Center for Regulatory Effectiveness
1601 Connecticut Avenue, NW
Washington, DC 20009
Tel: (202) 265-2383 Fax: (202) 939-6969
secretary1@mbsdc.com www.TheCRE.com

September 24, 2014

To: The Honorable Thomas James Vilsack, Co-Chair Pollinator Health Task Force
The Honorable Regina A. McCarthy, Co-Chair Pollinator Health Task Force

cc: Richard Aucoin, Executive Director, Pest Management Regulatory Agency/Health Canada
Jeff Leal, Minister of Agriculture, Food and Rural Affairs, Ontario
Kareena Arthy, Chief Executive Officer, Australian Pests and Veterinary Medicines Authority
Scott Gallacher, Deputy Director General, Regulation & Assurance, New Zealand
Bernhard Url, Executive Director, European Food Safety Authority
Liz McIntosh, DEFRA Policy Lead – National Pollinator Strategy
Nature, Landscape and Outdoor Recreation Branch, Welsh Government
Volney Zanardi Junior, President of IBAMA

From: Jim Tozzi

Subject: Is *Varroa Destructor* or Neonicotinoid Pesticides Responsible for Bee Health Decline?

President Obama has charged the Pollinator Health Task Force with preparing a Research Action Plan to "determine the relative contributions of, and mitigation strategies for, different stressors leading to species declines and colony collapse disorder...." Although many factors ranging from nutrition to genetics to pathogens have been studied to assess whether or to what extent they contribute to bee health decline, the two factors which have received the most attention are the *varroa destructor* mite and the class of pesticides known as neonicotinoids.

To assist the Task Force in its deliberations on bee health decline, we are summarizing below the recent research, findings and statements of several national regulatory authorities concerning (1) *varroa destructor* and (2) neonicotinoids. In this memorandum we will review the research and findings reached on *varroa* and neonicotinoids by agencies including

(1) The United Kingdom's Department of Environment, Food and Rural Affairs (Defra),

(2) New Zealand's Ministry for Primary Industries (MPI), and

(3) The Australian Pesticides and Veterinary Medicines Authority (APVMA).

The reviews of bee health by national regulatory authorities will make clear that

(1) *Varroa* mites are, by far, the greatest threat to feral and managed bees around the world,

(2) Neonicotinoids pose no threat when pollinators when used in accordance with regulatory requirements, and

(3) Studies which blame neonicotinoids for contributing to bee health decline are poorly designed and rely on massively overdosing sample bee populations.

It is important for the Task Force to recognize that the popular term "colony collapse disorder" (CCD) is used by scientists to refer only to a specific set of attributes of a failed colony, not to the broader issue of honey bee health.

USDA's Agricultural Research Service (ARS) explains that

> *The main symptom of CCD is very low or no adult honey bees present in the hive but with a live queen and no dead honey bee bodies present. Often there is still honey in the hive, and immature bees (brood) are present. Varroa mites, a virus-transmitting parasite of honey bees, have frequently been found in hives hit by CCD.*[1]

The term CCD, however, is often incorrectly used in media in referring to any colony loss. Throughout this memorandum we refer to "bee health decline" to make clear that we are discussing the broader issue of bee health, which includes CCD, rather than just a single syndrome.

Varroa Destructor: The Leading Cause of Bee Health Decline

In recent testimony before the House Committee on Agriculture, the USDA/Agricultural Research Service's (ARS) Research Leader explained that the "varroa mite's full name is *Varroa destructor*, and it is perhaps the most aptly named parasite ever to enter this country. *Varroa destructor* is a modern honey bee plague. It has been responsible for the deaths of massive numbers of colonies both within the United States and worldwide."[2]

"The varroa mite's full name is *Varroa destructor*, and it is perhaps the most aptly named parasite ever to enter this country. *Varroa destructor* is a modern honey bee plague. It has been responsible for the deaths of massive numbers of colonies both within the United States and worldwide."

– *USDA/Agricultural Research Service (April 29. 2014)*

USDA's testimony also discussed *varroa* within the context of overall bee health decline in the US. With respect to *varroa's* economic consequences to beekeepers alone, USDA explained that "[w]hen Varroa destructor was first found in the Unites States in 1987, beekeepers managed more than 3 million colonies for crop pollination and their winter losses were typically about 10 to 15 percent. Today, beekeepers are having trouble maintaining 2.5 million managed colonies,

[1] USDA - Agricultural Research Service, "Honey Bees and Colony Collapse Disorder," http://www.ars.usda.gov/News/docs.htm?docid=15572.

[2] USDA - Agricultural Research Service, "Testimony before the House Committee on Agriculture Subcommittee on Horticulture, Research, Biotechnology and Foreign Agriculture," ("USDA Testimony") April 29, 2014, http://docs.house.gov/meetings/AG/AG14/20140429/102155/HHRG-113-AG14-Wstate-PettisJ-20140429.pdf.

winter losses are averaging over 30 percent a year, and the economic sustainability of beekeeping is at the tipping point."[3]

USDA's congressional testimony, took note of the synergistic effects of *varroa* with other bee health factors. USDA/ARS's Lead Researcher explained that the Department's research program "Varroa does not act alone on bee health and thus many of these [USDA] projects take a holistic approach, looking into the multiple factors affecting honey bees and other pollinators. In one NIFA [National Institute of Food and Agriculture] funded project, University of Minnesota extension specialists are assisting honey bee queen breeders in selecting for hygienic behavior, a trait that helps bees defend against varroa mites and other diseases. In another, Cornell scientists are testing the hypothesis that giving colonies smaller hives will provide the mites fewer opportunities to reproduce and this will lower the per capita level of mite infestation of the bees."[4]

USDA's assessment of the harm *varroa* inflicts on honeybees is in keeping with the findings of science agencies and the regulatory authorities in other countries with major beekeeping and agricultural industries which suffer from *varroa* and from Australia which, so far, has remained varroa free.

Australia is the only *varroa*-free country which has a commercial beekeeping industry. Australia's *varroa*-free helps us isolate the role of *varroa* in bee health decline because (1) several popular neonicotinoid pesticides are widely used by Australian farmers, and (2) Australia does not have CCD.

