HOUSE OF COMMONS

Science, Innovation and Technology Committee

Oral evidence: Insect decline and UK food security, HC 1239

Wednesday 7 June 2023

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Watch the meeting

Members present: Greg Clark (Chair); Aaron Bell; Chris Clarkson; Tracey Crouch; Rebecca Long Bailey; Stephen Metcalfe; Graham Stringer.

Questions 1-109

Witnesses

I: Dr Erica McAlister, Senior Curator of Diptera (Flies), Natural History Museum; and Professor Phil Stevenson, Head of Trait Diversity and Function, Royal Botanical Gardens, Kew.

II: Professor Dave Goulson, Professor of Biology, University of Sussex; and Professor Simon Potts, Director, Centre for Agri-Environmental Research, University of Reading.

III: Professor William Kunin, Professor of Ecology, University of Leeds; Dr James Bell, Head, Rothamsted Insect Survey, Rothamsted Research; and Dr Claire Carvell, Senior Ecologist, UK Centre for Ecology and Hydrology.

Written evidence from witnesses:

Professor Dave Goulson

Professor Simon Potts

Dr James Bell

Dr Claire Carvell

Examination of witnesses

Witnesses: Dr McAlister and Professor Stevenson.

Q1 **Chair:** The Science, Innovation and Technology Committee is in session. Today we begin the oral evidence for a new inquiry into insect decline and UK food security.

To begin our scrutiny and questions in this area, we are very pleased to have two expert and eminent witnesses. I would like to introduce Dr Erica McAlister, the senior curator of Diptera—informally known as the senior curator of flies and fleas, which is a glorious title—at the Natural History Museum. Dr McAlister is also the outgoing president of the Amateur Entomologists' Society, has presented two Radio 4 series on insects and has published widely, as one might expect, on flies and fleas.

She is joined by Professor Philip Stevenson, head of trait diversity and function at the Royal Botanical Gardens in Kew. Professor Stevenson's research is on the plant chemistry of nectar and pollen and how this mediates plant-pollinator interactions, as well as pollinator health and behaviour. Some members of the Committee visited Kew's base at Wakehurst, where we were introduced to some of the work of Kew in practice in this area, for which we are very grateful.

This being the first session of this inquiry, we are going to ask some pretty basic questions to establish our ground understanding and to inform those members of the public who may be watching of some basic questions before we get into questions of policy.

In that vein, I will start with Dr McAlister. Can you describe the domain in which you work? How do insects compare to other species across the planet? How important are they in our life?

Dr McAlister: I am a bit "taxist", so I will start off by saying that insects are arguably the most important animals that I know of. When it comes to numbers, they dominate. About 80% of described animals are insects—and that is only the species described so far. Their roles are so important. Not only are they important in pollination, but they underlie so many of our ecosystems. When it comes to recycling of nutrients, biological control within those and regulating ecosystems, insects are very important.

The amazing thing about insects is that because they go through this change in their life cycle they can get into many different parts of the environment. You name it, insects have got there. They are found up on mountains, there are really important Arctic systems and they are at the bottom of lakes and in caves. They manage to go into all these different habitats. In doing so, they are absolutely crucial for most of the vertebrate survival on the planet.

Q2 **Chair:** That is very clear and a good basis to start. Before I come to Tracey Crouch, I will put a question to Professor Stevenson. We will go into this in more detail, but there is a broad sense that there has been a

decline in the diversity and population of insects, certainly in this country. Is that the straightforward truth, or is it more complicated than that?

Professor Stevenson: Nothing is straightforward in natural sciences, much as people would like it to be, but there is lots of different evidence that has been published in the last 20 or more years that points to declines in different taxonomic groupings. Perhaps the most evidence is with moths and butterflies. We are a little behind with pollinators, but we are just starting to catch up, certainly with bees. You will probably hear a lot more about the processes when the third session, with Claire and Bill, is on this morning. You will then find out a little more about the challenges that we face when we are monitoring.

Certainly, it is nuanced. There are some species that appear to be doing better in some of these surveys, but, on balance, more are doing worse than are doing better. It may be that the greatest stress is on species that are more specialist and that they are losing habitat. That is possibly where we need to focus our attention.

Q3 **Chair:** Is there any broad characterisation that it is possible to make of the species that are on the wane and the ones that are on the rise, relatively? You mention moths, for example, as declining. What insects are rising in numbers?

Professor Stevenson: It depends largely on the processes that have been used to monitor. For example, the fact that there has been a long-standing monitoring experiment at Rothamsted, for decades now, means that we have more information about certain groups, including moths and aphids, than we have for other groups. It is not that one group is doing better than another. It is just about where we have had the ability to monitor those different groups.

Chair: I will go to my colleagues. We have lots of questions, starting with Tracey Crouch.

Q4 **Tracey Crouch:** I am climbing Kilimanjaro at the end of July. I had hoped that I would have left the insects behind by the time that I got to the summit, but it does not sound like that is the case, based on your first answer, Dr McAlister. Great; thank you.

Could you walk us through the lesser-known roles or functions of insects that are often overlooked but are crucial for maintaining the health of ecosystems and food production?

Dr McAlister: We know a lot about pollination—it has been very much in the news and everyone understands it—but one of the most important roles is decomposition and recycling. When we think about our environment, we do not think, "If we removed the insects, we would suddenly have corpses everywhere." I do not think that that is attractive to anyone. We would also have a huge amount of decomposing waste, be it vegetable or animal matter. They are very important in recycling back into the environment.

They are also very important when it comes to regulating ecosystems. We talk about beneficial insects in this way, such as predators. Wasps are a classic one. Everyone says, "What's the point of wasps?" Actually, there is a huge point in wasps, because they go around helping to maintain a healthy ecosystem. There are lots of hidden factors. As well as that, there are the parasitoids and the parasites. Because they have such diversity of function and form, they are doing lots of regulatory behaviour that we are not paying attention to.

Q5 **Tracey Crouch:** That is really interesting. Are there any unique characteristics or adaptations of insects that mean that they can carry out these ecological roles?

Dr McAlister: Yes. The change in morphology of insects is phenomenal. Even within the flies, it is like they have taken the blueprint of what they look like and changed it across all these different habitats. When we think about pollinators, we should think about those pollinators' mouth parts. Many of these different insects have co-evolved with different plant species, so they have unique characteristics associated with those plants. It is not like we could just bung honey bees into all environments. Lots of plants would not be able to be pollinated because they do not have the right tube lengths. These insects have adapted to all these things.

Professor Stevenson: Is it okay for me to jump in?

Chair: Yes.

Professor Stevenson: It is worth bearing in mind that that also means that you cannot satisfy all your pollinators, for instance, by having an eight or 10-seed flower mix to put down a field margin, because that will not satisfy the needs of all the pollinators. You have 275 types of bee, for instance, in the UK, many of which are specialist on one or just a few species of plants, so we need a much broader understanding of that.

Q6 **Tracey Crouch:** If we are going to halt not just declining insect abundance but declining insect diversity, you have to have diversity of the local environment.

Dr McAlister: Yes.

Professor Stevenson: Yes. That is fundamental.

Dr McAlister: When we talk about diversity, a lot of people talk about species richness. Biodiversity is not just species richness. It is a change in whether they are herbivores or detritivores—all these different things. We need to make sure that the environments we are looking after—the habitats—cater for all these different types of insects.

Q7 **Tracey Crouch:** The honey bee and the butterfly are quite often the poster boys, if I can say that—

Dr McAlister: Ladies.

Tracey Crouch: They are the poster species, if you like, around a healthy ecosystem. Are there any other insect species or groups that act as health markers for an ecosystem?

Professor Stevenson: Just to reiterate, honey bees are an excellent entry point to entomology for people who do not have any knowledge, because somehow we see ourselves in bees. They have this sort of little civilisation we can identify with. Actually, they are domestic animals. You get wild honey bees, of course, but in the main they are domestic animals.

Conserving honey bees has become this flagship activity for conservation when, actually, it does nothing of the sort. We have good data from London alone that shows that the enthusiasm for honey beekeeping is now impacting on the available resources for other species, so it is doing more harm than good. We need to widen the narrative to encompass the biodiversity that we really need to be focusing on.

I do not want to demonise honey bees or honey beekeeping. The work that we have done has been with the London Beekeepers' Association, because it was worried about it. We are talking about 400 hives in 1 sq km at the moment in London, which is just madness.

Are there other species? Yes, of course. One of the reasons why butterflies were a good target is that there are not very many of them. Actually, there are not that many species of bees either—there are only 270—but if you want to do the same project with wasps you are talking about many thousands of different species just in the UK. The scale of the problem becomes quite challenging when you start moving over into other groups.

Dr McAlister: I would argue that you need to move across to other groups.

Professor Stevenson: Absolutely.

Dr McAlister: We talked about this at a recent Royal Entomological Society event, where we picked 10 pollinator highlights—or 10 insect species—across all the different groups to highlight all the different roles that these insects play. At the Natural History Museum, we did one recently where we picked key flies that we knew that people could identify to get them to go out and record. They start looking at the different diversity. It is incredibly important that we do not focus just on the traditional bees and butterflies.

Chair: That leads neatly on to some questions that Rebecca Long Bailey has.

Q8 **Rebecca Long Bailey:** Professor Stevenson, you have mentioned the problems with using bees as the flagship campaign. There has been an enormous amount of campaigning just in the eight years that I have been

an MP. One of the first things in my postbag was hundreds and hundreds of emails from constituents asking me to save the bees. Why do you think that insect species, such as bees and butterflies, get more focus than others? What do we need to do to tackle this?

Professor Stevenson: I think that we should save the bees—don't get me wrong. It is just that the focus on honey bees has been a bit of a distraction. There are 275 other species that we need to focus on. There are also all these other species and useful functions that we need to encourage.

How do we do it? I think that we could do more in schools. There is very little. My son is going through GCSEs at the moment. He is doing biology O-level. I am sorry; I meant to say "GCSE". That shows my age. The only work on insects in his GCSE is on aphids as a vector of plant diseases. I think that they also have a single lesson that includes something on pollinators. We can do more there. The introduction of a natural history GCSE is a good step because that will allow us to have much more capacity at an early age to teach children in a formal way about the broader ecosystem value of all these insects, on a much grander scale.

Rebecca Long Bailey: Dr McAlister?

Dr McAlister: There are 24,000 insect species in the UK. We focus on just a couple of hundred, but we really need to broaden out.

I agree about the GCSE, but I think that it should be earlier than that. I work with a local community group. One of the children, who is eight or nine, had never touched soil. This is in London. We really need to get in at a very early age to explain the importance of insects. I also think that in tertiary education we need to build into our degrees more understanding of insects, how many there are and their diversity and importance.

Q9 **Rebecca Long Bailey:** Professor Stevenson, you mentioned concerns about the popularisation of beekeeping. What impact is that having on the wider insect population? Should we be encouraging more beekeeping to take place? We have some brilliant beekeepers in Salford whom I do not want to offend.

Professor Stevenson: It is just the volume of it that is really problematic. There is now a strong body of evidence that demonstrates that within the halo around each hive, which could be many hundreds of metres, pollen and nectar availability for other species is severely impacted. There is good evidence that you will have fewer other species that feed off nectar and pollen. This is not just about bees, of course. It is about moths, hoverflies and many other species, too. It is impacting on all of those. There is very strong evidence that it is causing problems. In London, we have a particular problem.

I think that you just need to tell people that there are alternatives—other things that you can do. I know that bees are not the only insect—I am

right on board with that—but if people are particularly interested in bees, there are other things that you can do. You can have nest boxes. You can do more in your garden to support them. You can start to recognise them, understand them and see different species. That is a very important part of it.

