Recreate the BUZZ:

Bee-friendly Farming Measures for Food Security and Biodiversity in the United Kingdom

Figure 1. Bee pollinating a flower while gathering nectar. This process creates a mutualistic relationship (1).

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Executive summary

Bees, the world's primary pollinators, have been experiencing population declines worldwide and in the UK. This causes a loss of the ecosystem services they provide – pollination and biodiversity intactness – which threatens the quality of food supply and brings us closer to irreversible environmental change. The drivers of bee decline are land-use change (urbanisation, habitat fragmentation), the intensification of agricultural practices (increased pesticide use, monoculture planting), the spread of pathogens and climate change. Existing governance has been insufficient in addressing these threats in their complexity by ignoring their interconnected impacts, which is why supporting international actions against climate change, deforestation and pesticide use is proposed. The lack of data on bees and their needs hinders effective policy creation. This could be improved via increased funding for expert research as well as using citizen science for large-scale monitoring. Both local and international governance measures prioritise education over direct action. Thus, it is proposed that the new Agri-environment schemes require farmers to use bee-friendly farming measures on 10% of their land and provide financial incentives in the case of higher land proportions. Funding for the development of a tool that identifies the most effective bee-friendly farming practices would help facilitate this process. Well-informed and intersectional governance action can protect bee populations, our ecosystems, and us.

Bee decline

Bees, the world's primary pollinators have been continuously experiencing severe regional declines in population numbers (2) and global declines in species richness (3). The UK is no exception, having recorded a decline in most bee species and a third of all wild pollinators over the past 40 years (Figure 2) (4;5). Bee decline concerns us because if bee populations continue to disappear, so will the vital services they provide to humans and ecosystems, being the main pollinator of agricultural crops and wild plants (2).
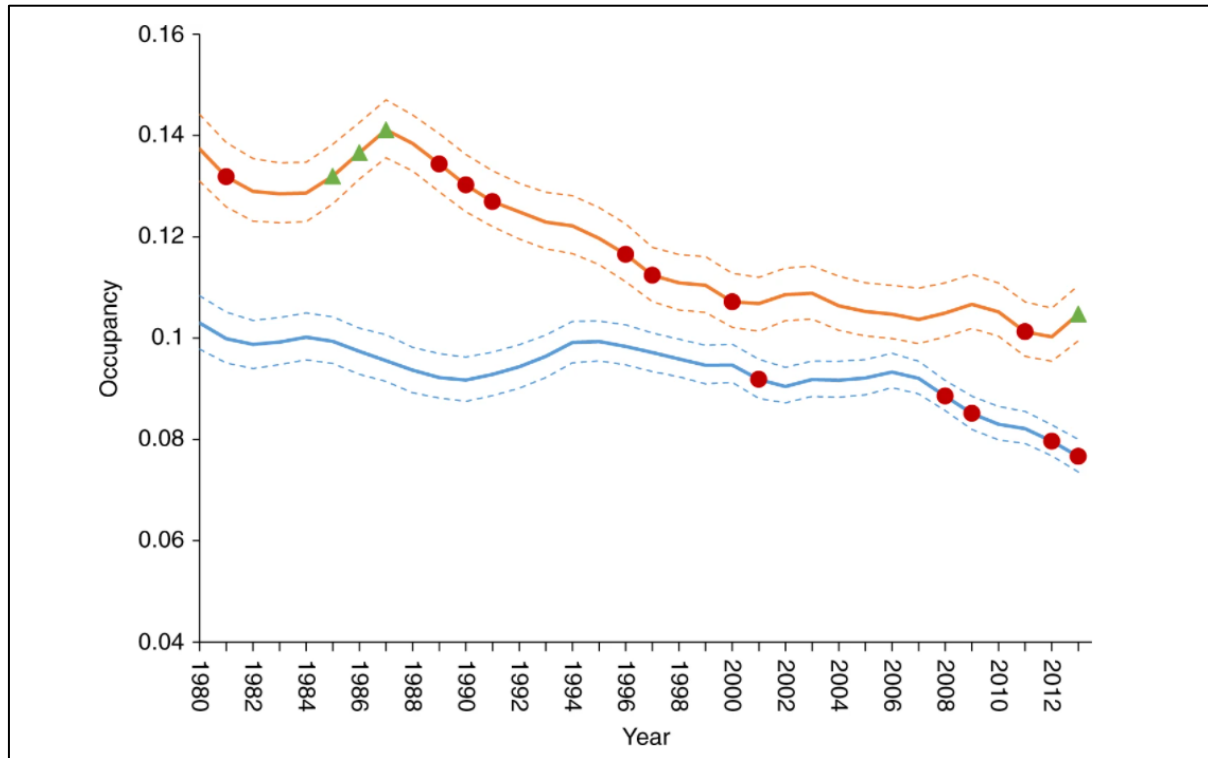
Figure 2. The graph demonstrates the "widespread losses of pollinating insects in Britain" between the years 1980 and 2013. "Trend lines show average occupancy of 1 km grid cells in Britain" by bee species (blue) and hoverfly species (orange). Years with notable decreases are marked with red circles and years with notable increases with green triangles (4, p3).

