Royal Entomological Society response to DEFRA call for evidence on insect decline and food security

April 2023

The Royal Entomological Society (RES), founded in 1833, is a global scientific learned society and UK charity with a vision to enrich the world with insect science. The Society has a membership of over 2100 Fellows and Members, many of whom are researchers within universities and research institutes. The Society publishes 7 academic journals, including *Insect Conservation and Diversity* and *Agricultural and Forest Entomology*. We have 23 Special Interest Groups including ones specialising in climate change, conservation, pollination and sustainable agriculture. We co-own (with Gloucestershire Wildlife Trust) Daneway Banks Nature Reserve and are one of the leading organisations involved in the reintroduction of the Large Blue butterfly. We support insect science to benefit people and nature.

We have committed to be an independent voice to decision makers for the advancement and application of insect science. The Society welcomes the opportunity to respond to the DEFRA call for evidence in relation to insect decline and food security. **The Royal Entomological Society would welcome any further consultation, liaising with our considerable number of expert insect scientists from a range of disciplines.**

1. **The current evidence base for insect abundance in the UK, and the gaps in scientific understanding that require further research.**

Insects contribute significantly to ecosystems as predators, prey, decomposers and pollinators [1,2], providing several crucial ecosystem services that include pollinating up to 75% of the world's major food crop species[3]. However, whilst they play this crucial role it is estimated that less than 1 million species have been identified of an estimated 5.5 million[4]. The Royal Entomological Society strongly believes there is a need for more identification of insect species, and better understanding of their important role within ecosystems.

The UK is one of the best monitored countries globally for insects, especially for certain groups such as butterflies and moths (https://nbn.org.uk/). Survey data generally fall into two types: structured and unstructured. Structured data involve constant monitoring schemes using standardised methods at the same sites on a regular basis e.g., UK Butterfly Monitoring Scheme (UKBMS) which started in 1976, and Rothamsted Insect Survey which started in the 1960s. Data are used to report changes in species abundance trends (https://ukbms.org/official-statistics). Unstructured data generally comprise ad hoc citizen science records of occurrence and are used to report species ranges, and range changes (e.g., The State of the UK's Butterflies[7]). Insect pollinators are surveyed through a semi-structured recording scheme started in 2017, which includes a survey of bees and hoverflies sampled using pan traps (https://ukpoms.org.uk/). There are many other recording schemes for different insect groups (e.g., BWARS – bees, wasps and ants https://www.bwars.com/).

However, there are still many other insect groups for which abundance records are patchy with inadequate monitoring, and so there is an urgent need for a better network of long-term monitoring. There are opportunities to get more people involved in monitoring insects as 'citizen scientists', and to develop new technologies[5,] including mobile phone apps (e.g., iRecord), bioacoustic techniques and AI to improve monitoring[6].

Butterflies are particularly well studied, with data on abundance trends at sites (UKBMS) as well as changes in range from occupancy trends (from citizen science records). Of the 58 UK butterfly species, 30 have declining abundance trends, and 28 are increasing. Data on occurrences reveal 43 species have declined in range and only 15 increased[7].

Patterns of insect change also vary over time. An analysis of ~3000 terrestrial UK insects over the past 5 decades[8] showed increases pre-1992 but declines post-92. The RES agrees with the views of the wider scientific community over concerns about insect declines and the national approach to insect conservation. Over the past decades there has been intensification of agriculture, loss of habitat, introduction of invasive species and impacts of climate change[9]. Light pollution, particularly artificial light at night, is causing moth declines[10].

Climate change has resulted in the local extinction of populations of montane butterflies[11]. The sensitivity of insects to environmental changes and their boom-and-bust population fluctuations make it difficult to disentangle short-term fluctuations from long-term trends[12]. However, short generation times and rapid population growth can result in rapid recovery of populations if the environmental conditions are good. After going extinct in the UK, the Large Blue butterfly has been reintroduced to several sites in southwest Britain (including a site the Society co-owns at Daneway Banks) following successful conservation underpinned by science[13].

Landscape scale approaches to insect conservation are needed to support metapopulation networks of species. Improving landscape connectivity can help insects respond and adapt to climate change.

Many agricultural landscapes are inhospitable to insects unless there are conservation set-asides and patches of natural habitats to provide corridors and stepping-stone habitats[14].

There is a need for further long-term investment and research in understanding insect trends. The Grand Challenges in Entomology: Priorities for action in the coming decades[1] published by the RES in early 2023 identified 61 key priority challenges with some specifically focused on insect declines and gaps in current scientific research. These include:

- **Global monitoring of insects:** establish a global network of insect monitoring sites that allow long-term monitoring of insect diversity and abundance over space and time.
- **Novel monitoring techniques:** develop new and effective biodiversity monitoring techniques for poorly recorded insect groups, so changes in abundance and status can be measured reliably.
- **Insect genetics:** enhance the use of genetic methods to increase knowledge about the impacts of environmental change on insects.
- **Global declines:** evaluate whether insect declines are global in extent.
- **Causes of change:** identify the main drivers of insect change and their relative importance in different biomes.
- **Consequences of change:** evaluate the ecological consequences of losses and/or changes to insect diversity.
- **Insect resilience to environmental change:** evaluate how quickly/completely insects can respond to changes, including in vulnerable ecosystems such as peatlands.
- **Climate change impacts:** quantify the impacts of climate change on insect dispersal, migration, behaviour and interactions.
- **Tipping points:** increase understanding of the role of tipping points and non-linearities in the effects of change in insect communities and ecosystems.