> The Varroa mite is considered the most serious global threat to beekeeping and is without question the most serious threat to the viability of the Australian honey bee industry.
>
> – CSIRO, March 2014

To prevent the introduction of *varroa* and the expected subsequent massive loss of colonies, the Australian government has extensive screening and other biosecurity protections programs in place to prevent the mite being introduced into the country.

A report from Australia's national science agency, the Commonwealth Scientific and Industrial Research Organisation (CSIRO) "one of the largest and most diverse research agencies in the world" to the Senate stated that "Varroa destructor diminishes the feral honey bee population to the point that they are virtually non-existent."[5]

To determine the likely effect of the mite on Australian bees and agriculture, the CSIRO report traces the effect of *varroa* on bees in the US. The report from the science agency explains,

> *No better is this [the effect of varroa] exemplified than in the USA where the mite first entered in 1987. Since its arrival and establishment:*

[3] Id.

[4] Id.

[5] Paul De Barro, "CSIRO Submission 13/491: Future of the beekeeping and pollination service industries in Australia," ("CSIRO Beekeeping Report") March 2014, p. 6.

> *• The feral honey bee population has diminished to the point where it is no longer a common pollinator;*
>
> *• Managed colonies have been reduced by about 30 per cent and cost of maintaining hives has increased by 25 per cent;*
>
> *• Many beekeepers have left the industry and those remaining have been forced to use chemical treatment in the hive to reduce Varroa;*
>
> *• The honey bee population has suffered a pronounced loss of genetic variation. Selection of stock Future of the beekeeping and pollination service industries in Australia from a few 'Varroa tolerant' colonies has exacerbated the problem;*
>
> *• Crop growers have been forced to look elsewhere for their pollinators, including importing Australian honey bees.*
>
> *• Innovation and development within the honey bee industry has been stifled because of redirected resources (particularly research effort) to counter Varroa.*
>
> *• Sustainable management of Varroa in managed hives is difficult as the mite rapidly develops resistance to miticides used in hives to control Varroa.*
>
> *• The decline in the total number of available managed hives along with an increasing demand for hives by agricultural and horticultural producers has seen a four-five fold increase in the cost of hives and an annually increasing gap between demand for hives and the capacity to supply them.*[6]

With respect to the question of whether *varroa* or neonicotinoids are primarily responsible for bee health decline in the US, it is important to note that CSIRO attributes (1) the virtually complete eradication on feral bees and (2) a 30% decline in managed colonies to *varroa*, not pesticides or CCD. CSIRO is careful, however, not to equate *varroa* with CCD. Instead, CSIRO states that "it is increasingly likely that CCD is the consequence of the interaction between multiple stressors including Varroa."[7]

Consistent with the CSIRO report, Australia's Department of Agriculture states on their website that the "Varroa mite would decimate Australia's feral bee population and cause a rapid increase in demand for pollination services."[8] The Department also warns that "the major part of the cost of Varroa would probably be felt not by the honeybee industry but by other industries with crops that rely on honeybees for pollination, including almonds, avocadoes, cotton, stone fruits, pome fruit, melons and pumpkins."[9]

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[6] CSIRO Beekeeping Report, pp. 6-7.

[7] Id, p. 9.

[8] http://www.daff.gov.au/animal-plant-health/pests-diseases-weeds/animal/varroa-mite/

[9] Id.

The CSIRO report discusses New Zealand's experience with *varroa* since they had been *varroa*-free until relatively recently are fairly close to Australia. CISRO explained that in "In New Zealand feral bees virtually vanished from the North island within four years of the [varroa] invasion."[10]

The *varroa* infestation of New Zealand began on the North Island where the pestilence is now "widely distributed" throughout the island according to the Ministry for Primary Industries.[11] New Zealand's MPI was formed in 2012 through a merger of the Ministry of Agriculture and Forestry, the Ministry of Fisheries and the New Zealand Food Safety Authority.

The New Zealand government's Varroa Planning Group made an early assessment of *varro*a's economic impact just on the South Island and estimated the impact would be over $235 million per annum.[12] More recently, the country's National Beekeepers Association estimated the long term costs of varroa at about $1 billion.[13]

In an August 2013 report to Parliament, MPI explained that since "its arrival in 2002 and subsequent spread to nearly all of the North and South Islands, the Varroa mite has had a major impact on bees. The only wild hives now found are those that have recently swarmed from apiaries. All beekeepers have to manage Varroa levels in hives through the use of insecticides, other products and good disease management. Bees that are under stress from Varroa are more susceptible to infections from bacteria, fungi and viruses."[14]

The Parliamentary report also distinguished the effect of *varroa* on New Zealand bees from CCD. MPI informed the lawmakers that in "New Zealand, most reports of significant hive losses have been linked to high levels of Varroa infestation or to insufficient food. Classical symptoms of CCD have not been recorded in New Zealand, but it remains important to monitor bee health."[15]

The UK has more extensive experience with *varroa* than New Zealand because the mite was discovered in southern England starting in 1992. The government agency with primary responsibility for protecting agriculture is Defra, the UK ministerial department "responsible for policy and regulations on environmental, food and rural issues."

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[10] Id., p. 7.

[11] Ministry for Primary Industries, Varroa Mite, http://www.biosecurity.govt.nz/pests/varroa

[12] Bruce Simpson, Varroa Planning Group, "Summary of Assessments of the Economic Impact of Varroa on the South Island of New Zealand," http://www.biosecurity.govt.nz/files/pests/varroa/assessment-summary.pdf

[13] Radio New Zealand News, "Signs of resistance to varroa bee mite treatments – assoc," http://www.radionz.co.nz/news/rural/215943/signs-of-resistance-to-varroa-bee-mite-treatments-assoc

[14] Ministry for Primary Industries information on pollinator security for the Local Government and Environment Committee -August 2013, ("MPI Report") http://www.parliament.nz/resource/mi-nz/50SCLGE_EVI_49DBHOH_PET3075_1_A347361/e387f4d64bb700c8d2dad551cf77fec9f4a1298d

[15] Id.

