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# Pesticides and pollinators: a context-sensitive policy approach

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I examine recent policymaking efforts in the United States (US) that seek to improve how risks posed by pesticides to insect pollinators are assessed and managed. Utilizing the case of ongoing honey bee die-offs, I argue for a *context-sensitive* policy framework. From a scientific perspective, this entails not ignoring the uncertain knowledge emerging from laboratory and field studies regarding the *indirect* effects of low levels of certain insecticides in combination with other factors. From a social scientific perspective, policy initiatives to build partnerships between growers and beekeepers toward mitigating exposure to pesticides are crucial, and need to acknowledge barriers to the adoption of best management practices as well as a historically-established asymmetry between growers and beekeepers in the pollination industry.

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## Introduction

Roughly a decade after the first reports of Colony Collapse Disorder, the public continues to hear troubling echoes of concern from scientists and beekeepers about a 'new normal' of honey bee deaths being experienced by beekeepers in the US [1•]. Research points to a 'complex' set of causal factors, highlighting potential roles for parasitic mites, *Nosema*, multiple viruses, poor nutrition and pesticides — both beekeeper — and grower-applied [2•]. However considerable uncertainty remains about which factors are more influential, and how they might interact to cause the ongoing die-offs, exemplified by debates over the nature and extent of the role of neonicotinyl systemic insecticides (neonicotinoids), the world's most widely used insecticides, whose usage in the US has risen dramatically since 2003, especially in the form of seed treatments [3]. An array of emerging laboratory and field studies suggest that relatively low and environmentally relevant levels of neonicotinoids, both alone as well as in combination with other factors such as microbial pathogens, negatively affect honey bees and other insect pollinators [4••,5–11]. These results stand in contrast to studies that purport to show that the effects of neonicotinoids on honey bees and other insect pollinators are negligible at field-representative levels [12–15]. The question of whether newer systemic insecticides are contributing to honey bee declines has developed into a scientific controversy with experts disputing results on multiple methodological grounds [16–18,19••,20••]. How are contemporary policymaking practices reflecting and responding to the scientific uncertainty and complexity that has come to mark this matter of public concern?

## Policy responses in the US and the European Union

The dynamic and relatively uncertain situation about what is known and what is *not* known regarding the relationships between neonicotinoids and insect pollinator deaths has triggered divergent policy-level actions in the European Union (EU) and the US. Policymakers at the EU have declared a moratorium from 2013 to 2015 on the usage of neonicotinoids in pollinator-dependent crops [21•]. In doing so, they have taken seriously uncertain knowledge and suggestive evidence of harm from laboratory and field studies — a false-positive policy orientation that prefers to bear the costs of being wrong about the harm posed by these chemicals, rather than overlooking that harm [22]. By contrast, even though there has been considerable movement on this issue at the US Environmental Protection Agency (EPA), including new labeling requirements [23] and pollinator risk assessment guidelines [24], as well as likely restrictions on new outdoor uses of these chemicals in the absence of additional effects-data on developing honey bees [25], the EPA has to date refused to take action to prohibit or restrict the current use patterns of these chemicals in general, and in specific contexts of usage [26]. The EPA's decision not to take such regulatory action in the absence of definitive knowledge of harm is a false-negative policy orientation that prefers to bear the costs of overlooking harm rather than being wrong that the chemicals are harmful. In justifying its policy position, the EPA calls into question studies reporting negative interactive effects of these pesticides in laboratory and field studies and cites the lack of certainty regarding the biological relevance of reported negative effects for actual field settings [26,27•].

