CREATING AND MAINTAINING HEALTHY POLLINATOR HABITAT

Guidance to Protect Habitat from Pesticide Contamination

This guidance document was designed to help growers, land managers, and others safeguard pollinator habitat from harmful pesticide contamination. It includes information on selecting habitat sites, as well as ways to maintain clean habitat by limiting and carefully managing pesticide use.

There is a growing body of evidence demonstrating that pesticides can and do contaminate pollinator habitat at levels that could harm native bees and butterflies, as well as honey bees placed in the area (Gilburn et al 2015; Pecenka & Lundgren 2015; David et al 2016; Long & Krupke 2016). Pesticides have been found at hazardous contamination levels in habitat immediately adjacent to agricultural fields (Pecenka & Lundgren 2015; David et al 2016) as well as in areas further from agricultural sites, although not all pesticide contamination in these more distant sites is from agricultural uses (Gilburn et al 2015; Hladik et al 2016; Long & Krupke 2016; Mogren & Lundgren 2016).

With growing interest in installing pollinator habitat, it is very important to manage the habitat and surrounding areas to reduce pesticide contamination. This can be achieved by instituting a combination of measures such as incorporating non-chemical options into pest management plans, eliminating prophylactic and other pesticide uses, and instituting risk mitigation efforts that limit movement of pesticides into habitat. If pesticide risks cannot be managed, habitat should not be installed.

Priority Pesticide Concerns for Pollinators

While a wide range of pesticides could pose risk to pollinators, priority pesticide concerns include:

- **Insecticides**. In general, insecticides are more acutely toxic to insect pollinators than other pesticides. Insecti-

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cides of particular concern worth noting are neonicotinoids and insect growth regulators (IGRs).

- Neonicotinoids are a high priority concern because of their systemic nature, persistency, toxicity, and widespread use (Douglas & Tooker 2015). They have been linked with a number of debilitating, sublethal effects (Whitehorn et al 2012; Laycock et al 2014; Rundlof et 2015; Wu-Smart & Spivak 2016) and bees can be exposed to toxic levels months to years after an application (Bonmatin et al 2003; Doering et al 2004; Bonmatin et al 2005).
- IGRs are generally classified as lower toxicity relative to other insecticides. However, new data are showing risk that warrants caution because toxicity assessments are performed on adult bees, while the harm from IGRs is to immature insects (EPA 2015).

- **Pesticide mixtures**. Bees are often exposed to pesticide mixtures (Johnson et al 2010; Mullin et al 2010), yet little is known about the effects of these chemical combinations. For some pesticide combinations there is evidence demonstrating that the mixture is more toxic than the sum of the two pesticides (Pilling et al 1995; Iwasa et al 2004; Gill et al 2012).
- **Fungicides**. While most fungicides are characterized as practically nontoxic to bees, they are now being linked with a number of harmful effects to bees (Bernauer et al 2015; Park et al 2015; Sanchez-Bayo et al 2016). Of the various fungicide classes, the DeMethylation Inhibitor (DMI) fungicides have been linked with concerns for pollinators, including increased risk of disease and synergism with some insecticide classes.
- **Synthetic-auxin herbicides**. Herbicides in general can limit forage for pollinators. Due to their tendencies to drift, the synthetic-auxin herbicides, like dicamba and 2,4-D, have been responsible for injury to nontarget plants. Now research has found that low concentration drift of the synthetic-auxin herbicide dicamba can cause plants to produce fewer flowers and also reduce pollinator visitations (Bohnenblust et al 2016).
- **Soil fumigants**. Fumigants can be toxic to a broad spectrum of invertebrates and are active on most, if not all, life stages of insects. Furthermore, fumigants are designed to penetrate spaces where other types of pesticides don't reach. With approximately 70% of North America's native bees nesting in the ground, they are at risk of exposure to soil fumigants.