Pollination for Food Security

Since most plants rely on pollination for reproduction and thus survival (6), pollinators largely contribute to global food production (7). Losing bees would mean losing the economic value of the pollination service they provide, which has been calculated to be as high as €153 billion (8, p819). In the past 50 years, agricultural dependency on pollination has grown by more than 300% (9, p915), meaning that bee decline could severely threaten the quality of the global food supply (10).

Pollination for Biosphere Integrity

Pollination is not only crucial for food production but is also irreplaceable in the functioning of ecosystems (11) and their ability to provide us with services (12). If bees die, so will the flower species with which they have a co-dependent relationship (2) (Figure 1), a phenomenon already observed in the UK (13). Plant die-off would contribute to a wider biodiversity loss and could threaten biosphere integrity, possibly leading to irreversible

environmental change (14). This has been explained by the planetary boundaries' framework, which identified nine boundaries within which humanity can safely operate, biosphere integrity being one (15). Bee decline and the associated declines of dependent species could add to the crossing of the biosphere integrity boundary's threshold and bring about an abrupt change in our environment that we are severely unprepared to deal with (16). To prevent this and maintain the services that healthy, balanced ecosystems give us, bee population declines must quickly be halted. Inaction would negatively impact our efforts to reach the Sustainable Development Goals (17) of Zero Hunger and Life on Land (18) (Figure 3).

Figure 3. Sustainable Development Goals 15 (Life on Land) and 2 (Zero Hunger) which fulfilment depends on protecting bee populations (17).

Drivers of Bee Decline

Bees require suitable nesting habitats (specific soil substrates, tree cavities) and sufficient resources (flower nectar or pollen) (19). The availability of these is decreasing due to changes in land use and agricultural practices (20). Increased urbanisation and habitat fragmentation are destroying bees' food sources and nesting sites or obstructing bees' access to them (21;22). The agricultural sector is planting less-diverse crops (which lowers bee species diversity) (20) and increasing the use of pesticides toxic to bees (23). Invasive species, diseases, parasites, and climate change (that magnifies all drivers) also cause bee declines (2). Since all individual drivers interact together and amplify each other's impact, complex intersectional policies are needed to stop bee population declines (11).

Assessment of Existing Governance

International actions

Addressing bee decline on a national scale in the UK is crucial, however insufficient. The UK imports, "over 50% of its food and feed" (24, p1), which makes it heavily dependent on land outside of its territory for food security. To ensure the pollination of half of its food-producing crops, the UK thus needs to protect global bee populations. This requires international action and cooperation.

Neonicotinoid pesticide ban

An example of an international agreement is the EU ban on three neonicotinoids, which are pesticides toxic to bees due to their impact on the bees' central nervous system (25). This ban was adopted by the European Union Member States in 2018 after numerous citizen protests (Figure 4) and has received praise for its unusually fast regulatory action (26). However, the UK has not initially supported this restriction and only joined the movement in 2017 (5). Quicker regulatory decisions are required to protect the UK's bees, as neonicotinoid residues continue to pose health risks post the EU ban (27) and new pesticides have already been found harmful (28).

Figure 4. Protests in Brussels, Belgium before the EU vote on banning bee-toxic neonicotinoid pesticides (29).