Dr McAlister: The thing with honey bees is that the larval stage is really doing nothing. There are so many other insects that we could encourage in whose larvae are really important in soil. With a lot of flies, the larval stage is either in the soil or in the streams. They are really important for filter feeding and nutrient recycling—all those things. The more we can encourage people to think about insects as a whole, rather than specialise in one or two individual groups, the better.

Q10 **Rebecca Long Bailey:** This is the last question from me. Do you think that we need a national insect strategy, rather than a national pollinator strategy?

Dr McAlister: We need a strategy that focuses more on all the insects. When looking through the pollinator strategy, I saw that it was very much on bees. I feel that it is very much outdated. We have so much more information now. The European strategy is very relevant. It is taken into lots of biodiversity studies and things like that, so I think that we need to build it in. If there is to be an insect strategy, it should be much more policy-driven, much more focused and, maybe, split up into different components to help us to have a clear understanding of what is going on.

Professor Stevenson: First, I have contributed to the national pollinator strategy, so I think that it is excellent. It was designed to target pollinators. That is probably more a reflection on the amount of expertise in academic circles that we have in the UK. We simply do not have the breadth of expertise that we require. We need more entomological expertise. In my career, I have seen it decline quite badly in universities and museums. We simply need more expertise across more of these important areas.

The national pollinator strategy is an excellent model for how you can bring together experts and stakeholders to design an action plan to deliver outcomes that benefit pollinators. We can use that as a model for all these other species. The natural pest-regulating wasps and flies, the detritivores and all these other things could use that as a model or approach, perhaps with a similar scientific group that could come together and coalesce in a DEFRA direction and help to build a similar strategy for other groups of insects going forward.

Q11 **Chair:** Before I go to Stephen Metcalfe, I have a couple of follow-up questions. On that point, Professor Stevenson, why has there been a decline in the number of people working in entomology, given that research funding generally is increasing—it is doubling—and there are more students than ever before? Why is there a particular decline?

Professor Stevenson: Not entomology students.

Q12 **Chair:** Indeed. Why is there a contraction?

Professor Stevenson: It may be that the approach to funding and what has been seen as a priority in academic and scientific research has pushed back some subjects, such as entomology and nematology. We are talking about the decline in entomology, but think about nematology.

Q13 **Chair:** Tell us about nematology.

Professor Stevenson: Nematodes are a group of invertebrates. There are many other invertebrates that are probably in a worse situation in terms of the numbers of people who are working in those fields. Why? It is perhaps because the kinds of impacts that they have in academic circles, in the research citations that you get for that kind of work, mean that they do not get valued under the current system of funding and approach. When you publish something on evolution or the genomics of a whole taxon, that may have more credibility in the research excellence framework than something a little more niche on insects, despite its significance ultimately longer term.

Q14 **Graham Stringer:** If you were to start doing a zoology degree as an undergraduate, what proportion of that zoology degree would be devoted or dedicated to insects?

Dr McAlister: It would be very small. There are not enough insect specialists and lecturers to teach a lot of these courses. They can specialise more at master's level, but the three-year zoology degree is dominated by vertebrates.

Q15 **Chair:** One of the things that this Committee does is scrutinise the system and structure of research funding, including UKRI and the research councils. If you were, through us, to make a request or a steer to the research councils and the funding infrastructure, how could they overcome the disadvantage that the field is suffering?

Dr McAlister: When I was doing my PhD, we had to do it in exactly the same time as every other PhD. However, I am trying to describe and look at insects. Because of the pure numbers—the diversity—maybe some allowance should be made to give more funded time to do any PhD or research with insects. The pure practicality of it is quite extreme.

Q16 **Chair:** Professor Stevenson, is there any steer that you would give?

Professor Stevenson: No. I think Dr McAlister has summed it up pretty well.

Dr McAlister: Can I also highlight the fact that a lot of the people giving information on our insects are not paid professionals? The only reason I call them amateurs is that they are not paid. They are the ones producing most of the data, most of the publications and most of the records within our country. The lead global expert on two groups of flies has never been

paid to look at entomology in his life. They are doing all these publications and all this amazing work. We need to think about giving more funding down that route as well.

Professor Stevenson: That is a very good point. Citizen science approaches to data generation have become a thing of necessity, even to the point where it is being funded by UKRI. I think that it is seen as an easy and economical cop-out when actually we need more investment and more people who are paid professionally to undertake this kind of work, because it is so important.

Q17 **Chair:** That is very helpful. I have a final brief question for Professor Stevenson. You quoted a figure about a square kilometre in which there were how many hives?

Professor Stevenson: It is a one-off, but there is one location where there are 400 hives. I know that from a beekeeper who was formerly at APHA but is now independent. There are two apiaries right next to each other.

Q18 **Chair:** Where is this?

Professor Stevenson: It is in London. I cannot tell you where.

Q19 **Chair:** Do you know whereabouts?

Professor Stevenson: I cannot tell you exactly where it is. There are GDPR issues associated with the information that we have. Each hive comes with personal information.

We did a survey of the whole of London as part of a paper that we published in 2020. We overlaid that on the available green space and used metrics that had been developed by Professor Ratnieks at Sussex University about how many hives a square kilometre could support. Because most green space in London is actually green park, for football pitches and so on, we estimated about seven and a half hives per square kilometre.

We regularly have over 50 hives per square kilometre in some locations, particularly in the City, where we have businesses putting multiple hives on roofs, ticking a green box and thinking that they have done their bit for the environment, when actually they have done the absolute opposite. That really needs to stop. There is this one location, which I cite because it shows how bad it can be.

Q20 **Chair:** It is a very arresting statistic. Is it possible to discern the impact on other insects from that? Can you see a depletion?

Professor Stevenson: Yes. It has been done in multiple studies over the last five to 10 years—in Canada, in the south of France, in Paris and in Switzerland. There are multiple studies that demonstrate this. I can provide additional evidence to the Committee afterwards.

Q21 **Chair:** That would be helpful. In London, since you mention London and it is obviously—

Professor Stevenson: We have not done any direct studies where we have looked at hives in certain locations and then measured the impacts, but it has been done in other cities. Ours was really looking at the extent and intensity of honey beekeeping and how that correlated with the available forage. It showed that it was unsustainable.

Q22 **Chair:** I understand that you have not done the research in London, but your expectation would be that the proliferation of hives was causing a loss of insect diversity for other pollinators.

Professor Stevenson: Correct. If you want to talk about bees, one of the scissor bees, which is the smallest bee in the country and is a specialist on bellflowers, has a foraging radius of about 50 metres. If you think that the average hive has a halo, so to speak, of about 600 metres where it forages, that insect is going to be outcompeted. The evidence from other cities is exactly as we have predicted for London, where we have demonstrated that there are too many hives for the available forage.

Q23 **Chair:** Some people who keep bees in London and elsewhere do it for the honey, but some may do it for what they think are environmental reasons—that they are making a contribution. Can they do something different to do that? Can they create things in the garden or in fields that they have to encourage other types of bees, for example?

Professor Stevenson: Yes. We are working with developers in London to help them to do just that. We have a four-point plan. First, you provide flowers—food—for all of these insects. Secondly, you have a certain knowledge about how you leave areas untidy—rough—so that these organisms have somewhere for refuge and nesting. Then you manage the landscape approach, with reduced mowing and reduced application of herbicides, pesticides and fungicides. We are also providing these developers with information about how they can engage their residents in understanding more about the invertebrates that they have in their environments. That is an approach that you can take.

There is also evidence that very small interventions—just 2-square-metre areas of little flower meadows in your garden—can have a measurable impact on the diversity and abundance of invertebrates.

Dr McAlister: I would add that we need more water bodies. We forget about this, especially in London, but we have drained so many of our low-level marshes and things like that. We need to encourage those in, because that is a huge component of our insect diversity.

Q24 **Chair:** Finally from me—I promise that I will then go to Stephen—in recent weeks there have been reports of an increased incidence in swarms of honey bees. Do these things vary from time to time? Is there anything to be read into that? Has your scrutiny picked that up?

Professor Stevenson: My understanding from the London Beekeepers' Association—which recruited us to help it to do this study, by the way, and is a very responsible organisation that recognised this problem maybe a decade ago—is that swarming comes from poor practice. There may be honey beekeepers who are very enthusiastic but have not learned the tradition as they might have done.

Q25 **Chair:** For the lay audience, tell us what the poor practice is that causes swarming to take place.

Professor Stevenson: Perhaps it is allowing the build-up of disease. Perhaps it is allowing inadequate forage in a landscape, if they are short of food. Things like that may be influencing it. I am not a beekeeper myself, I might add.

Q26 **Stephen Metcalfe:** I agree with the Chairman that those who are creating hives in London are doing it with the best intentions but, potentially, creating problems. That indicates that there needs to be a role in raising public awareness and greater engagement, which my colleague Rebecca touched on.

Both your organisations have programmes of outreach to the public. I was very fortunate recently. I had a behind-the-scenes tour at the Natural History Museum, which was fantastic. I saw some incredible examples of beetles on this occasion. It was very engaging and made our little group think about this. What work do both organisations do to engage with the public to promote greater awareness of insects generally and their role? What role do you think that the Government can play in supporting you as arm's-length organisations delivering this outreach?

Dr McAlister: I would argue that we do a lot, but not enough. We have the UK urban nature project. We are working with a lot of different organisations and schools. We have a very active school group. We get a lot of the students in and go into schools. I have talked in many a school to encourage people to think about insects.

We got ourselves involved with B-Lines to understand all the pollinator networks that are going on. A lot of us undertake a huge amount of fieldwork. This may be with different organisations, to help to spread the knowledge and information. I am the chair of the Dipterists Forum, which is a group of amateur entomologists. We run around the countryside, engage with lots of people in the countryside and make sure that we give lots of local talks to communities, to talk about other things. I am also involved with Operation Wallacea, which is an organisation that deals with students, be they tertiary or secondary. They work on projects with us. We are trying to spread ourselves quite a lot.

We are trying to think about our collections and how they are utilised as well. We are sitting on approximately 34 million insects—give or take the odd 34 million insects—so we have all this data. The earliest records we have are from 1680, so we have this huge dataset. We are seeking ways to mine our collection to help us understand more about the insects. In

our current strategies, where we are involved in the Darwin Tree of Life and the UKBOL, we are looking at genomes. I have been involved in work where we have managed to extract historical DNA. That is really interesting. We could start looking at how populations have changed, how populations have done, but ideally we should also be imaging a lot of our specimens, and not just for providing data. The specimens themselves are covered in pollen, and their guts have pollen in them. If we started to look properly at what is in the collections, we could find a wealth of information about which insects are associated with which plants and, if we are going to have seed mixes, which are the best for different groups of insects. There are lots of ways that we can do it.

Q27 **Stephen Metcalfe:** That is absolutely fascinating. My visit was wonderful, so grateful thanks for that, but if I went to a school or community group in Basildon or Thurrock, would they be aware of your work? Is that, potentially, where the Government could help in raising that awareness so they would know where to find the resource to inform themselves?

Dr McAlister: Yes. I think that is needed at both Kew and NHM, within those school groups. It is very important. Many people think about museums as just bones and stones, and not as a biological heritage. They do not understand the research work that goes on behind the scenes. So there is definitely a need for a bigger push in such areas, especially in schools.

