HOUSE OF COMMONS LIBRARY

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Bees and neonicotinoids

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Summary

This briefing from the House of Commons Library concentrates on the interaction between bees and a group of insecticides, known as neonicotinoids.

Neonicotinoids have been in the spotlight after a number of studies yielded evidence that they have sub-lethal, harmful effects on bees. However, much of that evidence is contested and the picture emerging from the numerous scientific studies on bees and insecticides is complicated and nuanced.

Key points are:

- The use of three neonicotinoid insecticides - clothianidin and imidacloprid (made by Bayer) and thiamethoxam (made by Syngenta) - has been subject to 2 year precautionary restrictions in the EU since December 2013. This is based on concerns that they have sub-lethal but still harmful effects on bees.
- The UK Government has implemented the restrictions but did not support them because, in its view, field trial evidence did not support the restrictions. The Government believed that there had not been sufficient analysis of the impacts of the other insecticides that would be used instead.
- The EU Commission is currently reviewing the restrictions taking into account "relevant scientific and technical developments". The European Food Safety Authority was expected to complete a review in January 2017, but nothing has yet been made public.
- The restrictions are not time-limited and will stay in place until the Commission decides to change them.
- After leaked draft regulations were shared with the *Guardian* newspaper, it was reported in March 2017 that the EU was preparing regulations to ban the use of neonicotinoids.
- The NFU applied to use neonicotinoid pesticides on 11% of the oil seed rape (OSR) crop in England in 2017. It was announced in April 2017 that, on advice from the Expert Committee on Pesticides, Defra had refused the applications.
- An application for an emergency authorisation in 2016 was also refused.
- In July 2015, the UK Government granted an emergency authorisation for the use of restricted neonicotinoids on OSR seeds after an application from the National Farmers' Union (NFU).

This briefing therefore examines:

- The risks that neonicotinoids might pose to bees and the evidence for those risks (and conversely the risks of not using neonicotinoids)
- Bee health: why are numbers declining?
- The UK's restriction on neonicotinoids
- The UK emergency authorisation in 2015 and unsuccessful applications for authorisations in 2016 and 2017
- How pesticides are regulated at the EU level and in the UK
- EU Commission restrictions imposed in 2013 and
- Scientific studies and reviews in recent years and before the imposition of the restrictions in 2013.

In a nutshell

Bees and other pollinators, such as moths and butterflies, play an important role in natural habitats and food supply by pollinating crops and wild plants.

Pollinators, including bees, are showing declines worldwide but, although the overall trend is downwards, this is not universal and not all species are declining. Some are threatened whilst others are extending their ranges. The same bee species that are being found to be threatened at EU level are not always the same as those that pollinate commercial crops.

Where declines in bee health and bee numbers have been observed, a number of factors - such as disease, habitat loss, climate change and pesticides – are thought to have contributed.

There has been increasing scrutiny of the harmful, sub-lethal impacts of pesticides in general and neonicotinoids in particular on bees. There are numerous scientific studies on bees and pesticides, but neonicotinoids' effects are not yet fully understood (and differ among neonicotinoids). There are gaps in the evidence - some of it is contested and sometimes contradictory and there are disparities between laboratory and field study results. The methodology of some studies has also been questioned; manufacturers have (broadly speaking) argued that the doses used in some laboratory tests are far higher than bees would encounter in the field and so unrealistic compared to field conditions.

Although the evidence is not conclusive, the EU, acting on the precautionary principle, took action in 2013 and imposed restrictions on the use of three neonicotinoids - clothianidin, imidacloprid and thiamethoxam. These controls are often spoken of as a *ban*, but neonicotinoids may still be used in certain situations and so it is more accurate to describe them as *restrictions*.

The UK government did not consider that the evidence merited this action, but abided by the restrictions, although it's granting of emergency authorisations for neonicotinoid use in 2015 prompted concern in some quarters that it might seek to overturn the restrictions.

For policy makers and other concerned bodies, the situation remains contested and unclear: an October 2015 review statement by a group of pollinator experts concluded that the evidence still does not provide a clear steer for policy makers in relation to neonicotinoids.

The European Food Safety Authority (EFSA) was expected to complete a review of available data on the risk to bees from clothianidin, imidacloprid and thiamethoxam, update its risk assessments and report to the Commission in January 2017. Nothing has yet been made public and there has been speculation that the EFSA report might not appear until September 2017.

What do we know about bee health?

In the UK, wild bees and other wild pollinators have declined in number in the last 50 years, with changes in the species reflecting changes in our landscapes. Managed bees in hives, though, are faring better; their numbers in the UK are recovering from large losses due to the Varroa mite in the early 1990s.

Pollinator strategies set out (broadly speaking) to support pollinator populations and enable their survival and success. There are pollinator strategies for England and for Wales and an All-Ireland strategy, as well as one being developed in Scotland, to tackle adverse impacts on bees and other pollinators beyond pesticides.

What are neonicotinoids?

Neonicotinoids are widely-used insecticides. They were developed in the 1980s and 1990s and were the first new class of pesticides for 50 years. They have low mammalian toxicity, which has made them an important means of crop protection. Bayer CropScience and Syngenta are the main producers. Neonicotinoids are systemic, which means that they can be applied to the seed before sowing (a cheaper method of application) and will be taken up by the whole of the plant including the pollen and nectar.

Clothianidin, imidacloprid and thiamethoxam have been restricted for use at EU level since December 2013 (and there were controls before that). Imidacloprid was listed as an approved substance on 1 August 2009. Clothianidin is listed as an approved substance as a seed treatment only when measures have been taken to minimise leakage into the environment.

Are neonicotinoids bad for bees?

The Centre for Ecology and Hydrology (CEH) suggested in August 2016 that neonicotinoid use is linked to large-scale and long-term decline in wild bee species distributions and communities. Other, more recent studies are mentioned below.

Manufacturers of neonicotinoids, on the other hand, have generally argued that they are unlikely to be responsible for declining bee health or bee numbers and that the alternatives (such as organophosphates) might pose greater risks. On its Bee Care website, Bayer points to the many factors influencing bee health and bee numbers and maintains that realistic field studies show no harmful effects to bees from neonicotinoids.

Similarly, the relationship between restrictions on neonicotinoid use, crop damage and yields is contested.

The Crop Protection Association (CPA, which comprises 22 companies from the UK plant science industry) responded to the CEH study, arguing that neonicotinoids were important for farming and food production and there was no evidence that restricting them helps bee populations. The CPA pointed to the links between the decline of wild bee populations and several other factors – especially the Varroa mite.

The NFU in England and Scotland claimed in 2015 that the restriction on neonicotinoids had caused heavy losses through oilseed rape crop (OSR) damage from pests.

The most recent figures, available in the ADAS Final Harvest Report 2016, indicate that yields are down: the national yield estimate for winter OSR was 3.0-3.2 t/ha – an 11-17% decrease on the five year average (3.6 t/ha). Commenting on the poor harvest and decreasing OSR area, the NFU said in November 2016 that it was reviewing the way forward, as OSR production might be in jeopardy if neonicotinoids remained restricted.

The Humboldt Forum for Food and Agriculture in 2013 (in a report funded by Bayer CropScience and Syngenta) estimated that the overall cost of a ban could be as high as €4.5 billion and, over a five-year period, put one million arable production jobs at risk across the EU. *Farmers Weekly* reported in August 2015 that the restrictions on neonicotinoids had cost farmers £22 million: £7.8 million for alternative chemical use, £11.4 million for applying the chemicals and £2.3 for crop lost and not replanted.

Wildlife and environmental groups take a different view.

In an open letter to the UK government in December 2016, to mark the third anniversary of the restrictions,18 wildlife and environmental groups argued that it was "clear that there is now more than enough evidence to retain the ban and extend it to all crops, and

that this is essential to reverse the decline of bees and other pollinators", although the NFU disputed these claims. The Wildlife Trusts are calling for an outright ban on neonicotinoids. Friends of the Earth (FoE) also continue to call for a ban on neonicotinoids. In a report published in January 2017, looking in particular at the use of clothianidin on wheat, FoE urged the UK government to "commit to a comprehensive ban now that will apply whatever our future relationship with the EU". The RSPB continues to be concerned about neonicotinoids' potential effects on biodiversity.

What restrictions did the European Commission impose in 2013?

The European Food Safety Authority published an assessment in May 2012. This led the European Commission to restrict the use of imidacloprid, thiamethoxam and clothianidin for two years from December 2013.

Will the EU now ban the use of neonicotinoids?

These restrictions will stay in place until the Commission decides to change them. A review of the evidence was promised after two years – in other words by 2015 - but that was expected to be published in January 2017. There has been speculation that the EFSA report might not appear until September 2017.

After leaked draft regulations were shared with the *Guardian* newspaper, it was reported in March 2017 that the EU was preparing regulations to ban the use of neonicotinoids. Commenting on the leak, the *Guardian* suggested that, although there was only limited evidence to link pesticide exposure with falls in overall bee populations, the European Commission had decided to act on EFSA's risk assessments.

What is the UK government's stance?

The UK Government did not support the restrictions but has implemented them in full. The Government was reluctant because, in its view, field trial evidence did not merit the restrictions; the Government believed that there had not been sufficient analysis of the impacts of the other insecticides that would be used instead.

What does the scientific evidence say?

It is sometimes asserted that neonicotinoids must be harmful to bees, but the picture emerging from the numerous scientific studies on bees and pesticides is more complicated and more nuanced.

Already this year there have been studies published, attempting to shed more light on the interaction of factors such as exposure to neonicotinoid pesticides and bee behaviour and health:

- Woodcock *et al* (2017) used large field experiments to assess the effects of crop treatment with clothianidin or thiamethoxam on honey bees and wild bees in Germany, Hungary and the UK. They found that neonicotinoids reduced bee species' capacity to establish new populations in the year following exposure.
- Baron *et al* (2017) examined the effects of field-relevant doses of one neonicotinoid, thiamethoxam, on wild queens of four bumblebee species and found that two weeks' exposure led to a reduction in feeding in two out of four species, with evidence too of effects on ovary development in multiple species of wild bumblebee queens.
- Klein *et al* (2017) found that "even at low intensity levels, many stressors damage the bee brain, disrupting key cognitive functions needed for effective foraging, with dramatic consequences for brood development and colony survival".

- LaLone *et al* (2017) concluded that "sufficient biological plausibility exists to link activation of [nicotinic acetylcholine receptors by neonicotinoids] to colony death."
- Schick *et al* (2017) found that data in a 2013 study of thiamethoxam funded by Syngenta - which had concluded that there was no evidence of detrimental effects and so thiamethoxam posed a "low risk" to bees – had not been sufficiently analysed and so the 2013 study's findings were both misleading and unacceptable in principle.
- In preliminary findings from a study reported in *Farmers Weekly* in December 2016, *Dr Penelope Whitehorn* at Stirling University found that bees' ability to produce the buzz needed to shake pollen from crops such as potatoes, tomatoes and aubergines (so-called buzz pollination) may be harmed by neonicotinoids.
- In 2015, Botias *et al* drew attention to the contamination of wildflowers at the margins of arable fields and the associated persistence of neonicotinoids, which would increase bees' exposure.

UK emergency authorisation in 2015

Even where, as with certain neonicotinoids, use of a pesticide has been restricted at EU level, it is still possible to seek an emergency authorisation for its use if certain criteria are met.

In July 2015, the UK Government (advised by the Expert Committee on Pesticides or ECP) granted such an authorisation to the NFU, after the initial application was refused because it was not sufficiently targeted. The authorisation allowed use of a restricted seed treatment for 120 days in Suffolk, Cambridgeshire, Bedfordshire and Hertfordshire.

In August 2015, FoE sought judicial review of the Government's decision process to grant the emergency authorisation, arguing that it did not comply with EU law governing such authorisations, but the application was denied.

Unsuccessful applications for emergency authorisations in 2016 and 2017

More recent applications for emergency authorisations have been refused.

In 2016, a similar application from the NFU and the Agriculture and Horticulture Development Board (AHDB, a statutory levy board, funded by farmers, growers and others in the supply chain and managed as an independent organisation) was refused: the two organisations had sought emergency authorisation for products containing neonicotinoid active substances for use as seed treatments on winter OSR to control Cabbage Stem Flea Beetle (CSFB).

Farmers Weekly reported in January 2017 that – because of ongoing problems with CSFB - the NFU had applied to use neonicotinoid pesticides on 11% of the OSR crop in 2017. On the NFU website, the NFU vice-president, Guy Smith, set out the farmers' case.

The ECP considered the application at its meeting on 11 April 2017. In its advice to Ministers, the ECP drew attention to gaps in the information provided by the NFU and also expressed concern about whether the emergency use would be sufficiently "limited and controlled". The ECP also examined the information submitted about risks to pollinators.

Farming minister George Eustice announced in April 2017 that, taking account of the ECP's advice, Defra had rejected the applications, as the ECP had concluded that neither met the requirements for emergency authorisation.

What impact might Brexit have?

Concerns about the future of the restrictions have been amplified by the UK's decision to leave the EU.

In the Brexit white paper published on 2 February 2017, the Government sets out its approach to agriculture, fisheries and food. It confirms that the UK will not be seeking to remain in the Single Market and argues that Brexit presents an opportunity to create a "world-leading" food and farming industry.

Further details of the UK government's approach to agriculture – and more specifically to pesticide regulation - post-Brexit have yet to emerge but, before the referendum, George Eustice was reported as saying that the EU's precautionary principle needed to be reformed in favour of a US style, risk-based approach, allowing faster authorisation of pesticides. In response to a PQ in October 2016, he again spoke of the need for decisions to be based on the level of identified risk. In February 2017, Lord Gardiner of Kimble argued for an approach based on risk assessment, saying that protection of people and the environment will be the highest priority.

Most recently, George Eustice has reiterated the Government's commitment to a scientific assessment of risk and has said that pesticides that carry unacceptable risks to pollinators should not be authorised.

This might therefore indicate that the Government could be minded to take a very different approach to pesticides approval with any opportunity for more UK autonomy, although (obviously) much would depend on the terms agreed on exit. Membership of the EEA (for example) requires adopting some pesticides marketing and approval systems.

Other briefings on farming and environmental issues are available on Parliament's topic pages for agriculture and nature conservation.

The Commons Library debate pack on bees and neonicotinoids was published for a Commons debate in December 2015, triggered by an e-petition.

1. Are neonicotinoids bad for bees?

In brief:

The role of neonicotinoids in bee decline remains contested and contentious.

An October 2015 restatement (that is, a review of the natural science evidence base) by a group of pollinator experts concluded that the evidence still does not provide a clear steer for policy makers in relation to neonicotinoids.

The Centre for Ecology and Hydrology (CEH, for example) has suggested that neonicotinoid use is linked to large-scale and long-term decline in wild bee species distributions and communities and the decline is, on average, three times stronger among species that regularly feed on OSR crop compared to species that forage on a range of floral resources.[1]

Organisations such as FoE, Buglife and the Soil Association want to see a permanent ban on neonicotinoids and the current restrictions extended to other crops.

Manufacturers of neonicotinoids, on the other hand, have generally argued that they are unlikely to be responsible for declining bee health or bee numbers and that the alternatives (such as organophosphates) might pose greater risks. They have also questioned the dosages used in some studies, arguing that they are unrealistic compared to actual field conditions.

On its Bee Care website, Bayer points to the many factors influencing bee health and bee numbers and maintains that realistic field studies show no harmful effects to bees from neonicotinoids.[2]

The Crop Protection Association (CPA, which comprises 22 companies from the UK plant science industry) responded to the CEH study, arguing that the situation is more complex, as (they argue) neonicotinoids are important for farming and food production and there is no evidence that restricting them helps bee populations. The CPA pointed to the links between the decline of wild bee populations and other factors such as habitat loss, climate change, intensive farming and argued that all of these – and especially the Varroa mite - have become more destructive over time.[3]

In a debate on bees and neonicotinoids in December 2015, triggered by an e-petition, Department for Environment, Food and Rural Affairs (Defra) minister George Eustice argued that it was an "over-simplification" to suggest that neonicotinoids were solely responsible for bee decline and the reasons were many and various:

> The reality is that we have seen declining bee populations since the mid-1950s. The reasons for the decline in our bee populations are many, varied and complex. We believe that a large element is loss of habitat, particularly the loss of wild, traditional flowering meadows. We have lost hedgerows, which are an important habitat for bees, particularly bumblebees.

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1 CEH, *New study: neonicotinoid insecticides linked to wild bee decline across England*, 16 August 2016. This study is discussed in more detail later.
2 Bayer Bee care, *Neonicotinoids* [undated]
3 Crop Protection Association, *CPA response to report in Nature Communications on neonicotinoids and bees*, 17 August 2016

> We have also seen problems with disease, and sometimes stress makes bees more susceptible to disease. We have had Varroa and hive mites, and a linked problem is that many of our honeybees are imported from countries such as Italy. Those bees are not genetically disposed to survive winters here in the UK so we often have winter losses. […]
>
> Neonicotinoids are a relatively recent group of chemicals so we cannot directly attribute the decline in the bee population just to them.[4]

1.1 What are neonicotinoids?

Neonicotinoids are a class of insecticides with a common mode of action that affects the central nervous system of insects, causing paralysis and death. They are systemic insecticides, so are taken up by the whole of the plant including the pollen and nectar gathered by pollinating insects.

They were pioneered in the 1980s and 1990s by chemical companies such as Bayer, Syngenta and Sumitomo Chemical. They were the first new class of insecticides developed for more than 50 years. Bayer Crop Science has described the development of neonicotinoid insecticides as a step change in a farmer's or grower's ability to control destructive pests and the diseases that they spread, using products of very low mammalian toxicity.[5]

1.2 Do neonicotinoids affect bees?

A number of studies have suggested that exposure to neonicotinoids at sub-lethal doses while foraging (for example by collecting pollen and nectar containing neonicotinoids) can have significant negative effects on bee health and bee colonies, including (perhaps) lower egg production and less honey being produced. These studies are discussed in more detail later.

