Pollinator Strategy for Scotland

2017–2027 Technical Annex








Scottish Natural Heritage
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Scotland’s pollinators

What are Scotland’s pollinators?

UK pollinators include the western honey bee (*Apis mellifera*), bumble bees, solitary bees, wasps, hoverflies, other flies, beetles, moths and butterflies. By far the most important groups of wild pollinators in UK are bees and hoverflies. Wild and managed pollinators deliver pollination services to support healthy wild plant populations and also to a variety of flowering crops that in part depend on these insects to maintain the quantity and quality of agricultural yields.

Bees

There are around 250 species of bee in the UK, comprising the honey bee, 25 species of bumble bees, and around 224 solitary bee species. In Scotland there are 23 bumble bees, 79 solitary bees, and the honey bee.

The domesticated western honey bee is an important crop pollinator that has been translocated and used around the world. Honey bees have great utility as crop pollinators because their colonies contain thousands of workers, providing a large potential pollination service. Their hives are manageable and can be readily transported to where they are needed (Woodcock *et al*. 2013), thus the timing of pollination by honey bees can be controlled to improve the synchrony of harvests and the uniformity of yields. Honey bees are not, however, always the most effective pollinator for all crops (Garibaldi *et al*. 2013, Woodcock *et al*. 2013). Other insect species may be better adapted to pollinate a particular crop. Bumble bees, for example, have longer tongues than honey bees and so are more effective pollinators of soft fruit crops. About 8% of all flowering plants (including tomatoes and blueberries) have specialised flowers that release pollen through narrow openings at the tip of their anthers – a morphological adaptation analogous to a salt shaker (Free 1993). Honey bees perform comparatively poorly in the pollination of such plants whilst bumble bees are especially skilled at dislodging pollen from them. Managed colonies of bumble bees are therefore often used by growers of crops like fruits to aid pollination; for example over 95% of glasshouse tomatoes are pollinated by bumble bees (Velthuis & van Doorn 2006).

Some solitary bee species, such as mason bees, are also better adapted than honey bees to pollinate apples, pears, plums, cherries, strawberries, raspberries and a wide range of garden flowers. The red mason bee, which is rapidly spreading naturally into Scotland (Robinson 2009), is widespread in England and has shown to be a promising pollinator for a number of crops grown in glasshouses or polytunnels; in particular for strawberry, raspberry and blackberry.

Flies

Flies, such as hoverflies, are considered to be the next most important group of pollinators in the UK and beyond (IPBES 2016). They are abundant visitors to flowers in northern regions and upland or montane habitats of the UK and are often particularly important pollinators in these places (Vanbergen *et al*. 2014b). Compared to bees, they have been the subject of relatively little research and their overall contribution to pollination services in Scotland is not well known. However, evidence from elsewhere in the UK and around the world suggests they are likely to have an important role in pollination of both crops and wildflowers (Orford *et al*. 2015, Rader *et al*. 2015).

Moths, butterflies and other insects

Butterflies, moths, beetles and wasps are widespread and wide-ranging visitors to flowers. While they can be important pollinators for certain crops in particular regions of the world, generally they are thought to be less efficient pollinators compared to bees and flies (IPBES 2016). Research from Scotland showed that relatively few moths (3 to 10%) carried pollen grains (Devoto *et al*. 2001), although a subsequent study in south-east England indicated that nearly a quarter of sampled moths carried pollen (Macgregor *et al*. 2016). Compared with bees, there is generally less information about the ecosystem or economic benefits of pollination by these insects.

While the effectiveness of different pollinator species in delivering pollination services to various crop or wild plant flowers can vary greatly, evidence is mounting that the best way to assure the stability and quality of yields of insect-dependent crops (Garibaldi *et al*. 2016), and healthy wild plant populations, is to manage our landscapes sympathetically to support a diverse and resilient pollinator community (Garibaldi *et al*. 2013, Pywell *et al*. 2015).

What is threatening our pollinators?

There are growing concerns worldwide that environmental pressures are leading to declines in the abundance, diversity and geographic range of our pollinator species (Vanbergen *et al*. 2013, IPBES 2016).

