Several initiatives exist with the aim of better connected habitats within UK landscapes.

- the UK Government's 12 Nature Improvement Areas, each of which is 10,000-50,000 ha in size
- the Wildlife Trust's Living Landscapes, which is made up of over 100 projects
- RSPB's Futurescapes, which is an EU-funded project comprised of 40 sites across the UK
- B-Lines, which is a Buglife and Co-op project based in Yorkshire, creating corridors of wildflower grassland to connect existing pollinator habitats using voluntary stewardship by farmers.[58]

If managed correctly, England's 402,000 km of hedgerows could act as corridors for movement and provide valuable foraging and nesting habitat.[54,59] The charity Plant Life suggest that the UK's 238,000 ha of road side verges may provide extensive habitat corridors if local councils adapted

Box 4. Advances in Monitoring Methods for Pollinators
Data analysis tools continue to be developed to deal with biases in volunteer recorded data and information technology is providing additional solutions to identification.[60] Defra is considering more systematic recording methods and it is funding research to explore new ways of monitoring pollinators. The project, in collaboration with the Centre for Ecology and Hydrology and voluntary recording schemes, aims to develop and test new standardised, repeatable survey methods.[61] The Bumble Bee Conservation Trusts is also piloting a monitoring scheme, Bee Walks, which replicates the methods of the UK Butterfly Monitoring Scheme to provide data on both the presence and abundance of species.[62] Agriland, a research project of the UK Insect Pollinator Initiative, is conducting a landscape scale survey that is sampling 96 sites across GB. This has used a sophisticated, systematic method for selecting its sites so that they are representative of its different habitats and regions. [63]

their management.[64] Communication and co-operation between stakeholders, such as councils, landowners, food suppliers and NGOs, are required to co-ordinate actions within landscapes for pollinators.[36,39] Formal mechanisms for facilitating such co-operation are not available.

*Agricultural Landscapes*
Agri-environment schemes (AES) aim to make agricultural habitats more wildlife friendly. AES options can increase the diversity and abundance of wild pollinators particularly in areas of intensive agriculture.[65-68] A halt in the declines of plants species, an increase in some solitary bee species in GB and an increase in hoverfly species in some regions of Europe, have been attributed in part to the implementation of EU agri-environment schemes since 1992.[2] In England, AES is implemented through Defra's Environmental Stewardship programme (Box 6). This scheme has provisions for supporting co-operation between farmers, to target environmental stewardship options within their region.

Integrated pest management (IPM, POSTnote 336), aims to minimise the use of pesticides by utilising non-chemical approaches to pest management. The EU's 2009 Sustainable Use of Pesticides Directive states that member states shall take all necessary measures to promote, wherever possible, IPM methods over chemical methods.[68] Defra encourages the adoption of IPM methods in the National Pesticide Strategy, but the Environmental Audit Committee recommended that Defra incentivise the uptake.[47,70]

## Policy Developments

### Europe

*Pesticides*
The European Commission placed a moratorium on the usage of the three most commonly used neonicotinoids (Box 2) effective from December 2013, for review after two years. This bans their use on crop plants attractive to bees, with some exceptions, and completely bans domestic use.[70]

Concerns have also been expressed about the adequacy of regulatory preapproval testing.[47,72,73] In July 2013, the European Food Safety Authority published new guidelines on the testing of pesticides, which include schemes for testing on honeybees, bumble bees, and solitary bees.[74] These will evaluate chronic and repeated exposure from spray and dust deposits, pollen, nectar and water.

**Box 5. Urban Pollinators: Research and Action**
The Insect Pollinator Initiative-funded Urban Pollinators project aims to identify which urban habitats support the most pollinators by studying those found in Bristol, Edinburgh, Leeds and Reading.[75] It also aims to identify how urban habitats can be best managed for pollinators. Wildflower meadows have been planted in parks and schools and on roundabouts and roadside verges in all four cities to examine the effects of adding floral resources to cities on pollinator populations. In 2012, Bristol City Council established the Meadow Bristol project, which aims to cover 30,000 $m^2$ of the city with wildflower meadows.

The Bee Guardian Foundation, a charity, helped Gloucester City council to manage its green spaces, road verges and roundabouts to be more bee friendly.[76] By 2011, 30,000 $m^2$ of wildflower and pictoral meadows had been planted in Gloucester, along with 16,000 'bee friendly' trees, saving the council £4 million overall.[77]

**Box 6. Environmental Stewardship in England**
Defra's Environmental Stewardship scheme has options that are targeted at pollinators, the main ones being:

Entry Level Stewardship (ELS)
- sowing a mix of nectar and pollen rich flowers in field margins
- adding wildflowers to buffer strips and field corners
- promoting legume and herb rich swards in grassland

Higher Level Stewardship (HLS)
- management of chalk and limestone grassland
- restoration and creation of semi-natural grasslands.

Nearly 60% of England's agricultural land is now under ELS. Defra provide a bundle of ELS options specifically aimed at encouraging butterflies, bees and grassland plants, as well as information as to where in the country these would best be targeted. As of January 2013, 6.6% of all ELS agreements included the nectar flower mix option, covering 3,618 ha, 0.06% of all land covered by the ELS. The effectiveness of Environmental Stewardship for insect pollinators is limited by low uptake and variability in implementation. Improving both of these factors is key to improving pollinator conservation in agricultural landscapes.

*Common Agricultural Policy (CAP) Reform*
Recent agreements in the European Parliament on CAP reforms will have implications for pollinators. Of the money for direct payments, 30% will now be dependent on compulsory, environmentally friendly measures:
- the maintenance of permanent grassland
- crop diversification – at least two crops must be planted in arable land over 10 ha and three in land over 30 ha
- ecological focus areas – at least 5% of an arable holding must be set aside for measures such as field margins, hedges and buffer strips.

These may benefit pollinators, depending on implementation and management.

### England and Wales

There are a number of policy initiatives being undertaken to address declines in honeybees and wild pollinators in GB:
- Defra initiated the Healthy Bee Plan in 2009, a £4.3 million 10-year initiative run by the National Bee Unit, to improve bee husbandry among bee keepers and keep pests and disease at low levels.[78]
- In January 2013, Natural England updated their non-native bumblebee-licensing scheme. Producers of non-native species are now required follow protocols to screen colonies for parasites and disease.[79]
- In March 2013, Defra made commitments to improving both industry and government advice to farmers on best practice. [80]
- In July 2013, Defra published the report 'Bees and other pollinators: their value and health in England', which outlined its plans for a policy and evidence review to inform development of a National Pollinator Strategy.[81]
- The Welsh Government also published its Action Plan for Pollinators in Wales, to reduce and reverse the declines in wild and managed pollinator populations.[82]

Endnotes
For references please see:
http://www.parliament.uk/documents/POST/postpn442_Reversing-Insect-Pollinator-Decline.pdf

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