In 2012 alone, over 100 scientific papers and reports on bees and pesticides were published.[6] The studies on neonicotinoids led to some countries, such as France, introducing restrictions on their use before the 2013 EU restrictions (also discussed later), but, many other factors - such as habitat and parasites - are also involved and the debate is complicated by a lack of understanding about the relative importance of pesticides as a driver of bee declines.

In reply to a PQ in September 2016, George Eustice pointed out that Defra had funded a range of research on neonicotinoids' and other pesticides' effects on bees.[7]

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4 HC Deb 7 December 2015 c248WH. The Commons Library debate pack on bees and neonicotinoids (CDP 2015-0117, 4 December 2015) was published for that debate.

5 EAC, *Pollinators and Pesticides*, 5 April 2013, HC 668 2012-13: Ev 123

6 *Bumblebees and pesticides*, Nature Vol 491, 1 November 2012: page 43

7 PQ 45290, 6 September 2016

1.3 What does the scientific evidence show?

Despite the number of studies carried out, some key questions remain unanswered.

It is sometimes asserted that neonicotinoids must be harmful to bees, but the picture emerging from the numerous scientific studies on bees and pesticides is more complicated and more nuanced.

The scientific evidence for the impacts of neonicotinoids on bees is mixed, with gaps in information and different effects on different aspects of bee health observed according to the specific neonicotinoid used. There are disparities, too, between laboratory and field study results.

The methodology of some studies has been questioned – some commentators have (broadly speaking) argued that the doses used in some laboratory tests are far higher than bees would encounter in the field and so unrealistic compared to actual field conditions - and their findings remain controversial.

Syngenta's Chairman, Martin Taylor, argued on BBC Radio 4 in February 2013, for example, that doses had been excessive.[8] Similarly, Bayer has argued that, where evidence has been found of sub-lethal and other effects, these may be attributable to unrealistic exposure levels in laboratory and other studies.[9]

The UK Government commissioned research to understand what levels of pesticide residues and disease in honey bees are normal, quantify the actual exposure of wild bumblebees to sub-lethal doses of neonicotinoid insecticides in UK landscapes, and better understand the environmental and agronomic implications of restrictions on neonicotinoids (including the consequences of using alternative pesticides or pest control measures).[10]

Some recent findings

Research findings over several years are discussed in more depth in section 7.

Already this year there have been studies published, attempting to shed more light on the interaction of factors such as exposure to neonicotinoid pesticides and bee behaviour and health.

Woodcock et al (2017) used large field experiments in Germany, Hungary and the UK to assess the effects of crop treatment with clothianidin or thiamethoxam on honey bees and wild bees and particularly on overwintering (a key measure of year-to-year viability). Woodcock *et al* concluded that neonicotinoids reduced bee species' capacity to establish new populations in the year following exposure.[11]

Baron *et al* (2017) examined the effects of field-relevant doses of thiamethoxam on wild queens of four bumblebee species and found that two weeks' exposure led to a reduction in feeding in two out of

8 BBC Radio 4, *Today*, 8 February 2013 as quoted in EAC, *Pollinators and Pesticides*, 5 April 2013, HC 668 2012-13: page 20
9 Bayer Bee care, *Neonicotinoids* (undated)
10 Defra, *Policy paper: 2010 to 2015 government policy: food and farming industry*, 8 May 2015
11 Woodcock *et al*, "Country-specific effects of neonicotinoid pesticides on honey bees and wild bees", *Science,* 356, 1393-1395 (2017), 30 June 2017, doi 10.1126/science.aaa1190

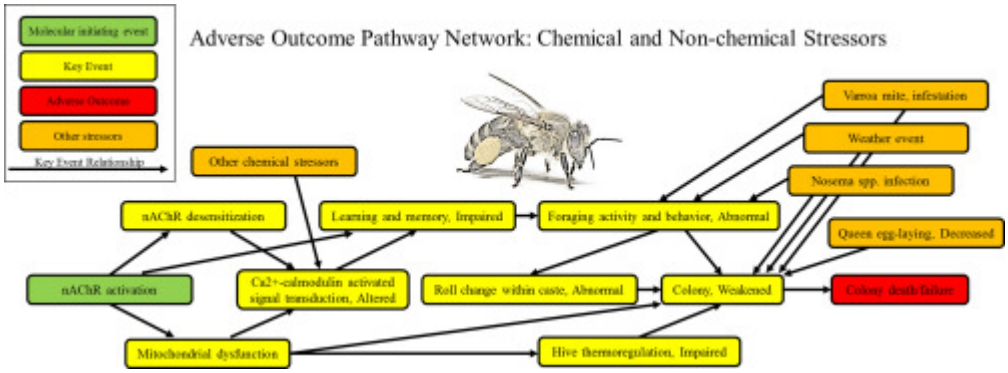
four species, with evidence too of effects on ovary development in multiple species of wild bumblebee queens.[12]

Klein *et al* (2017) examined the neurobiological, ecological, and evolutionary reasons why bees might be vulnerable to environmental stressors - such as pesticides, pollutants, parasites, diseases, and malnutrition - and their brains susceptible to damage. They found that

> even at low intensity levels, many stressors damage the bee brain, disrupting key cognitive functions needed for effective foraging, with dramatic consequences for brood development and colony survival.[13]

LaLone *et al* (2017) also examined stressors associated with honey bee death. Neonicotinoid pesticides act on the nicotinic acetylcholine receptors (nAChRs) in the central nervous system to eliminate pest insects.[14] Noting that "mounting evidence indicates that neonicotinoids also may adversely affect beneficial pollinators, such as the honey bee, via impairments on learning and memory, and ultimately foraging success", the study set out to establish adverse outcome pathways (AOPs) as a means of evaluating any linkage between activation of the nAChR and colony level consequences.

They mapped those AOPs:



The study concluded that "sufficient biological plausibility exists to link activation of nAChR to colony death."[15]

Schick *et al* (2017) have re-examined the data from a 2013 study of field use of the neonicotinoid thiamethoxam. The 2013 study – all five of whose authors were current or former employees of Syngenta or had been paid by Syngenta for their work on the study or the field trials on

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12 Baron *et al*, "General and species-specific impacts of a neonicotinoid insecticide on the ovary development and feeding of wild bumblebee queens", *Proceedings of the Royal Society B*, 3 May 2017 DOI: 10.1098/rspb.2017.0123

13 Klein *et al*, "Why Bees Are so Vulnerable to Environmental Stressors", *Trends in Ecology and Evolution*, January 2017 DOI: 10.1016/j.tree.2016.12.009

14 Acetylcholine is a neurotransmitter. According to AK Jones and DB Sattelle (2010), "nicotinic acetylcholine receptors (nAChRs) are ligand-gated ion channels that mediate fast synaptic transmission in the insect nervous system and are targets of a major group of insecticides, the neonicotinoids" (*Diversity of insect nicotinic acetylcholine receptor subunits*, Adv Exp Med Biol. 2010; 683:25-43)

15 LaLone *et al*, "Weight of evidence evaluation of a network of adverse outcome pathways linking activation of the nicotinic acetylcholine receptor in honey bees to colony death", *Science of the Total Environment,* January 2017 http://dx.doi.org/10.1016/j.scitotenv.2017.01.113

which it reported - had concluded that there was no evidence of detrimental effects and so thiamethoxam posed a "low risk" to bees. Schick *et al* argue, though, that the 2013 study lacked rigour: its conclusions, derived from inspecting the data without formal analysis, were both misleading and unacceptable in principle. Statistical analysis of the 2013 data now indicates (Schick *et al* conclude) that the confidence limits were generally so wide that any effects of thiamethoxam could have been large without being statistically significant.[16]

In preliminary findings from a study reported in *Farmers Weekly* in December 2016, *Dr Penelope Whitehorn* at Stirling University found that bees' ability to produce the buzz needed to shake pollen from crops such as potatoes, tomatoes and aubergines (so-called buzz pollination) may be harmed by neonicotinoids.[17]

Another issue that has been examined is the persistence of neonicotinoids, either in the soil or in wildflowers growing in field margins. In 2015, Botias *et al* drew attention to the contamination of wildflowers at the margins of arable fields and the associated persistence of neonicotinoids, which would increase bees' exposure:

> Both previous and ongoing field studies have been based on the premise that exposure to neonicotinoids would only occur during the blooming period of flowering crops and that it may be diluted by bees also foraging on untreated wildflowers. Here, we show that exposure is likely to be higher and more prolonged than currently recognized due to widespread contamination of wild plants growing near treated crops.[18]

An October 2015 restatement (that is, a review of the natural science evidence base) by a group of pollinator experts concluded that the evidence still does not provide a clear steer for policy makers in relation to neonicotinoids:

> There still remain major gaps in our understanding of how pollinator colony-level (for social bees) and population processes may dampen or amplify the lethal or sub-lethal effects of neonicotinoid exposure and their effects on pollination services … While these areas continue to be researched there is still a limited evidence base to guide policymakers on how pollinator populations will be affected by neonicotinoid use or how agriculture will respond to neonicotinoid usage restrictions.[19]

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16 Schick *et al*, "An experiment on the impact of a neonicotinoid pesticide on honeybees: the value of a formal analysis of the data", *Environ Sci Eur* (2017) 29:4 DOI 10.1186/s12302-016-0103-8. The study in question is Pilling *et al*, "A Four-Year Field Program Investigating Long-Term Effects of Repeated Exposure of Honey Bee Colonies to Flowering Crops Treated with Thiamethoxam", *PLoS ONE*, 8(10), e77193, 2013. DOI 10.1186/s12302-016-0103-8

17 "Study suggests neonics impair bees' buzz pollination", *Farmers' Weekly* online, 14 December 2016

18 Botias *et al*, "Neonicotinoid Residues in Wildflowers, a Potential Route of Chronic Exposure for Bees", *Environ. Sci. Technol.*, 49 (21), 2015, pages 12731–12740

19 Godfray *et al*, 2015, "A restatement of recent advances in the natural science evidence base concerning neonicotinoid insecticides and insect pollinators", Oxford Martin School Restatement project no.3, *Proceedings of the Royal Society B*, 282, 20151821, http://dx.doi.org/10.1098/rspb.2015.1821

Commenting on this, the RSPB blog observed that the review had stressed that there were still gaps in knowledge, but the RSPB would continue to be concerned about neonicotinoids' effects on biodiversity.[20]

1.4 Support for neonicotinoids from some agronomists

Written evidence to the House of Commons Environmental Audit Committee's (EAC) inquiry into pollinators and pesticides from the National Institute of Agricultural Botany explained the implications of not being able to use neonicotinoids. It described how the use of neonicotinoids had avoided the use of non-selective pesticides which would have large impacts on the invertebrate population:

> The loss of neonicotinoids in the combinable crop sector, oil seed rape, winter wheat and barley, would not, at this moment in time threaten crop viability but would make control of pests and the diseases they transmit more difficult. […] If the neonicotinoids family is banned the best available alternative chemistry is organophosphate (Chlorpyrifos). This non selective pesticide will have a large impact on the invertebrate population.
>
> […]
>
> The loss of Neonicotinoids could also affect the viability of the UK seed potato crop and vegetable production.
>
> […]
>
> The loss of neonicotinoids would lead to the increased use of pesticides. The loss of seed treatments in oil seed rape and cereals would lead to at least one additional insecticide application per crop. Currently no integrated pest management system has been developed for the control of aphids and flea beetles in open field situations and as such is not an option.[21]

In similar vein, CCC Independent Agronomy Services provided evidence to the EAC setting out which crop diseases could still be controlled without neonicotinoids. They suggested that a ban on their use on cereals could be "disastrous", as farmers would instead be forced to use repeated applications of chlorpyrifos (an organophosphate aphicide) on a very wide scale on cereals in the autumn to control Barley Yellow Dwarf Virus, which affects a range of winter sown cereals.[22]

1.5 The view from the National Farmers' Union

On its website, the National Farmers' Union (NFU) suggests that the question of whether neonicotinoids are causing widespread declines in bee populations or whether insecticide-treated fields are inhospitable places for insects is still unresolved:

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20 RSPB, *Blog: Farming: Neonicotinoids: any closer to a conclusion?*, 30 October 2015

21 EAC, *Pollinators and pesticides: written evidence submitted by the National Institute of Agricultural Botany*, Ev w71

22 EAC, *Pollinators and pesticides: written evidence submitted by CCC Independent Agronomy Services*, Ev w73

> Much of the evidence around the harmful effects of neonicotinoids relies on studies where bees have been dosed artificially with the insecticide. The big unanswered question remains whether the harmful impacts observed in studies based on artificially dosing bees, occur in real-life field situations and cause the population declines we are all so concerned about.
>
> A Swedish study earlier this year did find harmful impacts on wild bees (but not honeybees) in real fields, but does this mean neonicotinoids are causing widespread declines in bee populations? or does it just mean that insecticide-treated fields can be inhospitable places for insects? We still don't know.[23]

There has not, the NFU continues, been an "apocalyptic" decline caused by neonicotinoids:

> Reading the press you'd be forgiven for thinking bees are facing apocalyptic declines caused by neonicotinoids. The evidence tells a very different story…
>
> - That the dramatic declines in pollinator biodiversity happened in Britain between the 1950s and 1980s – decades before neonicotinoids were introduced, and
> - That during the last 25 years (the same period during which neonicotinoids were introduced and their use taken off) declines in bumblebee biodiversity have slowed significantly in Britain, and the biodiversity of 90% of our wild bees - the solitary bees - has actually increased.[24]

The NFU asks too for the impact of the neonicotinoid restrictions on crop production to be taken into account when the European Commission reviews the restrictions:

> All the NFU asks is that as part of this process, as well as a review of all the latest evidence, an assessment of the impact of the restrictions on crop production is also taken into account. This isn't about profits. This is about having the tools to effectively control crop pests in a way that is responsible, not just in terms of minimizing environmental impacts, but also in terms of being able to produce food and plants in a way that is safe, reliable and affordable for everyone – from the farmer to the buying public.[25]

1.6 The manufacturers' view

Bayer Crop Science, one of the producers of neonicotinoids, has said that the development of neonicotinoid insecticides represented a step change in a farmer's or grower's ability to control destructive pests and the diseases that they spread, using products of very low mammalian toxicity.[26] They also point out that, although France has restricted the use of neonicotinoid seed treatments for over 10 years, bee health in France remains similar to, or worse than, that seen here in the UK.[27]

On its Bee Care website, Bayer points to the many factors influencing bee health and bee numbers and maintains that realistic field studies show no harmful effects to bees from neonicotinoids:

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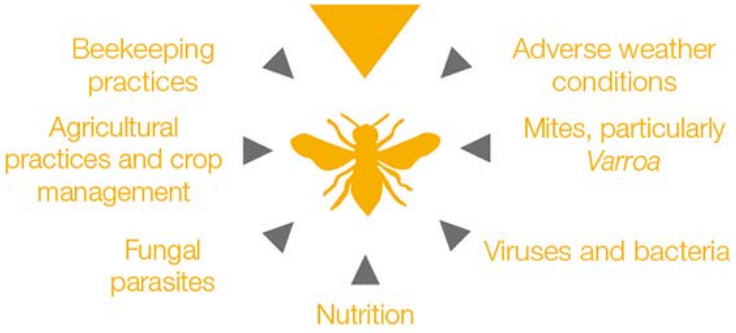
23 NFU, *Bees and neonicotinoids - what's it all about?*, 23 July 2015
24 As above
25 As above
26 EAC, *Pollinators and Pesticides*, HC 668, 5 April 2013 2012-13: Ev 123
27 As above

> Researchers from the Universities of Wageningen, Ghent and Amsterdam have come to a different conclusion [about a possible connection between the use of neonicotinoids and bee losses]: A few years ago, a review summarized 15 years of research on the hazards of neonicotinoids to bees for the first time. The conclusion: While many laboratory studies and other studies applying artificial exposure conditions described sub-lethal and other effects, no adverse effects to bee colonies were ever observed in field studies at field-realistic exposure conditions. Another recent causal analysis of US researchers likewise comes to the conclusion that neonicotinoids are unlikely to be a cause of honeybee colony losses.



> These findings are in line with many large-scale, multifactorial studies that were undertaken in the USA, Austria, Belgium, Canada, France, Germany and other countries. These have shown that poor bee health is correlated with the presence of the Varroa mites, viruses and many other factors, but not with the use of insecticides.[28]

In its evidence to the EAC, Syngenta (who manufacture the seed treatment thiamethoxam) offered its view on the research and criticism of neonicotinoids available at the time. Syngenta quoted a range of studies indicating that neonicotinoids were unlikely to be responsible for any decline in bee health (or not the main reason for bee decline) and described neonicotinoids as "essential" to sustainable intensive agriculture:

> Syngenta believes that insecticides, in particular neonicotinoid based seed treatments, are an essential contributor to sustainable intensive agriculture and do not damage the health of bee populations. They significantly reduce the load on the environment when compared to many other pesticides because of their extremely low dose; long lasting protection against pests that destroy crops; and when used in via seed treatment application result in fewer sprays over the course of the growing season.
>
> […]
>
> 2.3. Although several Member State Governments, reputable universities, and experts across Europe share the view that these innovative pesticides are safe, there are a small number of vocal individuals and groups who continue to suggest the opposite by focusing only on the intrinsic hazard of these products. In recent years these groups have leveraged media reporting of individual alarmist studies despite the fact that they are typically based on

[28] Bayer Bee care, *Neonicotinoids* (undated)

> unrealistic dose rates and/or the forced exposure of bees to the insecticides in question.[29]

Syngenta also stated its commitment to ensuring that pesticides were part of a sustainable agriculture system and highlighted their Operation Pollinator initiative, where 2,500 hectares of pollinator strips had been sown to provide essential habitat and nutrition for bees alongside field crops treated with pesticides.[30] The company argued that this action had helped to "produce a dramatic recovery in bee populations reversing the decline of some bumblebee species close to extinction".[31]

In FAQs on its website, Syngenta mentions again the other factors that may underlie the decline in bee populations and sets out the company's view on bees and neonicotinoids:

> More than one third of the world's crops depend on pollination, which means our business is reliant upon the pollination provided by bees and other pollinators. We conduct constant research on the environmental effects of our products, while helping beekeepers and farmers to maintain suitable areas for bee forage and beekeeping coexistence. Our Operation Pollinator program has helped boost the number of pollinating insects near farmland. It provides farmers with locally suited flower seed mixes and best practice advice to enable them to create bee friendly areas in field.[32]

Bayer CropScience and Syngenta funded a "socio-economic, technological and environmental review of neonicotinoids" in 2013 by the Humboldt Forum for Food and Agriculture (HFFA) supported by, among others, the European Seed Association and the European Crop Protection Association.[33] This report estimated that:

- Neonicotinoids contribute over £1.6 bn (€2bn) annually to commodity crop revenues and reduce production costs by £800 million (approx €1bn) across the EU compared to alternatives.
- The overall cost of a ban could be as high as €4.5 billion and over a five-year period, EU wealth could erode by up to £13.8bn (€17bn), putting the jobs of over a million people engaged in arable production across the EU at risk.[34]

More recently, *Farmers Weekly* reported in August 2015 that the restriction on neonicotinoids had cost farmers £22 million: £7.8 million for alternative chemical use, £11.4 million for applying the chemicals and £2.3 for crop lost and not replanted.[35]

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29 EAC, *Pollinators and Pesticides*, 5 April 2013, HC 668 2012-13: Ev 153

30 Syngenta, in partnership with Bayer CropScience, launched its own bee health action plan in March 2013 complementing its work through the Operation Pollinator Initiative.