Each of the priority challenges identified by leading entomologists and RES members from around the globe require research prioritisation and funding to gain better understanding of insect abundance and diversity at a time of a climate and biodiversity crisis[9,12].

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2. The effects of pesticides, such as neonicotinoids or other agricultural control methods on insects including pollinators and their impact on UK food security.

It is well documented that pesticides can have detrimental impacts on non-target insects. The negative impacts on physiology and survival of invertebrates can be seen in a variety of terrestrial and aquatic habitats[15]. Research published from the European Academies Science Advisory Council (EASAC) in February 2023, examined neonicotinoids and their substitutes in sustainable pest control[16]. This research concluded that existing restrictions on neonicotinoids should be continued but also minimise use even in emergency situations. This was primarily due to the growing evidence around the impacts on severity of associated insect decline.

The conclusions from the EASAC report also state that maintaining and increasing food security remain a priority. It is therefore important that the UK focuses on Integrated Pest Management (IPM) in agriculture. Whilst IPM has been used for several years, it has also continued to evolve. For successful IPM application innovation is needed with sustainable crop protection innovations (e.g., resistant plant varieties, biopesticides, pheromones, Artificial intelligence decision support systems, agronomy). A paper written by *Dara* in 2022 suggested that the original models of IPM primarily focused on ecological models[17]. However, it was suggested that with business and sustainability aspects, IPM should consider human, environmental, social and economic factors influencing food production. A general uptake of IPM by the farming community will only happen once evidence of the effectiveness of the more sustainable methods are available and demonstrated. IPM is more knowledge intensive than the traditional pesticide applications, hence support and assistance will need to be provided to farmers for this transition.

Some studies have shown that pesticides do not significantly reduce insect pest populations in the presence of their natural enemies. This reinforces the need to take evidence-based approaches to IPM and keep pesticide use under close review to conserve natural enemies in agricultural systems and only use pesticides where efficacy is proven and they work in harmony with naturally occurring controls, such as predators and parasitoids[18].

Improvements in testing practices for pesticides are needed. The current pesticide safety assessment system is based on simplified tests that are limited to a few "surrogate species", mainly adult workers of the honeybee. However, it is known that the effects of pesticides will vary across developmental stages and insect species[19]. Data on toxicity should consider not only measurement of survival but also include sub-lethal effects on behaviour. Emerging data indicate that high-dimensional molecular methods provide an invaluable insight into the effects of pesticides and offer a modern solution for new testing practices[19,20,21,22]. Unlike traditional assays, where only a few selected phenotypic traits are studied, modern molecular methods provide a more comprehensive outlook on the effects of pesticides on metabolism throughout an insect's body[23] and make it possible to compare the effects between castes of social insects and insect species[20,21]. Post-registration safety monitoring of pesticides must be implemented to respond to unintended and unforeseen impacts on ecosystems, soil and water.

Baseline data on farm biodiversity, insect pest abundance, occurrence and effect on crop yields are lacking or outdated, and fundamental research and surveys to renew this knowledge in current climate conditions is urgently needed. The RES encourages further investment and research into Integrated Pest Management, and it is important that peer-reviewed research under practical and realistic conditions is completed before bans are imposed. It is also important that such research is independent, and long term (at least five years). Insect communities experiencing long term intensive pesticide use are likely to take many years to recover, and short-term studies (3 years or less) would not be expected to measure the beneficial effects of management to encourage natural enemies.

The Royal Entomological Society recently published the scientific paper entitled Grand Challenges in Entomology: Priorities for action in the coming decades[1]. Several themes and priority actions have been identified by entomologists relating to the control of pests and its interaction with land management more generally:

- **Agricultural landscape management:** evaluate how agricultural landscapes can be managed to promote insect diversity and reverse insect declines, while also providing food security.
- **Soil biodiversity:** research the role of biodiversity in soil health/quality, including food webs, species interactions and interdependencies.
- **Role of insects in agroecosystems:** quantify the role of insects in agroecosystems, including their role as pollinators, natural predators and decomposers, and comparing this across different farming systems, such as organic versus conventional.
- **Spatially integrated pest control:** integrate control strategies at both local and global scales, with involvement of all stakeholders.
- **Invasive pests:** improve the management of non-native and invasive species and their associated diseases.
- **Insect pathogens:** exploit insect pathogens as alternatives to chemical pesticides for pest control.
- **Avoiding harm to non-target insects:** develop methods to control crop pests without harming non-target insect species.
- **Reducing pesticide exposure:** develop and expand strategies to reduce the exposure of people to pesticides, to protect human health in all countries.
- **Predicting and controlling pest outbreaks:** determine drivers of pest outbreaks in agricultural, plantation and urban landscapes, and establish how they can be predicted and controlled sustainably.
- **Semiochemicals and pheromones in pest management:** improve monitoring and control of pest insects using semiochemicals and pheromones.
- **Farming:** improve engagement with the farming community to encourage the development of practices that benefit invertebrates.

