Bees, Birds and Beneficials

How fields of poison adversely affect non-target organisms

By Nichelle Harriott

There is no doubt that pollinators are in crisis. Reports from beekeepers across the country say that honey bee colonies were down as much as 20-60 percent in 2012, with losses as high as 90 percent in 2013. On average, U.S. beekeepers lost 45.1% of the colonies in their operations during the winter of 2012/2013.[1] In June 2013, 50,000 bumblebees, likely representing over 300 colonies, were found dead or dying in Oregon. Authorities confirmed that this massive bee die-off was indeed caused by the use of a neonicotinoid pesticide, dinotefuran, on nearby trees. Similarly, recent surveys of Monarch butterflies saw a 59 percent decline in populations, corresponding to the lowest numbers in 20 years, due in part to habitat loss.[2] Judging from current trends, pollinators may not be able to support our growing agricultural needs for much longer. With many specialty crops like almonds, apples and blueberries dependent on pollination, the loss of pollination services will undoubtedly hurt U.S. agriculture and impact the nature of our diet.

In early 2013, many beekeepers who regularly make the annual trek to California

Systemic Pesticides: The Pervasive Presence

Systemic pesticides, like the neonicotinoid class of pesticides, are insecticides that, when taken up by the plant, translocate to, and remain in, every part of the plant for the life of the organism. This means that seeds treated with systemic pesticides, like clothianidin, retain residues from the chemical in the pollen, nectar, leaves, and stem of the plant. The entire plant becomes poisonous. Systemic pesticides are used on over 90 percent of corn grown in the U.S., and since corn is the cornerstone of the American diet, residues can be found in many of the foods we eat. Unfortunately, the effects of these pervasive poisons have been underestimated by regulators. The impacts of residues in pollen and nectar, for instance, have not been sufficiently evaluated for their impacts on the organisms that forage pollen and nectar –bees and birds.

to bring their bees to pollinate thousands of acres of almond fields struggled to meet the demand for healthy, viable bee colonies for almond pollination. Wild bees and other pollinators are not faring any better, but data on these are harder to come by.

So why have these important organisms taken such a turn for the worse? Our dependency on toxic chemicals is a major cause. Within the last 20 years, U.S. agriculture replaced management strategies, such as crop rotation, with a growing reliance on chemical inputs, producing crops laden with toxic chemical residues that contaminate the environment. This shift away from sustainable practices is characterized by the widespread application of chemicals before pest damage has occurred, and often in the absence of any pest monitoring data.[3] Reliance on chemical inputs and its far-reaching impacts threatens ecosystem fitness and biodiversity. Losses of biodiversity caused by anthropogenic activities during the past 50 years are unprecedented in human history. Data shows that diverse pollinator communities, comprising honey bees and other wild insect pollinators, synergistically increase pollination services through species interactions and pollination effectiveness.[4] A loss of biodiversity is particularly poignant for pollinators and the services they provide.

Over five billion pounds of pesticides are used in the U.S. each year. This, coupled with the increase in the use of systemic pesticides, like the neonicotinoids clothianidin and thiamethoxam, and genetically engineered (GE) material in major crops like corn and soybeans, ensures that thousands of acres of land across the U.S. have become fields of poison.

Systemic Contamination

As a result of the systemic nature of the pesticides, pollinators, especially bees, are being exposed to lethal and sublethal doses of pesticide every time they forage for food, or take poisoned pollen back to the hive where the next generation becomes exposed even before they are hatched. A March 2013 report by Pierre Mineau, PhD and Cynthia Palmer, American Bird Conservancy, shows that it only takes a single corn kernel to kill a song bird and about 1/10th of a corn seed per day to impact avian reproduction.[5] But neonicotinoid pesticides have broad ranging negative impacts not only on beneficial pollinators, but on overall biodiversity and ecosystem health. According to a June 2013 review[6] conducted by David Goulson, PhD of the University of Sussex, concentrations of neonicotinoids in soils, waterways, field margin plants, and floral resources overlap substantially with concentrations that control pests in crops, and commonly exceed levels that are known to kill beneficial organisms. As such, soil dwelling insects, benthic aquatic insects, grain-eating vertebrates, along with pollinators are victims of these systemic chemicals. Other work by Dr. Goulson reports that exposed bee colonies have a significantly reduced growth rate and reduced production of new queens.[7] In all, bees, butterflies, moths, carabid beetles, and birds (the groups for which good data are available) have all shown significant overall declines in recent years since the introduction of these chemicals.