31 EAC, *Pollinators and Pesticides*, 5 April 2013, HC 668 2012-13: paras 2.4-2.6

32 Syngenta, *What is Syngenta's view on bees and neonicotinoids?* (accessed 9 March 2017)

33 HFFA, *The value of Neonicotinoid seed treatment in the European Union: A socio-economic, technological and environmental review*, 2013

34 "Banning neonicotinoids could cost EU economy 4.5 billion EUROS - report", *Farmers Guardian*, 15 January 2013

35 "Neonicotinoids ban cost farmers millions in 2015, study reveals", *Farmers Weekly* online, 25 August 2015

Should manufacturers publish more of their research?

One question which continues to attract debate is whether manufacturers should publish more of the research findings on which they rely.

Godfray *et al* in 2015 (for example) commented on the difficulties in undertaking an unbiased assessment of the efficacy of neonicotinoids when so much of the research is conducted by industry and might not be peer-reviewed or placed in the public domain:

> Efficacy studies are largely conducted by industry, the sector that benefits most from the data, and are not the type of science usually funded by public organizations. Typically, the studies are not published in the peer-reviewed literature (though they are often made available to regulators) and some are kept confidential for commercial reasons. Efficacy trials are expensive and it seems unlikely that they will ever be publicly funded at scale. It is an interesting topic for debate whether industry would benefit in the long run from placing more of its data in the public domain as well as putting in place measures to increase public confidence in studies they fund themselves.[36]

1.7 The view from wildlife and environmental groups

Wildlife and environmental groups take a different view

In an open letter to the UK government in December 2016, to mark the third anniversary of the restrictions, 18 wildlife and environmental groups (including FoE, Buglife (the Invertebrate Conservation Trust)(the Invertebrate Conservation Trust) and the Soil Association) argued that the available evidence was clear and justified a ban on neonicotinoids' use on all crops:

> Since 2013 many more independent laboratory and field studies have found neonics impairing the ability of different bee species to feed, navigate and reproduce resulting in declining populations.
>
> There is now solid evidence of harm from neonics to wild bumble and solitary bees which are even more sensitive to these pesticides than honeybees. Evidence has also grown of neonics harming the wider environment with studies indicating a link to butterfly population decline, identifying risks to bird species and finding neonics accumulating to dangerous levels in wildflowers surrounding crops.[37]

The NFU, though, disputed these claims and (referring to Godfray *et al's* work from 2014 and 2015) argued that the picture derived from the scientific evidence was less clear than the open letter alleged:

> NFU horticulture chief adviser Dr Chris Hartfield said: "The fact is the evidence is not clear on the issue of bees and neonicotinoids

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36 Godfray *et al,* "A restatement of recent advances in the natural science evidence base concerning neonicotinoid insecticides and insect pollinators", Oxford Martin School Restatement project no.3, *Proceedings of the Royal Society B,* 282, 20151821, 2015, http://dx.doi.org/10.1098/rspb.2015.1821

37 "Wildlife and environment groups call for neonicotinoid pesticides ban to be retained and extended", *Horticulture Week* online, 1 December 2016

> 'there still remain major gaps in our understanding' and 'there is still a limited evidence base to guide policymakers on how pollinator populations will be affected by neonicotinoid use'.
>
> "These aren't my words. These are statements made in an independent study reviewing all the current evidence around neonicotinoids and pollinators. A review written by Professor Charles Godfray & Professor Angela McLean FRS (both from the Oxford Martin School at the University of Oxford), Dr Tjeerd Blacquière, Wageningen University; Professor Linda Field, Rothamsted Research; Professor Rosemary Hails & Dr Adam Vanbergen, Centre for Ecology & Hydrology; Professor Simon Potts, Reading University; and Professor Nigel Raine, Guelph University.
>
> "These are serious heavyweight international experts in insecticides, ecology, beekeeping, toxicology, mathematical biology, biodiversity and pollinators. So when we say the evidence around neonicotinoids and bees is unclear – it is not me saying this, it is not the NFU saying this, it is what independent experts are saying.
>
> "These experts published a review in 2014 and an update at the end of last year and the reviews conclude that there is limited evidence to guide policy makers*.
>
> "So when you hear someone telling you that the evidence around neonicotinoids and bees is clear, and that it supports a ban on the use of all neonicotinoids, it rings alarm bells. What they are actually saying is that the evidence is clear enough for them. That is a very different thing from the evidence being clear for independent and impartial experts, and policymakers."[38]

FoE continue to call for a ban on neonicotinoids.[39] In a report published in January 2017, looking in particular at the use of clothianidin on wheat, FoE urged the UK government to "commit to a comprehensive ban now that will apply whatever our future relationship with the EU".[40] A report in *Farmers Weekly* indicated that the manufacturer and the NFU did not support this call:

> But Julian Little, spokesman for Bayer CropScience UK, which manufactures neonicotinoids, said any ban on the use of the pesticides on wheat crops would "make no sense at all" as the crop is not pollinated by honeybees.
>
> […]
>
> NFU vice-president Guy Smith said: "Friends of the Earth's latest idea to limit the use of neonicotinoids on wheat is not justified by the available scientific evidence and could have serious consequences for farmers' ability to grow food sustainably.
>
> "With no restrictions of this kind anywhere else in the world farmers would be put at an extreme competitive disadvantage without the use of neonicotinoids on wheat."[41]

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38 "Wildlife and environment groups call for neonicotinoid pesticides ban to be retained and extended", *Horticulture Week* online, 1 December 2016

39 FoE, *Bees, pesticides and neonicotinoids*, (updated November 2016)

40 FoE, *Farming wheat without neonicotinoids*, January 2017

41 "Farm leaders attack 'unjustified' bid to extend neonics ban to wheat", *Farmers Weekly* online, 5 January 2017

2. What do we know about bee health?

Bees can broadly be placed into two groups; domesticated pollinators such as honey bees and wild pollinators such as bumble bees and solitary bees. This distinction is important as, although they are threatened by the same problems, they are affected in different ways. For example, habitat loss (with the resultant loss of food and nesting resources) is of primary importance for wild pollinators, whereas the managed nature of honey bees means their food can be supplemented.

Parasites and disease, particularly the parasitic *Varroa* mite and the viruses it transmits, have been identified as a particular threat to honey bees, whereas the impacts of disease on wild species remain little understood. Insecticides, most recently the neonicotinoids, have also been implicated in the declines of both domestic and wild bee species, both on their own and in interaction with other factors.

It is, perhaps, unsurprising that bees are so affected by the diverse factors driving their decline; they need to be able to maintain the capacity for learning, memory and navigation to get to pollination sources and so any disruption of cognitive function – whether the result of malnutrition, disease or pesticide exposure – will have significant implications for survival. A recent study offers a narrative review of the biological and ecological reasons for this.[42]

Under the heading *what is known?* the Royal Horticultural Society highlights some recent trends and their potential significance for plants and crops:

- The strength and health of honeybee colonies has declined, making it more **difficult for beekeepers to maintain** their hives in good condition. In Europe (including the UK), however, extensive colony collapse - that has been observed in north America - has not yet occurred
- Some bumblebee and solitary bee species are doing well and have increased their distribution in Britain. Others have shown **marked declines in distribution over the last 30 years**
- Bumblebees and solitary bees that are able to collect nectar and pollen from a wide range of plants, including garden flowers, are thought to be maintaining their numbers and distribution
- It is species that are more selective in their flower-visiting habits, or have special requirements for nest sites, that have declined and now have a more restricted distribution
- Many species of moth and butterfly are in decline although this is thought to be largely due to habitat loss due to

[42] S Klein *et al*, 2017, *Why Bees Are so Vulnerable to Environmental Stressors,* Trends in Ecology and Evolution, January 2017 DOI: 10.1016/j.tree.2016.12.009 (discussed at more length in section 7)

changes in land use. Less is known about the distribution and abundance of other pollinators such as hoverflies.

- Many garden plants and agricultural/horticultural crops need bees to bring about pollination by transferring pollen from the flowers' anthers to the stigmas. These include most tree and soft fruits, and many vegetables including runner beans, broad beans, tomatoes, marrows and courgettes
- Plants that are not pollinated will not set fruits or produce seeds[43]

The European Commission is funding a number of studies to better understand the status of pollinators in Europe, such as the STEP (Status and Trends in European Pollinators) Project.

2.1 Are bee numbers declining in the UK?

Bees and other pollinating insects are generally declining in numbers, with parallel declines in the plants that rely upon them, but these declines are not universal to all species and there has been some more recent increase in the number of managed bees in hives.

Pollinators, including bees, are showing declines worldwide, but not across all species. Some are threatened whilst others are extending their ranges.

In the UK, there has been an overall decline in wild bee diversity over the last 50 years. Managed bees in hives, though, are faring better; their numbers in the UK are recovering from large losses due to the Varroa mite in the early 1990s.[44] In 2013, over 29,000 beekeepers managing around 126,000 colonies were registered in England on the National Bee Unit's BeeBase database, compared with 15,000 beekeepers managing just under 80,000 colonies in 2008.

The same bee species that are being found to be threatened at EU level are not always the same as those that provide pollination for commercial crops. The International Union for Conservation of Nature reported in March 2015 that Europe's wild bees were in decline, with 9.2% of European wild bee species threatened with extinction, while 5.2% are considered likely to be threatened in the near future.[45]

The *Red List* report remarked on population trends:

> Looking at the population trends of European bee species, 7.7% (150 species) of the species have declining populations, 12.6% (244 species) are more or less stable and 0.7% (13 species) are increasing. The population trends for 1,535 species (79%) remains unknown.
>
> A high proportion of threatened bee species are endemic to either Europe (20.4%, 400 species) or the EU 27 (14.6%, 277 species), highlighting the responsibility that European countries have to protect the global populations of these species. Almost 30% of all the species threatened (Critically Endangered, Endangered, or

43 Royal Horticultural Society, *Pollinators: decline in numbers* (undated, accessed 9 March 2017)
44 Defra, *Supporting document to the National Pollinator Strategy: for bees and other pollinators in England*, November 2014
45 European Commission Press Release, *European bees: new report shows nearly one in ten wild bee species face extinction*, 19 March 2015

> Vulnerable) at the European level are endemic to Europe (e.g., found nowhere else in the world).[46]

2.2 What is causing the decline in bees and pollinators?

There are a variety of factors affecting bees and pollinators in general.

Factors affecting bee and pollinator populations include: habitat loss, pesticides, disease and climate change. It is not clear how these factors interact or which are having the biggest impacts. In England it is thought that the loss of flower-rich habitat is one of the biggest sources of pollinator decline arising from changes in agricultural land use and urbanisation.[47]

A global review of honeybee deaths by the World Organisation for Animal Health (OIE) reported in May 2010 that there was no one single cause, but highlighted the "irresponsible use" of pesticides as potentially damaging bee health and making them more susceptible to diseases.[48]

A study in 2013 suggested that a complex interplay between pressures (such as lack of food sources, diseases and pesticides) and biological processes (such as species dispersal and interactions) at a range of scales (from genes to ecosystems) underpin the general decline in insect-pollinator populations. This, the authors suggested, highlighted the need for interdisciplinary research on these interactions.[49]

A study in Germany, reported last year by the European Commission's Science for Environmental Policy under the headline *Bumblebees pollinate urban gardens better than agricultural land* found that pollinators were faring better in urban areas than on agricultural land:

> **Land use** changes are one of the main causes of **biodiversity loss, including of pollinator species.** Urbanised areas and intensively managed agricultural land have reduced floral diversity and nesting habitat for pollinators compared to natural habitats.
>
> […]
>
> The researchers found both bumblebee abundance and pollination of wild flowers was higher in urban than rural agriculture sites. This may be due to higher availability of nesting resources and higher local flower species richness, which were related to insect visitation and pollination rates. This indicates the importance of local habitat quality and surrounding land use for pollinator species.[50]

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46 Nieto *et al*, *European Red List of Bees, 2014:* page 8. The IUCN Red List provides taxonomic, conservation status, and distribution information on taxa that are facing a high risk of global extinction.

47 Defra, *Supporting document to the National Pollinator Strategy: for bees and other pollinators in England*, November 2014

48 "Fears for crops as shock figures from America show scale of bee catastrophe", *Observer* online, 1 May 2010

49 Adam J Vanbergen and the Insect Pollinators Initiative, 2013, "Threats to an ecosystem service: pressures on pollinators", *Frontiers in Ecology and the Environment* 11: 251–259. http://dx.doi.org/10.1890/120126

50 Theodorou *et al,* 2016, "Pollination services enhanced with urbanization despite increasing pollinator parasitism,", *Proceedings of the Royal Society B*, DOI: 10.1098/rspb.2016.0561

2.3 Why does any decline matter?

Pollination services are critical for both ecosystem function and crop production and are estimated to be worth between £430 million and £603 million a year to UK agriculture.[51] Syngenta has described bee health decline as among the biggest challenges facing agriculture.[52]

2.4 UK Pollinator Strategies

In brief:

- Pollinator strategies set out (broadly speaking) to support pollinator populations and enable their survival and success.
- Defra commissioned a report, published in March 2014, on the *status and value of pollinators and pollination services.*[53]
- That report supported the *National Pollinator Strategy for bees and other pollinators in England*, which provides an overview of the known trends in UK pollinators.
- The strategy outlined actions that could expand food, shelter and nest sites across all types of land, so that pollinator species could survive and thrive and remarked that there was

  evidence that loss of good quality natural and semi-natural habitats that feed and shelter pollinators has been a key driver of change to their populations.[54]

The previous Government's National Pollinator Strategy for bees and other pollinators in England in November 2014 set out a 10 year plan for helping pollinators survive and thrive.[55]

The UK National Pollinator Strategy Implementation Plan sets out actions under five key themes:

- Supporting pollinators on farmland
- Supporting pollinators across towns, cities and the countryside
- Enhancing the response to pest and disease risks
- Raising awareness of what pollinators need to survive and thrive and
- Improving evidence on the status of pollinators and the service they provide. [56]

The Pollinator Advisory Steering Group (PASG) guides and deliver actions under the Plan.

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51 See for example, Potts *et al* (Centre for Agri Environmental Research, University of Reading), *Global Pollinator declines: trends, impacts and drivers*, Trends Ecol Evol. 2010 Jun; 25(6):345-53. DOI: 10.1016/j.tree.2010.01.007. Epub 24 February 2010.

52 Syngenta Press Release, *EU Member States again fail to agree restrictions on key crop protection technology*, 29 April 2013

53 Vanbergen *et al*, *Status And Value Of Pollinators And Pollination Services*, March 2014

54 Defra, *National Pollinator Strategy: for bees and other pollinators in England,* November 2014

55 As above. See also Defra, *Supporting document to the National Pollinator Strategy: for bees and other pollinators in England*, November 2014

56 Defra, *UK National Pollinator Implementation Plan*, November 2015

In the supporting evidence for the strategy, loss of habitat has been identified as a likely main cause of pollinator declines. Thus key actions focus on expanding food, shelter and nest sites.

George Eustice said in July 2016 that the pollinator strategy showed the "vital contribution" everyone could make to supporting pollinators.[57] He reiterated the Government's commitment to the pollinator strategy in October 2016 and outlined the bee health programme.[58]

In January 2017, junior environment minister, Therésè Coffey, said that the Government was determined to leave the natural environment in a better state than it had found it and again outlined measures to help conserve butterflies and bees:

> Our agri-environment schemes also play a major role in the conservation of pollinators. The Wild Pollinator and Farm Wildlife Package in the Countryside Stewardship scheme offers options to improve habitats and provide nectar sources for butterflies and bees, thereby supporting the National Pollinator Strategy.[59]

Earlier, in December 2016, David Jones, Minister for Exiting the European Union, had said that the Government understood the need for clarity and so had offered guarantees (with some conditions) for CAP Pillar 2 funding for rural development policies, including agri-environment schemes, and would be consulting on future policy options.[60]

Scottish National Heritage's consultation on a pollinator strategy for 2016-2026 was published in December 2015.[61] The Honey Bee Health Strategy has been in place since 2010.

The Welsh Government has an Action Plan for Pollinators, having set out a draft plan in 2013, ahead of the UK Government's strategy.[62]

Meanwhile Northern Ireland and the Republic of Ireland have come together to produce the All Ireland Pollinator Plan (2015-2020).