Professor Stevenson: To mirror that, at Kew Gardens we also have a lot of outreach. A lot of kids come to the schools and we essentially build the training and teaching around what they are doing at school. With key stage 2 kids, aged 7 to 11, we teach about evolution and adaptation, and how different animals are adapted to their environment. At key stage 3 we talk about food webs and pollination services and natural pest regulation. We supplement what they are learning. We also have training for 14 to 16-year-olds and 16 to 18-year olds, key stages 4 and 5, when we go into greater depth about all those aspects. So we have quite formal approaches to teaching, but, of course, it is a day visit and most of the kids look on it as a day out.

We have another programme, called Grow Wild, which was supported by the national lottery. Essentially, it was sharing packets of wildflower seeds for different communities. In the first period of funding we managed to get over 1 million seed packets out to individuals. These were followed up by a team of people who went to talk about the value and importance of flower diversity to support invertebrates. So we have had ways of doing it, but it has been through our own ingenuity. It would be great to have a bit more formal support to build these aspects of our outreach and delivery.

Q28 **Stephen Metcalfe:** In both cases is it a push model—where you push out your direct and online resource to schools? There are 25,000 schools. Do you email them to say, "Look here, there is a 30-minute segment you

could include in a lesson, which would have this aspect of our work"? If you do not do that, is it something you could consider?

Professor Stevenson: I think it is something that we could do. We are actually inundated. So many schools want to come for their day out at Kew that it is a case of, "You can come, and we can offer this," rather than the other way round. We probably need to do a lot more of that and a lot more locally, as well, for other reasons about engaging with our local populations, to diversify our staff.

Q29 **Stephen Metcalfe:** And the population that cannot reach you. I am in no doubt that you are inundated with people wanting to come, but if you are in the middle of the country—

Dr McAlister: We do a lot of the UK online. We have the Angela Marmont Centre for UK Biodiversity, and through that lots of groups come in, and we do a lot of training. Much to the horror of many curators, we have also filmed ourselves talking about our different taxonomic specialisms, to go online. There are a lot of people willing to do it; it could be pushed further.

Q30 **Stephen Metcalfe:** Perfect. And if you were to make one suggestion about how the Government could support that work, because of its wider importance to the ecosystem, what would you like us to do?

Professor Stevenson: Provide the schools with the resource they need to get to where they need to go to learn about insects. It need not necessarily be Kew—it might be other organisations, where they have similar expertise—but it would be about resourcing those schools to be able to get out and visit.

Dr McAlister: Yes, and I would also ask for those institutions—the museums and botanical gardens—to have more funding to provide those sorts of things. It takes a lot of time.

Q31 **Stephen Metcalfe:** What about judging schools on their use of external resources—including it as a metric in something like a school inspection?

Dr McAlister: Yes.

Professor Stevenson: Yes, I think that would encourage. There may be schools that are more challenged, as you have already alluded to, to do it.

Professor Potts: Some might not welcome it as an equal metric, if you cannot get somewhere very easily, but resourcing and giving them the opportunity would be very important.

Stephen Metcalfe: Thank you very much.

Chair: Thank you very much. Finally, in this panel, Tracey Crouch.

Q32 **Tracey Crouch:** I am going to ask you, Dr McAlister, about amateur entomology, but, before I do, I am really interested in how you got into

flies and fleas. What is the pathway into that specialisation?

Dr McAlister: They are amazing. I have always had a slight fascination with insects. I was brought up, as I say, quite feral. This enabled me to explore, and it was great. When you are quite nosy, insects are fascinating. In my garden alone there are more species of insect than there are vertebrates in the UK. When you start thinking about numbers, and look at the interactions, it is very cool. Starting off, I flirted with many other insect groups, but once you stumble across flies there is really no turning back. There is the sheer diversity of numbers: there are more than 7,000 described species of fly in the UK. That is more than the butterflies, bees and beetles put together. I love their sheer diversity of ecology. There is one family of flies called Phorids, which you will probably never have paid any attention to. I understand that, because they are small and predominantly black. They are tiny little creatures, but their larvae do absolutely everything. There is more diversity in that one family of flies than there are animals, in terms of what they do. It is fascinating and I love them.

People talk about charismatic versus non-charismatic, but the more you study about any subject the more you get drawn in to it. We have been doing the bee-fly watch. I do not know whether any of you have paid any attention to bee-flies, but they look like little fluffy flying narwhals. These beautiful creatures turn up in urban gardens and everyone is suddenly looking at them. It has triggered people to see it is not all bees; there are a lot of things that may look like bees, and they start to think, "Hold on, if that's not a bee, what else is there?" It draws a lot of people in, by saying, "Look at these creatures here."

Q33 **Tracey Crouch:** Your enthusiasm is helpful for my next question, because I am interested in what defines an amateur entomologist. Am I one, because I do the Buglife survey? Other surveys are available. Is that what amateur entomology is?

Dr McAlister: To me, an amateur is just somebody who is not being paid. Again, as with professionals, the scale of knowledge is phenomenal. Anyone who takes a photo and adds a record is helping with the entomological data, so it is very important; but we need to be aware and mindful that there are some extreme experts within the community. Within the Dipterists Forum there are 28 recording schemes, which are all, bar maybe one, run by amateurs. They have been monitoring hoverflies, which has been really important in looking at data trends, for 50 years. There is a guy who looks at Anthomyiids, which is never going to win any hearts and minds when it comes to looking at these flies; but they are economically important and we need him to maintain the dataset. He needs funding to do that. It is really important.

There are huge studies looking at hoverflies that are migratory into the UK. This is great. Billions turn up on our shores every year; but now it has been found out, in one study from Cyprus, with regard to Anthomyiids, that 86% were Diptera and the majority of those were

these tiny little flies. We need people like him—all these amateurs—to help us with recording things.

Q34 **Tracey Crouch:** Do you think there is an over-reliance on amateurs?

Dr McAlister: There is an over-reliance on their free time and their generosity. A lot of people love to do it, and it is really important, but we have to make sure that their information is not lost but maintained. The distributed online datasets are incredibly important for professionals and amateurs. The records and the information they have often go into small journals that do not have a high impact factor. The data may not necessarily be included. It might be lost in the archives. BHL is doing an amazing thing in scanning old books and data, but we need to get all the hidden data from the last 50 years, which includes behavioural knowledge and all sorts of information that will help us to understand our environment better.

Q35 **Tracey Crouch:** Presumably—I know this is going to be covered in the next panel—that data can be regionally carved up, and therefore perhaps we should not send the same packets of wild seeds to Kent as are sent to Manchester, for example. Presumably the requirements are different. One insect might be abundant in Kent, but not in Manchester.

Professor Stevenson: It also depends on the soil types. That has not been really well studied. We are just doing that now at Kew, but, yes, that is right.

Q36 **Tracey Crouch:** We need to move on, but you covered quite a lot on university studies and the academic stuff. I am really interested in your thoughts on the new GCSE in nature, which is not coming in as quickly as we would have liked, and whether as far as you are aware insects are given the prominence they deserve. Also, primary schools are rushing to develop their own forest schools, with mixed or patchy pictures of forest schools across the country. Insects would not necessarily require the green, leafy Tunbridge Wells schools versus the not-so-leafy Chatham schools. Is that something that could be incorporated in all forest schools? Are you feeding into that in discussions of those kinds of natural history or nature-type curriculum developments? Are you having those conversations with the DFE?

Professor Stevenson: I have not been involved in curriculum development, so I wouldn't know.

Q37 **Tracey Crouch:** Should you be?

Professor Stevenson: I would like to. If I had an opportunity, I am sure I would be able to contribute meaningfully to it. I suspect there are others who have helped, but I do not know the details of the curriculum.

Tracey Crouch: And you, Dr McAlister?

Dr McAlister: I personally have not been involved. The Natural History Museum, however, is involved in the GCSE. We have one member sitting

on that, who will be arguing quite vocally about including insects. I would always argue that we need more about insects, because of their dominance within our ecosystems, but I am not specifically involved.

Tracey Crouch: Thank you.

Chair: Thank you very much. You have got our inquiry off to a flying start, so to speak, so we are very grateful. I thank Dr McAlister and Professor Stevenson for joining us today, and invite our next pair of witnesses to the table.

Examination of witnesses

Witnesses: Professor Goulson and Professor Potts.

Q38 **Chair:** I will introduce our witnesses as they take their seats. We are pleased to have Professor Dave Goulson, professor of biology, specialising in evolution, behaviour and environment, at the University of Sussex. He specialises in the ecology and conservation of insects, and particularly bumblebees, and is the author of several books—including on bumblebees.

We are also pleased to welcome Professor Simon Potts, the director of the centre for agri-environmental research at the University of Reading and co-chair of the UN's intergovernmental panel on diversity and ecosystem services, which produced a thematic assessment of pollinators. He is also a member of DEFRA's pollinator advisory steering group.

Thank you both for joining us. You were kind enough to sit in on the previous panel, so you have heard some of the evidence that was taken. Perhaps I can just return to the question that we briefly explored at the beginning of the sitting about whether insects can firmly and objectively be said to be in decline in the UK and globally. Perhaps you can summarise the evidence, starting with you, Professor Goulson.

Professor Goulson: Yes, is the short answer. It is pretty clear that an abundance of studies published in different countries, focusing on different insect groups, almost all agree that there is a downward trend. The speed of the trend varies enormously, depending on which insects you look at, and where you look at them, but the direction of the trend is almost universally downwards. It is important to stress that the knowledge gaps are huge. None the less, I think any reasonable person would accept that the trend is negative.

It was summed up quite nicely when a whole issue of the *Proceedings of the National Academy of Sciences*, published in 2021, was devoted to insect decline. The editorial estimated that overall, globally, insects are probably declining at about 1% to 2% per year, which does not sound that big, but, given that the declines probably began many decades ago, and perhaps as many as 80 years ago, it starts to look like a pretty huge decline, overall.

Q39 **Chair:** That is a global figure. How does the UK do? What is our domestic performance?

Professor Goulson: We have good data for butterflies and moths. The butterfly data, for example, show that populations have roughly halved, and the geographic ranges of British butterflies are down 42% since 1976—so on average each species has disappeared from 42% of the sites it used to live in, essentially. The moth data show slightly slower rates of decline. It think it is 38% since 1968. We have data on wild bees and hoverflies based on occupancy of grid cells in the landscape, which suggest that they have declined by about 33%, if I recall correctly, in their ranges, since 1980, I think. So we are in the same ballpark, and there is no real reason to suppose that Britain is fundamentally different from other European countries.

Q40 **Chair:** Professor Potts, do you have any perspective on that?

Professor Potts: Yes, I would agree with that assessment. I think it is important, to build on the UK case, to say that in the quite recent study that has been referred to there is this 33% of declining species, but there are also 10% increasing; but the vast majority—57%—are showing no trend. There could be several reasons for that: insufficient data, maybe they are stable, or maybe they are fluctuating. It is notoriously difficult to monitor insects because of their variation between years. They are up and down, up and down, so you need quite long-term datasets to really pull it apart. The study referring to bees and hoverflies is probably one of the best datasets in the world.

There is a key caveat that needs to go with this. We have been talking about declines in occupancy or distribution, but what we are missing is about abundance. There may be ranges that are contracting, but at the business end, when it comes to pollination services, supporting crops—and if we are thinking about food security, pollination of crops is essential—diversity is important. The more diverse the community the better pollination you will get, in general, because there are different types of pollinators able to serve different crops. But it is a numbers game; you need enough of the right species. We are really lacking that abundance data. We have a wonderful wealth of occupancy data from citizen scientists and professionals, but we have only recently been starting to understand the trends in abundance.