Research by Christian Krupke, PhD finds that during the spring foraging period pollinators are exposed via multiple pathways to high levels of systemic chemicals from field dust and nearby contaminated flowering plants.[8] How does this happen? When treated seeds are planted, usually by large multi-row farming

Song Sparrow (Melospiza melodia),Photo by Wikipedia user MDF, 2005.

Threats to Birds Go Underestimated

While the acute toxicity of neonicotinoids in birds is lower than the acute toxicity of many of the insecticides they have replaced, notably organophosphate and carbamate insecticides, they still pose risks to birds. According to *The Impact of the Nation's Most Widely Used Insecticides on Birds*, by Pierre Mineau, PhD and Cynthia Palmer, American Bird Conservancy, neonicotinoids are lethal to birds and the aquatic systems on which they depend. A single corn kernel coated with a neonicotinoid can kill a songbird. Even a tiny grain of wheat or canola treated with one of the oldest neonicotinoid, imidacloprid, can poison a bird. As little as 1/10th of a corn seed per day during egg-laying season is all that is needed to affect reproduction with any of the neonicotinoids registered to date. Some researchers have suggested that birds may already be affected by neonicotinoids and that, based on data in Europe, bird population declines can be blamed on these popular insecticides.

equipment, residues from the seed coatings are ejected into the dust and air. These toxic dust plumes can travel long distances off site, encountering bees, birds and other organisms along the way. After treated seeds are planted, beneficial microorganisms in the soil, necessary for releasing vital nutrients, maintaining fertility, structure, and aeration of the soil, are also destroyed. Without these beneficial organisms, the functional services they provide is lost and soil fertility decreases, leading to a need for more artificial inputs, thus continuing the cycle of toxic dependency.

Preliminary studies have also observed adverse impacts of neonicotinoids in aquatic systems, with high toxicity in aquatic invertebrates.[9] Systemic pesticides persist in the environment for long periods of time as well, ensuring that successive generations of beneficial organisms bear this chemical burden. If the use of systemic pesticides continues, environmental degradation can only worsen, wreaking havoc with pollinators.

Hedgerows planted along agricultural fields to attract and protect beneficials. Photo taken by Jay Feldman at Live Earth Farm in Watsonville, CA.

GE Domination of the Heartland Destroys Essential Natural Habitat

Along with systemic pesticides, GE crops, with escalating pesticide use and loss of habitat, are a growing threat. Corn, soybeans, sugar beets, and alfalfa, to name a few, are now being genetically engineered to incorporate genes that would allow these plants to become tolerant to chemical applications of glyphosate (Roundup), 2,4-D, dicamba and many others. Industry promises that this technology will reduce total pesticide applications has turned out to be false. In fact, applications of these herbicides have continually increased,[10] despite industry assurances to the contrary, with increasing prevalence of these GE crops. Cropland across the Midwest, which has historically provided feeding areas of milkweed for butterflies, has now been replaced with GE fields. Species like the Monarch butterfly are no longer finding sources of food in these areas, resulting in alarming population declines.[11] Increased use of pesticides on GE-tolerant crops means increased surface water contamination, an increase in herbicide resistant weeds and insecticide resistant insects (which leads to more toxic pesticide applications), and the poisoning of beneficial organisms, including fish, birds and mammals.