2.5 Helping bees

The Wildlife Trusts' Bees Needs webpages give advice on how to help bees and other pollinating insects. They point to five easy actions which land owners can take, to improve the quality and range of habitats for pollinators:

- growing more flowers, shrubs and trees providing pollen and nectar
- leaving patches of land to grow wild
- cutting grass less often
- avoiding disturbing or destroying nests and

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57 PQ 42929, 20 July 2016
58 PQ 49239, 26 October 2016
59 PQ 60341, 24 January 2017.
60 PQ 56851, 15 December 2016
61 Scottish National Heritage, *A Pollinator Strategy for Scotland 2016 – 2026: Consultation document*, December 2015
62 Welsh Government, *Action Plan for Pollinators*, 5 June 2015

- thinking carefully about whether to use pesticides.[63]

Similarly, the Royal Horticultural Society suggests ways in which gardeners can help bees.[64]

63 Wildlife Trusts, *Bees' needs: food and a home* (undated, accessed 9 March 2017)
64 Royal Horticultural Society, *Pollinators: decline in numbers* (undated, accessed 9 March 2017)

3. Why restrict neonicotinoids? The UK government's stance

In brief:

Three neonicotinoids – clothianidin and imidacloprid (made by Bayer) and thiamethoxam (made by Syngenta) - have been restricted for use at EU level since December 2013 whilst further scientific evidence on their impact on bees is gathered. These controls are often spoken of as a *ban*, but neonicotinoids may still be used in certain situations and so it is more accurate to describe them as *restrictions*.[65]

The European Commission's restrictions (discussed later at more length) were controversial and the UK Government did not support them. Nevertheless, it implemented them in full. The Government was reluctant because, in its view, field trial evidence did not merit the restrictions; the Government believed that there had not been sufficient analysis of the impacts of the other insecticides that would be used instead.

3.1 How did we get here? Development of the Government's stance

The Government's longstanding stance on the impact of neonicotinoids on bees - predating the 2013 restrictions - has been continually to stress that it will act in accordance with the evidence and advice from its Expert Committee on Pesticides (ECP, formerly the Advisory Committee on Pesticides, ACP).[66]

Defra used regularly to acknowledge new studies on neonicotinoids and bees on its website and indicate whether these raised new issues that might merit investigation. In September 2012, the then Defra Minister, Richard Benyon, indicated that a response to new evidence could include restrictions or withdrawals relating to the approved uses of neonicotinoids:

> We have therefore kept the evidence on neonicotinoids under close and open-minded scrutiny and have made it clear that we are prepared to take whatever action is necessary. This action could include restricting or withdrawing the approved uses of neonicotinoids.[67]

Studies published in spring 2012 (discussed later) suggested that low doses of neonicotinoids could have sub-lethal effects on bees with consequences for bee populations. This prompted Government experts and the ACP to investigate whether further restrictions on the use of neonicotinoids were required, changes needed to be made in the assessments of the effects of pesticides on bees and whether further work was needed to extend knowledge.

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65 Imidacloprid was listed as an approved substance on 1 August 2009. Clothianidin is listed as an approved substance as a seed treatment only when measures have been taken to minimise leakage into the environment.

66 See for example HC Deb 14 February 2013 cc882-3W

67 HC Deb 18 September 2012 c550W

A summary of the evidence and an assessment by the ACP was published in September 2012. The review took account of the European Food Safety Authority (EFSA) work which was taking place in parallel and concluded that:

- Some of the new studies [provided] evidence of sub-lethal effects of neonicotinoids in the conditions applied in the research.
- However, none of the studies [gave] unequivocal evidence that sub-lethal effects with serious implications for colonies [were] likely to arise from current uses of neonicotinoids.
- Existing studies submitted in support of the present regulatory approvals fully [met] current standards. They [did] not explicitly address all the sub-lethal effects suggested by the academic research. However, they [did] cover a wide range of important endpoints and, in these studies, hives exposed to treated crops did not show any gross effects when compared to control hives exposed to untreated crops.[68]

Based on these findings, Defra concluded that the studies did not justify changing existing regulation. The Department also accepted the need to update the process for assessing the risks of pesticides to bees and to fill evidence gaps identified (such as the relevance of laboratory studies to field conditions) and to understand what levels of pesticide residues and disease in bees are normal.[69]

On the advice of the ACP in January 2013, informed by further studies, the Health and Safety Executive's (HSE) Chemical Regulations Directorate (the UK pesticides regulator) carried out a review of neonicotinoid authorisations.[70]

UK stance on the European Commission's proposals

The Government's approach to the Commission's proposed restriction of certain neonicotinoids was to ask for "a proportionate response to the science".[71]

The EU could not reach a qualified majority vote on the restrictions. At the Standing Committee for Food Chain and Animal Health (SCoFCAH), nine Member States including Ireland, Hungary and the Czech Republic voted against the restrictions and five – including the UK, Germany, Bulgaria, Estonia and Finland – abstained. Nor was there a qualified majority vote at the EU appeal committee – the UK again abstained – and so the European Commission brought out its own text.

Giving evidence to the EAC in February 2013, junior agriculture minister Lord de Mauley commented that, in taking a UK position on the restriction, there were real issues for pollinators and real economic issues which are "potentially quite finely balanced". Hence, the UK was

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68 Defra, *Neonicotinoid insecticides and bees: The state of the science and the regulatory response*, 13 September 2012: para 2
69 As above
70 Defra, *Policy paper: 2010 to 2015 government policy: food and farming industry*, updated 8 May 2015
71 HC Deb 14 February 2013 c882W

keen for the Commission to produce more information on the economic and agricultural impacts of the restriction and to complete an assessment of the science.[72]

In a letter, Lord de Mauley explained the reasons for the UK abstention from the vote in the SCoFCAH to support the Commission's proposed restriction:

> We have called on them to complete the scientific assessment, taking account of our new research, and to assess the impacts of action so that the measures taken are proportionate to the risks identified..... Regrettably, the Commission have not listened to our views and those of many other Governments.[73]

Owen Paterson, at the time Secretary of State for the environment, food and rural affairs, reiterated the UK position at the EU Agriculture Council in March 2013 and asked the Commission to ensure that any decision was taken in the light of field studies into effects on bee populations. He promised to forward the results of Defra-commissioned, UK field studies (discussed again later). These field studies aimed to provide "much needed" experimental evidence in this area as the ACP had highlighted that there was not "unequivocal" evidence about serious sub-lethal effects at the levels actually used in the field.[74]

Responding to a Westminster Hall debate on bee health on 26 March 2013, the then Defra Minister David Heath said that the UK had abstained because the "Commission's proposal was not well thought through". He reiterated concerns about the differences between laboratory tests and field trials:

> The difference between the laboratory tests on which much of the information is based and the field trials that we have now undertaken is that the dosage levels are not comparable. The dosage in the field is much lower than that used in the laboratory experiments, so the toxicity might not be demonstrable or replicable in field conditions.[75]

Defra's field trials (discussed later) run by the UK Food and Environment Research Agency (FERA) were, though, publically criticised by the European Food Safety Authority (EFSA) as containing "several weaknesses", "deficiencies" and "contradictory statements". The Authority concluded that the study did not affect its January 2013 conclusions.[76]

3.2 What impact might Brexit have?

In the Brexit white paper published in February 2017, the Government sets out its approach to agriculture, fisheries and food. It confirms that the UK will not be seeking to remain in the Single Market and argues

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72 EAC, *Pollinators and Pesticides*, 5 April 2013, HC 668 2012-13, Ev 103, Q586 and Letter from Lord De Mauley to all Members of Parliament and Peers, 15 March 2013

73 Letter from Lord De Mauley to all Members of Parliament and Peers, 15 March 2013

74 As above and HC Deb 26 March 2013 c89WS

75 HC Deb 26 March 2013 c.467 WH

76 EFSA, *Bumble bee study does not affect neonicotinoid conclusions EFSA says*, 4 June 2013

that Brexit presents an opportunity to create a "world-leading" food and farming industry.[77]

Concerns about the future of the restrictions have been amplified by the UK's decision to leave the EU.

The details of the Government's approach to agriculture – and more specifically to pesticide regulation post-Brexit - have yet to emerge. Some remarks by George Eustice before the referendum and Ministers' repeated references to risk assessment and the availability of evidence might perhaps, though, give some indication of the Government's likely approach.

In May last year, George Eustice was reported as saying that the EU's precautionary principle needed to be reformed in favour of a US style, risk-based approach, allowing faster authorisation of pesticides.[78] Also in May 2016, the Government indicated that it would prefer Member States to decide on such restrictions as part of their own national re-approval processes.[79]

Similarly, in response to a PQ in October last year, George Eustice again spoke of the need for decisions to be based on the level of identified risk.[80] In February 2017, Lord Gardiner of Kimble argued for an approach based on risk assessment, saying that protection of people and the environment will be the highest priority.[81]

Most recently, George Eustice has reiterated the Government's commitment to a scientific assessment of risk and has said that pesticides that carry unacceptable risks to pollinators should not be authorised:

> As part of the preparation for EU exit, we are considering future arrangements for the regulation of pesticides. Our highest priority will continue to be the protection of people and the environment.
>
> The Government remains of the view that decisions on the use of pesticides should be based on a careful scientific assessment of the risks.
>
> Pesticides that carry unacceptable risks to pollinators should not be authorised. The Government keeps the developing evidence on neonicotinoids under review, advised by the UK Expert Committee on Pesticides, but on the basis of current available evidence, we support the existing restrictions.[82]

This might therefore indicate that the Government could be minded to take a very different approach to pesticides approval with any opportunity for more UK autonomy, although (obviously) much would depend on the terms agreed on exit. Membership of the EEA (for example) requires adopting some pesticides marketing and approval systems. In the words of Full Fact:

> Neonicotinoids, a type of pesticide accused of harming bees, are restricted by the EU. The British government argued against these restrictions at the time, saying that the mixed scientific evidence

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77 *The UK's exit from and new partnership with the European Union*, CM 9417, February 2017: pages 36-41

78 "Brexit would free UK from 'spirit-crushing' green directives, says minister", *Guardian* online, 30 May 2016

79 HL8171, 11 May 2016

80 PQ 49293, 26 October 2016

81 HL5196, 8 February 2017

82 PQ 2757, 11 July 2017

didn't justify a ban. Leaving the EU would mean we're no longer covered by these restrictions, and the government might not continue them given the choice. Ministers say it depends what the latest research says.[83]

[83] Full Fact, *Bees, neonicotinoids and the EU*, 20 May 2016

4. How and when were UK emergency authorisations sought and granted?

The EU neonicotinoid restrictions remain in place until the EU Commission decides otherwise.

In 2015, in line with EU rules, the UK government granted a time-limited emergency authorisation for two types of seed treatment in four counties in England. This did not mean that the overall restrictions were overturned.

Those other Member States which have granted emergency authorisations include some of those that voted in favour of restriction: Denmark, Finland, Estonia, Romania and Bulgaria. Germany already had some emergency authorisations for neonicotinoid seed treatments in place, despite having restricted a number of neonicotinoid pesticides before the EU Commission's proposals.[84]

4.1 What is the emergency authorisation process?

Emergency authorisations are temporary, limited in scale and controlled

There is a process for seeking emergency authorisations for banned pesticides if certain criteria are fulfilled. Authorisations are only granted for a certain period under certain conditions and do not undermine any overall restrictions that apply to that product.

Article 53 of Regulation 1107/2009 on placing plant protection products on the market sets out how Member States can authorise the use of a plant protection product for a period not exceeding 120 days for a limited and controlled use where such a measure is necessary because of a danger which cannot be contained by any other means.[85] This is a specific derogation from the requirements of Article 28 of the Regulation which requires products to have approval before being placed on the market.

When issuing such emergency authorisations, the Member State concerned must inform the other Member States and the Commission of the authorisation given, detailed information about the situation and any measures taken to ensure consumer safety. If necessary, the Commission will take a decision as to whether the Member State can extend or repeat the emergency authorisation or not or whether the authorisation must be amended or withdrawn. The regulation does not set out any requirements for making the information public beyond the Commission.

The criteria include the following conditions:

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84 See, for example, *Bee activist: EU ban on neonicotinoids undermined by national derogations*, EurActiv.com, 22 September 2014

85 Regulation (EC) No 1107/2009 of the European Parliament and of the Council, 21 October 2009

- there must be no effective and economic alternative chemical or non-chemical treatment available (emerging resistance thus being an acceptable reason to allow treatment)
- there must be adequate evidence of human and environmental safety available
- the proposed use of the compound must be limited in scale
- the proposed use must be controlled, allowing perhaps for additional conditions of authorisation to be required and
- the long-term economic and environmental benefits from granting a temporary emergency authorisation must outweigh any potential adverse effects resulting from the authorisation and
- there is evidence of a permanent solution to the problem being developed.[86]

The application has to provide evidence of why any risks to the environment will be acceptable. Special conditions can be applied to the authorisation, such as limiting a treatment to a particular site or sites so that environmental impacts or uncertainties that would not normally be permitted could be tolerated.

UK authorisations are overseen by the Chemicals Regulation Directorate in the HSE, which works to criteria laid down by Directive 91/414/EEC.[87] They are considered by the ECP. The ECP makes its minutes public. It used not to routinely publish its advice to Ministers, but has done so more recently (in May and July 2015 and May and June 2016) in relation to neonicotinoid pesticides, because of the level of interest.[88]

4.2 How was the UK emergency authorisation granted in 2015?

In spring 2015, the NFU applied to the UK Government for rapeseed that autumn. The first application was rejected but a narrower request was approved.

The NFU sought an emergency authorisation to use neonicotinoids on 79% of the UK OSR crop area early in 2015, which was considered by the ECP in May 2015.[89] On 3 July 2015, the NFU announced that its application had been refused (because the application was not sufficiently limited or controlled) and expressed frustration with the process and the delays within it.[90]

The NFU criticised the application process, calling it "obscure and confusing". It said that it was not given information in good time to provide responses to regulators' questions, interpretation of legislation appeared to have changed and the NFU was "left in the dark by government until the last minute".[91]

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86 *ECP Guidance On Emergency Authorisations* (undated)

87 The full process and criteria for emergency authorisations are set out in the HSE's *ACP Guidance on Emergency Authorisations*.

88 See "Advice to Ministers" on *UK Expert Committee on Pesticides (ECP)* (undated, accessed 9 March 2017)

89 A similar application had been made by Syngenta in 2014 but withdrawn, because the government did not complete the required process in time for the seeds to be treated for sale and planting.

90 NFU, *NFU neonicotinoid application refused*, 3 July 2015

91 As above

The NFU put in further, narrower applications which were then successful. On 22 July 2015, the NFU announced that the Government had approved limited use of two neonicotinoid pesticides in four English counties.[92] The ECP had accepted that the use would be limited and controlled, was subject to stewardship arrangements and was to control a danger which could not be contained by any other reasonable means.[93]

This equated to around 90,000 hectares (ha) of OSR (based on 2014/15 yields) and 5% of the 2014/15 OSR crop area in England (c.30, 000 ha). The NFU would monitor the crop for useful data but there would not be specific monitoring of bee populations linked to the approval.

The authorisation allowed access to Modesto (Bayer) and Cruiser OSR (Syngenta) for 120 days in Suffolk, Cambridgeshire, Bedfordshire and Hertfordshire.

Although pleased finally to gain approval, the NFU warned that the extremely limited nature of the authorisation was not going to help the vast majority of farmers in need of flea beetle protection. The NFU called on Defra to "contribute to solutions" for these farmers.[94]

ECP advice in 2015

The detailed record of the ECP's discussion on 7 July 2015 of the authorisation is available in the National Archives.[95] The ECP advised Ministers to accept the July application and advised them that:

> A decision needs to be taken urgently. If authorisation is given this needs to be issued in time for at least one of the authorisation holders to finalise seed labels by 24th July for seed to be available for sowing this season.[96]

The ECP's minutes are normally published promptly (within around 3 weeks of meetings) but the May 2015 minutes, in which the first 2015 application covering 79% of the OSR crop was discussed, were not published until July 2015.[97] This caused press and campaigners to speculate about the delays and doubt the legitimacy of the process. The ECP is reported to have explained that Defra had asked it to delay the publication of the minutes so that the Government could have space to consider the matter without intense lobbying from stakeholders whose views were already very clear.[98]

The minutes were published later than would normally be the case.

In August 2015, FoE sought judicial review of the Government's decision to grant the emergency authorisation, arguing that it did not comply with EU law governing such authorisation, but the application was denied.[99]

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92 NFU, *Neonics emergency application approved*, 22 July 2015
93 HL 1921, 7 September 2015
94 NFU, *Neonics emergency application approved*, 22 July 2015
95 ECP, *Detailed record of discussion of the meeting of the UK Expert Committee on Pesticides (ECP) held on 7 July 2015*, September 2015
96 ECP Advice, *Emergency authorisation of Cruiser OSR and Modesto as a seed treatment for oilseed rape: Advice to Ministers*, July 2015
97 ECP, *Detailed record of discussion*, 20 May 2015
98 See, for example, Damian Carrington, "UK government gags advisers in bees and pesticides row", *Guardian* online, 17 July 2015
99 FoE Press Release, *Bees: Friends of the Earth mounts legal challenge over 2015 pesticides decision*, 24 August 2015

4.3 Unsuccessful application for emergency authorisation in 2017

Farmers Weekly reported in January 2017 that – because of ongoing problems with Cabbage Stem Flea Beetle (CSFB) - the NFU had applied to use neonicotinoid pesticides on 11% of the OSR crop in England in 2017.[100]

On the NFU website, the NFU vice-president, Guy Smith, set out the farmers' case:

> This application recognises that, because of the neonicotinoid restrictions, pest numbers have increased in recent years to such an extent that there are now areas of the country where these seed treatments are less likely to be of benefit – areas where the pest pressure is so high that the risk of losing oilseed rape is too great and control with pyrethroids is compromised by increased pesticide resistance. Overreliance on pyrethroids, caused by the neonicotinoid restrictions, is exacerbating this resistance problem.
>
> But there are areas where the pest pressure has not reached these levels yet, and where resistance hasn't been an issue, where we believe highly targeted, highly controlled use of neonicotinoid seed treatment would help deliver significant benefits in controlling flea beetles and allowing crops to establish and thrive. It is these areas, equating to 11% of the national crop, which we have targeted with this application.
>
> With the absence of neonicotinoids causing farmers to stop growing oilseed rape, bees and beekeepers also stand to lose out from restrictions as the area of this valuable food source for all bee declines. There is still no clear evidence showing that neonicotinoids, on crops like winter oilseed rape, cause widespread impacts on bee populations.[101]

George Eustice announced in April 2017 that, taking account of the ECP's advice, Defra had rejected the application:

> The ECP has submitted its advice on the NFU applications to the Government. It finds that neither of the applications meets the requirements for emergency authorisation. The ECP's full advice note has been published on the GOV.UK website.
>
> Based on the evidence and the expert advice, Defra has rejected the applications.[102]

The ECP considered the application at its meeting on 11 April 2017.