Native bees require greater protection than honey bees. For example, unlike honey bee colonies with thousands of workers, the majority of native bees are solitary species. As such, they do not have a buffer to protect the egg-laying female from risks. If a female solitary bee dies, her nest remains incomplete.

Common Ways Pesticides can Move into Habitat

Four common ways for pesticides to move into habitat are:

- drift during or immediately after a pesticide application (including dust that drifts when coated seeds are planted),
- volatilization, when the pesticide turns into a vapor and moves with air, sometimes miles off-site (EPA, n.d.),
- movement with water into habitat and subsequent uptake by pollinator attractive plants (Gilburn et al 2015; Long & Krupke 2016; Mogren & Lundgren 2016), and
- wind erosion, when contaminated soil is blown off-field (Limay-Rios et al 2016; Long & Krupke 2016).

Pesticide use in pollinator habitat also must be considered. In particular, habitat can become contaminated from:

- management of pest issues that arise in habitat, and
- uptake of residual pesticides from prior pesticide applications on site (Bonmatin et al 2003; EPA 2015).

Intercropping is the cultivation of two or more crops simultaneously on the same field. It increases plant diversity and helps in pest management.

Recommendations for Healthy Pollinator Habitat

When planning to create, enhance, or restore habitat it is imperative that you take steps to protect pollinators from the pesticide use on your own property and use by adjacent landowners.

Selecting, preparing, and maintaining habitat

- Separate habitat from areas receiving treatment with a pesticide-free buffer. While the appropriate size of a setback or pesticide-free area is dependent upon numerous site specific factors, at a minimum, habitat should be:
  - 40 feet (12 meters) from most ground-based pesticide applications, or
  - 60 feet (18 meters) from the use of air blast sprayers.
- Because of the particular concerns over the effects of neonicotinoids, at a minimum, the pollinator habitat should be:
  - 125 feet (38 meters) from crops treated with nitroguanidine neonicotinoids, including those planted with coated seeds, with the 40 to 60 feet closest to the habitat free of all pesticides (see above).
- Sites should not receive overspray from aerial pesticide applications.
- If there are predominant winds from one direction, especially during seasons when pesticides are used, select a habitat site that is upwind of pesticide use, unless that area has other drawbacks that don't make it suitable for habitat.
- Select a site that has not had an application of clothianidin, imidacloprid, or thiamethoxam—including the planting of coated seed—in the last two years.
- To minimize use of herbicides, take precautions during site preparation to eliminate weeds and weed seeds.
- Do not include plants in habitat that can be alternate hosts for crop pests or crop diseases.
- Avoid pesticide use in habitat once it is established, with the exception of herbicide use to maintain necessary diversity of pollinator attractive plants. Whenever feasible, nonchemical options should be considered for weed control. Herbicide use in habitat should be targeted to unwanted plants and applied during times when herbicides will be most effective (e.g., young and actively growing plants) and least harmful to pollinators (e.g., before flowering).

Reducing reliance on and use of pesticides whenever possible

Adopting integrated pest management methodologies that reduce reliance on pesticides is an integral component of protecting pollinators and other beneficial insects.

- Include biological, cultural, and other nonpesticide pest management strategies.
- Eliminate all prophylactic use of pesticides. Monitor and scout for pests to inform pesticide use decisions.

According to a recent study, flowering crops and adjacent wildflowers can be "heavily" contaminated with a broad range of pesticides, including potentially synergistic mixtures.

- Only use pesticides when a pest reaches an economic threshold (if a threshold exists).
- Treat limited crop areas (spot, bands, perimeter, alternate rows).