For the UK's most important wild pollinators (bumble bees, solitary bees and hoverflies) we lack data on population trends and so have to rely on information gleaned from records of species presence gathered by volunteers and analysed by professional scientists and academics. Such analyses indicated declines in species richness of wild bees during the 20th century (Vanbergen *et al*. 2014a). We also know that the range of six bumble bee species has declined, four have declined locally and another six are stable or increasing. In Scotland, there is evidence that the geographic ranges of four out of 12 bumble bee species have contracted. Recent analytical advances (Isaac *et al*. 2014) have now made it possible to estimate reliable trends from species presence data to produce an index of pollinator status. One such analysis produced an indicator of the average relative change in distribution of 213 wild bee and hoverfly species, as measured by the number of 1-km grid squares across the UK in which they were recorded. In 2010, this occupancy indicator had declined to 68 % of the value in 1980. Between 1980 and 2010, 27 % of pollinator species became more widespread (14 % showed a strong increase), and 51 % became less widespread (36 % showed a strong decrease) (Powney *et al*. 2015).

It is not clear whether these changes in wild bee and hoverfly diversity and distribution are related to similar changes in population sizes. However, analyses of butterfly and moth species for which we do have time-series of abundance data have shown long-term population declines, at least in certain regions of GB. This suggests that wild bees and flies may be similarly declining in population sizes if there are common drivers (Powney *et al*. 2015).

The 2016 report of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES 2016) on pollinators, pollination and food production describes many threats to insects (and other animals) and the pollination service they provide. No single factor seems to be responsible for all the observed changes in pollinators and pollination and the importance of different factors varies with the environmental setting and the species in question. However, it seems likely that many factors combine to exacerbate the overall level of impact.

Land-use changes leading to habitat loss, degradation and fragmentation

This is often considered to be the main cause of changes in wild pollinator communities during the 20th century. Since the 1940s, the conversion of semi-natural flower-rich habitats (e.g. meadows, traditional hedgerows) to conventional intensive agriculture comprising large monocultures has reduced the food and nesting opportunities available to our pollinators (Baude *et al*. 2016). In Scotland, areas of moorland and unimproved grassland, which are important habitats for pollinators, have also declined steadily in extent. Mass flowering crops (e.g. orchards, oilseed rape) only provide transient nectar and pollen sources so policies that promote these crops will not compensate for the losses of other sources of foods like wildflowers. Moreover, large-scale cultivation of oilseed rape may even disrupt pollination services in the wider landscape (Holzschuh *et al*. 2016). Agricultural intensification can also fragment natural and semi-natural habitat, making it more difficult for pollinators to disperse and find food. Urban and infrastructure expansion is more complex, depending on the type of land that is converted and the extent and management of urban green spaces (gardens, amenities, railway embankments, etc.) which can support pollinator populations (Baldock *et al*. 2015).

Pesticides

Excessive or inappropriate use of insecticides (e.g., where labelling is not followed or application equipment is faulty) can harm pollinators. The majority of pesticides used in Scotland are herbicides and fungicides as our comparatively cool climate means that there is less pressure from insects and less need to use insecticides. Herbicides will reduce the abundance and diversity of flowering plants that provide pollen and nectar to pollinators foraging in fields (IPBES 2016).