In its advice to Ministers, the ECP drew attention to gaps in the information provided by the NFU and also expressed concern about whether the emergency use would be sufficiently "limited and controlled". The ECP also examined the information submitted about risks to pollinators:

> […] The ECP has kept abreast of new information/research which is emerging on this subject and adopts a weight of evidence approach. The risks from the proposed use are, therefore, understood inasmuch as they can be.

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100 "NFU applies to use neonics on 11% of oilseed rape crop", *Farmers Weekly* online, 31 January 2017

101 NFU online, *Crop news: NFU submits neonicotinoid application*, 7 February 2017

102 PQ 71446, 25 April 2017

The Committee considered that:

- A submission by Friends of the Earth relating to the application was clear and articulate and contained some worthwhile perspectives on the use of alternative approaches. It did not, however, raise any issues of which the Committee was unaware.
- There was a case for need, but the approach proposed by the applicant did not necessarily mean that this would prevent emergency occurrences (considered to be severe yield loss or crop loss).
- The application did not provide sufficient assurances the product would or could be used in locations of moderate pest pressure.
- There was insufficient information available to take a view on suitability of the stewardship arrangements, in particular the advisor training.
- There is a relatively high (but not unacceptable) environmental risk associated with the proposed use of these products.[103]

The ECP's advice was therefore that

> … the applications do not meet the tests enabling an emergency authorisation to be granted; and should therefore be refused.[104]

The NFU was reported as being very disappointed with the decision:

> NFU vice president Guy Smith said: "This is very disappointing news for oilseed rape growers. Pest pressure is a serious and costly issue for growers and the number of cabbage stem flea beetles remain high and continues to grow.
>
> […]
>
> "Farmers will be frustrated, especially at a time when oilseed rape is an arable crop with one of the strongest, average gross margin in areas where pest damage is low."[105]

Friends of the Earth, on the other hand, welcomed the decision:

> …Friends of the Earth nature campaigner Sandra Bell described the decision as "great news for bees".
>
> "Farmers need support to find effective bee friendly ways to protect their crops, not the reintroduction of products that have been shown to harm essential pollinators and the other beneficial insects that help control pests," she said.[106]

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103 Defra and ECP, *Advice to Ministers: Application for an emergency authorisation for the use of 'Cruiser OSR' and 'Modesto' as neonicotinoid seed dressing on oilseed rape*, April 2017

104 As above

105 "Ministers advised to reject pesticides plea", *Yorkshire Post*, 26 April 2017 (via pressreader)

106 Gareth Simkin, "NFU's neonic request fails again", *ENDS Report*, 26 April 2017 [requires subscription]

4.4 Unsuccessful applications for emergency authorisation in 2016

An application from the NFU for 2016 (this time with support from the Agriculture and Horticulture Development Board (AHDB, a statutory levy board, funded by farmers, growers and others in the supply chain and managed as an independent organisation) was refused. The two organisations had sought emergency authorisation for products containing neonicotinoid active substances for use as seed treatments on winter OSR (WOSR) to control CSFB.

The ECP advised Ministers that the application did not fulfil the criteria for grant of an emergency authorisation:

> The Committee, therefore, advises that whilst it recognises the potential for damage to crops by CSFB the applications do not meet the criteria for an emergency authorisation, as:
>
> 1. there is insufficient information to ensure that use will be limited only to those areas where there is a danger or threat to plant protection; and
> 2. the stewardship arrangements proposed by the applicant do not offer adequate assurance that the use will be controlled in an appropriate fashion.[107]

These applications were considered by the ECP on 4 May 2016.

In a press release, the NFU vowed to continue making applications:

> [The NFU] will persist in applying for the emergency use of neonicotinoid seed treatments on behalf of farmers facing pressure from cabbage stem flea beetle.[108]

[107] ECP, *Emergency Authorisation of 'Cruiser OSR' and 'Modesto' as a seed treatment on oilseed rape*, May 2016

[108] NFU, *NFU to continue with neonicotinoids application*, 13 May 2016. The Government's decision to reject the emergency application is discussed in "Defra rejects NFU application to use neonicotinoids on OSR", *Farmers Weekly* online, 12 May 2016.

5. How are pesticides regulated?

5.1 At the EU level

The rules for pesticide controls apply across the EU and allow Member States to authorise individual pesticide products following a national risk assessment process.

The main, active substances used in pesticides are approved at EU level and are authorised only if scientific assessment by the EFSA under Council Regulation 1107/2009 finds that their use is not expected to have harmful effects on human health or to have unacceptable effects on the environment. The conclusions are provided to the European Commission, which proposes approval or non-approval. This recommendation is subject to a vote by all Member States in the SCoFCAH. Pesticide approvals can be reviewed in the light of new scientific evidence.[109]

Once listed on the EU approved substance list, the pesticide must gain consent at national level.

In its recent report on Brexit and agriculture, the House of Lords European Union Committee noted that the NFU had criticised the EU regulations in this area, claiming they were burdensome and not based on sound evidence.[110]

Will the EU now ban the use of neonicotinoids?

After leaked draft regulations were shared with the *Guardian* newspaper, it was reported in March 2017 that the EU was preparing regulations to ban the use of neonicotinoids:

> The world's most widely used insecticides would be banned from all fields across Europe under draft regulations from the European commission, seen by the Guardian.
>
> The documents are the first indication that the powerful commission wants a complete ban and cite "high acute risks to bees". A ban could be in place this year if the proposals are approved by a majority of EU member states.[111]

Commenting on the leak, the *Guardian* suggested that, although there was limited evidence to link pesticide exposure with falls in overall bee populations, the European Commission had decided to act on EFSA's risk assessments:

> [The] the European commission (EC) has decided to move towards implementing a complete ban now, based on risk assessments of the pesticides by the European Food Safety Authority (Efsa), published in 2016.
>
> Efsa considered evidence submitted by the pesticide manufacturers but the EC concluded that "high acute risks for bees" had been identified for "most crops" from imidacloprid and clothianidin, both made by Bayer. For thiamethoxam, made by

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109 See National Assembly for Wales Research Paper, *Bee Health*, May 2013, para 5.3. Review of pesticide approval in the light of new scientific and technical knowledge and monitoring data is In accordance with Article 21 of Regulation (EC) No 1107/2009.

110 House of Lords European Union Committee, *Brexit: agriculture*, HL 169 2016-17, 3 May 2017: page 47

111 "Europe poised for total ban on bee-harming pesticides", *Guardian* online, 23 March 2017

Syngenta, the EC said the company's evidence was "not sufficient to address the risks".[112]

5.2 UK Pesticide Regulation

In the UK, it is the Health and Safety Executive's Chemicals Regulation Directorate which provides the necessary risk assessment and authorisation. The HSE's website offers a brief guide to active substance approval and product authorisation, with links to more detailed guidance.[113]

In 2013, the EAC described the system for approving pesticides as "opaque".[114]

The honeybee is the only species of bee considered in the risk assessment process (and ecological outcomes, such as effects on pollination services, are also not considered).

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[112] "Europe poised for total ban on bee-harming pesticides", *Guardian* online, 23 March 2017

[113] HSE, *An Introduction to Active Substance Approval and Product Authorisation* (undated)

[114] EAC, *Pollinators and Pesticides*, 5 April 2013, HC 668 2012-13: page 3

6. Why did the EU restrict neonicotinoid use in 2013?

In December 2013, the European Commission introduced restrictions on the use of the three most common neonicotinoids for seed treatment, soil application (granules) and foliar treatment on bee attractive plants and cereals. The remaining authorised uses are limited to professionals with exceptions allowed for treating bee-attractive crops in greenhouses and in open air-fields only after flowering.

Winter cereals are exempt from the restriction, as dust exposure during autumn is not considered to be such a risk, but other flowering crops such as rapeseed, flax and maize have been affected.

The restrictions are not time-limited but were introduced with a promise of a review after two years of the "relevant scientific and technical developments".[115]

The UK Government did not support the introduction of the restrictions because, in its view, field trial evidence did not merit the restrictions; the Government believed that there had not been sufficient analysis of the impacts of the other insecticides that would be used instead.

The UK Government has said that the restrictions will remain in place "until and unless" the European Commission decides to change them.[116]

The EFSA was expected to publish a fresh review of the evidence in January 2017 and then advise the Commission on the continuing restrictions on the use of these neonicotinoids.[117] Nothing has yet been made public and Professor Dave Goulson has suggested that the EFSA report might not appear until September 2017.[118]

6.1 Recent comments from the EU

Wood and Goulson (2017) (in a study which received funding from Greenpeace) found that exposure from non-target plants represented a greater risk than the pre-2013 evidence suggested and there was a greater risk to free flying wild bees. They called for an extension of the moratorium.[119]

In response to the study and calls from Greenpeace to extend the scope of the current EU restrictions, a spokesperson for the European

115 Europa Press Release, *Bees and Pesticides: Commission to proceed with plan to better protect bees*, 29 April 2013

116 HL 775, 28 June 2015

117 EFSA, *Pesticides and bees: EFSA to update neonicotinoid assessments*, 11 January 2016. The EFSA called for data in September 2015: see EFSA, *Call for new scientific information as regards the risk to bees from the use of the three neonicotinoid pesticide active substances clothianidin, imidacloprid and thiamethoxam applied as seed treatments and granules in the EU*, 30 September 2015

118 Dave Goulson, *Blog: On neonicotinoids and impartiality in scientific research*, 16 January 2017

119 T Wood and D Goulson, "The Environmental Risks of neonicotinoid pesticides: a review of the evidence post-2013", *Environmental Science and Pollution Research*, June 2017 doi: 10.1007/s11356-017-9240-x

Commission was quoted as saying that the protection of bees was a priority:

> It is exactly because [bees'] protection is a priority that (neonicotinoid) restrictions are, and will remain, in place until an evaluation is finalised.[120]

This article too suggested that the EFSA report would be delayed until later in 2017:

> An EFSA neonicotinoid review is due to be finalised in the second half of this year.[121]

6.2 What prompted restrictions on the use of some neonicotinoids?

The European Commission's restrictions were prompted by a report by the EFSA in January 2013, based on a review of data previously submitted for active substances' approval at EU level and for product authorisations at Member State level, together with other literature and data, which found that:

- seeds coated with neonicotinoid insecticides posed serious risks to bees from crops producing nectar and pollen, including oilseed rape (OSR), sunflowers and maize.
- a more comprehensive risk assessment for bees when approving pesticides was needed and
- a higher level of scrutiny in interpreting field studies on the impact of pesticides should (they recommended) be introduced.[122]

The European Commission's webpage on EU efforts for bee health provides a timeline up to 2014 for the main EU actions and the EFSA has a webpage on bee health.

The review focussed on the effect of the pesticides on bees and their colonies and highlighted that limited information was available for pollinators other than honey bees. The EFSA therefore advised that the risk to these other pollinators should be further considered. It also concluded that more information was needed to update the existing risk assessments for the pesticides.[123]

Syngenta (the main producer of neonicotinoids) wrote to all EU governments in February 2013 arguing that the EFSA's report was flawed. The company said that seed planting rates were used which were much (2-4 times) higher than those actually used in the field.[124]

In May 2013, the EFSA also concluded that the insecticide fipronil posed a high, acute risk to honeybees when used as a seed treatment for maize.[125] The EFSA's risk assessment was requested by the European

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120 "Europe should expand bee-harming pesticide ban, say campaigners", *Guardian* online, 12 January 2017

121 As above

122 EFSA, *EFSA identifies risks to bees from neonicotinoids*, 16 January 2013

123 HC Deb 14 February 2013 c882W

124 Syngenta News Release, *EFSA review of risk to bees from neonicotinoid technology is fundamentally flawed, 15 February 2013*

125 EFSA, *Conclusion on the peer review of the pesticide risk assessment for bees for the active substance fipronil*, EFSA Journal 2013; 11(5): 3158, doi 10.2903/j.efsa.2013.3158. Fipronil is a broad use phenylpyrazole used to control various soil insects in their larval stages. It too is systemic, but is not a neonicotinoid.

Commission and the Authority was asked to pay particular regard to the acute and chronic effects on colony survival and development and the effects of sub-lethal doses on bee mortality and behaviour.[126] The EFSA called for data in September 2015.[127]

6.3 EU restrictions before 2013

A 2009 report by Buglife drew attention to concerns about neonicotinoids' effects and the full or partial bans which some Member States had already introduced.[128]

In its evidence to the EAC's inquiry into pollinators and pesticides, Defra explained why it did not consider that these bans added support for the Commission's ban or suggested that the UK was out of line.[129]

6.4 Stakeholder reaction to the 2013 restrictions

Environment and wildlife groups largely welcomed the restrictions, although they cautioned that they did not address the other major causes of bee decline.

- The British Bee Keepers Association said in 2013 that it remained concerned about the impact of the restrictions on honey bees in terms of any related changes in agricultural practice or use of pesticides that might not be safe for honey bees, thereby undermining the measures.[130]
- Greenpeace saw the UK's vote against the restriction as exposing the UK Government as "being in the pocket of big chemical companies and the industrial farming lobby." Greenpeace believed that the scientific evidence was clear that the insecticides were badly affecting bees.[131]
- FoE welcomed the restrictions of "some of the worst bee-harming pesticides" but cautioned that this in itself would not solve bee decline.

  Research commissioned by FoE in 2013 indicated that, although pesticides had a role, intensive farming and urban development were having a huge impact on bee decline. FoE lobbied for the Government to urgently introduce a Bee Action Plan to tackle all causes of bee decline.[132]

  In August 2015, FoE unsuccessfully applied for judicial review of the Government's decision to grant an emergency authorisation for certain neonicotinoid seed treatments.

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126 EFSA press release, *EFSA assesses risks to bees from fipronil,* 27 May 2013
127 EFSA, *Risk to bees from fipronil: call for data*, 1 September 2015
128 Buglife, *The impact of neonicotinoid insecticides on bumblebees , honeybees and other non-target invertebrates*, October 2009 (revised version)
129 EAC, *Pollinators and Pesticides*, 5 April 2013, HC 668 2012-13: Ev 194
130 British Bee Keepers Association, *Update: EU vote on neonicotinoids*, 2 May 2013
131 GreenPeace Press Release, *Government votes against saving bees and loses*, 29 April 2013
132 FoE, *New report reveals extent of bee decline*, 9 May 2013

- In November 2015, the Bee Coalition published *Policies for Pollinators: The Need for Government Leadership in Backing England's bees*. The Coalition includes FoE, the Soil Association and Buglife.[133]
- Buglife has campaigned against the use of neonicotinoids since 2009, when it published a report (just mentioned) raising concerns about the impact of neonicotinoids on wild pollinators. It heralded the restrictions as a "good start" but said that the restriction would "not be robust enough to see our bee populations recover".

  The charity pointed out that neonicotinoids have a half-life (the time taken for half of the chemical to breakdown) in soil of over three years, and will still be used on winter crops. Buglife called for the next step to be a monitoring programme, to assess how all pollinators, not just honeybees, were doing as a result of the restriction.[134]
- Syngenta said that the restriction would "not save a single hive", was based on "poor science" and ignored a wealth of evidence from the field that the insecticides did not damage the health of bees. The company urged the Commission to take the opportunity to address the real reasons for bee health decline: disease, viruses and loss of habitat and nutrition.[135]

6.5 House of Commons Environmental Audit Committee report

In evidence to the EAC, Defra reiterated that, in its assessment, the studies available at the time did not provide "unequivocal evidence that sub-lethal effects with serious implications for colonies are likely to arise from current uses of neonicotinoids".[136]

The EAC published its report on Pollinators and Pesticides in March 2013.