Defra is supported by 35 government agencies and public bodies including the Advisory Committee on Pesticides,[16] the Science Advisory Council,[17] the Environment Agency[18] and the Food and Environment Research Agency (Fera) which "provides evidence, analysis and professional advice to the government, international organisations and the private sector."[19]

> The blood-sucking Varroa is the biggest killer of honey bees world-wide, having developed resistance to beekeepers' medication. It is particularly destructive in winter as depleted colonies do not have enough bees huddling together to keep warm.
>
> – UK Department for Environment, Food and Rural Affairs (Defra)

Fera addressed the effect of *varroa* in a Q&A fact sheet which supplemented an agency press release on research to control *varroa*.

> ***Q How much of a role is Varroa having on worldwide honey bee colony losses?***
>
> *A It is difficult to compare drivers of honey bee decline such as climate, pest and diseases. However, it is clear that the Varroa mite has had a massive impact on and is one of the leading causes of honey bee colony losses in contrived* [sic] *to which the mite has spread.*[20] [Emphasis added]

A formal report on bee health prepared jointly by Defra and the Welsh Government was unambiguous about *varroa's* role is harming pollinator health on a national scale. The report that "colony losses over the winter of some 15-20% have been reported over recent years with up to 30% losses in 2007/08 representing significant losses to beekeepers and pollination services. High levels of winter losses are assessed by the NBU [National Bee Unit] and the review group to be mainly caused by poor management of the Varroa mite...."[21]

Neonicotinoids: Are they Causing Bee Health Decline?

The European Food Safety Authority (EFSA) issued a press release which stated that the organization "identified a number of risks posed to bees by three" neonicotinoids. However, EFSA issued the press release even while explaining that "there is a high level of uncertainty in the latest evaluations." The press release also went on to note that "[a]ll of these factors mean that EFSA's scientists were unable to finalise risk assessments for some of the uses authorised in the EU, and identified a number of data

[16] http://www.pesticides.gov.uk/guidance/industries/pesticides/advisory-groups/acp

[17] https://www.gov.uk/government/organisations/science-advisory-council

[18] https://www.gov.uk/government/organisations/environment-agency

[19] https://www.gov.uk/government/organisations/the-food-and-environment-research-agency.

[20] Defra/Fera, "Q&A for RNAi in Varroa press release," https://secure.fera.defra.gov.uk/beebase/downloadNews.cfm?id=92 [Emphasis added].

[21] Department for Environment, Food and Rural Affairs and the Welsh Government, "Improving honey bee health: Proposed changes to managing and controlling pests and diseases," January 2013, pp. 9-10.

gaps that would have to be filled to allow further evaluation of the potential risks to bees from clothianidin, imidacloprid and thiamethoxam."[22]

The EFSA statements and conclusions on neonics needs to be evaluated in the context of the European Union's use of the "precautionary principle" a term which is neither well defined nor consistently invoked. The Director of the King's College Centre for Risk Management in London explained that there is "a 'misuse' of the precautionary principle to appease national of political interests."[23]

> Furthermore, as much of the data were generated before publication of the opinion, a number of shortcomings were identified. And, because the final guidance document for the risk assessment of plant protection products and bees is still under development, there is a high level of uncertainty in the latest evaluations.
>
> – European Food Safety Agency

The Centre Director cited an EU report on protecting public health from endocrine disruptors to make the point that "the feared effects of endocrine disrupters... override any evidence-based reasoning."[24] The risk expert went on to note that such precautionary "statements can be applied to more or less anything – you basically could apply it to chocolate, milk or why not coffee."[25]

It is the overriding of "evidence-based reasoning" that makes the precautionary principle an oxymoron, since ignoring evidence and reason is not a sustainable method for protecting public health.

Despite EFSA's data limitations and other uncertainties on neonics combined with a vague "principle" that can be used or misused at will, the agency's concerns regarding the potential impact of neonics on bees needs to evaluated rather than simply dismissed. Thus, we will review the evaluations by national regulatory and science agencies of (1) the effect of neonics on bee health and (2) how to evaluate conflicting data from studies on neonics and bee health. Based on the evaluations of national regulatory and science agencies, we can then determine whether or not there is a viable case that neonics used according to labeling restrictions are causing sustained honeybee losses in the US and around the world.

About a year after EFSA issued their press release and conclusions regarding neonicotinoids and bees, they issued a comparable press release and conclusions regarding neonicotinoids and developmental toxicity.[26] The US EPA quickly undertook a review of EFSA's report and published the following

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[22] EFSA, "Press Release: EFSA identifies risks to bees from neonicotinoids," 16 January 2013, http://www.efsa.europa.eu/en/press/news/130116.htm.

[23] EurActive, "Risk expert: Policymakers often misuse precautionary principle," 11/06/2013, http://www.euractiv.com/specialreport-risk-hazard-policy/risk-expert-policymakers-misuse-interview-528396.

[24] Id.

[25] Id.

[26] EFSA, Press Release: EFSA assesses potential link between two neonicotinoids and developmental neurotoxicity," 17 December 2013, http://www.efsa.europa.eu/en/press/news/131217.htm.

statement on their website, "Although EPA has only had a short time to review the Panel's report on the toxicity of ACE and IMI, our initial evaluation does not warrant any change to our current risk assessment conclusions."[27]

There is currently no evidence of the [colony collapse] disorder in New Zealand, although these [neonicotinoid] pesticides are commonly used here as a seed dressing and as foliar sprays.