Putting the Horse Back in the Barn

The U.S. Environmental Protection Agency (EPA) is tasked with safeguarding the environment, but has nevertheless allowed numerous chemicals into the environment unchecked. The agency fails in its duty to fully review and assess these technologies and their impact on pollinators and other beneficial organisms before they are allowed to contaminate the environment. Now that the dangers of systemic pesticides have come to light, the agency is attempting to mitigate risks by reducing fugitive field dust and improving farming equipment, instead of addressing the prime cause of pollinator decline: toxic pesticides. Similarly, the U.S. Department of Agriculture (USDA) turns a blind eye to the full breadth of hazards associated with introducing GE material into the environment. Rising incidents of resistant weeds and insects are reported with increased regularity –a consequence not fully considered. As a result of GE-mediated weed and insect resistance, farmers now find themselves applying even more pesticides in order to control these new threats to their crop.

The federal regulatory system is inadequate in its assessment of impacts on beneficial organisms. Pesticide labels go unenforced, adverse incidents go underreported, scientific uncertainties are ignored, and the philosophy that mitigating risks instead of upholding a precautionary approach ensures that benefits are shifted to industry, and the pesticide burden is borne by the public and the environment. While they do not use it, federal regulators have the discretionary authority under the *Federal Insecticide Fungicide and Rodenticide Act* (FIFRA), *Clean Water Act*, and the *Endangered Species Act* to stem the flow of chemical poisons into the environment, and protect vulnerable species from unreasonable adverse effects.

A Better Path Forward

Modern agriculture as we know it in the U.S. is intrinsically detrimental to our bees, birds and beneficial organisms. Our way of farming must not put pollinators, other beneficial organisms, and humans at risk. There needs to be a holistic change to our toxic dependency. To do this, we must remember that while certain pesticides can have a place in farming, sustainable, integrated solutions and systems must be reinstituted, where an emphasis on feeding and maintaining healthy soils, respectful of nature, and moving away from toxic chemical inputs is standard. Rigorous science-based decision making that requires precaution on the allowance of chemical products in the face of hazards and scientific uncertainty must be adopted at the regulatory level. One system exists that has already given consideration to sound, integrated farming strategies. The *Organic Foods Production Act* provides the framework for doing this with the independent stakeholder National Organic Standards Board (NOSB) of environmentalists, farmers, consumers and public input providing oversight on allowable synthetic materials in organic production and policies that govern organic systems. Keeping in mind the underlying standards of the organic law, which require that practices "maintain or improve soil organic matter content in a manner that does not contribute to contamination of crops, soil, or water by plant nutrients, pathogenic organisms, heavy metals, or residues of prohibited substances," is the only viable and sustainable path forward that is protective of bees, birds, and other beneficial organisms.

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Chemical Industry Blames Beekeepers

While studies show systemic pesticides create bee hive vulnerability

Commercial beekeepers are bearing the brunt of the pollinator crisis. Many beekeepers have consistently lost over 25 percent of their operations each year, with loses as high as 90 percent. This translates into a billion dollar loss since 2005. Modern day beekeeping is becoming unsustainable and many beekeepers predict that there will be no commercial beekeeping within two to three years. The chemical industry has accused beekeepers of bad beekeeping practices as the reason for honey bee losses. It points to lack of proper nutrition, stressful conditions, and the prevalence of mites (and use of miticides), bacteria, and other pathogens in hives, as some examples. However, when scientists began testing dead bees and collapsing hives, they found a common theme: high agricultural pesticide residues, along with high virus levels.

Reduced Immune Functioning in Bees?