The EAC supported a "precautionary moratorium" on the three neonicotinoids targeted by the Commission, criticising the Government for not implementing the precautionary principle themselves in the light of their view that the scientific evidence was not conclusive or the balance of risks and costs clear.[137]

The Committee observed that:

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133 Bee Coalition, *Policies For Pollinators: The Need for Government Leadership in Backing England's Bees,* November 2015

134 Buglife press release, *European Commission places a temporary suspension on dangerous insecticides*, 29 April 2013

135 Syngenta Press Releases, *EU Member States again fail to agree restriction on key crop protection technology*, 29 April 2013 and *Syngenta and Bayer CropScience propose a comprehensive action plan to help unlock EU stalemate on bee health*, 28 March 2013

136 EAC, *Pollinators and Pesticides*, 5 April 2013, HC 668 2012-13: Ev 194

137 As above: page 30

> DEFRA Ministers have refused to back EU efforts to protect pollinators and can't even come up with a convincing plan to encourage bee-friendly farming in the UK.[138]

The Committee also called for reforms to the EU pesticide approvals process and a more strategic approach to supporting insect pollinators in the UK.[139]

In its response to the Committee, the Government rejected the recommendation to implement the precautionary principle.[140]

In 2015, the chair of the EAC, Huw Irranca-Davies, wrote to the Secretary of State for Agriculture, Liz Truss, seeking clarification of how the emergency authorisation had been granted and calling for "greater levels of transparency".[141]

6.6 The impact on farmers

In brief:

- The NFU in England and Scotland have claimed that the restrictions on neonicotinoids have caused heavy losses through OSR crop damage from pests.[142]
- The most recent figures, available in the ADAS Final Harvest Report 2016, indicate that yields are down: the national yield estimate for winter OSR (WOSR) was 3.0-3.2 t/ha – an 11-17% decrease on the five year average (3.6 t/ha).[143]
- Commenting on the poor harvest and decreasing OSR area, the NFU said in November 2016 that it was reviewing the way forward, as OSR production might be in jeopardy if neonicotinoids remained restricted.
- Before this, the Home Grown Cereals Authority (HGCA)'s survey results in April 2015 for WOSR had shown that 5% of the WOSR area originally planted was reported to have been lost to adult Cabbage Stem Flea Beetle; the area lost in England (after some replanting) was estimated to be equivalent to 22,000ha. HGCA also estimated that around 38,000 ha of additional WOSR would have been planted if farmers had access to neonicotinoid seed treatments.[144]
- Buglife argued then that these harvest figures showed that the Government's approval of an emergency authorisation had been unnecessary and a "total nonsense". Buglife argued too that, while some farmers had struggled to establish their OSR because the weather had been ideal for flea beetles, where they had persisted the results had been good.[145]

The NFU in England and Scotland (the main UK producers of OSR) has been concerned that, because neonicotinoids are a seed treatment for

138 EAC, *Pollinators and Pesticides*, 5 April 2013, HC 668 2012-13: Ev 194
139 As above: Page 18
140 *Pollinators and Pesticides: Government response to the Committee's Seventh Report of Session 2012–13*, 10 September 2013, HC 631 2013-14
141 Huw Irranca-Davies to Liz Truss: undated letter
142 NFU, *Bulletin*, 3 June 2015
143 ADAS, *Final 2016 Harvest Summary Report*, 6 October 2016 on the ADHB Cereals and Oilseeds website
144 As above
145 Buglife, *Breaking news: Oilseed rape flourishes without bee-killing chemicals*, 31 July 2015

OSR, the restriction on the range of neonicotinoids has caused farmers across the country to suffer heavy losses through OSR crop damage from pests.[146]

Yields and impacts in 2016

Clearly, CSFB will not be the only pest affecting OSR. Other pests and diseases - notably verticillium wilt - will be contributing to declines in yields. (See, for example, ADAS' comments below about black grass).

The most recent figures, in the ADAS Final Harvest Report 2016, indicate that yields are down: the national yield estimate for WOSR was 3.0-3.2 t/ha – an 11-17% decrease on the five year average of 3.6 t/ha.[147] Commenting on the poor harvest and decreasing OSR area, the NFU said in November 2016 that it was reviewing the way forward, as OSR production might be in jeopardy if neonicotinoids remained restricted:

> "The NGOs and ministers were doubting the need for neonics but this autumn quite clearly showed there was one," [NFU vice-president Guy Smith] added. "In addition, we need to bear in mind pyrethroid resistance gathers pace every year and reliance on just one insecticide exacerbates the problem going forward.
>
> "There are serious question marks over the future of oilseed rape production in the UK because of the drip, drip loss of key actives. We desperately need more R&D into non-chemical solutions."[148]

Friends of the Earth continue to call for a ban on neonicotinoids, arguing that – although loss of habitat and climate change are also key factors – neonicotinoids are playing "a huge part in the decline of our bee populations":

> Neonicotinoids – or neonics – are systemic pesticides, which means they are absorbed into every part of the plant – from the roots and stem, to leaves and flowers. When a bee feeds on the pollen or nectar containing neonicotinoids, the neonic can damage its nervous system and motor function, affecting its feeding, navigation, foraging and reproduction.
>
> […]
>
> As the UK heads for Brexit, we'll be pushing our government to commit to tough environmental legislation that protects our wildlife - and not to give in to pesticide industry lobbying.

FoE also argue that there is no evidence that neonicotinoids help farmers and other methods of controlling pests are viable:

> Actually yields for oilseed rape in 2015, when neonics could not be used, were higher than in 2014 and **above the ten year average**. Although yields in 2016 are looking to be below the five year average, this is due to a range of factors including weather, with loss to pests being only one.

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146 NFU, *Bulletin*, 3 June 2015

147 ADAS, *Final 2016 Harvest Summary Report*, 6 October 2016 on the ADHB Cereals and Oilseeds website.

148 "NFU reviews neonics emergency application", *Farmers' Weekly* online, 16 November 2016

> Some farmers will have suffered crop losses due to pests, but these could have happened even with neonicotinoid treated seeds. In fact one study found no consistent benefit on crop yield from using treated seeds.
>
> What we do have evidence for is that **i**nsect pollination enhances oilseed rape yields - and has also been found to increase the value of 2 British apple varieties by £37m a year.
>
> […]
>
> The NFU says that farmers will be forced to use more of other pesticide sprays such as pyrethroids if the neonicotinoid ban continues. It's true that some farmers have used more of these sprays, but we believe there is no need to.
>
> Research for Friends of the Earth found that there are **effective non-chemical means of control**, such as encouraging **natural predators** that eat the pests. Measures to help natural predators like planting wildflower margins and hedgerows can be good for pollinators too.
>
> Pesticide use can also be reduced if crops are **carefully monitored** for pests before a decision is taken to use a chemical. If sprays are only used as a last resort the pests are less likely to develop resistance too.[149]

Yields and impacts in 2015

The HGCA's survey results in April 2015 for WOSR (planted after the restriction) showed that 5% of the WOSR area originally planted was reported to have been lost to adult Cabbage Stem Flea Beetle (CSFB). About 1.5% of this area was reported to have been successfully replanted.[150] The remaining 3.5% was estimated to be equivalent to 22,000ha lost in England.[151] This represented a small increase in losses to CSFB and drop in yields from 2014.[152]

HGCA also estimated that around 38,000 ha of additional WOSR would have been planted if farmers had access to neonicotinoid seed treatments.[153]

Final harvest figures were brought together in October 2015 in the ADAS Final Harvest Report 2015, which reported "some very good yields [that] season" for WOSR – estimated at 3.8 t/ha - a 13% increase in yield compared to the national 10 year average of 3.4 t/ha. Yields ranged from 2.25 - 6.70 t/ha, with the lowest yields seen from crops grown on fields with high black-grass pressure, or those crops that were affected by pigeon or CSFB damage.[154]

Buglife argued then that these harvest figures showed that the Government's approval of an emergency authorisation had been

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149 FoE, *Bees, pesticides and neonicotinoids*, updated November 2016
150 ADHB, *Neonicotinoid pesticide restrictions*, 20 April 2015
151 House of Commons Library and other UK Parliaments/Assemblies and Oireachtas Library and Research Service, *CAP reform 2014-20: EU agreement and implementation in the UK and in Ireland (updated)*, RP I4/56, 30 October 2014. Total crop for England is around 676,000 ha and 72,000 ha UK-wide.
152 ADHB, *Neonicotinoid pesticide restrictions*, 20 April 2015
153 As above
154 ADAS, *Final 2015 Harvest Summary Report*, 9 October 2015 on the ADHB Cereals and Oilseeds website.

unnecessary and a "total nonsense". Buglife argued too that, while some farmers had struggled to establish their OSR because the weather had been ideal for flea beetles, where they had persisted the results had been good.[155]

The NFU said in June 2015 that it was "becoming nearly impossible for many farmers and many are using older products which the pest [CSFB] is increasingly resistant to".[156] The Agriculture and Horticulture Development Board (ADHB) has issued guidance to farmers about how to try and control the CSFB without neonicotinoids and with limited use of older, more toxic, pesticides such as pyrethroids.[157]

FoE took a different view. It recognised that the restrictions might "pose challenges for some farmers" but did not accept that a 5% loss constituted an "emergency" which would justify the emergency authorisation granted in 2015. Whilst expressing sympathy for farmers who had lost crops, FoE argued that there was "no evidence to suggest that continued enforcement of the restriction [would] place an unacceptable stress upon the sector as a whole, or [would] have net negative effects on wildlife."[158]

[155] Buglife, *Breaking news: Oilseed rape flourishes without bee-killing chemicals*, 31 July 2015
[156] NFU, Weekly Bulletin, 3 June 2015
[157] ADHB, *Information Sheet 43: Cabbage Stem Flea Beetle*, Summer 2015
[158] FoE, Campaign letter to Rt. Hon Liz Truss MP, Secretary of State for Environment, Food and Rural Affairs: *Application for emergency authorisation of neonicotinoid-treated oil-seed rape* (accessed 9 March 2017)

7. In more detail: what does the science tell us?

A number of key studies on the impact of pesticides, particularly neonicotinoids, on honey and bumble bees have been published in the last few years. Although new studies on pollinators and pesticides are published frequently, there are still gaps in knowledge. The methodology of some studies has been questioned and their findings remain controversial.

This remains a highly contentious area: there is a constant stream of new studies but, even so, little agreement on what constitutes good evidence.

7.1 Do laboratory studies accurately represent what happens in nature?

Much of the debate around the scientific evidence centres on the question of whether the levels of pesticide to which bees are exposed in laboratory studies realistically represent the levels and mix of chemicals that will be experienced by free ranging bees. In addition, although it is not disputed that pollinators will be exposed to the pesticides and there is risk of harm, it is not clear what levels they are being exposed to and the exact consequences of those doses. The disparities between field and laboratory findings have added to the controversy and significant uncertainties remain.

Defra has consistently argued that field research is required, to explore the knowledge gaps, but there are confounding factors in field research (such as weather and habitat difference) that can make conclusive results problematic. The large number of variables that cannot be controlled make direct cause and effect difficult to determine.

In February 2013, Professor Ian Boyd, Defra's Chief Scientific Adviser, explained to the EAC why he thought field trials were imperative, to understand the risks from neonicotinoids to pollinators:

> The real question is: are [neonicotinoids] toxic to bees in the field at the kind of doses that bees actually experience? The evidence to date does not support that. […] But at the moment we do not see that evidence. It is not without having looked for it, as well.[159]

7.2 Key studies

The following tables highlight some of the studies - carried out by Defra or universities in the UK or overseas - that have generated particular comment and attention or prompted a Government response. They are offered as a reference source.

[159] EAC, *Pollinators and Pesticides*, 5 April 2013, HC 668, 2012-13, Ev 111, Q655

Studies in 2017

Date and study	In brief
June 2017 Woodcock *et al* "Country-specific effects of neonicotinoid pesticides on honey bees and wild bees" *Science,* 356, 1393-1395 (2017)[160]	Woodcock *et al* (2017) used large field experiments to assess the effects of crop treatment with clothianidin or thiamethoxam on honey bees and wild bees in Germany, Hungary and the UK. The observed effects differed between countries. In Hungary, clothianidin – but not thiamethoxam – was associated with reduced worker bee numbers. In the UK, honeybee colony survival was generally very low, but lowest where bees fed on clothianidin-treated oilseed rape in the previous year. In Germany there was no evidence of a treatment effect. Woodcock *et al* concluded that neonicotinoids reduced bee species' capacity to establish new populations in the year following exposure. The press release accompanying the article discusses why the outcomes might be different between countries: > [Lead researcher Ben Woodcock] suggests the differing impacts on honeybees between countries may be associated with interacting factors including the availability of alternative flowering resources for bees to feed on in the farmed landscape as well as general colony health, with Hungarian and UK honeybees tending to be more diseased. > In contrast, the hives in Germany happened to be larger, showed little evidence of disease and had access to a wider range of wild flowers to feed on.[161]
May 2017 Baron *et al* "General and species-specific impacts of a neonicotinoid insecticide on the ovary development and feeding of wild bumblebee queens" *Proceedings of the Royal Society B*[162]	This study examined the effects of field-relevant doses of one neonicotinoid - thiamethoxam - on wild queens of four bumblebee species. It found evidence that two weeks' exposure led to a reduction in feeding in two out of four species of wild bumblebee queens, with evidence too of effects on ovary development in multiple species of wild bumblebee queens. This, the researchers concluded, indicated a need for more information on residues, persistence and the risks of exposure, as queens had been shown to be sensitive to neonicotinoids in realistic exposure scenarios: > This study provides the first evidence that field-realistic exposure to thiamethoxam can have an impact on feeding and ovary development in multiple species of wild-caught bumblebee queens. Bumblebee queens are not currently considered in pesticide risk assessments for pollinators, and yet these results indicate that queens are sensitive to neonicotinoids in realistic exposure scenarios. (…) More information is urgently needed on residues and persistence of pesticides in crops, wild plants and in wild bee nests in order to accurately assess the exposure risks for the full range of species and castes of bees likely to encounter them.

[160] doi: 10.1126/science.aaa1190
[161] CEH, *First pan-European field study shows neonicotinoid pesticides harm honeybees and wild bees*, 29 June 2017
[162] doi: 10.1098/rspb.2017.0123

January 2017 Schick *et al* "An experiment on the impact of a neonicotinoid pesticide on honeybees: the value of a formal analysis of the data" *Environ Sci Eur* 29:4[163]	In this study, the data from a 2013 study of field use of the neonicotinoid thiamethoxam was re-examined. The 2013 study – all five of whose authors were current or former employees of Syngenta or had been paid by Syngenta for their work on the study or the field trials on which it reported - had concluded that there was no evidence of detrimental effects and so thiamethoxam posed a "low risk" to bees. The authors of the present study, though, argue that the 2013 study lacked rigour: it lacked formal statistical analysis and its conclusions, derived from inspecting the data, were both misleading and unacceptable in principle. Statistical analysis of the 2013 data now indicated (Schick *et al* conclude) that the confidence limits were generally so wide that any effects of thiamethoxam could have been large without being statistically significant.[164]
January 2017 T Wood and D Goulson "The Environmental Risks of neonicotinoid pesticides: a review of the evidence post-2013" *Environmental Science and Pollution Research,* June 2017 [165]	This study – which received funding from Greenpeace and has not yet been peer-reviewed or submitted to a journal – set out to "summarise how the new evidence has changed our understanding of the likely risks to bees". Amongst its conclusions are: • Exposure from non-target plants represents a greater risk than the previous evidence suggested. • There is a greater risk to free flying wild bees. • Neonicotinoids can persist in agricultural soils for several years; traces of residual neonicotinoids can have a mixture of lethal and sub-lethal effects on a wide range of taxa.
January 2017 Klein *et al* "Why Bees Are so Vulnerable to Environmental Stressors" *Trends in Ecology and Evolution*[166]	This study considered the neurobiological, ecological, and evolutionary reasons why bees might be vulnerable to environmental stressors (such as pesticides, pollutants, parasites, diseases, and malnutrition) and their brains susceptible to damage. The study concluded that key cognitive functions could be disrupted even at low levels: Central-place foraging on flowers demands advanced capacities of learning, memory, and navigation. However, even at low intensity levels, many stressors damage the bee brain, disrupting key cognitive functions needed for effective foraging, with dramatic consequences for brood development and colony survival. We discuss how understanding the relationships between the actions of stressors on the nervous system, individual cognitive impairments, and colony decline can inform constructive interventions to sustain bee populations.
January 2017	This study examined stressors associated with honey bee death.

163 doi: 10.1186/s12302-016-0103-8
164 The study in question is Pilling *et al*, *A Four-Year Field Program Investigating Long-Term Effects of Repeated Exposure of Honey Bee Colonies to Flowering Crops Treated with Thiamethoxam*, PLoS ONE, 8(10): e77193, 2013. DOI 10.1186/s12302-016-0103-8
165 doi: 10.1007/s11356-017-9240-x
166 doi: 10.1016/j.tree.2016.12.009

LaLone *et al* "Weight of evidence evaluation of a network of adverse outcome pathways linking activation of the nicotinic acetylcholine receptor in honey bees to colony death" *Science of the Total Environment*[167]	Neonicotinoid pesticides act on the nicotinic acetylcholine receptors (nAChRs) in the central nervous system to eliminate pest insects.[168] Noting that "mounting evidence indicates that neonicotinoids also may adversely affect beneficial pollinators, such as the honey bee, via impairments on learning and memory, and ultimately foraging success", the study set out to establish adverse outcome pathways (AOPs) as a means of evaluating any linkage between activation of the nAChR and colony level consequences. The study found: From weight of evidence evaluation, sufficient biological plausibility exists to link activation of nAChR to colony death.
January 2017 Friends of the Environment "*Farming wheat without neonicotinoids*"	In this report, drawing on a number of case studies, FoE said that the EFSA had already concluded that "use of clothianidin as a seed treatment for wheat does pose a high risk to bees because of the way neonicotinoids persist and move in the environment". FoE argued that the risk to other organisms – such as aquatic invertebrates – also needed to be taken into account. Noting the potential disbenefits of using pyrethroids, the FOE argued that the priority should be to promote non-pesticide approaches to pest management and urged the UK government to "commit to a comprehensive ban now that will apply whatever our future relationship with the EU".

Studies in 2014 – 2016

Studies in 2016

Date and study	In brief
December 2016 Whitehorn study: preliminary findings reported to the British Ecological Society annual meeting 2016	In preliminary findings from a study reported in *Farmers Weekly, Dr Penelope Whitehorn* at Stirling University found that bees' ability to produce the buzz needed to shake pollen from crops such as potatoes, tomatoes and aubergines (so-called buzz pollination) may be harmed by neonicotinoids. In the study, a colony of bumblebees was divided into three groups of workers. Each group was fed different but field-realistic doses of thiamethoxam. The amount of pollen they collected in the lab from buffalo-bur flowers (Solanum rostratum) was measured and their buzzes were subject to acoustic analysis. The study found that • the more bumblebees practice, the more pollen they collect over time, so learning is key to buzz pollination • bumblebees fed field-relevant doses of thiamethoxam did not collect more pollen over time, suggesting it had impaired their learning.[169]

[167] http://dx.doi.org/10.1016/j.scitotenv.2017.01.113

[168] Acetylcholine is a neurotransmitter. According to AK Jones and DB Sattelle, "*Diversity of insect nicotinic acetylcholine receptor subunits*", *Adv Exp Med Biol.* 2010; 683:25-43:"Nicotinic acetylcholine receptors (nAChRs) are ligand-gated ion channels that mediate fast synaptic transmission in the insect nervous system and are targets of a major group of insecticides, the neonicotinoids".