– New Zealand House of Representatives, Primary Production Committee

New Zealand's Primary Production Committee, the parliamentary committee responsible for "matters relating to agriculture, biosecurity, fisheries, forestry, lands, and land information," received a July 2014 "Briefing on the health of bees." Based on this briefing, the committee issued a report which recognized that "[i]nternationally much attention has been given to the possible effect of neonicotinoid insecticides on bees' health, and their possible role in colony collapse disorder." [28] The parliamentary report went on to unambiguously state "There is currently no evidence of the disorder in New Zealand, although these pesticides are commonly used here as a seed dressing and as foliar sprays."[29]

The committee report did explain that "the use of neonicotinoid pesticides is overseen by the [New Zealand] EPA and the Ministry for Primary Industries ACVM [Agricultural Compounds & Veterinary Medicines] Group, which ensures that they are used so as to minimise residues and to ensure that food safety is not compromised."[30]

After discussing the European Union's restrictions on three neonicotinoids, clothianidin, imidacloprid, and thiamethoxam, the report stated, "Currently, we heard there is no evidence that these pesticides, when used correctly, are affecting bees' health in New Zealand."[31]

After reviewing assertions that neonicotinoids harm bees, the report concluded that

> *Neonicotinoids have been used in New Zealand since the early 1990s with little controversy. Suspected problems have come to light in the EU much more recently. We heard that when anecdotal evidence of losses are investigated, the causes seem to be mainly Varroa or starvation rather than pesticides. A recent report by the Australian Pesticides and Veterinary Medicines Authority into the effects of neonicotinoids on bees in Australia, where the insecticides are used extensively, has also found little evidence of a problem.*[32]

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[27] EPA, EPA's review of the European Food Safety Authority's conclusions regarding studies involving the neonicotinoid pesticides, December 20, 2013, http://www.epa.gov/oppfead1/cb/csb_page/updates/2013/efsa-conclus.html.

[28] New Zealand, House of Representatives, Primary Production Committee, "Briefing of the health of bees," July 2014, p. 3, http://www.parliament.nz/resource/en-nz/50DBSCH_SCR56864_1/34a0a5f2526c4db590c2b0330083d8af2313b150.

[29] Id.

[30] Id., p. 4.

[31] Id.

[32] Id.

The Australian government report referenced by the New Zealand agriculture committee was published in February 2014.[33] In preparing the report, the Australian regulatory authority "consulted with a wide range of stakeholders including:

> ...the introduction of the neonicotinoids has led to an overall reduction in the risks to the agricultural environment from the application of insecticides.
>
> – Australian Pesticides and Veterinary Medicines Authority

- national bee experts from the Commonwealth Scientific and Industrial Research Organisation (CSIRO), the NSW Department of Primary Industries, the WA Department of Agriculture and Food, the Australian Government Department of Agriculture, and the Rural Industries Research and Development Corporation (RIRDC)
- the manufacturers of imidacloprid and thiacloprid, thiamethoxam, clothianidin and sulfoxaflor
- international experts within other regulatory agencies, including the US Environmental Protection Agency and the Canadian Pest Management Regulatory Agency
- primary industry associations including Cotton Australia and canola growers
- bee keepers, honey packers and exporters
- the Australian Government Department of the Environment
- Australia's representatives to a Society of Environmental Toxicology and Chemistry global workshop on insect pollinators (external site) and the OECD's Pesticide Effects on Insect Pollinator Expert Group (external site)."[34]

Moreover, the agency also "examined a large number of published scientific papers and reports as well as three published risk assessments on clothianidin, imidacloprid and thiamethoxam carried out by the European Food Safety Authority."[35] The questions the report was undertaken to answer specifically include "whether the use of the neonicotinoid insecticides in Australia is presenting any more of a risk to the health of honeybees than other pesticides which have been in use for many years...."[36]

Following its extensive consultations and review of the literature, the Australian Pests and Veterinary Medicines Authority (APVMA) concluded that,

(1) "in Australia, honey bee populations are not in decline and insecticides are not a highly significant issue..."[37] and

[33] Australian Pesticides and Veterinary Medicines Authority, "Overview Report: Neonicotinoids and the Health of Honey bees in Australia," ("Overview Report") February 2014, http://archive.apvma.gov.au/news_media/docs/neonicotinoids_overview_report_february_2014.pdf.

[34] Australian Government, Australian Pesticides and Veterinary Medicines Authority, http://archive.apvma.gov.au/news_media/chemicals/bee_and_neonicotinoids.php.

[35] Id.

[36] Overview Report, p. 1.

[37] Id.

(2) that the APVMA is "currently of the view that the introduction of the neonicotinoids has led to an overall reduction in the risks to the agricultural environment from the application of insecticides."[38]

Thus, the Australian government is (1) rejecting the neonic theory of bee health decline and (2) concluding the use of neonicotinoids results in an overall decline in environmental risks. With respect to the benefits from the use of neonicotinoids, the APVMA explained that

> *The introduction of the neonicotinoid insecticides has brought a number of benefits, including that they are considerably less toxic to humans (and other mammals) than the organophosphorus and carbamate insecticides they have significantly replaced. Furthermore, because of the physicochemical properties of a subset of the neonicotinoids, they can be used to coat crop seeds; this insecticide coating protects the seeds and the young plants while they are growing. This means that there is much less need for farmers to apply chemicals to the growing crops using in-field sprays (applied by ground boom or aerial spraying) which have the potential to lead to a greater spread of the pesticide in the environment.*[39]

With respect to the reduction in environmental risks resulting from the use of neonicotinoids, the Australian report states without caveat that "[w]hen compared with OPs [organophosphates] and carbamates, neonicotinoids pose lower risks to humans and other mammals."[40]

The APVMA statements discussing how use of neonicotinoids can lower overall environmental risk are a sharp rebuke to the EU's precautionary principle. The Australian research illustrates how "precautionary" regulatory actions can backfire.

The Australian report looked squarely at the widespread concern over neonicotinoids and concluded that it is often the result of sensationalization by the media and by scientists.

> *Maini et al. (2010) noted that:-*
>
> > *"… many hypotheses are available on the problem of declining bee populations …. The problem is made worse by some in the media who sensationalize and report unsupported data and opinion. Such sensationalizing and the use of unsupported data are, unfortunately, not restricted to the media and can be made by scientists who report data that are not sufficiently verified, come from suspected sources, and/or fail to cite relevant research … in some published manuscripts neither the author(s), reviewer(s), [or] editor(s) were acquainted with competing literature".*
>
> *These comments convey quite well the level of discussion and debate that is occurring at the moment.*[41]

[38] Id., p. 2.