Avoiding high hazard pesticide uses

- Avoid all use of nitroguanidine neonicotinoids (clothianidin, dinotefuran, imidacloprid and thiamethoxam), including the planting of coated seed.
- Do not apply tank mixes of a DeMethylation Inhibitor fungicide with a pyrethroid, neonicotinoid, chitin biosynthesis inhibitor, or butenolide insecticide.
- Screen all potential pesticides for pollinator risk to avoid harmful applications.
  - The pollinator index of the Pesticide Risk Tool's Pollinator Index assesses the short-term risk to bees and can help guide applicators in how to reduce risk by assessing different chemicals, application rates and methods. (Access the Index at https://pesticiderisk.org/about.aspx.)
  - The University of California Statewide Integrated Pest Management Program offers the bee precaution pesticide ratings tool, which gives an overarching look at pesticide toxicity and includes information on potential concerns with pesticide mixtures. (Access the Program web site at http://www2.ipm.ucanr.edu/beeprecaution/.)
- Avoid bloom-time pesticide applications to sites that pollinators visit.
- Avoid use of soil fumigants.

Implementing measures that minimize movement of pesticides to habitat

- Establish vegetative barriers (windbreaks) between the habitat area and areas where pesticides are used. Barriers should be densely planted, evergreen, small-needled, non-pollinator-attractive species such as fir and spruce. Barrier height should be above spray release height. Plant density should be approximately 60%.
- If you have field runoff moving towards habitat consider planting grassed filter strips to help catch pesticides.
- Reduce or eliminate tillage to minimize movement of contaminated soil dust. Limiting tillage also helps protects ground nesting bees that might be present in fields.
- Only apply pesticides during appropriate weather con-

Prevention is at the Core of Pollinator-Friendly Pest Management

Incorporating integrated pest management methodologies that reduce reliance on pesticides is an integral component of protecting pollinators and other beneficial insects. Fortunately, there are many strategies that prevent pest populations from reaching problematic levels. These techniques include:

- Cultural controls designed to alter the crop environment to make it less favorable for the pest, resulting in pest prevention or suppression. Examples include crop rotation, sanitation, and strategic planting dates.
- Biological or habitat related controls that use beneficial insects to manage pests. Examples include conservation biological control techniques, such as beetle banks in fields, and companion habitat plantings.

The creation of pollinator habitat works hand in hand with these pest management efforts when pollinator habitat is designed to also serve as habitat beneficial insects that prey on crop pests.

ditions, when winds are between 2 and 9 mph and when risk of inversion is low.

- Modernize application technology with tools such as hooded sprayers, electrostatic spray nozzles, or image responsive technology.
- Use seed coatings and lubricants that are less prone to come off or drift during planting. It is critical that the best stickers are used and applied correctly.
- Calibrate application equipment according to manufacturer specifications on an annual basis.

While this document lists numerous actions that can be taken to protect pollinators from pesticides, overall pesticide contamination is best decreased by limiting pesticide use as compared to only mitigating the effects of applying pesticides. With that goal in mind, pest management plans designed to protect pollinators should include an integrated pest management framework grounded in pest prevention that employs a combination of biological, cultural, physical, and mechanical controls before using pesticide options. Furthermore, pesticides should not be used prophylactically and should only be used when other management options are not feasible and pest populations have reached levels known to cause harm. If pesticides are deemed necessary, the least toxic option should be selected. Within that, the use of a nitroguanidine neonicotinoid (dinotefuran, imidacloprid, clothianidin, and thiamethoxam) should be avoided, as should use of fumigants and applications of pesticide mixtures with evidence of synergistic effects. To avoid incidents of heavy exposures to harmful pesticides, moderately and highly toxic pesticides should not be used on or near blooming plants, and a pesticide-free zone should be established next to habitat.

Many of the recommendations contained in this guidance, as well as instructions on creating a windbreak, are further explored in the U.S. Department of Agriculture's Agronomy Technical Note No. 9, *Preventing or Mitigating Potential Negative Impacts of Pesticides on Pollinators Using Integrated Pest Management and Other Conservation Practices*.