[169] See also "Study suggests neonics impair bees' buzz pollination", *Farmers' Weekly* online, 14 December 2016

November 2016 Theodorou *et al* "Pollination services enhanced with urbanization despite increasing pollinator parasitism" *Proceedings of the Royal Society B*[170]	A study in Germany, reported in November 2016 by the European Commission's Science for Environmental Policy under the headline *Bumblebees pollinate urban gardens better than agricultural land* found that pollinators were faring better in urban areas than on agricultural land: The researchers found both bumblebee abundance and pollination of wild flowers was higher in urban than rural agriculture sites. This may be due to higher availability of nesting resources and higher local flower species richness, which were related to insect visitation and pollination rates. This indicates the importance of local habitat quality and surrounding land use for pollinator species.
October 2016 Arce *et al* "Impact of controlled neonicotinoid exposure on bumblebees in a realistic field setting", *Journal of Applied Ecology* reported in Science Media Centre, *Expert reaction to study looking at neonicotinoid pesticides and bumblebees in the field*	The Science Media Centre reported that this study had examined the effect of three specific neonicotinoid pesticides on bumblebee colonies in a field setting and found "changes to colony numbers with some pesticides (for imidacloprid or thiamethoxam) more than with others (clothianidin)". Dr Christopher Connolly (Reader in Neurobiology and Associate Director of the Centre for Environmental Change and Human Resilience, University of Dundee) commented on these findings: This study [concludes] that clothianidin does not exhibit the same level of toxicity to bumblebees as demonstrated for imidacloprid or thiamethoxam. This is important as it demonstrates further that neonicotinoids need to be considered independently. Moreover, other beneficial species are likely to have different sensitivities to each neonicotinoid. Therefore, a pragmatic approach is required where the risk of a particular neonicotinoid is matched to a particular species.
August 2016 Centre for Ecology and Hydrology "New study: neonicotinoid insecticides linked to wild bee decline across England"	This study examined data from FERA and the Bees, Wasps and Ants Recording Society showing changes in the occurrence of 62 wild bee species with OSR cropping patterns across England between 1994 and 2011. It found evidence to suggest that • neonicotinoid use is linked to large-scale and long-term decline in wild bee species distributions and communities. • the decline was, on average, three times stronger among species that regularly feed on the crop (such as the buff-tailed bumblebee, *Bombus terrestris*) compared to species that forage on a range of floral resources, indicating that OSR is a principle mechanism of neonicotinoid exposure among wild bee communities. Lead researcher, Ben Woodcock, did point out, though, that neonicotinoids were not the only factor contributing to wild bee species population decline: Although we find evidence to show that neonicotinoid use is a contributory factor leading to wild bee species population decline,

[170] doi: 10.1098/rspb.2016.0561

	it is unlikely that they are acting in isolation of other environmental pressures. Wild bees have undergone global declines that have been linked to habitat loss and fragmentation, pathogens, climate change and other insecticides.[171]
May 2016 Garratt *et al* "Apple Pollination: Demand Depends on Variety and Supply Depends on Pollinator Identity" PLOS ONE	This study identified the economic benefits to apple production in the UK of pollinating insects (solitary bees, bumble bees, honey bees and hoverflies) as £92.1M: solitary bees £51.4M, honeybees £21.4M, bumblebees £18.6M and hoverflies £0.7M.
April 2016 Moffat *et al* "Neonicotinoids target distinct nicotinic acetylcholine receptors and neurons, leading to differential risks to bumblebees" *Nature Scientific Reports 6*, Article number 24764	The study found that each restricted pesticide had very different or little harmful effects on the bees and so it was important to assess each pesticide on its own particular risks. The research showed that imidacloprid and thiamethoxam, but not clothianidin, exhibited toxicity to bumblebee colonies when exposed at field-relevant levels. It found that imidacloprid and thiamethoxam had harmful effects at realistic levels of exposure e.g. on egg production and numbers of bees. However, clothianidin only increased the numbers of queens produced. In a press release, one of the lead researchers, Dr Chris Connelly of the University of Dundee, noted that previously the evidence for clothianidin had been extrapolated from studies on the other pesticides. He urged a moratorium on the use of clothianidin: From our findings, we consider that it is premature to place a permanent ban on the use of clothianidin. That said, a moratorium on its use should continue until the knowledge gaps are filled on its wider impact on other species.[172] Researchers and industry commenting on the study highlighted some conflict with the results of other studies and remarked that it illustrated how challenging it was to work out the effects of these pesticides on bees.[173]
February 2016 IPBES	A key international assessment on pollinators was published in February 2016 by the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES), a group including a leading UK academic on bees, Professor Simon Potts at Reading University. The assessment has 77 authors and over 500 reviewers so will be a key contribution to the European Commission's

[171] For earlier CEH work on neonicotinoids, see CEH, *The impacts of neonicotinoids on honeybees: A large-scale, pan-European field experiment*, 6 January 2015.

[172] University of Dundee, *Bees research shows that not all neonicotinoids are the same*, 28 April 2016. More comment on the study can be found in "Two of the world's top three insecticides harm bumblebees", *Guardian* online, 28 April 2016

[173] See, for example, Science Media Centre, *Expert reaction to the effects of different neonicotinoids on bumblebees*, 28 April 2016.

Press Release: Pollinators Vital to Our Food Supply Under Threat	review. The study's press release sums up the findings on neonicotinoids: [P]esticides, including neonicotinoid insecticides, threaten pollinators worldwide, although the long-term effects are still unknown. A pioneering study conducted in farm fields showed that one neonicotinoid insecticide had a negative effect on wild bees, but the effect on managed honeybees was less clear.
January 2016 US Environmental Protection Agency *EPA release the first four preliminary risk assessments for insecticides potentially harmful to bees*	The US Environment Protection Agency (EPA)'s preliminary risk assessment of imidacloprid found that chemical residues of more than 25pp billion would likely harm bees and their hives and result in the bees producing less honey. These findings were welcomed by FoE, although FoE were critical of the fact that the study related to honey bees and not native US bees.[174]

Studies in 2014 - 2015

Date and study	In brief
December 2015 Carreck critique of previous studies, reported in "Bee Scientist casts fresh doubt on pesticides ban", *The Times*, 16 January 2015	Bee researcher Norman Carreck at the University of Sussex suggested that his colleague Prof Dave Goulson had fed bees unrealistically high levels of neonicotinoid imidacloprid – several times greater than bees were likely to encounter in fields and "worst case scenario". He also criticised a range of other studies for giving the bees one dose, rather than over a longer period of time representing their real life foraging behaviour. Overall, Carreck argued that the restriction may do more harm than good because farmers would spray crops multiple times with older pesticides that were more damaging to wildlife. Carreck has published his paper in the Journal of Agricultural Research. Prof Goulson has said that some field studies had found higher levels of pesticide in pollen and nectar than he had fed to bees.
November 2015 Mickaël Henry *et al* "Reconciling laboratory and field assessments of neonicotinoid toxicity to honeybees" *Royal Society Proceedings B*, vol.282, Issue 1819	The French National Institute for Agricultural Research examined the disparity between field and laboratory studies of the impact of neonicotinoids on bees. The study found that honey bees seem to adapt their operations to compensate for increased mortality. *Farmers Weekly* summarised the conclusions as: • Field exposure to one of the restricted neonicotinoids (thiamethoxam) is linked to significant excess mortality in free-ranging bees. • Colonies appear to compensate for this to preserve their performance in terms of population size and honey production. The most exposed colonies modified the timing of their reproduction and delayed drone brood production in favour of increased worker production.[175]
October 2015	In May 2014, the Oxford Martin School at Oxford University brought together an international group of experts to

[174] FoE, *EPA assessment finds common pesticide harms bees,* 6 January 2016
[175] "*Honey bees can recover from insecticide harm in the wild*", *Farmers Weekly*, 20 November 2015

Godfray *et al* "A restatement of recent advances in the natural science evidence base concerning neonicotinoid insecticides and insect pollinators" Oxford Martin School Restatement project no.3, *Proceedings of the Royal Society B*, 282, 20151821[176]	review the evidence around neonicotinoids and insect pollinators. They aimed to provide an independent restatement of the evidence and its imperfections but no direct policy recommendations. In October 2015 they updated their statement, on the request of the Government's Chief Scientific Advisor, to include evidence published in the last 18 months and concluded that there was still no clear steer for policy makers: There still remain major gaps in our understanding of how pollinator colony-level (for social bees) and population processes may dampen or amplify the lethal or sub-lethal effects of neonicotinoid exposure and their effects on pollination services; as well as how farmers might change their agronomic practices in response to restrictions on neonicotinoid use and the resulting positive or negative effects on pollinators and pollination. While these areas continue to be researched there is still a limited evidence base to guide policymakers on how pollinator populations will be affected by neonicotinoid use or how agriculture will respond to neonicotinoid usage restrictions.
October 2015 Botias *et al* "Neonicotinoid Residues in Wildflowers, a Potential Route of Chronic Exposure for Bees" *Environ. Sci. Technol.*, 49 (21), pp 12731–12740	This study drew attention to the contamination of wildflowers at the margins of arable fields and the associated persistence of neonicotinoids, which would increase bees' exposure: [C]urrent focus on exposure to pesticides via the crop overlooks an important factor ‑throughout spring and summer, mixtures of neonicotinoids are also found in the pollen and nectar of wildflowers growing in arable field margins, at concentrations that are sometimes even higher than those found in the crop. […] Both previous and ongoing field studies have been based on the premise that exposure to neonicotinoids would only occur during the blooming period of flowering crops and that it may be diluted by bees also foraging on untreated wildflowers. Here, we show that exposure is likely to be higher and more prolonged than currently recognized due to widespread contamination of wild plants growing near treated crops.
August 2015 Food and Environment Research Agency (FERA, a Government agency now part-privatised) "New evidence on the pollinator costs and farming benefits of neonicotinoid pesticides"	The research showed that farmers who use neonicotinoid seed coatings subsequently use less insecticide to control pests on OSR, but more honey bee colonies were lost as the usage of imidacloprid increased. Fera concluded that honey bee colonies were being lost due to a range of pressures including: imidacloprid usage, regional factors, adverse weather and pests and diseases. The drivers behind these losses were complex and (Fera said) further evidence from large scale field trials was needed. The ECP commented at its September 2015 meeting that it was not possible to draw any definitive conclusions from the evidence; it made a useful contribution to the suite of evidence but did not show causation.[177]

[176] http://dx.doi.org/10.1098/rspb.2015.1821
[177] Draft minutes, *3rd meeting of the Expert Committee on Pesticides*, 22 September 2015

August 2015 European Food Safety Authority (EFSA) "Neonicotinoids – foliar spray risks confirmed as a risk to bees"	The EFSA confirmed that its assessments showed that neonicotinoid pesticides applied as foliar sprays posed a risk to bees. The Authority has published assessments on the risks to bees from clothianidin, imidacloprid and thiamethoxam for all uses other than seed treatments and granules. In cases where the assessment could be completed, high risks were either identified or could not be excluded. In other cases the risk assessment could not be finalised due to data gaps.
May 2015 Rundlöf *et al* "Seed coating with a neonicotinoid insecticide negatively affects wild bees" *Nature* 521, pages 77–80[178]	In the Swedish field trials, insect life in 16 fields of OSR - 8 fields of untreated OSR seeds and 8 fields of neonicotinoid treated seeds – was compared. Wild bumblebees and solitary bees were found to be much less plentiful in the treated fields, with bumblebee numbers cut by half. Honeybees were more resilient, showing little effect from the pesticide. The *Financial Times* quoted Prof Goulson as calling this study "the first fully field-realistic, well-replicated trial so far…..it is no longer credible to argue that agricultural use of neonicotinoids does not harm wild bees." However, the paper also quoted Julian Little of Bayer CropScience disagreeing, arguing that the study did not substantiate the conclusions that OSR seed treatment with neonicotinoid insecticides affected wild bees.[179]
April 2015 "Bee studies stir pesticide debate" *Nature News* online	In a news article, the journal *Nature* summed up some of the recent debate: > In March [2015, Prof Dave] Goulson reanalysed data from a 2013 study by the UK Food and Environment Research Agency…which had concluded that neonicotinoid pesticides do not harm bees: Goulson found that they do. In the same month, work from the United States found that the probable harm from exposure to imidacloprid in seed-treated crops was "negligible" in honeybees, and last year a study done in Canada reached a similar conclusion for clothianidin on oilseed rape.
April 2015 Kessler *et al* "Nature, bees prefer foods containing neonicotinoid pesticides" and University of Newcastle "Bees prefer nectar containing pesticides"	Two studies, by researchers from Newcastle University and Lund University, Sweden were also published in *Nature*. The journal described them as "settling outstanding questions about the threat that the chemicals pose to bees."[180] The Newcastle study looked at the behaviour of foraging bees and investigated the hypothesis that the negative impacts of neonicotinoids only arise from concentrations greater than those found on the nectar and pollen of pesticide-treated plants and that bees could choose to forage on other available flowers and avoid or dilute exposure. It found that: • the honeybee and the buff-tailed bumblebee do not avoid nectar-relevant concentrations of imidacloprid, thiamethoxam and clothianidin in food.

[178] doi: 10.1038/nature14420
[179] "Studies strengthen insecticide link to bee population decline", *Financial Times*, 22 April 2015
[180] "Bee studies stir pesticide debate", *Nature News*, 22 April 2014

	• Bees of both species prefer to eat more of sucrose solutions laced with imidacloprid or thiamethoxam than sucrose alone. • Bees cannot taste neonicotinoids and are not repelled by them. Instead, bees preferred solutions containing imidacloprid or thiamethoxam, even though the consumption of these pesticides caused them to eat less food overall. And concluded that: • bees cannot control their exposure to neonicotinoids in food, which implies that treating flowering crops with imidacloprid and thiamethoxam presents a sizeable hazard to foraging bees.
March 2015 International Union for Conservation of Nature (IUCN), reported in European Commission press release *European bees: new report shows nearly one in ten wild bee species face extinction*	In March 2015, the IUCN reported on its European Red List of Bees and the Status and Trends of European Pollinators (STEP) project. The report (co-funded by the European Commission) provided information on all 1,965 wild bee species in Europe, including their status, distribution, population trends and threats (although more than half of all species were classified as "data deficient", as lack of experts, data and funding made it impossible to evaluate their extinction risk). The IUCN found that Europe's wild bees are in decline, with 9.2% of European wild bee species threatened with extinction, while 5.2% are considered likely to be threatened in the near future.
June 2014 and September 2014 IUCN, "Worldwide Integrated Assessment"(WIA), published in *Environment Science and Pollution Research,* September 2014	In June 2014, the IUCN Taskforce on Systemic Pesticides[181] publicised the conclusions of a large scale analysis (meta-analysis) of 800 peer-reviewed reports of neonicotinoids and fipronil, which they said confirmed that the substances were "causing significant damage to a wide range of beneficial invertebrate species and are a key factor in the decline of bees".[182] The scientists concluded that the most damage was being done to terrestrial invertebrates, such as earthworms, and then insect pollinators such as butterflies and bees. One of the scientists involved in the study likened the threat to that posed by organophosphates or DDT. There was some press speculation in December 2014 that the scientists had designed the study to support a restriction, but the scientists disputed this vigorously.[183] The RSPB urged regulators to review the evidence presented in this analysis very carefully.[184]
July 2014	Defra's Chief Scientific Adviser, Professor Ian Boyd, commented on various studies on his blog and made some

[181] The Task Force on Systemic Pesticides is a group of global, independent scientists affiliated with the IUCN Commission on Ecosystem Management and the IUCN Species Survival Commission and they believe that their work shows that there is clear evidence of harm sufficient to trigger regulatory action.

[182] IUCN news, *Systemic pesticides pose global threat to biodiversity and ecosystem services*, 24 June 2014

[183] See, for example, "Scientists 'fixed evidence to ban neonicotinoids", *Farmers Guardian*, 10 December 2014 and the comments from the scientists involved which were added on-line.