[39] Id, p. 2.

[40] Id., p. 15.

No case better illustrates the unsupported sensationization of neonicotinoids that the "Harvard" study.[42] In 2012, a professor at the Harvard School of Public Health, Alex Lu, published a study of neonicotinoids that received substantial media attention.[43] Publications ranging from the *New Yorker* to *Wired* to the *Boston Globe* carried stories about the Harvard/Lu study. Reuters even carried an opinion article which declared that the mystery of the disappearing bees had been "solved!"[44] The Australian regulators reached a very different conclusion, however, about Harvard/Lu 2012.

Rather than solving any mysteries about bee health, the Australian government report explains that the Harvard study used massive, utterly unrealistic overdosing of bees, minimal sample size and misinterpretation of the data. After describing the Harvard study, the report explained that,

> ***Note:*** *This study by Lu et al, often referred to in the literature as 'the Harvard study', explicitly linked neonicotinoids to CCD and has been the subject of heavy criticism. It has been noted in particular that (1) bee colonies were fed 'astronomical' levels of imidacloprid-laced corn syrup; (2) that the sample sizes were far too small; and (3) that the symptoms the colonies subsequently suffered did not, in fact, mimic the symptoms of CCD. The flaws in this study are detailed in Randy Oliver's Scientific Beekeeping website at http://scientificbeekeeping.com/the-harvard-study-on-neonicotinoids-and-ccd/ . Oliver concluded that the Lu et al. results actually showed that feeding colonies for four weeks with HFCS spiked with imidacloprid at field-realistic levels (1) did not have any negative effects; and (2) then feeding the colonies with extremely high levels of the insecticide for another nine weeks still did not harm them enough to cause mortality during treatment or for three months thereafter (http://scientificbeekeeping.com/neonicotinoids-trying-to-make-sense-of-the-science/).*[45]

Randy Oliver's Scientific Beekeeping website does more than just demolish the credibility of the Harvard study, it also debunks numerous myths about neonicotinoids including EFSA's assertion that neonics pose a threat to bees that was discussed early in this memo. The source the Scientific Beekeeping website uses to demonstrate that flaws in EFSA's study is CRE's Data Quality Act (DQA) Alert to EPA, http://www.thecre.com/oira_pd/wp-content/uploads/2013/04/DQA-Alert-EU-Commission-Ban-on-Neonicotinoids-4-10.pdf. The website included a link to the Alert which is publicly available on CRE's Review of Bee Health Decline Interactive Public Docket, http://www.thecre.com/oira_pd/.

A portion of Randy Oliver's Scientific Beekeeping chart citing CRE is reprinted on the next page.

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[41] Id., p. 4.

[42] Chensheng Lu, Kenneth M. Warchol, Richard A. Callahan, "In Situ Replication of Honey Bee Colony Collapse Disorder," *Bulletin of Insectology*, June 2012.

[43] Harvard School of Public Health, "Press Release: Use of common pesticide linked to bee colony collapse," April 5, 2012, http://www.hsph.harvard.edu/news/press-releases/colony-collapse-disorder-pesticide/

[44] http://blogs.reuters.com/great-debate/2012/04/09/mystery-of-the-disappearing-bees-solved/.

[45] Id., p. 35.

From: Randy Oliver's Scientific Beekeeping website

Debunking The Myths

As anyone who knows me will tell you, I am a stickler for honesty, accuracy, and factuality. I am concerned about the amount of misinformation and speculation going around about the neonics. So let's look at some of the claims vs. the actual facts.

Arguments Against Neonic Seed Treatments	Actual Facts
The neonicotinoids have been "linked" to increased colony mortality.	In actuality, such a "link" is merely an urban legend, and has never been demonstrated or confirmed in any study. On the other hand, the residues of other classes of pesticides are more suspect for causing increased brood or adult bee mortality [24].
The timing of CCD coincides with the introduction of the neonic seed treatments in 2004.	CCD started in California bees in the winter of 2004/2005, prior to them ever being exposed to seed-treated crops.
But what else could have changed at that time other than the introduction of neonics?	In California, Dr. Eric Mussen [25] determined that the increased colony losses were due to poor summer forage and failure of mite control products (just as this last winter). There is actually a much stronger association between the incidence of the novel gut parasite *Nosema ceranae* and increased colony mortality [26]. But the main thing that has changed is the dynamics of the varroa/virus complex, which coincidentally occurred at about the same time that the neonics came into use.
European countries banned the neonics, and the bees recovered after those bans.	A few countries placed temporary suspensions on certain seed treatments until planting dust issues were resolved [27]—only Germany has one suspension still in place. The foliar applications were not suspended. The suspensions did not resolve bee health problems.
The European Food Safety Authority recently decided that neonics pose a threat to bees.	"The Center for Regulatory Effectiveness (CRE) has recently completed a Data Quality Act (DQA) Alert on the … (EFSA) report on neonicotinoids which found that neonicotinoids pose a risk to bees. The DQA Alert outlines the serious deficiencies of the EFSA report and demonstrates why the EFSA report violates the DQA…In particular, the EFSA report failed to maximize the objectivity of the data by failing to reconcile numerous studies whose conclusions contradicted the findings of the EFSA report" [28].

See Randy Oliver's complete Debunking the Myths chart here, http://scientificbeekeeping.com/what-happened-to-the-bees-this-spring/#debunking-the-myths.

Following release of the Australian regulatory agency's review of neonicotinoids and bee health, an Australian Senate committee undertook an inquiry into the "Future of the beekeeping and pollination service industries in Australia" and released their report in July 2014.[46]

In addition to receiving written responses to questions the committee sent to government agencies and private organizations, the Senate committee also solicited public comments on their inquiry and reviewed more than 80 written submissions from diverse interested persons ranging from government agencies to academicians, apiarists, representatives of various organizations, and private citizens. The committee also held public hearings and took oral testimony.