Butterfly Conservation in the UK has good numbers on the abundance of butterflies. Yes, overall they are declining. We have more recent information on bumblebees from the Bumblebee Conservation Trust. I think that 14 species are showing declines. We really need to know about the changes in abundance of crop-pollinating insects—and, thinking about the first panel, those other useful insects that help with food production, the natural enemies of pests, like spiders, parasitoid wasps and hoverflies, which take away crop pests—because in thinking about food security we not only need the right types of beneficial insects there, but the right numbers. We need both.

Q41 **Chair:** Can we draw any inference, or get any insight from food growers? For the most part they are commercial farmers. Are they struggling to have their crops pollinated in the way they used to be able to rely on?

Professor Potts: Yes, there is very good evidence from a series of case studies showing that, if you assess the contribution of pollination to a crop, there is a shortfall in many cases. That translates into less yield and lower-quality produce. Fruit is a great example. For food security those quality attributes are things like vitamins and minerals that make crops highly nutritious. So they are important for human diets. With poor pollination there is a shortfall in the production of nutrients. For the farmers, of course, that translates into loss of profit. A good example is that for one variety of apple, Gala, in Kent—quite a small area, but important for apple production—the deficit in pollination equates to something like £5 million in lost production. That could be fixed with some very simple interventions to boost pollinators—particularly wild pollinators. There is also evidence from other crops.

What is really interesting about the UK case is that about 50% of our fresh fruit and veg comes from overseas. If we think about insect declines and food and nutritional security, we have—yes, absolutely—a challenge from declines at home; but we have almost no data on the status and trends of pollinators and other beneficial insects in countries that produce a huge amount of fruit and veg that comes to the UK. That is a huge challenge in policy and practice. How do we influence overseas producers to ensure that they provide protecting pollinators and natural enemies? Many crops, such as mangos, raspberries and strawberries, come in from north Africa, Europe and south America. If they are suffering declines as well, we are already, let us say, in quite a fragile state with the food system. Given all the challenges of food prices, economic shocks, climate and so on, we are quite vulnerable, not only at home, with loss of insects, but overseas.

Q42 **Chair:** Thank you. Finally, before I turn to Graham Stringer, Professor Goulson, is there a climate change dimension to this? Is there a shift in the incidence of insects? For example, if it is the case that we are getting warmer, will insects that were previously in southern France become endemic in the UK and things will move north? Are we just swapping one set of insects for another? Is that happening?

Professor Goulson: There is clear evidence that climate change is starting to kick in and impact on insects. For example, bumblebees, which are my speciality, are found mainly in relatively cool parts of the world. They are disappearing from the southern edges of their ranges. The ones that live in the mountains of Europe are climbing to higher altitudes. There are some species that will benefit from climate change, undoubtedly—particularly some of the pest species that are adaptable and mobile, and able to move northwards easily, with the climate.

The bigger concern is that many insects exist in fragmented populations, perhaps occupying isolated nature reserves, in a way that they did not

historically. They have already declined considerably, as we were saying. The added burden of climate change, requiring them somehow to jump from one stepping stone to the next, northwards, may be more than many can manage. There was a study on UK butterflies that found that, despite the fact that most butterflies like warm weather, essentially, the overall impact of climate change was overwhelmingly negative on British butterfly populations. In short, some species will benefit, but the majority probably will not.

Q43 **Chair:** Thank you. Given that you are a bumblebee specialist, you obviously heard the discussion about honey bees in urban areas, in the previous panel. Are bumblebees outcompeted or disadvantaged by a proliferation of honey bees?

Professor Goulson: Yes. There have been some pretty clear studies showing that bumblebee nests grow more slowly, for example, if they are near a high density of honey bees. The last session focused very heavily on the honey bee and wild insect interaction, but I would stress that in the grand scheme of things I do not think we should be focusing on honey bees. There are millions of species of insect, and the impact of honey bees on wild insects is probably relatively small compared with the other big issues that wild insects face.

Chair: Understood. Let us go to my colleagues, starting with Graham Stringer.

Q44 **Graham Stringer:** Have we lost any species? Have there been any extinctions?

Professor Goulson: Yes, but if you are going to ask me how many, I am afraid—any idea, Simon?

Professor Potts: I think it is 10. Jeff Ollerton's paper said 10 over the last century.

Professor Goulson: That's bees and wasps, isn't it?

Professor Potts: It is bees and wasps.

Professor Goulson: I think we have lost about 50 species of moth. Others, I have no idea off the top of my head.

Q45 **Graham Stringer:** Professor Potts, you talked about insect populations going up and down through various natural cycles, I presume, of predators, and then the predators die because there is nothing to eat. Given that there is a paucity of long-term information, how do you disaggregate those cyclical trends from a general decline?

Professor Potts: It is extremely difficult. A good example of the main way that is being done at the moment would be the UK pollinator monitoring scheme. That has already collected five years of data. Multiple sites have been collected very carefully to reflect different environments, with standardised and well-replicated methods. You need that long-term,

very standardised way of monitoring to be able to account for these cycles. Think about last summer, with unbelievable temperatures. That is bound to have had a huge impact not only on the insects flying and available last year, but there will be knock-on effects this year. We need to account for that variation with high replication and standardised methods.

Q46 **Graham Stringer:** You talked a little about some insect populations increasing. Which are they? Is that a problem or a bonus?

Professor Potts: It depends which side you are looking at. There have been some reports of increases in common species—more generalist species—some of which are pollinators of crops. That could be a good thing. But, as I have said, we need many different sorts of insects to pollinate crops. You cannot rely on just a small number.

It will depend on whether the increases are in pest numbers. I think that biting midges and one of the flea beetles have increased; maybe the next panel will be able to fill in some more detail. Some pest species have increased, which is obviously an issue. Some of them will be agricultural pests, as well, which may have an impact on food production. It depends on the identity of those things that are increasing.

Q47 **Graham Stringer:** In terms of putting things right—if getting back to where we were, say, 50 years ago is putting things right; that might be a contentious statement, I don't know—would it be easy to do? Is it entirely environmental? How would one go about restoring what we had previously?

Professor Potts: That is a really good question. It is a very contentious question as well. Should we be aiming to recreate what we had, say, 50 years ago? Many people would argue we have gone past that point, but we can recreate a new stable, biodiverse and sustainable farming system. There are routes to do that. There are great policy routes through ELMS—through environmental land management. In many ways it would probably need strengthening with measures to support insects. We have local nature recovery strategies. Again, they could be strengthened with elements targeting pollinators. The emerging biodiversity net gain could, again, include measures specifically on insects, and particularly those important for food security.

Probably one of the biggest wins would be to connect those. We have the agri-environment schemes working independently of the protected areas and the connectivity. We need a more holistic approach to managing whole landscapes, with different actors—farmers, nature reserves, highways agencies and control of the land. We need a more joined-up way to get those different agencies to work together to deliver high-quality habitats that will be friendly for insects and other biodiversity.

Q48 **Graham Stringer:** Just to repeat the line of questioning in a previous panel, is it difficult to get students interested in insects? If you see a

television programme about space, the number of physics entrants at the University of Manchester goes through the roof. Is there an equivalent interest from new students or in sixth forms in insects, or is the number of students in decline, as well?

Professor Potts: There has been a longish-term decline, as outlined by the first panel. However, as a personal view, I am seeing a resurgence of students interested in environmental issues and insects. Pollinators are a brilliant flagship. Everybody needs food. Our food depends on pollinators; all the wild plants and wider ecosystems depend on pollinators. That is a great way in, but I take Erica's earlier point. Who loves the worms, the springtails and the mites? These are the super-important ones. How we make those more attractive within courses and for people to apply to courses is a real challenge. I do not have an answer to that, but it is critical. We need that expertise and capacity desperately in the UK.

Q49 **Graham Stringer:** Professor Goulson at the University of Sussex, what do you say about the study of insects?

Professor Goulson: I have a colleague who coined the term hippo-huggers to describe many of our students who are much more attracted to big, usually furry, cuddly tigers or whatever. I think it is an innate human trait. We find insects slightly alien. The majority of people, sadly, do not really like insects, which those of us who love them find puzzling, but there has definitely been a slight change, with the bee as a kind of flagship and a growing awareness of bee declines. That is drawing a small cohort of students to want to study insects, but it is still pretty small.

Q50 **Rebecca Long Bailey:** You touched briefly on climate change, but what do you think are the primary drivers contributing to the decline in insect populations?

Professor Potts: It is a great question and probably the one I am most often asked by policymakers and policy advisers. It is hard to give a simple answer. It is, however, very context dependent. We have very strong evidence that particularly land use change and land use management loss of habitats across the globe and in the UK is probably the single strongest driver. Coming behind that we have the overuse and inappropriate use of pesticides and climate change.

One way to try to get a consolidated view on this appeared recently in a paper by Dicks et al where we assembled 30 global experts and said, "Examine all the evidence, and for each region, Europe and the other continents, rank those drivers." Pretty consistently, it was land use, particularly land management, that came out as the most important driver.

The key thing is that these interact. Quite often, moderate pressure from one driver—say land use—compounded by climate and pesticides, means you get a lethal cocktail from which it is very hard to bounce back. Disentangling in the UK the exact role of, say, pesticides from habitat management and climate is extremely difficult. Many researchers are

working on this. There are some good case studies, but at this point it is impossible to say absolutely that this is the No. 1 pressure, except in a very localised sense where we might be able to do that. It is a great question and it is still open, but we know the main candidates and that they interact.

Professor Goulson: I would largely agree. There are others that Simon did not mention which are undoubtedly contributing. Fertiliser use and in particular eutrophication of fresh waters has had a big impact on aquatic insects. Light pollution has recently started to gain attention and certainly impacts on nocturnal insects and perhaps some diurnal insects. There are problems with invasive species and so on, but I agree. In a sense, it is almost fruitless to try to disentangle it and say that x percentage is due to this and y percentage is due to that, because it is the combination that is the problem. Insects are quite adaptable. They have been around for 480 million years and have survived all the mass extinction events that have gone before, but if simultaneously their home is destroyed, there is nowhere to nest, they cannot find anything to eat or, when they do, it is contaminated with pesticides, they are infected with a foreign disease, or are being predated by a foreign predator—putting all of that together—we should not really be surprised that they are struggling to cope.

Q51 **Rebecca Long Bailey:** If there was one policy you could ask the Government to champion to try to alleviate the issues that both of you have just discussed, whether that be a land management support plan or perhaps tighter regulation of pesticides, what should they be concentrating on now?

Professor Potts: I would pick one thing and place it very squarely in the context of food security. It would be deep incentives to support the transitioning to integrated pest management. That would be having standards; that would be having training, education, knowledge and support to help a whole cohort of farmers to move towards that. Some are already quite a long way down that line; many others are not. It is a particularly difficult time because of the challenges with production, for all the reasons externally. Making that transition needs support. I think many farmers would be keen to do it, but in the short term it is a risk.

Q52 **Chair:** Will you describe what integrated pest management is?

Professor Potts: Instead of relying on a steady application of synthetic agrochemicals to control a pest, it is the use of alternative methods, such as natural enemies, encouraging bio-control, like spiders and Carabid beetles that can chomp their way through pests on crops. It is about having the right habitats on the farm, even introducing managed bio-control agents to help you use chemical pesticides only as an absolute last resort. You go through a kind of escalation, and avoiding those kinds of inputs is one way of doing it. It needs to be well defined and to work for different farming systems, so it is not one case fits all.