[184] RSPB, *Pesticides analysis underlines need for more sustainable farming*, 24 June 2014

Comment on various studies by Defra Chief Scientific Adviser, Ian Boyd *More is sometimes less: a response to the Hallmann et al paper*[185]	general observations about the types of studies being conducted. He said: When it comes to neonicotinoids overall the evidence base almost certainly contains considerable systematic bias; it is easier to design and publish studies to show a positive effect than it is to genuinely test the null hypothesis that neonicotinoids have no effect. The scientific community needs to build a much more rigorous evidence base than it has hitherto seemed capable of providing. It needs to face up to the challenge that there is no real substitution for properly controlled experimental studies carried out at appropriate scales, and that few of the many ad hoc studies that are currently hawked around as evidence, including the Hallmann study, contribute to this need.
July 2014 Hallmann *et al* "Declines in insectivorous birds are associated with high neonicotinoid concentrations" *Nature* 511, 341-343	This Dutch study showed that bird populations fell most sharply in those areas where neonicotinoid pollution was highest. Starlings, tree sparrows and swallows were among the most affected. The analysis indicated that pesticide use may reduce the amount of prey insects available to birds, causing the association, and suggested that neonicotinoids posed an even greater threat to wildlife than previously thought.[186] The researchers recommended that future legislation should take into account the potential cascading effects of neonicotinoids on ecosystems. Commenting on the report, one of the authors, Hans de Kroon, highlighted the disturbing amount of imidacloprid they found in water.[187] An editorial in *Nature* described these as 'provocative findings' and cautioned that the study showed correlation, not necessarily causation, and that the evidence that the agricultural chemicals could be blamed for the loss of the birds was circumstantial. The authors, though, said that the declining trend in birds remained after correcting for spatial differences in land-use changes that are known to affect bird populations in farmland. In response, the NFU sceptical about the importance given to food decline due to pesticides as the reason for overall bird population decline.[188]
June 2014 Gibbons *et al* "A review of the direct and indirect effects of neonicotinoids and fipronil on vertebrate wildlife"	This study reviewed 150 studies of the direct (toxic) and indirect (e.g. food chain) effects on vertebrate wildlife (mammals, birds, fish, amphibians and reptiles) of two neonicotinoids (imidacloprid and clothianidin) and fipronil, an insecticide which acts in the same systemic manner. It highlighted evidence suggesting that the systemic insecticides, neonicotinoids and fipronil, are capable of exerting direct and indirect effects on terrestrial and aquatic vertebrate wildlife, thus warranting further review of their

185 no longer available online
186 "Be concerned: A possible link between neonicotinoid pesticide use and a decline in bird numbers is worrying", *Nature* (Editorial) vol 511, 10 July 2014
187 "Neonicotinoids linked to recent fall in farmland bird numbers", *Guardian* online, 9 July 2014
188 NFU Online, *NFU response: Neonicotinoids 'kill birds'*, 10 July 2014

Environment Science and Pollution Research	environmental safety. The study found that all three insecticides exert sub-lethal effects, ranging from impaired immune function to reduced growth and reproductive success, often at concentrations well below those associated with mortality.
May 2014 Godfray *et al* "A restatement of the natural science evidence base concerning neonicotinoid insecticides and insect pollinators" *Proceedings of the Royal Society B*	*A restatement of the natural science evidence base concerning neonicotinoid insecticides and insect pollinators* was published by a group of nine scientists across different organisations and examined the then-current evidence base. The restatement deployed as policy-neutral terms as possible, providing series of evidence statements listed and categorised according to the nature of the underlying information. The NFU highlighted that the study pointed out that declines in bees predate by some decades the introduction of neonicotinoid pesticides.[189]
March 2014 Defra *Status and Value of Pollinators and Pollination Services*	This report described the debate on neonicotinoids and their impact on bee health and performance as "an emerging and rapidly moving area of study" where "the effects are little understood outside highly controlled experimental settings".

Studies before the restrictions

Date	In brief
March 2013 Defra assessment	Defra's assessment of key evidence about neonicotinoids and bees was an update on previous work intended to "help inform national and international considerations of this issue". It reviewed recent studies, including a new UK field trial (see below), and concluded that "the risk to bee populations from neonicotinoids, as they are currently used (in the UK), is low." The assessment also found: • rare effects of neonicotinoids on bees in the field could not be excluded • effects on bees did not occur under normal circumstances • laboratory based studies demonstrating sub-lethal effects on bees from neonicotinoids did not replicate realistic conditions, but extreme scenarios.[190]
March 2013 Thompson *et al* for FERA "Effects of neonicotinoid seed treatments on bumble bee colonies under field conditions"	Defra also commissioned new research to explore the impacts of neonicotinoids on bumble bees under field conditions. This was attached as an Annex to the March 2013 assessment. The study concluded that, whilst rare effects cannot be excluded, under normal circumstances, neonicotinoids were not having harmful effects on bees. This research, though, was commissioned in rapid response to other studies and was heavily criticised for its approach. Professor

189 NFU online, *Neonicotinoids review highlights limited evidence*, 22 May 2014
190 Defra, *An Assessment of key evidence about neonicotinoids and bees*, March 2013

	Dave Goulson told the journal *Nature* that "in many ways, it was appalling."[191] The most damning criticism of this study came from the EFSA, which pointed out a number of flaws in the study which meant that it did not consider it necessary to change any of its January 2013 conclusions.[192]
March 2013 Palmer *et al* "Cholinergic pesticides cause mushroom body neuronal inactivation in honeybees" *Nat. Commun.* 4:1634, 2013	This study examined the impacts on honey bee brain function at the cellular level when exposed to two neonicotinoid pesticides (imidacloprid and clothianidin) and a miticide (coumaphos oxon) used to treat honey bee hives for the *Varroa* mite. Whole honey bee brains were exposed to either imidacloprid, clothianidin or coumaphos oxon and the electrical activity in the learning centre of the bee brain (the mushroom body) was measured. The levels of each compound to which the brains were exposed was deemed realistic to those levels encountered by bees in the wild, based on measure in nectar and in bees themselves. The study found that exposure to each of these compounds rendered important cells (Kenyon cells) within the bee brain non-functional, which would lead to significant impairment of brain function in honey bees. The effects of imidacloprid and the miticide were also found to be to additive, which is important as honey bees' hives could be exposed to both of these compounds simultaneously. In live bees these effects would result in the impairment of learning, memory and spatial orientation, all essential for successful foraging.
January 2013 EFSA, *EFSA identifies risks to bees from neonicotinoids*	EFSA was asked by the European Commission to assess the risks associated with the use of clothianidin, imidacloprid and thiamethoxam as a seed treatment and at sub-lethal doses. The EFSA advised that the risk to pollinators other than honey bees should be further considered and more information was needed to update the existing risk assessments for the pesticides.[193] The study found that seeds coated with neonicotinoid insecticides posed serious risks to bees from crops producing nectar and pollen, including OSR, sunflowers and maize. Where the risk assessments could be completed, EFSA, in cooperation with scientific experts from EU Member States, concluded the following for all three substances: • **Exposure from pollen and nectar**. Only uses on crops not attractive to honey bees were considered acceptable. • **Exposure from dust**. A risk to honey bees was indicated or could not be excluded, with some exceptions, such as use on sugar beet and crops planted in glasshouses, and for the use of some granules. • **Exposure from guttation [sap]**. The only risk assessment that could be completed was for maize treated with thiamethoxam. In this case, field studies show an acute effect on honey bees exposed to the substance through guttation fluid.[194] Even so, the researchers said not enough data was available to conclude that neonicotinoids were contributing directly to the

[191] "Europe debates risk to bees", *Nature* .496, 25 April 2013: page.408
[192] EFSA, *Bumble bee study does not affect neonicotinoid conclusions EFSA says*, 4 June 2013
[193] HC Deb 14 February 2013 c882W
[194] EFSA, *EFSA identifies risks to bees from neonicotinoids*, 16 January 2013

	bee colony collapse disorder that sees healthy bee colonies fall into sudden, sharp decline. The study provided associated risks for all authorised uses for seed treatment and as granules. The study used data that had been previously submitted for the approval of the active substances at EU level and in support of product authorisations at Member State level, as well as the EFSA's own previous studies .
October 2012 Gill *et al* "Combined pesticide exposure severely affects individual- and colony-level traits in bees" *Nature* 491: 105-U119	The study dosed bumble bees with sugar solution containing 10 µg/l of imidacloprid and/or filter paper treated with λ – cyhalothrin. These are two of the most commonly used pesticides on flowering crops in the UK.[195] They looked at the impacts of the pesticides on the development and growth of bumblebee colonies and on the foraging activity of individual bees. The bees were also able to bypass the treated material and forage in the surrounding landscape for pollen and nectar. The study observed impairment of foraging that resulted in a reduction of colony productivity shown by a reduced number of worker bees within the colonies. It also found that fewer adult worker bees emerged from pupae in the colonies exposed to imidacloprid. This study was seen as important because it studied bumble bees, rather than honey bees which have different biology and are more susceptible to pesticides because they are smaller. However, they operate in bigger hives which means that sometimes colony effects might be buffered by their large size. The study also measured the effects on both individual bees and the whole colony as well as looking at the combined effect of the pesticides.
September 2012 Advisory Committee on Pesticides (ACP, now the Expert Committee on Pesticides or ECP)	The ACP's summary of the evidence and assessment took account of the EFSA work which was taking place in parallel. It found that: • Some of the new studies provided evidence of sub-lethal effects of neonicotinoids in the conditions applied in the research. • None of the studies, though, gave unequivocal evidence that sub-lethal effects with serious implications for colonies were likely to arise from current uses of neonicotinoids. • Existing studies submitted in support of the present regulatory approvals fully met current standards. They did not explicitly address all the sub-lethal effects suggested by the academic research but they did cover a wide range of important endpoints and, in these studies, hives exposed to treated crops did not show any gross effects when compared to control hives exposed to untreated crops.[196]
April 2012 Henry *et al* "A Common Pesticide Decreases Foraging	The study dosed honey bees with a single dose of 67 µg/l of thiamethoxam in 20 µl of sucrose solution. They tracked the behaviour of honey bees and found that this dose of thiamethoxam caused a degree of homing failure possibly because of disorientation. This failure was at levels that could put a colony at risk of collapse.

[195] EAC, *Pollinators and Pesticides*, HC 668 2012-13, 5 April 2013: page 19
[196] Defra, *Neonicotinoid insecticides and bees: The state of the science and the regulatory response*, 13 September 2012: para 2

Success and Survival in Honey Bees" *Science* 336: 348-350	It was this study which led the French Government to withdraw the approval for use in France of Syngenta's neonicotinoid pesticide Cruiser on OSR.[197] In the light of this study, Syngenta told the EAC that it was developing and conducting an in-use field study exposing honeybees to TMX seed treated OSR and using the same Radio-Frequency Identification Tags (RFiD) technology as Henry *et al*, which the company believed would investigate any potential foraging effects on honeybees under more "realistic in-use field conditions."[198]
March 2012 Whitehorn *et al* "Neonicotinoid Pesticide Reduces Bumble Bee Colony Growth and Queen Production" *Science* 336: 351-352	The study at Stirling University dosed bumble bees with sugar solution containing 0.7 or 1.4 µg/kg and pollen containing 6 or 12 µg/kg of imidacloprid for 2-4 weeks. The bees were then left to forage freely in the field. The end point of the experiment was the growth in mass of the bee colonies. There was a dose-dependent response in growth of the colonies with those colonies receiving no dose growing fastest and those with the highest dose growing slowest. There was also an 85% reduction in the number of new queens produced by the dosed colonies.[199] On 25 October 2012, Richard Benyon (then a junior Defra minister) was asked about the Government's position on this Stirling University study, which showed that quite low levels of neonicotinoids might cause harm to bumble bees: > The Health and Safety Executive's chemical regulation directorate, along with the Advisory Committee on Pesticides and the European Food Safety Authority, have looked in detail at Stirling University's research. They believe that it is interesting and adds to the debate, but that on balance the risks do not require a ban of neonicotinoids. However, in Defra we have commissioned further research, through the Food and Environment Research Agency, using expertise from Stirling University, which provided the original piece of research, because we want to make absolutely sure that we are getting this right.[200]

7.3 The three neonicotinoids in turn

Drawing on the studies mentioned above, these tables briefly set out what is known about clothianidin, imidacloprid and thiamethoxam.

For a fuller account of each study, refer back to section 7.2.

Clothianidin

Study	The findings in a few words
June 2017 Woodcock *et al*	In Hungary, clothianidin – but not thiamethoxam – was associated with reduced worker bee numbers. In the UK, honeybee colony survival was generally very low, but lowest where bees fed on clothianidin-treated oilseed rape in the previous year. In Germany there was no evidence of a treatment effect.

197 See EAC, *Pollinators and Pesticides*, 5 April 2013, HC 668 2012-13: page 19
198 As above: Ev 194
199 See EAC, *Pollinators and Pesticides*, 5 April 2013, HC 668 2012-13: page 19
200 HC Deb 25 October 2012 c1062

"Country-specific effects of neonicotinoid pesticides on honey bees and wild bees" *Science*, 356, 1393-1395 (2017)[201]	
January 2017 FoE, *Farming wheat without neonicotinoids*,	The FoE said that the EFSA had already concluded that "use of clothianidin as a seed treatment for wheat does pose a high risk to bees because of the way neonicotinoids persist and move in the environment" and argued that the risk to other organisms – such as aquatic invertebrates – also needed to be taken into account.
December 2016 Whitehorn study: preliminary findings reported to the British Ecological Society annual meeting 2016	Bumblebees fed field-relevant doses of thiamethoxam demonstrated impaired learning.
October 2016 Arce *et al*, "Impact of controlled neonicotinoid exposure on bumblebees in a realistic field setting", *Journal of Applied Ecology*	Clothianidin was found to be less toxic to bumblebees than imidacloprid or thiamethoxam.
April 2016 Moffat *et al*, "Neonicotinoids target distinct nicotinic acetylcholine receptors and neurons, leading to differential risks to bumblebees", *Nature Scientific Reports 6*, Article number 24764	Imidacloprid and thiamethoxam, but not clothianidin, exhibited toxicity to bumblebee colonies when exposed at field-relevant levels.
June 2014 Gibbons *et al*, "A review of the direct and indirect effects of neonicotinoids and fipronil on vertebrate wildlife", *Environment Science and Pollution Research*	Imidacloprid and clothianidin are capable of exerting direct and indirect sub-lethal effects on terrestrial and aquatic vertebrate wildlifes, ranging from impaired immune function to reduced growth and reproductive success, often at concentrations well below those associated with mortality.
March 2013 Palmer *et al*, "Cholinergic pesticides cause mushroom body neuronal inactivation in honeybees", *Nat. Commun.* 4:1634	Imidacloprid, clothianidin and coumaphos oxon (a miticide used to treat honey bee hives for the *Varroa* mite) caused significant impairment of brain function in honey bees.

Imidacloprid

Study	**The findings in a few words**

[201] doi: 10.1126/science.aaa1190

January 2016 US Environmental Protection Agency, *EPA release the first four preliminary risk assessments for insecticides potentially harmful to bees*	Chemical residues of more than 25pp billion of imidacloprid would likely harm bees and their hives and result in the bees producing less honey.
August 2015 Food and Environment Research Agency (FERA, a Government agency now part-privatised), "New evidence on the pollinator costs and farming benefits of neonicotinoid pesticides"	Honey bee colonies were being lost due to a range of pressures including: imidacloprid usage, regional factors, adverse weather and pests and diseases. More honey bee colonies were lost as the usage of imidacloprid increased.
April 2015 Kessler *et al* , "Nature, bees prefer foods containing neonicotinoid pesticides"	The honeybee and the buff-tailed bumblebee do not avoid nectar-relevant concentrations of imidacloprid, thiamethoxam and clothianidin in food. Bees preferred solutions containing imidacloprid or thiamethoxam to sucrose alone, even though the consumption of these pesticides caused them to eat less food overall. Treating flowering crops with imidacloprid and thiamethoxam presents a sizeable hazard to foraging bees.
June 2014 Gibbons *et al*, "A review of the direct and indirect effects of neonicotinoids and fipronil on vertebrate wildlife", *Environment Science and Pollution Research*	Imidacloprid and clothianidin are capable of exerting direct and indirect sub-lethal effects on terrestrial and aquatic vertebrate wildlifes, ranging from impaired immune function to reduced growth and reproductive success, often at concentrations well below those associated with mortality.
October 2012 Gill *et al*, "Combined pesticide exposure severely affects individual- and colony-level traits in bees", *Nature* 491: 105-U119	Exposure to imidacloprid (and another pesticide) led to impaired foraging by bumble bees, resulting in reduced colony productivity (in turn shown by a reduced number of worker bees within the colonies). Fewer adult worker bees emerged from pupae in the colonies exposed to imidacloprid.
March 2012 Whitehorn *et al,"* Neonicotinoid Pesticide Reduces Bumble Bee Colony Growth and Queen Production", *Science* 336: 351-352, 2012	Bumble bees were dosed with imidacloprid for 2-4 weeks and then left to forage freely in the field. There was a dose-dependent response in growth of the colonies, with those colonies receiving no dose growing fastest and those with the highest dose growing slowest. There was also an 85% reduction in the number of new queens produced by the dosed colonies.

Thiamethoxam

Study	**The findings in a few words**
Baron *et al*, "General and species-specific impacts of a neonicotinoid insecticide on the ovary development and feeding of wild bumblebee queens",	This study examined the effects of field-relevant doses of thiamethoxam on wild queens of four bumblebee species. It found evidence that two weeks' exposure to thiamethoxam at filed-relevant doses led to a reduction in feeding in two out of four species of wild bumblebee queens, with evidence too of effects on ovary development in multiple species of wild bumblebee queens.

Proceedings of the Royal Society B, 3 May 2017[202]	
January 2017 Schick *et al*, An experiment on the impact of a neonicotinoid pesticide on honeybees: the value of a formal analysis of the data, *Environ Sci Eur* (2017) 29:4 [203]	This study cast doubt on an earlier study carried out in 2013 that had concluded that thiamethoxam posed a "low risk" to bees. This study concluded that the confidence limits were generally so wide that they might have masked any effects of thiamethoxam.
November 2015 Mickaël Henry *et al* "Reconciling laboratory and field assessments of neonicotinoid toxicity to honeybees" *Royal Society Proceedings B*, vol.282, Issue 1819	Field exposure to thiamethoxam is linked to significant excess mortality in free-ranging bees. Colonies appear to compensate for this to preserve their performance in terms of population size and honey production.
April 2015 Kessler *et al*, "Nature, bees prefer foods containing neonicotinoid pesticides"	The honeybee and the buff-tailed bumblebee do not avoid nectar-relevant concentrations of imidacloprid, thiamethoxam and clothianidin in food. Bees preferred solutions containing imidacloprid or thiamethoxam to sucrose alone, even though the consumption of these pesticides caused them to eat less food overall. Treating flowering crops with imidacloprid and thiamethoxam presents a sizeable hazard to foraging bees.
April 2012 Henry *et al* (2012) "A Common Pesticide Decreases Foraging Success and Survival in Honey Bees", *Science* 336: 348-350, 2012	Honey bees dosed with thiamethoxam displayed a degree of homing failure, possibly because of disorientation. This failure was at levels that could put a colony at risk of collapse.

[202] doi: 10.1098/rspb.2017.0123
[203] doi 10.1186/s12302-016-0103-8

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