Resources

Xerces Society's habitat installation guides, a series of regional and state guides to creating beneficial insect habitat. Free download at http://www.xerces.org/pollinator-conservation/agriculture/pollinator-habitat-installation-guides/

Preventing or Mitigating Potential Negative Impacts of Pesticides on Pollinators Using Integrated Pest Management and Other Conservation Practices. (Agronomy Technical Note No. 9.) Published by U.S. Department of Agriculture. Free download at http://directives.sc.egov.usda.gov/OpenNonWebContent.aspx?content=34828.wba

How to Reduce Bee Poisoning from Pesticides. Published by Oregon State University, University of Idaho, and Washington State University. Free download at https://catalog.extension.oregonstate.edu/sites/catalog/files/project/pdf/pnw591.pdf

Monarch Butterfly Wildlife Habitat Evaluation Guide and Decision Support Tool: Midwest Edition. Published by U.S. Department of Agriculture Natural Resources Conservation Service. Free download at http://www.nrcs.usda.gov/wps/PA_NRCSConsumption/download?cid=nrcseprd895842&ext=pdf

Are Neonicotinoids Killing Bees? A Review of Research into the Effects of Neonicotinoid Insecticides on Bees, with Recommendations for Action. Published by the Xerces Society. Free download at http://www.xerces.org/neonicotinoids-and-bees/

Beyond the Birds and the Bees. Effects of Neonicotinoid Insecticides on Agriculturally Important Beneficial Insects. Published by the Xerces Society. Free download at http://www.xerces.org/beyond-the-birds-and-the-bees/

Cover Cropping for Pollinators and Beneficial Insects. Published by SARE. Free download at http://www.sare.org/Learning-Center/Bulletins/Cover-Cropping-for-Pollinators-and-Beneficial-Insects

Managing Cover Crops Profitably (3rd edition). Published by SARE. Free download at http://www.sare.org/Learning-Center/Books/Managing-Cover-Crops-Profitably-3rd-Edition

Conservation Buffers: Design Guidelines for Buffers, Corridors, and Greenways. Published by U.S. Department of Agriculture National Agroforestry Center. Free download at http://nac.unl.edu/buffers/docs/conservation_buffers.pdf

Managing Insects on Your Farm. Published by SARE. Free download at http://www.sare.org/Learning-Center/Books/Manage-Insects-on-Your-Farm

Natural Enemies Handbook: The Illustrated Guide to Biological Pest Control, by Mary Louise Flint and Steve H. Dreistadt. 1999. Published by University of California Press.

University of California Statewide Integrated Pest Management Program website: http://ipm.ucanr.edu/

University of California Statewide Integrated Pest Management Program's Bee Precaution Pesticide Ratings. Program website: http://www2.ipm.ucanr.edu/beeprecaution/

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Focus on Monarchs

It is estimated that at least 17% of North American butterflies are at risk of extinction (based on data on NatureServe, http://www.natureserve.org/) and many more are in decline (Forister et al 2010). While there are multiple factors involved in butterfly declines, recent research shows that use of highly toxic, persistent neonicotinoid insecticides may play a role in the decline of some butterfly species (Gilburn et al 2015; and Forister et al 2016).

This decline is epitomized by the once-common monarch which has experienced a more than 80% decline in the eastern United States and an estimated 74% decline in the west. Key factors of monarch decline include the loss of milkweed breeding habitat due to increased use of herbicides, lands being converted to agriculture, deforestation of overwintering sites, and climate change. New research highlights that milkweed contaminated with neonicotinoids could also be a contributing factor in monarch butterfly population declines. Pecenka and Lundgren (2015) found that monarch larval size was reduced from exposure to low doses of clothianidin (1 ppb). They also found that milkweed plants growing near corn fields where clothianidin coated seeds were planted had an average detection level of 1.14 ppb clothianidin suggesting that field realistic levels could be causing harm to monarch larvae. Estimates show that approximately 90% of all conventional corn seed is treated with neonicotinoids prior to planting (Douglas & Tooker 2015). A significant portion of monarch breeding habitat is next to field crops, including corn.

The potential risks that pesticides, and especially neonicotinoids, pose to monarchs and other butterflies should be mitigated when habitat is created and/or restored.