The committee's report reviewed various concerns that have been raised about neonicotinoids including discussion of studies suggesting that "neonics ingested by bees can seriously impact their ability to collect food, even at very low levels of contamination."[47] The inquiry also note of

[46] Australian Senate, Rural and Regional Affairs and Transport References Committee, "Future of the beekeeping and pollination service industries in Australia," July 2014, http://www.aph.gov.au/Parliamentary_Business/Committees/Senate/Rural_and_Regional_Affairs_and_Transport/Beekeeping/Report/~/media/Committees/Senate/committee/rrat_ctte/beekeeping/report/report.pdf.

[47] Id., Sec. 2.25.

suspensions of neonicotinoid use in Europe,[48] and legal actions against neonicotiniods in the US taken by NGOs.[49]

Following their review of the record, the Senate committee released their report which included ten recommendations—not one of which called for additional restrictions on neonicotinoid use.[50] However, two of the ten recommendations did single out *varroa* for action, including Recommendation 5, which states, "The committee recommends the categorisation of *varroa destructor* be completed as a matter of urgency to provide industry with funding certainty in case of an incursion."[51]

New Zealand's Parliament also recently considered pollinator protection policies in light of concerns regarding neonicotinoids. In an August 2013 report, Parliament, after discussing the "international concerns expressed about the possible role of the neonicotinoid insecticides on bee health, particularly the possible chronic effects"[52] stated that they had no evidence that neonicotinoids were harming bees and that even "[i]f these pesticides are affecting bee health in New Zealand, the effects are more likely to be small and/or localised. Note that the use of neonicotinoids is already subject to both EPA and ACVM controls."[53] The report also explained that

> *There is, however, a very important difference between the impacts of Varroa and that of pesticides on the health of New Zealand bees. While pesticides can be withdrawn from use, Varroa will be with us for the foreseeable future. It is causing major problems and costs for beekeepers throughout New Zealand. We currently have no way of eradicating Varroa and we are challenged to find new and innovative ways to manage the mite and its impacts on bee health.*[54]

The July 2014 parliamentary report, "Briefing on the health of bees," discussed above with respect to *varroa*, concluded that

> *Neonicotinoids have been used in New Zealand since the early 1990s with little controversy. Suspected problems have come to light in the EU much more recently. We heard that when anecdotal evidence of losses are investigated, the causes seem to be mainly Varroa or starvation rather than pesticides. A recent report by the Australian Pesticides and Veterinary Medicines Authority in to the effects of neonicotinoids on bees*

[48] Id. Sec. 2.29.

[49] Id., Sec.2.30.

[50] Parliament of Australia, "List of Recommendations," http://www.aph.gov.au/Parliamentary_Business/Committees/Senate/Rural_and_Regional_Affairs_and_Transport/Beekeeping/Report/b01.

[51] Id.

[52] New Zealand Parliament, "Ministry for Primary Industries information on pollinator security for the Local Government and Environment Committee -August 2013," para. 16, http://www.parliament.nz/resource/mi-nz/50SCLGE_EVI_49DBHOH_PET3075_1_A347361/e387f4d64bb700c8d2dad551cf77fec9f4a1298d.

[53] Id., para 32.

[54] Id., para 33.

> *in Australia, where the insecticides are used extensively, has also found little evidence of a has also found little evidence of a problem.*[55]

One of the most thorough reviews of studies which asserted that neonicotinoids are harming bee health was conducted by Defra.

Defra analyzed three studies which asserted that sub-lethal effects from neonicotinoids were harming bees. All three of the studies are recent and were published in prestigious journals, two in *Science* and one in *Nature*. The studies evalauted by Defra are,

(1) Henry M, Beguin M, Requier F, Rollin O, Odoux JF, et al. (2012) A Common Pesticide Decreases Foraging Success and Survival in Honey Bees. Science 336: 348-350.

(2) Whitehorn PR, O'Connor S, Wackers FL, Goulson D (2012) Neonicotinoid Pesticide Reduces Bumble Bee Colony Growth and Queen Production. Science 336: 351-352.

(3) Gill RJ, Ramos-Rodriguez O, Raine NE (2012) Combined pesticide exposure severely affects individual- and colony-level traits in bees. Nature 491: 105-U119.

Conclusion: While this assessment cannot exclude rare effects of neonicotinoids on bees in the field, it suggests that effects on bees do not occur under normal circumstances. This assessment also suggests that laboratory based studies demonstrating sub-lethal effects on bees from neonicotinoids did not replicate realistic conditions, but extreme scenarios. Consequently, it supports the view that the risk to bee populations from neonicotinoids, as they are currently used, is low.

– UK Department of Environment, Food and Rural Affairs

All three of the above studies have been influential in shaping the neonicotinoid debate. For example, according to Google Scholar, the Henry et al study has been cited 214 times, Whitehorn et al has been cited 167 times and Gill et al has been cited 101 times. However, despite the attention these studies have received, Defra found that all three were poorly designed and cannot be used to draw conclusions about neonicotinoids. Moreover, Defra found that all three studies shared a common deficiency that negates their results, "all of these studies have presented bees with doses that represent the extreme upper levels to which bees are likely to be exposed. They are, therefore, an examination of an extreme case or they may not be realistic in any circumstances."[56]

It is worth noting that Defra's criticism of the "extreme" doses of neonicotinoids administered to bees parallels the Australian regulatory agency's criticism of Harvard/Lu, that "bee colonies were fed 'astronomical' levels of imidacloprid-laced corn syrup..."

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[55] New Zealand, House of Representatives, Primary Production Committee, "Briefing of the health of bees," July 2014, p. 4.

[56] Department for Environment, Food and Rural Affairs, "An assessment of key evidence about Neonicotinoids and bees," March 2013, Sec. 3.1 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/221052/pb13937-neonicotinoid-bees-20130326.pdf.