These key priorities show significant gaps in understanding and therefore the risks to insects and associated impacts on food security remain a challenge. Further research is needed in these key priority areas to better understand pest management, and therefore improve food security.

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3. **The extent that biodiversity initiatives, such as creating reservoir populations, are addressing insect decline and whether there is sufficient co-ordination with the UK food system.**

Several biodiversity initiatives, such as Farmer Clusters (https://farmerclusters.com) have demonstrated successes with conservation on agricultural land. These are often more successful when management practices are coproduced by conservation managers and farmers[24]. The RES supports the call for more nature-friendly land-use practices in general to mitigate insect declines and re-establish insect diversity through the conservation of important habitats and populations, and the improved connectivity between those[25].

Whilst these schemes have demonstrated success, the IPBES global assessment report on biodiversity and ecosystem services in 2019[26] shows anthropogenic impacts on the biosphere and biodiversity to be significant. The current food system, including that of the UK, is a major driver of biodiversity loss [26,27,28].

The RES supports the approach and focus of the Farming, Agriculture, Biodiversity, Land-Use and Energy (FABLE) consortium. The consortium published research in February 2023[27] that gave alternative pathways for Wales to achieve nature-positive and carbon-neutral land-use and food systems. Investment in research programmes to address food systems and insect decline is urgently needed. In many cases, the baseline data are insufficient.

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4. Whether the threat to UK food security from insect decline receives sufficient cross-government priority.

The threat to UK food security from insect decline needs interdisciplinary and cross-agency consideration. Whilst the risks to certain insect species have been identified, the impacts on most other insect species remain unclear, and without dedicated investment and research, the impacts on food security will remain uncertain. The Royal Entomological Society would encourage a longer-term and cross-departmental approach that invests in monitoring and research across insect science.

The commitment to improving the overall status of declining species groups including butterflies and other pollinating insects in the DEFRA 25 year Environment Plan is strongly supported by the RES. The subsequent Environmental Improvement Plan has a number of goals which the RES also strongly supports including:

- 65 to 80% of landowners and farmers will adopt nature friendly farming on at least 10-15% of their land by 2030.
- Halt the decline in species abundance by 2030, and then increase abundance by at least 10% to exceed 2022 levels by 2042.

However, a more integrated approach, with targets across government departments is needed to enable real progress towards these goals, as well as the Global Biodiversity Framework target 3 set at the COP15 in December 2022. This approach would positively start to address the issues of insect decline and threat to the UK food system.

5. **Additional policy initiatives and solutions needed in the UK and internationally to reduce and reverse the trends in insect decline.**

The Royal Entomological Society welcomes the opportunity to discuss a range of policy areas as an independent voice. In particular, the RES is concerned that entomological skills across the insect sciences are not prioritised in many undergraduate and postgraduate courses at universities. The Grand Challenges in Entomology paper[1] identified priority challenges in this area including:

- **Diversity of the entomological community:** ensure that entomological research is visible and welcoming to members of ethnic minority groups and other underrepresented communities.
- **Career pathways:** increase funding and accessibility, to enhance routes into entomology for early career researchers and those with diverse career paths.

The Biotechnology and Biological Sciences Research Council (BBSRC) and Medical Research Council (MRC) put together a consultation and report in 2014 (refreshed in 2017) to identify vulnerable skills within the UK bioscience research base[29]. Entomology was highlighted as a subject area of concern within agriculture and food security. The RES strongly supports the report's recommendations that funding is required for fundamental entomological science, especially in areas such as taxonomy/systematics, including molecular taxonomy, population genetic studies and functional genomics studies.

The paper also identified some key aspects of knowledge transfer that needed further research and investment including:

- **Connecting professionals and amateurs:** stimulate and provide funds to support knowledge exchange between professional and amateur entomologists and facilitate reciprocal access to laboratory resources, literature, collections and field records.
- **Data access:** increase the accessibility of existing entomological data, including published and unpublished work, and raw data.

This analysis was further supported by a report by the House of Lords Science and Technology Committee in January 2022[30]. This report recognised that the UK did not have the requisite skills to deliver nature-based solutions at a scale to achieve net zero targets. This report recognised that there was no formal assessment of the skills needed and therefore no route for training on the timescales required.

The RES would encourage greater focus on these areas to gain a greater understanding of insects. This would have a beneficial impact on improving entomological skills that could have a positive impact in reversing trends in insect decline.

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