There are concerns about the approved use of some pesticides, particularly the neonicotinoid insecticides, which since their launch in 1991 have become the most used insecticides worldwide as soil, seed and leaf treatments. In Scotland, neonicotinoid insecticides are mainly used on winter sown cereal and oilseed rape crops and to a lesser extent on potatoes, soft fruit, vegetables, fodder crops and ornamental and house plants. Research in the laboratory or semi-field conditions has shown that sub-lethal neonicotinoid levels can affect bees' physiology and behaviour, and impair their foraging performance. There is some evidence of impacts on the pollination service they provide (Stanley *et al*. 2015). A landscape-scale experiment in Sweden showed neonicotinoid impacts on wild pollinator survival and reproduction over one season (Rundlöf *et al*. 2015). There is some correlational evidence of declines in British wild bee populations that forage on oil seed rape, which are, at least partly, associated with levels of neonicotinoid exposure (Woodcock *et al*. 2016). However, recent research provided evidence for the mechanism by which honey bee colonies may compensate for individual level effects of neonicotinoids leading to the replacement of lost worker bees (Henry *et al*. 2015).There is evidence that neonicotinoids used in seed treatments can move into water bodies and wildflowers. We still lack quantitative estimates of the degree to which pollinators are exposed and susceptible to neonicotinoids through different pathways in the environment (Krupke *et al*. 2012, Bonmatin *et al*. 2015). To get an answer, field scale experiments are needed. Because of concerns about impacts from these chemicals, the use of three neonicotinoids (imidacloprid, clothianidin and thiamethoxam) is currently restricted on pollinator-attractive crops throughout the EU while more evidence is generated. In order to balance sustainable use of pesticides with protection of the natural environment, including pollinators, the adoption of an integrated pest management approach is necessary. This must take into account emerging evidence on the impacts of pesticides on both honey bees and wild pollinators (Park *et al*. 2015).

Diseases

Pollinators such as bees face a variety of microbial pathogens and pests that cause or exacerbate disease (Vanbergen *et al*. 2013, 2014a). This risk to bee health may be worsened by the transport of pollinators for pollination services or beekeeping, by spreading known or new disease-causing organisms. An estimated 40,000 to 60,000 artificial bumble bee hives (pollination units) are imported to the UK each year to use for pollination of tomatoes (in glasshouses), soft fruit crops (in polytunnels) and in smaller-scale orchard fruit crops. Around 1,400 pollination units were estimated to have been brought into Scotland for use in glasshouses (mainly for tomatoes) and 1,900 for fruit pollination in polytunnels. Bumble bees are commercially important for other crops as well, such as raspberries, which accounted for £21 million of Scotland's economy in 2011. A further 13,000 packages of honey bee queens or colonies are imported into the UK each year to maintain honey production and pollinator services. Preliminary data suggest that less than 10% of the packages are destined for Scottish apiaries (Fiona Highet, pers. comm.).

Commercial rearing and imports of both bumble bees and honey bees pose a potential biosecurity risk to native pollinators. Studies in Ireland and the UK showed that over 70% of commercial bumble bee colonies were infected with pathogens, including parasites infectious to the honey bee (Graystock *et al*. 2013, Murray *et al*. 2013). Additionally, importation or movement of bees increases the risk of introducing novel pathogens, which native wild pollinators may have little resistance to (Fürst *et al*. 2014, McMahon *et al*. 2015, 2016). However, whilst there is evidence that these diseases may already be present in our wild pollinator populations, there are currently no statistics from Scotland clarifying the level of pathogen spill-over from these commercial colonies or the routes of transmission. International legislation and checks are in place to prevent the importation of honey bees, bumble bees and hive products carrying known non-native pathogens. New pathogens and pathways can be identified and assessed through horizon scanning exercises although it is often difficult to assess their impact on native pollinator populations. Beekeepers and users of commercially reared bumble bees can reduce the risk of impact on native pollinators by sourcing stocks responsibly, following best practice guidance and reducing levels of disease within their own colonies.

Climate change

The impact of climate changes on pollinators and pollination will take some time to appear due to time delays in responses of ecological systems. However, insects' body temperature is close to that of their environment, therefore a change in temperature can have a direct effect on their biology. There is some evidence that life-cycles, interactions among species, and the distributions of some insects and plants are changing in response to climate change (Forister *et al*. 2010, Kerr *et al*. 2015, Settele *et al*. 2016).

Pollinators and their food plants may become out of step with each other due to climate change if plants that pollinators rely on start to flower at different times; this could reduce the foraging season for queens establishing colonies (Memmott *et al*. 2010). Alternatively, pollinators may not be able to track the changing climate leading to a dislocation of geographical ranges where plant and pollinator co-occur (Kerr *et al.* 2015), leading to mismatches in the pollinator and plant and crop. This may have implications for future crop production (Polce *et al.* 2014). A better understanding of ecosystem functions, and the role of individual species, will help to identify the magnitude of changes that are climate-related and identify effective responses.

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