The highly cited Henry study, as was the case with the other two studies cited above, "all used artificial dosing of bees with sucrose solutions." To the Henry study's credit, it was the only of the three studies in which the neonicotinoid dose rate was controlled.[57] Defra's conclusion about Henry's dosing, however, was that the dosing regime was unrealistic as the "bees were given an estimated full daily dose in a single bolus of 20 µl. This is unrealistic for two reasons:"

(1) "Bees would normally metabolise the pesticide as they receive it while foraging across the whole day [9] and so would not be exposed to such a high single dose" and

(2) "The study assumes that bees only feed on food sources that have been treated with pesticide. An assumption which evidence from Thompson et al would suggest is incorrect."[58]

Defra's conclusion about Henry's dosing regime was

> *Consequently, the design of the dosing regimen used by Henry et al. gives a very high probability of showing deleterious effects of the pesticide. It is most likely to represent an unusually extreme case in a field situation, not the average or normal case.*[59]
> [Emphasis In Original]

Defra's criticism of the dosing regimens used in the Whitehorn and the Gill studies was even more damning since neither of the "studies measured the dose received by the bees so it is not possible to assess whether the dose was realistic."[60]

Defra's criticism of the dosing regimens used in Whitehorn (2012) and Gill (2012) went on to explain that "the following rational suggests that in both studies bees were over-dosed with neonicotinoids. The study designs were biased towards showing a deleterious effect of neonicotinoids because...."[61]

The first of the reasons Defra discussed for the overdosing and bias in the two studies was that both studies fed the bees sugar syrup which has the effect of increasing their food intake thus increasing their neonicotinoid consumption above the levels that would otherwise occur. As Defra explains, the studies used the sugar syrup even though

> *there is a substantial literature showing that both honey bees and bumble bees adjust their foraging rate and their metabolism depending upon the quality and quantity of their food available. When fed syrup in experiments in the lab, bees increase their metabolic rate and their food intake. This will have the effect of increasing the dose rate*

[57] Id.

[58] Id. [Notes omitted]

[59] Id. [Emphasis in original, note omitted].

[60] Id., Sec. 3.2.

[61] Id.

> *meaning that bees in these experiments probably ate more of the pesticide than they would have in the wild.*[62]

Defra provided additional criticism of both the Whitehorn and the Gill dosing regimens. The Defra Assessment explains that, the Whitehorn team's justification for dosing level

> *referred to two studies [11,29] only one of which quoted any quantitative evidence of the concentration in plants and this referred to crushed sunflowers or sunflower pollen and not OSR. Even then the "low" concentration fed in pollen was x2 the mean concentration measured in the reference study they used to guide the concentration used in the experiment. Consequently, it appears that **Whitehorn et al.** [2] did not know what dose the bees were receiving and the likelihood is that they received a much greater dose than would have been experienced in the field.* [63]
> [Emphasis In Original]

Defra's analysis is even more critical of Gill's dosing levels. Defra explained that Gill et al used seven times the dose that Henry considered appropriate and ten times the dose used in another lab-based study. Specifically, Defra stated that the Gill study

> *used a concentration of neonicotinoid in sugar solution that was about x6 that found in nectar of treated crops, including OSR, so the dosing in this study would have been at the high end of the potential spectrum. Even if, as claimed by **Gill et al.**, this was likely to be only 50% of the consumption by these bees then the dose was still high. **Gill et al.** admitted that their treatments were "at the high end" of what might be found in the field. In the early stage of the experiment, this would constitute a dose rate of about 10 ng/day/worker bee in the early growth phase of the study. This constitutes about x7 what **Henry et al.** considered to be a reasonable daily dose for honey bees and about x10 what another lab-based study considered to be the threshold of effect. Finally, **Gill et al.** also used 7 literature sources as justification for their dosing regimen only 3 of which were original sources and in all cases these contained potential sampling bias that would, if used uncritically, tend to magnify the level of exposure of the bees. Consequently, it appears that **Gill et al.** used unrealistically high doses and failed to simulate field conditions.* [64] [Emphasis In Original]

What we are seeing, therefore, is that four highly publicized studies which blame neonicotiniods for inflicting serious harm on bee health all used massive overdosing of the bees in reaching their conclusions. We also see that it was government regulatory agencies which have analyzed the studies, identified the study flaws and determined that the quality of the studies was inadequate to use for regulatory purposes.

[62] Id., Sec. 3.2.1. [Notes omitted].

[63] Id., Sec. 3.2.3. [Emphasis In Original, Notes omitted].

[64] Id., Sec. 3.2.2. [Emphasis In Original, Notes omitted].

Defra did more than criticize poorly designed studies, the agency also discussed five "field-realistic" studies "that have failed to find an effect of neonicotinoids on bees" in order to answer the question of why the different results were seen.[65] The five field realistic studies cited by Defra are:

(1) Blacquiere T, Smagghe G, van Gestel CAM, Mommaerts V (2012) Neonicotinoids in bees: a review on concentrations, side-effects and risk assessment. Ecotoxicology 21: 973-992.

(2) Chauzat MP, Carpentier P, Martel AC, Bougeard S, Cougoule N, et al. (2009) Influence of Pesticide Residues on Honey Bee (Hymenoptera: Apidae) Colony Health in France. Environmental Entomology 38: 514-523.

(3) Hecht-Rost S (2009) Thiamethoxam (CGA 293343): A field study with A9807C treated winter oilseed rape seed, investigating effects on honeybees (Apis mellifera L.) over four years in Alsace (France). Germany: Eurofins-GAB GmBH.

(4) Thompson H, Harrington P, Wilkins S, Pietravalle S, Sweet D, et al. (2013) Effects of neonicotinoid seed treatments on bumble bee colonies under field conditions. In preparation.

(5) Genersch E, von der Ohe W, Kaatz H, Schroeder A, Otten C, et al. (2010) The German bee monitoring project: a long term study to understand periodically high winter losses of honey bee colonies. Apidologie 41: 332-352.

> This evidence suggests that populations of bees in free-ranging situations do not normally experience the levels of neonicotinoids that result in sub-lethal toxic effects.
>
> – UK Department of Environment, Food and Rural Affairs

The Thompson study, singled out in the Defra evaluation because "it is representative of an increasing number of field-realistic studies..." is worth examining more closely. The Thompson study is a UK government study conducted by the Fera, Defra's science research arm and, essentially, the British counterpart of USDA's Agricultural Research Service.