## Sources of uncertainty: ecological complexity

However, it is notoriously difficult to execute real-world field experiments of the effects of low levels of pesticides *in combination with other factors* on honey bee colonies [20••]. The practical challenges entailed in isolating the effects of the chemical in question from potentially confounding sources of environmental variability, require a high number of colonies, resources, and time to achieve sufficient statistical power [17,18]. As a result, field experiments tend to be relegated to measuring the direct, causal effects of individual chemicals [4••,13–15]. However, the observation that an active ingredient or pesticide product is not having any measurable direct effect (lethal or sub-lethal) at 'field-realistic' levels does not exclude the potential for significant indirect effects that come into play only in the presence of other factors in particular spatio-temporal settings. This scenario of cumulative and interactive multifactoriality is highly plausible [28], given that managed honey bee colonies encounter on a regular basis hundreds of pesticides, transgenic toxins, 'inert' ingredients and other synthetic chemicals, apart from ambient parasites, pathogens, nutritional and other abiotic and biotic variables in the particular landscapes in which they are situated and their multiple routes of exposure [11,29]. Furthermore, the complex structure of a honey bee colony may buffer it from the negative effects of neonicotinoids and other pesticides, to a greater extent than other pollinator species [30]. This may partly explain the mixed effects observed in studies of neonicotinoids and honey bees in comparison to the more consistent and robust effects seen in bumble bees and solitary bee species [5,6,19••,30].

While the EPA acknowledges *on paper* the complexity of ongoing honey bee deaths [2•], *in practice* the EPA's policy belies an approach that privileges certainty about the direct effects of individual chemicals over uncertain knowledge about the more indirect effects of mixtures of chemicals and other factors. This is justified on the basis of field studies that are limited in their capacity to grapple with the multifactorial nature of honey be declines. In effect, the EPA's policy approach, in the case of honey bees and some other insect pollinators, ignores uncertain scientific knowledge pointing to the indirect role of newer systemic insecticides. A pollinator policy that ignores the ecological complexity in which honey bee colonies operate, even if scientific knowledge about it is highly uncertain, risks perpetuating a system in which honey bees, beekeepers and other insect pollinator species will continue to struggle.

## Sources of uncertainty: social complexity

Uncertainty stems not only from the biological complexity of interactions between assemblages of plants and pollinators, but also from the multiplicity of values represented by those for whom and by whom the policy is made. When policy on pesticides and pollinators is considered, a range of values are invoked, including the benefits of pollination services, economic efficiency, protecting innovation, feeding the world's growing population, environmental conservation, and sustaining future generations. The EPA incorporates valuation modeling through cost–benefit analyses with the goal of achieving the most cost-effective environmental regulation as mandated by the Reagan administration's executive order 12291 in 1981: 'regulatory action shall not be undertaken unless the potential benefits to society for the regulation outweigh the potential costs to society' [31]. Cost–benefit analysis entails calculating 'expectation values' that are based on quantitative probabilities of *expected* benefits accrued to those whose lives are improved by a policy compared to *expected* costs to those whose lives are made worse off [32,33].

For example, as various neonicotinoids come up for registration review beginning in 2016–2017, the EPA's latest cost–benefit analysis of neonicotinoid seed treatments in soybeans suggests that seed treatments provide negligible overall *yield* benefits to soybean production 'in most situations' and that 'much of the existing usage on soybeans is prophylactic in nature' [34]. 'Independent' analyses sponsored by agrochemical corporations counter the EPA's cost–benefit analysis and highlight significant non-pecuniary benefits, such as ease of application, early planting, and reduced scouting for pests, which growers accrue from using neonicotinoid seed treatments on a variety of crops [35]. Such cost and benefit valuations make simplistic assumptions [33,36] about the dynamics of grower behavior and biophysical plant–pollinator relationships. Analyses of growers' pest management decisions and perceptions are underpinned by the 'rational-choice' theory, which assumes that humans, growers included, are rational, calculating individuals who act to maximize their self-interests [32]. However, growers, like other people, do not always act in their own interests; they are also moved by their social networks, including other growers, crop consultants, extension agents, where shared norms and values regarding competition, size of operation, and specialization can influence preferences for certain pest management practices over others [37]. Related to this, growers also face constraints with regard to the available tools of pest control. For example, it is extremely difficult for US and Canadian growers to purchase *Bt* hybrid varieties without the seed being treated with a neonicotinoid–fungicide combination ([38], p. 5857). Similarly, the value of a pollinator valuation framework that does not take into account 'variation in pollinator density, crop cultivars and growing conditions that exist in practice' is debatable [39]. In the absence of comprehensive knowledge about the economic benefits of insect pollinators to various crops, and about the expected costs accrued due to pesticide-induced losses of pollinators and other beneficial insects, cost–benefit analyses of pesticides may tend to favor prophylactic use