Professor Goulson: I broadly agree that getting farming right is key. Approximately 70% of Britain is farmland and there is pretty clear evidence that the way farming has changed is the biggest driver of biodiversity declines. Moving towards a more sustainable approach to food production seems to me vital. There are lots of different opinions on how best you do that. One specific thing that would be really helpful would be to have a national action plan of some sort for pesticide reduction. Within Europe, there is a farm-to-fork strategy which aims to halve the use of pesticides overall. It seems that we completely lack any real strategy or direction on pesticide use, which is clearly vital given that many of these pesticides are insecticides designed specifically to kill the very things we are trying to conserve.

Q53 **Stephen Metcalfe:** David, you said that we do not have a warm, fuzzy, cuddly feeling towards insects. Do you think that is hardwired into us in some way over our development?

Professor Goulson: To some extent perhaps, but most little kids at primary school, given half a chance, love insects. You take them out with a net and pot and go bug hunting. They scream with excitement and run about like headless chickens; they love it. But by the time they are teenagers or adults they seem to lose that; they grow out of it and become frightened of insects. Usually, their first reaction if anything buzzes near them is to try to kill it. Something is going wrong. I think it is lack of familiarity, exposure and knowledge about insects, which brings us back to what was discussed in the previous session about how great it would be if right from the first year of primary school kids got more opportunity to go out into nature and interact with insects and learn about them.

Q54 **Stephen Metcalfe:** Brilliant. You said in an earlier answer that there is a huge knowledge gap in what is driving the decline of insects.

Professor Goulson: There are massive knowledge gaps in the sense that the large majority of insect species are not being monitored at all.

Q55 **Stephen Metcalfe:** In terms of drivers.

Professor Goulson: We broadly agree that there are many drivers and that habitat loss and intensification of farming are probably the biggest ones.

Q56 **Stephen Metcalfe:** Do you think there are any areas where we do have knowledge gaps about the drivers for insect decline?

Professor Goulson: There are some. Light pollution is an example of an area where there has not really been much research. I do not think we have much appreciation of how big a role that plays at present. I am sure there are others too.

Professor Potts: A recent horizon scan about potential future threats to pollinators at the European level, including the UK of course, highlighted

nano particles, nano pesticides and light pollution. I think that is fairly well established; it is probably a major driver. There is also diffuse pollution by particulates coming from vehicles. We have a shift towards EVs, but there are still enough particulates going around. Quite a lot of different things are on the horizon. We are not quite sure about them, but it is likely that with additional research we can probably pin down whether or not they are a genuine threat.

Q57 **Stephen Metcalfe:** Noise at all?

Professor Potts: That is an interesting one. Noise could be. Probably, something like traffic might be a bigger one, in the sense that we are planting verges along roads, which seems to be a fantastic idea, but are we just pulling in pollinators and other flower-visiting insects from the surrounding landscapes and putting them in front of an HGV? That may not be a good thing. We do not know whether or not that is happening. Are we just setting up insects to be more exposed to traffic?

Q58 **Stephen Metcalfe:** But we do know quite a lot. We have lots of areas where we could do more research. Are strategies for conservation being distorted perhaps by our lack of knowledge in those areas? Do we have a strategy that we think collectively will work?

Professor Potts: We know the main challenges and I think we know what works. There are still some open questions about how much, what and exactly where, but we know the general principles, putting in the resources for pollinators and other insects that work. There are two barriers to that. One is the funding to do that. Natural England has a big influence over our protected areas. Many of them are not in good condition for pollinators, so there could be more support there. We have talked about farming and giving farmers the opportunity and encouragement to do the right thing. Farmers are great at growing things, so they will also be good at growing flower habitats.

Q59 **Stephen Metcalfe:** I am glad you brought up farmers because I want to talk a little bit about food security. Do we know which insects are most important for food security and pollination? Is that well-established knowledge?

Professor Potts: To a reasonable extent. Going back to the first panel, Phil flagged up that we have about 270 species of bee in the UK, of which probably about 70 visit most of our crops that require pollinating, but the heavy lifting—80% of the work—is done by about 10 species. That sounds like a tiny amount, but what we need to keep in mind is that those 10 species may vary in different parts of the country. The critical thing is sustainability under climate and environmental change. The identity of those 10 species is likely to change considerably in the future. A small number are doing the heavy lifting, but we cannot rely on them alone because we set ourselves up to be very vulnerable.

Professor Goulson: Simon is focusing on pollinators, but there is a lot more to it than that. We need the recyclers that Erica talked about earlier

which are vital for breaking down cow pats, for example—it is not very glamorous, but it has to be done—and helping to keep the soil healthy, as well as the predators of crop pests. There is a whole extra dimension to this, but we do know broadly which are the predators of crop pests, for example, which are the dung recyclers and so on.

Q60 **Stephen Metcalfe:** Not all crops require a pollinator, but presumably all crops are dependent, for the reasons you have just given, on a healthy ecosystem around them, which will include insects. If there were a decline in insect diversity and prevalence, how great an impact do you think that would have on all the crops grown in the UK?

Professor Potts: It would certainly be significant. It would depend on the extent of the decline, but given that we understand pollination and the risks quite well, I would expect at least as big a risk and impact from loss of natural enemies and predators and an even greater catastrophe coming from below ground biodiversity. All crops require healthy soils, and we already know from quite a lot of the evidence that our soils are being challenged in many places. If you put all those together across the board I would expect food security to be greatly challenged.

Professor Goulson: We know that ecosystem services like pollination and recycling are delivered more reliably the more species are present because, depending on the weather or the precise conditions from one year to the next, one or other species may step in when another one is having a bad year. Diversity is key. This is exemplified by honey bees. People think sometimes that we can do all our pollination with honey bees. That is really putting all our eggs in one basket, which is not wise.

Q61 **Stephen Metcalfe:** I just want to emphasise the point that, while pollination is important, it is not the only reason we need prevalence and diversity of insects.

Professor Goulson: Absolutely right.

Q62 **Aaron Bell:** I want to talk a little bit about the way this is being communicated to the public. You have both addressed the fact that there are a lot of uncertainties in the data. Take, for example, the Buglife study—it sounds like Tracy participated in it herself—in 2022. There was a lot of pushback against that from some researchers and negative responses. They questioned the conclusions and methodology. Obviously, there have been other examples of people pushing back against some of the narrative. Why do you think insect decline studies attract this kind of debate? Why is it contentious? Is it because it is uncertain, or is it because people have interests on the other side of the argument from the side that you two broadly represent?

Professor Goulson: It may sometimes be because people have some vested interest in portraying a different narrative. Sometimes it is just the case that scientists are argumentative and like to disagree with one another.

Q63 **Aaron Bell:** We welcome that.

Professor Goulson: Referring to the Kent splatometer study that you mention, if it was a complete outlier and they found a 60% decline in less than 10 years, it sounds very dramatic.

Q64 **Aaron Bell:** Is it plausible?

Professor Goulson: It seems at the high end of what I might guess is happening, but it is broadly consistent with other rigorous and more scientific studies that have been carried out. We should not rely on any one study, but, given that we have dozens of studies all showing broadly similar things, I do not think that picking on one and trying to dissect it and criticise it is terribly helpful.

Professor Potts: I would not fully agree with that. There was an issue with the communication of the findings. If you read the technical report—like most science, it is pretty dry and you really need to work hard at it, but we are brokers of knowledge and have to present things and the assumptions and caveats—it is a fact that there was a 64% increase in splats. The problem is the secondary and tertiary reporting of that. If you read the technical report, it says, "We don't know their identity." There were some issues about it being just a snapshot, going back to the inter-annual variation of 2004-21. Maybe that was a good or a bad year. We do not know. When it came to secondary reporting, it went from, "There's been a change in the number of splats in this particular circumstance," to, "Insectageddon." That was the real issue.

It is the duty of the science community to communicate not only the main finding but the caveats and assumptions, but it does not make particularly newsworthy or clickworthy headlines, so it is a real challenge. I really like the study. I also drove around the splattered insects and contributed to it. It engaged scientists and got discussions going, and it has been brought up to date. It clearly has a role, but there needs to be a much stronger drive to get a balanced way of communicating that and to be honest about the shortfalls and communicate that as well.

Q65 **Aaron Bell:** We are all in favour of encouraging citizens to take part in science, but is there not a real methodological risk of selection bias? Most of the people who carry out the survey probably want to demonstrate the scale of the problem. Are you not more likely to get negative responses, apart from the other limitations about it being only at road level, it is only a few feet above the road and it does not remotely catch all the insects we have across the country, or more widely? Is there not also a methodological problem that the people who will respond to this are motivated to—

Professor Potts: If you do a survey about people's attitudes towards insects or anything, there will always be a self-selection bias and we need to be aware of that. We should try to encourage a wider representation of different people undertaking these studies, but the point of citizen science is that it is voluntary so you take what you get. If you have sufficiently

big numbers, a good methodology and you communicate well, that is super-brilliant in providing evidence, but if any one of those three does not work quite rightly it could be an issue.

Q66 **Aaron Bell:** I think with our next panel we will look at monitoring in a more traditional scientific way as well. I am pleased that you brought up the word "insectageddon", because the NFU was one of the organisations that submitted evidence to us. It also highlighted its concerns with that study. It said that the narrative was putting unwanted negative attention on farmers, saying it did not think the evidence justified "insectageddon" headlines or insect extinction campaigns, and the blaming that inevitably accompanied that. Its overall perspective is that the current decline that we have seen is due largely to legacy issues and it thinks "we have entered an alternative steady state for pollinator biodiversity in the UK". Do you think that is a defensible position, or is the NFU talking its own book, so to speak?

Professor Potts: Several questions are embedded in that. Maybe I will make a start. I think we are moving to a different state. I do not think we can recreate what we had 50 years ago because so many things have changed fundamentally, not just around farming but everything in the way we manage landscapes.

Insectageddon has been very newsworthy; it has certainly brought up the debate, and if you had to pick a really easy group of actors to be responsible for that it would be the people who apply agrochemicals and pesticides in particular to the landscape. It is not so easy to point to climate change causes. We know there is a lot of information behind that. I think that in one sense farmers are an easy target, but they are a major part of the solution and the NFU is clear about that. It can deliver measures on the ground to help with insects more broadly.

Professor Goulson: It is a shame if it becomes confrontational like this, because we all need food; we all need farmers. We need a thriving farming sector, but we also need to be prepared to accept that the way farming has changed is a huge driver of biodiversity loss and other environmental ills as well: pollution, soil erosion and so on. This is not to blame farmers; it is the fault of all of us that we have ended up in this situation. You could blame Government policies, consumers for what they buy and supermarkets for squeezing farmers. We are all involved and we all have a vested interest in a healthy environment and having something to eat. It is unfortunate that the NFU wants to make this argument.

The claim that we have entered some kind of stable and benign state is ridiculous, frankly. There is no evidence at all that environmental degradation has ceased in this country, or anywhere else that I am aware of. We need to face up to the reality and work together to find a way forward, not try to make enemies of each other.

Q67 **Aaron Bell:** The other study that has attracted a lot of attention and evidence submissions to our inquiry is the 2019 Sánchez-Bayoa and

Wyckhuys review, which is the meta-analysis. Clearly, there are some methodological concerns with that as well, given the fact they were looking only for studies that had the word "decline" in them and so on. I do not want to go into that because we have all read articles and scholarly pieces about that, but it concluded that "insects as a whole will go down the path of extinction in a few decades". That strikes me as definitely over-egging the pudding. Would you describe all this information as potentially misleading, because again it has driven some of this narrative?

Professor Goulson: Undoubtedly. There is no way that all insects will become extinct any time soon. That is an absurd claim. I am not sure the authors actually said that. It was reported in *The Guardian* as "insects may be extinct by the end of the century", or something like that. I do not believe the authors specifically said that.