The Fera/Thompson study was undertaken in response to the Whitehorn study. Specifically, Thompson "was a rapid response to concerns about the effects of neonicotinoids on bumble bee colonies raised by Whitehorn et al...." [66] The Fera study "was designed to examine, in a limited manner, under field conditions the suggestion from the Whitehorn et al (2012) laboratory study that of major effects on bumble bees from exposure to neonicotinoids." Fera does note that, because of the need for a rapid response to the Whitehorn concerns, Thompson "was not designed as a definitive statistically robust study."[67]

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[65] Id., Sec. 3.4.

[66] The Food and Environment Research Agency, "Effects of neonicotinoid seed treatments on bumble bee colonies under field conditions," March 2013, Background addendum added 14 June 2013, http://fera.co.uk/ccss/documents/defraBumbleBeeReportPS2371V4a.pdf.

[67] Id.

The Fera/Thompson study, despite its design limitations, "allowed assessment of the relationship between the residues detected in the colonies and both colony mass (at the time of sampling and at the end of the study) and the number of queens produced."[68] In contradiction to the dosing-based Whitehorn study, Fera's field study found that "there were no consistent relationships between neonicotinoid residues in pollen and nectar with colony mass at the time of sampling or at the end of the study or with the numbers of queens produced."[69]

The Fera study also undermined Gill's conclusions in finding that the "absence of significant imidacloprid and clothiandin residues suggests it is not a direct toxic effect on the foragers, as suggested by Gill et al (2012)...."[70]

One of the areas in which the Fera study was consistent with previous studies on the issue—an issue of particular importance to regulatory officials developing pollinator protection policies—is that bees feed on diverse pollen sources. The study states that "[e]ven when there was a large area of oilseed rape present it is clear that bumble bees have diverse foraging strategies."[71] The study further explains that the "importance of diverse forage sources to bumble bees has been raised by a number of authors particularly in relation to oilseed rape cropping...."[72]

It is the diverse feeding source habits of bumble bees that is thought to be one of the reasons why studies which rely on dosing bees with insecticides produce markedly different results compared with studies that examine any effects of the insecticides on bees under realistic conditions. The Fera study concludes that

> *The study did not show that neonicotinoids used within a normal agricultural setting have a major effect on bumble bee colonies. Even when there was a large area of oilseed rape present it is clear that bumble bees have diverse foraging strategies. Exposure to treated crops was diluted by foraging on a range of sources of pollen and residues of imidacloprid and clothiandin in nectar were either close to or below the LOQ* [Limits of Quantification[73]] *or were diluted by foraging on a wider variety of plants. Pollen and nectar were clearly collected from thiamethoxam treated crops but there were no major effects of exposure to thiamethoxam or clothianidin residues on queen production or mass gain at the time the residues were taken or at the end of the study.*[74]

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[68] Id., p. 32.

[69] Id.

[70] Id., p. 36.

[71] Id.

[72] Id.

[73] The Limit of Quantification (LOQ) is defined as "the lowest concentration at which the analyte can not only be reliably detected but at which some predefined goals for bias and imprecision are met." See, Armbruster and Pry, Clin Biochem Rev. Aug 2008; 29(Suppl 1): S49–S52. http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2556583/.

[74] Fera, p. 36.

In reviewing studies of neonicotinoids and bee health, Defra keyed in on the differences between dosing studies and field-realistic studies to understand why the two types of studies produced very different results and, of particular relevance to regulators, how to interpret the conflicting data from different study methodologies when setting pollinator protection policies.

Defra's evaluation of neonicotinoids and bee health explains that the differences in results between field-realistic studies and dosing studies are based on the basic fact that "dosing experiments appear not to produce realistic doses as experienced by bees in the field; all of the dosing to date is, at best, close to the upper end of the range that bees are likely to experience and, at worst, it is well beyond that level."[75] Moreover, as discussed above, bee's natural taste for variety in their diet means that "crop pollen was a minor part of the food taken by bumble bees even though it was the dominant flowering species in the landscape."[76]

Because studies which rely on dosing bees with neonicotinoid-laced sugar syrup don't permit bees to enjoy their variety in diet —variety which is enjoyed even among managed bees working at fields of crops which have been treated with an insecticide. Defra suggests that it is because bees seek multiple food sources that may be "why bees and other wild pollinators perform best when there are diverse local flower communities upon which to feed and there is evidence that appropriately managed agro-systems can benefit bee pollinators over natural or semi-natural systems."[77]

Aside from specific methodological criticisms of dosing studies, Defra cites a more overarching reason why they don't accept the validity of the studies purporting to demonstrate that neonicotinoids are harming bee health,

> *Insects are significant pollinators of crops like oilseed rape where yields can collapse in the absence of pollinators. In the UK, neonicotinoids have been used as seed treatments on OSR for 10 years. This suggests that if pesticide use was reducing pollinator effectiveness then this would also be detrimental to crop productivity. Consequently, the claim that treatment of OSR with neonicotinoids kills pollinators is partly countered by the success of the crops themselves.* [78] [Emphasis In Original]

[75] Defra, Sec. 4.1.1.

[76] Id. Sec. 4.1.2.

[77] Id.

[78] Id, Sec. 4.2. [Notes omitted]

Conclusions

At the outset of this memo, I posed the question "Is *Varroa Destructor* or Neonicotinoid Pesticides Responsible for Bee Health Decline?"

After reviewing the research, findings and statements of government science and regulatory agencies including USDA, US EPA, the Australian Pesticides and Veterinary Medicines Authority, the Commonwealth Scientific and Industrial Research Organisation, New Zealand's Ministry for Primary Industries, the UK's Department of Environment, Food and Rural Affairs, and the UK's Food and Environment Research Agency, we can now answer the question. The answer is that the key culprit behind bee health decline is *varroa destructor*.

The state of the science makes clear that

(1) *Varroa destructor* is, by far, the greatest threat to bee health; and

(2) Neonicotinoids used according to regulatory requirements pose little threat to bees.