EU Pollinator Conservation Initiatives

In 2018 The European Commission adopted what was the "first-ever EU initiative on wild pollinators" which outlined the actions the Member States should take to address pollinator declines (30, Paragraph 1). The initiative accurately identified the need to tackle the problem's main causes: habitat loss and pesticide use. However, it suggested little direct action to achieve its goals and focused mainly on data gathering, awareness-raising, and providing guidance documents (30). This is not unusual since education was found to be used in 53% of all EU "national-level policy documents [...] available in March 2019" with a pollinator conservation focus (31, p610). The least frequently used measures were found to be incentivization, restriction and coercion (31).

Hardin (32) warns that education alone is insufficient in addressing environmental issues and needs to be applied together with mutually agreed upon coercive measures (e.g., regulation, sanctions). The EU Pollinators Initiative is thus an important first step in recognising the significance of the bee population decline, however further combined actions are required.

UK Strategies

National Pollinator Strategy

The UK produced a National Pollinator Strategy (NPS) in 2014 outlining the planned actions to halt bee declines in the following ten years (10). Mainly through education, awareness-raising and increased monitoring, this strategy focuses on the provision of food and shelter for bees. The NPS aims to ensure that all actors involved in bee protection (farmers, researchers, citizens) are well informed on the actions that help or harm bee populations (33).

Through training, workshops, and informational materials, the NPS encourages farmers to create bee-friendly farms by planting flowering crops, managing hedges, or using Integrated Pest Management that lowers the need for pesticides (33). New farmers' training has been added post-Brexit for the transition from the European Common Agricultural Policy (CAP) to the still-developing national Agri-Environment Schemes (AES) (34). As these new schemes are still under development, it is crucial to learn from the criticism the CAP faced (35) and develop the new schemes accordingly.

The NPS employs an excellent involvement of actors across different sectors (farmers, beekeepers, researchers, NGOs, citizens) and enhances cooperation (33). However, most of its actions rely solely on education and no measures against climate change are suggested. The new Agri-environment schemes lack regulatory action to ensure cooperation and would benefit from an increased bee conservation focus as they decide the future of pollinator protection (36).

Governance Recommendations

Bee decline is a complex problem interconnecting more than half of the planetary boundaries: biosphere integrity (die-off of bees and bee-dependent species), land-system change (deforestation and intensive agricultural practices reduce bees' habitat) (20) climate change (as an amplifier of all drivers) (37), novel entities and biogeochemical flows (pesticide use) (Figure 5). Due to this complexity, simple technological fixes such as drone pollination cannot effectively tackle bee decline (38). Such approaches are financially unmanageable and undermine the unique inter-species interactions within ecosystems (38). Instead, a combination of specific instruments of environmental governance (39) that protect bees' habitat and reduce pesticide use is needed.
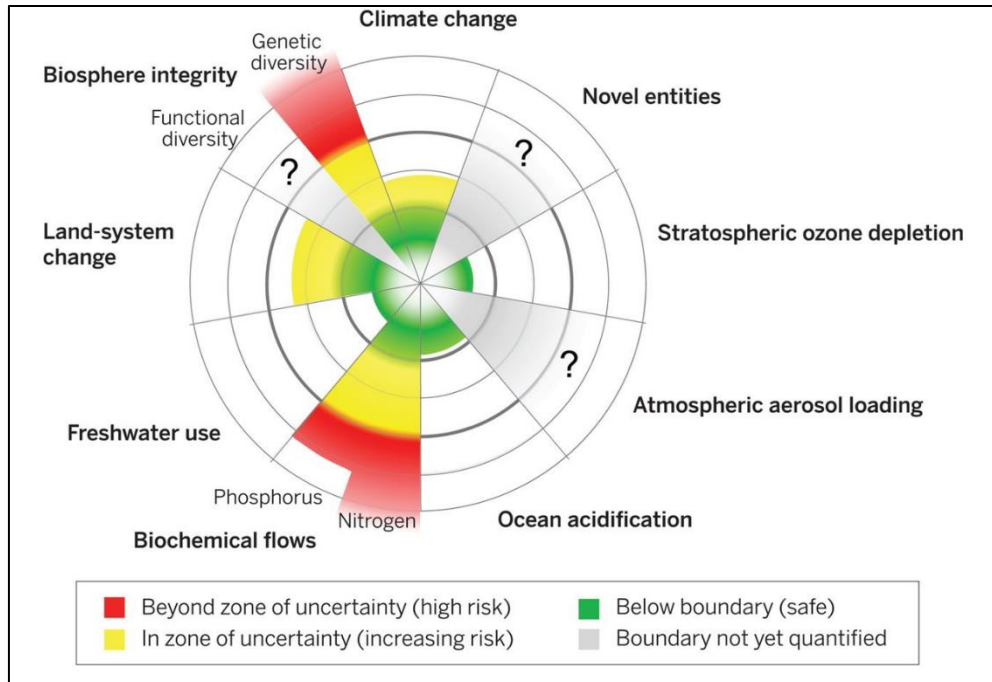