Professor Potts: In the abstract they do use wording consistent with 40%.

Q68 **Aaron Bell:** That is a quote I have in the brief, which I assume is right.

Professor Potts: Forty per cent. of insects are at risk of extinction in the next few decades. It has not been helpful. It was very comprehensively taken apart by six rebuttals and it is often talked about, so the flaws in it are very clearly stated. You are obviously already aware of several of them, so I do not think it was helpful from the scientific perspective. It also raises the question how it got through peer review. To me, it is absolutely shocking that that should have got through. What it did do was galvanise the wider scientific community to jump in and say, "These are the good studies; these are the ways to do the meta-analysis and the reviews," so it helped in that sense.

Q69 **Aaron Bell:** Is there a parallel to some of the climate change debate we have had where sloppy studies have been used to discredit the narrative more generally?

Professor Potts: Absolutely. Science is not an exact science. The majority is very rigorous, peer-reviewed and high quality, but there will always be things that slip through the net. Of course, if that matches your world view or values, you will cherry-pick that to support your case. I think it was useful because it galvanised the wider community to respond to that. It has also had negative impacts.

Q70 **Aaron Bell:** Do you think that, now, the nuances of this debate are being more widely aired? That is not, bluntly, what we get in our inboxes; that is, an apocalypse narrative, whether it is about honey bees, as Rebecca said earlier, or this or that is going extinct, rather than the fact that this is a very complicated subject. Is that getting across to the public yet?

Professor Potts: It is starting to. There is a lot of work to do by different communities. There is policy, academia and NGOs. We need to work together to get good stories based on facts through, but there is

still quite a lot of momentum that insect Armageddon is what is happening.

Q71 **Chris Clarkson:** On that theme, you have touched on insectageddon and insect apocalypse and the collapse of nature, with *The Guardian* probably misspelling all of them as well. Fundamentally, do you think this has changed the way that people perceive this issue? You talked about people being more galvanised to say this is a good study or that is a bad study. From the public's perspective, do you think it has increased awareness? Do you think this emotive language has helped raise awareness of it, or is this really unhelpful and it has tainted the narrative so that people are perceiving the problem to be something other than it is?

Professor Potts: It is definitely a double-edged sword. It has got the debate into the public domain and people talking about it, so that is a good start.

One of the risks is that if it shows that the scientific community—and this is a great parallel with climate change—cannot agree across the board, that can place the question in the public's mind, "If the scientists cannot quite agree on this, who do we believe?" However, I think the weight of evidence and the shift in scientists communicating better, or working with good communicators, is the key. I think that is happening, but we have a long way to go.

Q72 **Chris Clarkson:** If scientists are disagreeing on it, would that point to the fact that not enough attention is paid to this particular subject and not enough work has been done yet to reach a sound conclusion? Having this slightly unedifying conversation has helped things, inasmuch as it will encourage more people to look into it.

Professor Potts: I think so. There are definite gaps. I would say that the majority of the scientific community more or less agrees on the general trends and status. That is fairly clear. There are critical gaps and support for that will be important, but I think there needs to be support for better communication as well. That is something that scientists are increasingly doing, but we still need to do better.

Q73 **Chris Clarkson:** Is there anything you would like to add, Professor?

Professor Goulson: I agree with Simon. There is no serious disagreement. The scientific community accepts that there have been large declines overall in insect populations around the world. We will argue about the detail endlessly, but there is a serious issue and people should be aware of that. Whether you call it an apocalypse, insectageddon or whatever, there is certainly a serious problem with our insect populations declining and that has consequences for all of us.

Q74 **Graham Stringer:** The first panel were great enthusiasts for insects and the problems that the insect population have. We will produce a report at the end of these sessions, making recommendations to Government. What do you collectively do to influence Government policy already?

Professor Potts: We provide evidence reviews for DEFRA and Natural England; we hold webinars and workshops; we write policy briefs; we talk to our MPs. Basically, we try to distil what is quite often boring or complex scientific literature into a useful form. I think there is a big shift. Certainly, in Reading in any research we do we talk to the potential end-users before we start anything. If it is a policy question, it is like, "What kind of evidence do you need?" If it is farmers, "What kind of evidence do you need?" That will help us frame the research, the way we produce outcomes and how we then translate those outcomes and communicate them.

I think that as scientists we are doing a lot more of that, so it is like a co-development process rather than scientists doing something they find interesting and saying, "Well, this will be interesting to you." I think there is a good move to help support policy and decision making more generally.

Q75 **Graham Stringer:** I have been on this Committee a long time, and we have not looked at insects before. From some of the answers, should our subject have been invertebrates rather than insects?

Professor Potts: Absolutely. We missed earthworms. I love pollinators and I am passionate about pollinators, but if earthworms are under as big a threat as pollinators we are in exceedingly deep trouble. I would say, yes, it would be great to include invertebrates. The all-party parliamentary group on honeybees in 2010 had a similar discussion, and then we changed the name to pollinators because of the realisation to be inclusive of all the key players. We have touched a bit on other invertebrates beyond insects, so it is great to have that question.

Graham Stringer: Thank you.

Chair: Thank you very much indeed, Graham. Can I thank both witnesses for their evidence and that steer for our future inquiries or the remainder of this one? Thank you very much, Professor Goulson and Professor Potts.

Examination of witnesses

Witnesses: Professor Kunin, Dr Bell and Dr Carvell.

Q76 **Chair:** I would like to invite our final panel of witnesses for this morning to join us at the table. I will introduce them. We have Professor Bill Kunin, professor of ecology and deputy head of the school of biology at the University of Leeds. His interests are in spatial population and biodiversity patterns. He is the lead researcher on the DRUID insect monitoring project, DRUID being an acronym that means drivers and repercussions of UK insect declines, which is very germane to our investigation here.

We have Dr James Bell, head of the Rothamsted Insect Survey, Rothamsted being the agricultural research institute.

We have Dr Claire Carvell, an ecologist at the UK Centre for Ecology and Hydrology in Wallingford. Thank you very much for joining us today.

Perhaps I can start with Professor Kunin. Thinking about your study, you have seen repeatedly the question of what we know about insect decline and how certain we can be of it. What are the unknowns? What don't we know in this area?

Professor Kunin: You have heard quite a bit from the previous panels—and I will underscore it as well—that we know a great deal about a few insects. We know a lot about butterflies. We know quite a bit about moths. We know quite a bit about aphids. Beyond that, most of what we know about is modelling from haphazardly collected data and has big confidence intervals around it. We know a lot about a very small subset. Increasingly now, we are trying to add pollinators to that list. You will hear more from Claire about PoMS—the pollinator monitoring scheme. Those are things we know about numbers. Beyond that, we have hazy ideas or models that we think we can believe about distributions, but, ultimately, they are only models. A wider spectrum of actual detailed field surveying would be a lot of help.

Q77 **Chair:** Compared to studies of birds or mammals or perhaps even plants and trees, is there a particular dearth of information when it comes to insects?

Professor Kunin: There is, partly because insects are harder to study. They are so diverse and so variable across time. CEH has the countryside survey, where it has a stratified random sample of the British countryside in which it looks at the plant communities over time. That is fantastic and it is really world-class data, much better than any place else I know. You can do that every five or seven years, and that works for plants because the communities change very slowly, whereas the insect communities ricochet up and down from year to year based on whether it is a warm summer or a wet summer. Things move around so fast that you need to do a lot of work to spot the signal in the noise. I guess it is probably uniquely a problem for insects and other invertebrates.

Q78 **Chair:** Thank you. Dr Carvell, part of your work is responsibility for the pollinator monitoring scheme in the UK. In the same vein, you obviously know what you know through that monitoring scheme, but what are the areas that you do not know much about?

Dr Carvell: The pollinator monitoring scheme was started in 2017 and is able to give us data on a few insect groups that have not been monitored in this way before with structured, repeated standardised monitoring. That includes all our wild bees and hoverflies. We now have five years of data, and that is data, critically, on not just the abundance of the bees and hoverflies, but a whole range of other flower-visiting insects. At the moment, it is showing that those numbers of pollinating species have been fluctuating since 2017, but it provides us with a really solid baseline to use the structured, repeated monitoring at the same sites over time to try to measure change into the future and answer future questions.

You asked what we are still lacking. On PoMS, we have a network of 80 to 90 sites that include the whole of the UK. We have also extended to Northern Ireland. We are repeatedly sampling using water-based pan traps four times a year. Those pan traps generate a lot of insect samples, but not in such huge numbers that they would be considered to be detrimental to populations. At the moment, the funding for that scheme only covers the actual identification, the taxonomy, for the bees and the hoverflies in those pan traps. While the pan traps are considered to be a really effective passive way of sampling the insects that have received such little attention in the past in this way, about 95% of what we are catching is not going through the full taxonomic pipeline to give us really useful data. We are archiving it.

Q79 **Chair:** I see. Who funds the study?

Dr Carvell: It is funded jointly by the UK Centre for Ecology and Hydrology and the JNCC. The JNCC funding is received through DEFRA, the Scottish Government, the Welsh Government and DAERA in Northern Ireland.

Q80 **Chair:** Not through the research bodies and not through the research councils, for example.

Dr Carvell: Because just under 50% of the scheme is funded by UKCEH, that means that—

Q81 **Chair:** What is CEH?

Dr Carvell: The Centre for Ecology and Hydrology. It is indirectly funded through the money that CEH receives as part of its research council funding. The budget is about £216,000 annually.

Chair: £216,000.

Dr Carvell: Yes.

Q82 **Chair:** That is pretty low in the scheme of other research projects.

Dr Carvell: The challenge we had in designing this scheme is that we have thousands of insects to monitor. How do we go about choosing the methods that are appropriate to give us the metrics that we really need? Ideally, we want to be able to feed into DEFRA's biodiversity indicators, and some of the newly developing abundance targets that are looking to see how we can reach these targets for the 25-year plan. In designing this scheme, we have simply had to rely on volunteer recorders. The good thing is that we have a blended approach where we have those volunteers being highly supported and highly trained by experts and professionals. The final thing I would add is that the project has allowed us to recognise the expertise of taxonomists for the bees and the hoverflies, and we are able to pay them for the work they are doing to identify the specimens that we are collecting.

Q83 **Chair:** I can understand that. Do you have any views on why the funding

is so low in a context in which the public research budget is doubling to £20 billion compared with what it was a few years ago and there is a big increase in the research councils' funding? Why is your field not getting the benefit of that?

Dr Carvell: That is an interesting question. The subject of insect pollinators received a really good, joint funding boost in 2010 when we had the insect pollinators initiative. A number of us in this room were involved in some really critical research projects as part of that. The ecological research is well funded, but the long-term monitoring is difficult. We need timescales of more than five years, and we do not often see grant round proposals coming in for that period.

Q84 **Chair:** That is a feature of a lot of calls from the research councils; they are for relatively short periods, whereas you are talking about a longer period.

Dr Carvell: Absolutely, yes.

Q85 **Chair:** Let me turn to Dr Bell before going to my colleagues. You are responsible for the Rothamsted Insect Survey. Could you say a bit about that? What are the unknowns? Since we are talking about it, give us your reflection on the funding of that.

Dr Bell: You may know a book published in 1962 by Rachel Carson called "Silent Spring". That motivated scientists at Rothamsted to think about how they could communicate with farmers to reduce the prophylactic use of insecticides, and that has been our mandate since 1964. We issue bulletins every week during the aphid season. We now text farmers. In the olden days, they used the post, and it was a bit slower. Our funding since 1964 has been continuous, and that is perhaps a model for other schemes. We have an opportunity here looking at agriculture—

Q86 **Chair:** Is it direct from DEFRA?