A study (2013) by researchers at USDA finds that infections of *Nosema spp.* increased significantly in the bees from pesticide-contaminated hives when compared to bees from pesticide-free hives, demonstrating an indirect effect of pesticides on pathogen growth in honey bees. This study found 35 pesticides in pollen and high loads of fungicides. Most of the pollen the bees collected were from weeds and wildflowers adjacent to agricultural sites, indicating that foraging exposures are not restricted to agricultural fields. Other studies evaluating interactions between pesticides and pathogens have found similar results of decreased resistance to pathogens. Low doses of pesticides have sublethal effects in bees that lead to impaired foraging, navigation, and learning behavior. One newly released study (2014) finds that the prevalence of deformed wing virus (DWV) and the parasite *Nosema ceranae*, typically observed in managed honey bee populations, have now crossed over to bumblebees, highlighting how declines in native pollinators may be caused by interspecies pathogen transmission.[12] Can low levels of pesticides also be suppressing the immune systems of bees leading to conditions where vulnerable bees are unable to ward off health threats that otherwise healthy bees can? The emerging science seems to say so.

Honey bees work in hazardous environments. Commercial beekeepers zig zag across the country each year with their honey bees to pollinate various crops. Almonds in the West, blueberries, cherries and apples to the North, and pumpkins in the Midwest keep beekeepers and their hives busy for much of the year, fulfilling important pollination services (along with making honey). But the fields in which they work are contaminated with various levels of pesticides. Pesticide drift can expose hives even when bees are not in the fields. Nearby foraging areas, like wildflower beds, prairie, and forestland can also be contaminated with toxic residues, ensuring that bees are unable to find respite from the chemical onslaught. Even in areas where there is little to no agricultural activity, bees may be in danger. No matter what precautions a beekeeper may take to protect his/her bees from pesticides, the odds are that bees will face threats from doing what they naturally do.

References

1. The Bee Informed Partnership. 2013. Winter Loss Survey 2012 – 2013: Preliminary Results. Available at http://beeinformed.org/2013/05/winter-loss-survey-2012-2013/

2. WWF-Telcel Alliance and National Commission of Protected Areas (CONAP). 2013. Results from the 2012-2013 Winter Survey. Press Release available at http://monarchwatch.org/blog/2013/03/monarch-butterfly-survey-points-to-lowest-numbers-in-20-years/

3. Hopwood, J., S. H. Black, M. Vaughan, and E. Lee-Mäder. 2013. Beyond the Birds and the Bees. Effects of Neonicotinoid Insecticides on Agriculturally Important Beneficial Invertebrates. Portland, OR: The Xerces Society for Invertebrate Conservation

4. Brittain, C, Williams, N et al. 2013. Synergistic effects of non-Apis bees and honey bees for pollination services. Proc R Soc B: 280: 20122767

5. Mineau P, Whiteside M. 2013. Pesticide Acute Toxicity Is a Better Correlate of U.S. Grassland Bird Declines than Agricultural Intensification. PLoS ONE 8(2): e57457

6. Goulson, D. 2013. REVIEW: An overview of the environmental risks posed by neonicotinoid insecticides. Journal of Applied Ecology. 50: 977–987. doi: 10.1111/1365-2664.12111

7. Whitehorn PR, O'Connor S, Wackers FL, Goulson D. 2012. Neonicotinoid pesticide reduces bumble bee colony growth and queen production. Science. 336(6079):351-2.

8. Krupke CH, Hunt GJ, Eitzer BD, et al. 2012. Multiple routes of pesticide exposure for honey bees living near agricultural fields. PLoS One. 7(1):e29268

9. Starner K and Goh, S. 2012. Detections of the Neonicotinoid Insecticide Imidacloprid in Surface Waters of Three Agricultural Regions of California, USA, 2010–2011. Bulletin of Environmental Contamination and Toxicology. 88(3):316-321

10. Benbrook, C. 2012. Impacts of genetically engineered crops on pesticide use in the U.S. – the first sixteen years. Environmental Sciences Europe, 24:24

11. Ref. 2

12. Fürst, M, McMahon, D, Osborne, J., et al. 2014. Disease associations between honeybees and bumblebees as a threat to wild pollinators. Nature, 506:364–366