Figure 5. Nine planetary boundaries, which if crossed, could activate irreversible environmental change. The decline in bee populations interconnects five boundaries: biosphere integrity, land system change, biogeochemical flows, novel entities, and climate change (16).

1. Research & Monitoring

By experts

DEFRA should increase its monitoring activities and fund data collection of bee colonies and species numbers, to improve the fragmented global database (40). Research on harmful pesticides could enable the creation of pesticide maps that would show "regions with relatively high pesticide pressure" and would enable quick, cost-effective, local action (41, p10). More data on pesticides, bee populations and bees' needs would help locate areas that need protection (2) and better estimate extinction risks (42). Gathered data could be used in the ongoing educational activities under the NPS to better inform farmers and citizens on which bee-friendly plants and practices to choose for their farms, gardens, and community initiatives.

By citizens

Citizen science – voluntary bee-monitoring activities – could aid in the data collection process (43) with the help of existing bee-monitoring apps such as BEE ALERT (successfully used in Brazil) (44). DEFRA could implement information on using new apps and bee-identification into the educational events and online resources they already provide.

2. New Agri-environment schemes (AES)

There are multiple models available to help farmers determine the optimal pollinator plant mixes (45) and locate crops in areas that will most likely meet their pollination needs (46, 47). DEFRA should fund the development of a tool that combines these existing models. The new tool could be used nationwide by farmers to choose and locate pollinator-friendly crops on their land. This would renew natural bee-habitat and could increase bee diversity as it has in California (48). However, for farmers to choose this strategy it also needs to be economically viable (49) or required by law.

Regulation

DEFRA should thus make it mandatory for a portion of farmers' land - 10% - to be managed in a pollinator-friendly way (following the tool, using IPM or creating bee nesting sites) as a requirement under the improved AE schemes. Flower-rich farms in the UK that followed the previous Common Agricultural Policy have been found to increase resource availability but

not resource diversity (35). However, a larger proportion of land with carefully chosen pollinator-friendly crops could also enhance the diversity of plants and consequently bees (35). Farmers should receive sufficient time to adapt to this change (50). One year minimum is proposed here, as the new AE schemes should come into effect in 2022 and 2024 (36).

Incentives

To motivate farmers in their bee-conservation efforts beyond regulations, DEFRA could offer financial incentives to farmers who use bee-friendly methods on a larger portion of their land than is required. If only one respected farmer in an area decides to get these incentives, it could create a snowball effect, since other farmers are likely to copy their role model's sustainable behaviour (31).

3. International actions (on pesticides, climate change and deforestation)

DEFRA should pressure the UK government to uphold the ban on neonicotinoid use post-Brexit and spread awareness about the need to join new international regulations of other bee-harming pesticides (7). This is crucial because even pesticides that are not considered dangerous can become lethal when they bioaccumulate in bees' bodies (bees ingest bigger pesticide amounts by pollinating multiple flowers) or make bees more prone to other dangers such as parasites (41).

To acknowledge the interconnectedness of planetary boundaries, DEFRA should advocate for international agreements that pose regulations on deforestation to avoid the destruction of bees' habitats. To inform the MPs who will represent the UK in the COP26 on the threat climate change poses to bees (37) DEFRA should provide educational material and policy briefs. The MPs can then advocate for a rigorous agreement that also protects bees from climate change-imposed harm.

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