Dr Bell: BBSRC.

Q87 **Chair:** It is from the relevant research council, the BBSRC.

Dr Bell: It is a five-year funding round. We bid for it in the following five years, and then we have various performance indicators we have to achieve. We are also tasked with communicating and moving our science outside the labs into the field and sharing our knowledge with both scientists and farmers.

Chair: Let me turn to my colleagues now, and first is Chris Clarkson.

Q88 **Chris Clarkson:** Professor Kunin, DRUID is about halfway through its funding now. Can I ask you at this stage what you have learnt?

Professor Kunin: At this point, as you say, we are halfway through. We have collected the data from more than 4,000 insect species. We have now worked those through the models. We have about 1,400 species for

which we have managed to get the data to a quality that we can model it. Some of those species are increasing; some of those are decreasing.

One of the things that we have developed so far is a tool called ROBITT, which stands for risk of bias in studies of temporal trends in ecology, looking for ways we can flag up which of these datasets we can believe are credible and which ones are so biased by the locations or the times when the data is collected that we cannot really trust the models that come out of those. Hopefully, the models that we are coming up with are one notch better.

We have then started taking those and comparing them to the standardised monitoring for those groups that are standardised monitoring. That is pretty far along for freshwater insects, for which we have standardised monitoring from the Environment Agency. The next step is to take that further and look at moths and butterflies where we can have standardised monitoring.

Beyond that, we have been developing tools to try to use weather radar to monitor insects in the broad scale. We have got to the point now that those data streams are cleaned up. We have not yet been able to work out what the patterns are, but we are now getting to the point where we have the data to analyse. We have some improved methods for studying the drivers of change, and, again, at this point we have tried them on butterflies and moths because that is where the best data are. Those are explainable neural network methods that are being developed at Rothamsted. Those should be able to help us map which species are being driven by which drivers.

Some of the work at Reading has been looking at linking the dynamics of insect populations to the dynamics of bird populations. So far, they have done blue tits and how their population changes are being affected by insect population changes. There is a lot going on so far, but we are only halfway through the project, so obviously there is a lot more to come.

Q89 **Chris Clarkson:** Picking up on that and something that both your colleagues have said, do you think four years is an adequate amount of time to conduct this kind of survey, or would you have preferred more time?

Professor Kunin: Obviously, I would prefer more time. There is a different issue between a research project like DRUID and monitoring. Ultimately, if you want to have a value in a standardised monitoring programme, you have to maintain it for a long time. There is an awful lot that happens in the same populations in very short timescales. There are big differences from one year to the next. There are big differences from one day to the next. If you have a hot day and a cold day, you will have vast differences in the numbers you catch.

The questions we are trying to answer are those long-term questions. We really could only answer those long-term questions with continuous,

standardised work that gets done in the same way over and over again. It is not sexy. It is driven by big questions. Often, it will answer the next question, the one that we are not asking now. That really needs long-term monitoring. That needs long-term funding. Even the five-year funding cycle that the Rothamsted Insect Survey faces is too short. It ought to be decadal and where you have security that you know it is going to be measured in the long term.

Q90 **Chris Clarkson:** Essentially, what you are getting is a relative snapshot rather than the overlying trend. If you had a bit more time, you would actually be able to extrapolate that data further and see some of the bigger picture.

Professor Kunin: For insect populations, we know from PoMS that in the five years we have there are really high years and low years and so on in different sites. Before we really know what is happening to the pollinator populations over the long term, we really need another five years and probably another five years beyond that, because, ultimately, it takes that time to average out all the good and bad years and the good and bad days to get some sense of what is really happening.

Q91 **Chris Clarkson:** Thank you very much, professor, although I will disagree with you; it is actually quite sexy.

Dr Bell, how does the data that is gathered from the Rothamsted Insect Survey directly feed back to farmers and to policymakers?

Dr Bell: I mentioned the aphid bulletin—we have 20 species of aphids, the most pernicious species of aphids to our culture—which we communicate on a weekly basis. We now use our website. We use SMS. We also receive calls from those farmers who are concerned and need to know more information about a certain change. That information is not for them to go and spray. They still go and inspect their crops. We encourage them to do that because each field is different. We also issue pre-season forecasts. In the early 1990s, we had enough data—and that tells you about the long-term data; we started in 1964, remember—to start forecasting populations of aphid.

We issue cereals, brassicas and sugar beet forecasts. Sugar beets are notable because recently DEFRA has linked our forecast to the derogations of neonicotinoid seed coatings in sugar beet. The forecasting is essential. The first flight that we have predicted is essential. It basically tells the farmer, "The season is starting. Be aware. Go and inspect your crops because, now, things will change." Although we can chart regional changes, those changes may not be seen in an individual field. We must engage with farmers all the time and bring them into the conversation.

Without this data, you would have no knowledge. Without this data, I bet we would have more prophylactic spraying because farmers do not necessarily have time to inspect their crops but benefit from the information that we provide for them to make a change.

Q92 **Chris Clarkson:** If you do not mind me asking, how accurate are those forecasts? How often do you get it spot on, and how often do you get it wrong, or is it more of a general trend? I know you mentioned that it is a regional picture; it is not field by field. You cannot go that granular. How close are you to the facts on the ground?

Dr Bell: That is a good question. Your first question, Chair, was about what data we are missing. We transmit the data. The information we receive back is really very small. There are a few crop consultants who feed us information and say, "Do you know what? This is really good. I have seen this, that and the other." That is by far the minority. We are blind to what is happening in the field. The validation process is not there. We would like that information. That is one of the ideas I think we could go forward with in terms of the new Agriculture Act and the sustainable farming initiative. If we could collect the information and we could all share that information wherever we are and see that information, we can then make decisions on it. That is vital.

You asked about differences. The best system we have is, of course, sugar beet. Sugar beet is under contract. We know how many sugar beet contracts there are, where those contracts are, the size of the fields—all the metadata you might want to make a decision. If I just turn to my little chart here, in 2020, when we had the outbreak year in sugar beet, some farmers were losing 100% of their crop. That equated to something like £550,000 per individual farmer in places like Cambridgeshire and elsewhere. There were massive losses. Some left the industry as a result.

That was the argument for the derogation. Despite the fact that neonics had been banned in Europe in 2018, can they come under derogation if the incidence of yellows virus, the virus that affects sugar beets and determines their ultimate yield, is shown to be extremely high and above some trigger? DEFRA sets the trigger. We independently produce the forecasts, as we have done since the 1990s, and then DEFRA uses that information. We are not directly engaged with DEFRA. It just uses the information to make its decision to say whether or not there will be a seed coating. We have to produce a national figure, but there is huge variation, as you say, with that national figure.

Behind the scenes, we have our own confidence intervals about our forecasts. They fall within a range, and that is important. In 2021, we got it right. The derogation trigger was 9%. We forecasted 8.37%. The actual rate on the ground, because of the system, we know, was 2%, so that is pretty good. No neonics were used, and consequently 80,000 hectares of sugar beets were not coated with neonics. That is a good win.

In the last two years, we predicted much higher levels. We are seeing a change in the climate. Temperatures are warmer. Aphids are responding. They are flying earlier. As a consequence, even before a single seed has been planted and even before a single aphid has flown, we have to predict for August on St David's day on 1 March what the virus levels will be at a national level. It is a huge challenge. We get it reasonably

accurate. Show me any forecast that gets everything right. There isn't one.

Chris Clarkson: That is super. Thank you very much, doctor.

Q93 **Rebecca Long Bailey:** I have a very general question. How important are long-term survey studies in collecting evidence, and what is actually considered long term, Professor Kunin?

Professor Kunin: They are exceptionally important. At this point, the biggest problem is that they are too narrow. We have long-term surveys for a few things, and now we are beginning to have increasingly long-term surveys for pollinators, but those only started in 2017.

One of the problems with monitoring is that you only really find the value of it if you have started it before the problem starts. I remember hearing an interview on the radio where someone said, "We're not sure whether the neonic ban will solve the problem of pollinators, but after a couple of years of it we'll know." No, we will not. Because no one was monitoring pollinators before the ban, we do not have any baseline data to compare it to. We do not know whether the new neonic ban helped pollinators. The farmers who stopped using neonics started using other pesticides. Were those worse or better? I do not know.

You ultimately need to have monitoring begin well before the policy that you are trying to test with it. That requires a continuous process of long-term monitoring. You need to be monitoring the thing that becomes the next problem we want to deal with. It is partly also having a broad enough spectrum of things covered that the next problem is something that we are looking at.

One of the things we have been doing in DRUID is talking about the aphid data. Much of the aphid data comes from a series of suction traps, which are tubes 12 metres up in the air that are sucking whatever happens to come past. The aphids from those are sorted out. All the rest of the by-catch is sitting in little tubes and stored in a warehouse at Rothamsted someplace. Part of what we have been doing in DRUID is sorting through some of that by-catch. We cannot afford to do all of it, but we have used six of the sites every fourth day just as an arbitrary way to keep it as a manageable task.

In doing that, we have sorted through 500,000 insects of all the different groups that just happen to be up in the air at 12.2 metres. That begins to provide us some sort of broader time series. Beyond that, how long is long term? I think you need at least a decade because the interannual variations are just so huge.

Rebecca Long Bailey: Thank you. Dr Carvell.

Dr Carvell: If I might just clarify the question about the DRUID project, the real strength of it is that it may be running for only four years but we are processing and modelling thousands and thousands of biological

records stretching back 30 or more years. The strength is in having the expertise within the four research teams that are collaborating on this project, and the strength of the underlying datasets that have been made openly available to us to do this.

That brings us back to what Erica said in the first session: the strength of the national recording schemes that are co-ordinated by the Biological Records Centre at UKCEH. We have thousands of records. More than 70,000 people are submitting well over 1 million records per year. Yes, we know that those are not collected in a structured way. They are not collected in the repeated, what we might call standardised fashion that the Rothamsted Insect Surveys are or the pollinator monitoring scheme, but those long-term records have allowed us, with some quite challenging statistical analysis that has been developed, to inform our biodiversity indicators and our conservation targets to date.

Q94 **Rebecca Long Bailey:** Thank you. Dr Bell.

Dr Bell: You have captured everything, Claire. It is a very good summary of the DRUID project. It is an enormous amount of data. It is 30 years' worth of data. It is largely citizen science data. Standing out from that is the insect survey with its abundance data.

If I only had one message, it would be that we should commit to a clone of the insect survey elsewhere doing other things and have the long vision to fund that for not just the usual three or five-year cycle but a decent amount of time to show real evidence that agriculture has changed, for example, or that the carbon capture environments are still supporting insects.

All those important matters very high on our agenda could be solved by some commitment, and it would be a small amount of funding. The insect survey gets £2.2 million over five years. It is not a huge amount of money any more. With the help of volunteers, we run light traps throughout the country. There are 80 of those. There are 16 suction traps, the upside-down hoovers that Bill referred to in England and Scotland, and we use that very efficiently to inform agriculture and the wider environment and its changes.

Q95 **Graham Stringer:** I have a few questions on monitoring technologies. What are the pros and cons of using passive techniques like cameras and sound recordings as against capturing insects using traps?

Professor Kunin: There are increasingly good methods of trying to identify things from visual records. Sound recording is a little bit less good for insect monitoring. There are a few things like bush crickets. There is a retired member of staff at York who has been working on an AI method for identifying bush crickets by their calls, but with most of the insects you are not going to get very far with acoustic recording. Visual recording will do okay for quite a few species.

We have recently bought a unit developed by Naturalis, the natural history museum of Holland, that is trained on image recognition for Dutch insects. Most British insects also live in Holland, so we are trying to see whether it works here as well. We have only just received that. I cannot tell you whether it works yet. That will tend to work for the big, conspicuous insects. There are quite a few insects you can only tell apart by dissecting their genitalia, and the best camera in the world is not going to do that. You can get pretty far, but you cannot get down to species level, probably.

Q96 **Graham Stringer:** It is horses for courses.

Professor Kunin: Until these AI devices started being developed, you could basically count how many insects you saw and not really what they were. Gradually, we are getting to a point where the technology is improving, but it probably will not get down all the way to species level.

Dr Bell: We have deep learning models and image analysis on our phone. We have various apps to identify both plants and insects. I walk around with them. They are very useful. They may reveal a new taxonomy that we are not currently using. We are using deep learning models in aphid identification. All those small blobby insects that are not charismatic in any way have little information in terms of what a computer sees, but what a computer may be able to do is look at the curvature of the abdomen or the cord or the antenna and say, "Actually, this is really important"—something that we humans cannot do because we cannot measure those sorts of angles. It actually may bring a new taxonomy, a digital taxonomy, to us that we do not know.

Q97 **Graham Stringer:** We are running a concurrent investigation into AI. Do I take from what you are saying that you see an increase in the use of AI for monitoring insect populations?

Dr Bell: I am sure we are all the same; CEH, Leeds, Reading and Rothamsted are all being contacted by small spinout companies wanting to start a new AI business in wildlife monitoring, looking ahead to the sustainable farming incentive that will require some sort of biodiversity monitoring in the future. There are things you can do now with butterflies and moths, those things that are very colourful and large. They are definitely doable. The challenge with agriculture is that all the small blobby things, the mites and the insects, are really hard to identify both by humans and by AI, but they are the things that increase our food insecurity. The low-hanging fruit of butterflies has been done. That is good. It is great. It shows proof of concept. But the real hard challenge is with very small insects.

Chair: Thank you very much. I was going to go to Stephen, but you have covered some of the answers on artificial intelligence, unless there is anything further on that, Stephen.

Q98 **Stephen Metcalfe:** Not on the AI. That was covered pretty clearly, but I

have a question on the role of citizen science, if I may. How much of our knowledge about the abundance of insects generally is reliant on non-experts and citizens? Do we want to promote that? Do we want to replace it with something more formal, or is there a role for both?

Dr Carvell: I think we can say that our knowledge has been reliant on collaborative, productive working between volunteer citizen scientists and scientists and academics. Again, as we have heard, it is the volunteer citizen scientists who are generating the data, generating the records of insects, and that might be on what we refer to as these national recording schemes where they record wherever and whenever they choose. That data may be uneven in coverage, and, as we have said, there are some challenges interpreting it.

It is mostly volunteers who are also collecting what we call the more structured, standardised data. There are hundreds of volunteers in the butterfly monitoring scheme, volunteers putting out moth traps as part of the Rothamsted Insect Survey, and now we have hundreds of volunteers taking part in the pollinator monitoring scheme. Yes, they are providing the data, but the critical infrastructure that they need is the support, the training, and the tools to be able to interpret what they are seeing.

In the pollinator monitoring scheme, we have developed an app to go with our 10-minute flower-insect timed count. The interesting thing about that is that it is not just asking people to either photograph what they see and send that in or, indeed, just to look at bees and butterflies; it is asking them to look at every insect that lands on a flower and think, "What is this insect? What group does it belong to? Is it a fly? Is it a bee? Can I differentiate between a honeybee and a bumblebee?" That is moving us closer to having more people coming into that mid-tier where they might be more motivated to look at taxonomy and find out what things are.

Professor Kunin: Under the umbrella of citizen science, there is a wide range from people who are effectively the foremost experts on their taxa in the country down to people who are schoolchildren or other volunteers with very little entomological knowledge. The participation of people in monitoring in the less expert end of the spectrum is still useful for telling us about the overall visitation rates to flowers, which is a big piece of understanding pollination services even if we do not know what those things are. Hopefully, it also serves an educational role and gets people interested in insects. Maybe that then starts them on a ladder of gaining the skills and knowledge so that, ultimately, their data becomes more valuable. If we can find the tools to bring them in and to upskill them over time, their data becomes more valuable.

Q99 **Stephen Metcalfe:** You have talked about coverage. Presumably, if there is a value in citizen science, even if they do not have the entomological expertise that you would like, is that coverage spasmodic in the sense that there are pockets where you do not have coverage, and would it be useful to bridge those gaps? If so, how do you do that? How

do you reach out to perhaps the harder-to-reach areas and involve more people in this?

Dr Carvell: It is a great question. It is something that the scientists within the Biological Records Centre group at CEH are thinking about a lot. This is where the research expertise comes in to support the citizen scientists in basically telling us a little bit more about what we really want to know. With the record-based observation approaches, we have had a recent project called DECIDE, which looked at the distribution models of species occupancy and asked, "Where are the gaps? Where do we probably know that these species do occur, but we simply haven't been receiving records from them?"

Let's face it, we know that most natural historians or most people interested in looking at wildlife are less likely to spend all their time in an arable crop than they are out in a beautiful nature reserve. The DECIDE project has been able to use real data to nudge recorders and say, "If you could visit this site, it would really help to inform our model and increase the precision of the trend estimate that we get from that model of change in distribution."

There is also an opportunity to involve a lot more players in the citizen science. I want to take the opportunity to mention including farmers in this as well. With going out to a lot of landowners on the pollinator monitoring scheme, it is a passive sampling and an active sampling scheme. We are having to interact with the landowners to have permission to sample. They are very interested. If we can support them with the right training support and tools, they could be a really important group to help us to gather more data.

Q100 **Stephen Metcalfe:** Brilliant, thank you. I have one final short question. We talked about technology in the previous question. My colleague, Graham Stringer, brought up AI. Do you think there is a role for AI, not necessarily in identifying species but potentially looking at the mapping that you have, looking at the data, and filling some of those gaps? Maybe you already use AI for that.

Dr Bell: With the artificial neural networks that Bill referred to earlier, the distribution and the occupancy of insects is mostly determined by citizen science. They have their places where they go. They cannot go to all the places around Great Britain after all. So you can use AI to say, "Based on what the drivers of this species are in terms of temperature or habitat, where are those conditions occurring that they have not been?" That is a really quite complex problem. You cannot do that with a simple model. It is in the machine learning world that artificial neural networks exist, and they can provide the answer.

Outside DRUID, one of the projects we have been involved with in the insect survey was really quite profound. I gave Johan, the artificial neural network modeller, some data from the insect survey and said, "If we wanted to put another site in, where would we put it?" I did not realise at

the time, but I had not given him the new site of York. His model came back and said, "You need to put one in the Vale of York." I kid you not.

Q101 **Stephen Metcalfe:** That is where you had already just put one.

Dr Bell: Yes.

Q102 **Stephen Metcalfe:** That is a great way of testing the neural net, then.

Dr Bell: Yes.

Q103 **Stephen Metcalfe:** Very good. Who runs that model? Who owns that?

Dr Bell: Within DRUID, this is a project-level activity. It is within Rothamsted to deliver that for DRUID, but other machine learning models, presumably, are being considered and run.

Q104 **Stephen Metcalfe:** Written by yourselves.

Dr Bell: Yes. The important thing about any BBSRC, NERC or UKRI-funded piece of work is that that information becomes widely available. On publication, we make that information available so you could see the code.

Dr Carvell: UKCEH is also looking quite heavily into automated camera systems that use artificial intelligence, particularly at the moment for moths. I believe we have a new partnership with the Turing Institute as well. This brings us into new areas of collaboration that could be really productive.

Professor Kunin: Similar artificial intelligence systems are being used to try to understand the weather radar insect data. There is very little taxonomic level of precision in that data, but you can see that the shapes of insects rapidly change around sunset. There is a whole series of insects up in the air, and then the sun sets and there are different insects up in the air. The machine learning can at least spot that the insects are changing. How far we are going to get to be able to say that these are those insects or these, I don't know.

Q105 **Stephen Metcalfe:** We are in the foothills of that at the moment.

Professor Kunin: Yes.

Stephen Metcalfe: Brilliant. Thank you very much.

Chair: Finally for this morning, Chris Clarkson.

Q106 **Chris Clarkson:** Stephen covered a lot of what I wanted to ask, but, going back to citizen science, it is clearly very important to the field of entomology. As Dr McAlister said, you are relying on people who are not being paid to do quite a lot of the heavy lifting here. What opportunities are there to expand and develop the role of citizen scientists in entomology? Do you think there is a place for funding agencies or the Government to take the initiative on this, or do you think it is something that has to be entirely citizen-led? I will ask Dr Carvell, if I may.

Dr Carvell: There are definitely some opportunities. In the insect world, we could do with looking at some other projects going on that are exploring different types of approaches. I have just been learning about a new project with the Rivers Trust that is looking at a step change in the contribution of citizen science and community monitoring to evidence-based catchment management, and moving into options like sustainable finance solutions to interest a wider range of players in supporting this.

We also know that getting involved in citizen science and getting up close to nature has a significantly positive impact on people's wellbeing. There is increasing discussion in the sphere of green prescribing to help bring people in.

The key point underlying all of this is that, while there are lots of opportunities to involve more people, we need to make sure that we have a balance between the number of people coming in and the amount of high-quality data that we can use at the end of the day to generate the metrics that we need. Provided the tools, the informatics and the systems are in place, that is definitely possible.

Professor Kunin: One thing I would like to flag up quickly is that the Wellcome Sanger Institute has set up something called the BIOSCAN initiative, which involves citizen scientists setting up what are called Malaise traps, which are things that catch whatever flying insects are coming past and then individually plating them up into wells for molecular analysis. Ultimately, they will be trying to sequence the DNA from these species and get them down to species-level identification genetically. It is just starting up. It is not just in Britain; it is happening globally. They are beginning a process that will involve citizen scientists all over the world using a standardised collection method and then sending their assessments for genetic analysis.

Q107 **Chris Clarkson:** Presumably, something like that requires a level of training before they start doing it. You cannot just grab somebody off the street and say, "Start sequencing." How much enthusiasm have you detected for that? How many people are willing to commit that kind of time and study to do something like that?

Professor Kunin: I do not think they are doing a whole lot of the DNA analysis themselves.

Q108 **Chris Clarkson:** Yes, they are just doing the catching.

Professor Kunin: They are doing the catching and they are doing the manual labour of making sure they have one insect per well in the plates, but then they are sending them off to the Wellcome Sanger Institute to do the sequencing.

Q109 **Chris Clarkson:** It is not three weeks in night school before you start it.

Professor Kunin: Putting up your Malaise trap properly will take a little bit of training.

Dr Carvell: There are large numbers of volunteers who are undertaking free training to be able to put moth traps out and developing their moth ID skills. With the pollinator monitoring scheme, we have about 60 people who are committed to going out four times a year and spending a whole day surveying to bring back pan trap samples, and they seem to get a lot out of it. We have a good bit of feedback from that.

Chris Clarkson: That sounds good. Thank you.

Chair: Thank you very much, Chris. Can I thank our witnesses: Dr Carvell, Dr Bell and Professor Kunin? That concludes our first session of evidence on this important new inquiry. I am very grateful to all our witnesses this morning. That concludes this meeting of the Committee.