Recommendations from the Xerces Society for Invertebrate Conservation on Designing State Pollinator Protection Plans

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State pollinator protection plans are increasingly looked to as a means to reduce honey bee losses and restore native pollinator populations. While every state will focus on its own specific concerns, there are some overarching issues that should be considered by all states as they develop their plans.

In these recommendations, the Xerces Society seeks to share information about native pollinators and their needs in order for your state plans to address the diverse concerns that managed and native pollinators face. Specific regional information to support plan development is available through the Xerces Society website and other resources.

Include Information on Native Bees in Pollinator Protection Plans

Many crops are dependent upon strong populations of native bees for maximal production, so including native bees as well as managed bees in state pollinator plans is essential to achieving the goal of pollinator protection. This section provides a brief overview of the information about native bees that we recommend be included in plans.

1. Native bees provide important pollination services to the agricultural sector

There are approximately 3,600 species of native bees in the United States. The vast majority of bee species are solitary, creating nests in tunnels in the ground or wood. Bumble bees are the only social native bees, with small colonies of up to 300 workers. Native bees play a key role in ecosystem function as an estimated 85 percent of flowering plants require an animal pollinator. In addition to the contribution the work of native pollinators make to our food supply, their services also provides birds and mammals approximately one-quarter of their diets.

Honey bees, which were introduced from Europe in the 1600s, are perhaps the most well-known pollinator. While managed honey bees fulfill the majority of agricultural pollination, the value of native pollinators is increasingly recognized.[1] Native bees provide free pollination services conservatively valued at $3 billion per year in the United States.[2] Research has demonstrated that native bees can be more effective at pollinating crops than honey bees.[3] Furthermore, many crops, including field tomatoes, show improved quality and increased quantity when native bees are present.[4,5]

A reduction in the abundance and diversity of native bee species could translate to economic loss for many agricultural sectors. For example, cranberry crop production is highly dependent on bee pollination.[6,7] Research has shown that wild bees, particularly bumble bees, are the most active, effective, and efficient buzz pollinators for cranberry.[8,9,10,11,12,13] Without bumble bee pollination, cranberry and other crops would suffer economic damage.

2. Native bees face unique concerns

While native bees face many of the same threats as managed honey bees, their biology, behavior, and size are different enough that some honey bee protections fail to protect native bees.

Native pollinator decline is linked to degradation, fragmentation, and loss of habitat. Transmission of disease is another concern; parasites from managed pollinators are implicated in the decline of several native bumble bee species.[14] Pesticides are also of concern for native bees. Research suggests that native bees can be more sensitive to insecticides than honey bees[15,16]

Unlike the honey bee, 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, then her nest may remain incomplete.[a] Honey bee colonies, on the other hand, have thousands of workers that are not directly responsible for colony reproduction.

Specific to pesticide use, native bees have potential exposure routes that honey bees do not face. For example, nearly 70 percent of native bees in the U.S. nest in the ground, some within agricultural fields. Not only are field-dwelling native bees subject to disturbance from tillage, but they may come in contact with residues from soil drenches, chemigation, or seed coatings. Many native bees also gather mud or plant materials to construct their brood cells, and in doing so may be exposed to pesticide residues. Some native bees may also forage earlier in the morning or later in the evening than honey bees and thus can be exposed to pesticide applications designed to avoid honey bee foraging.[17]

Larvae of bees native to North America may also receive higher exposures than honey bee larvae. Honey bee larvae are primarily fed brood food (a substance secreted by adult workers), and consume only small amounts of diluted honey and pollen.[18] Native bee larvae are typically

[a] The Xerces Society is pleased that the Federal *Pollinator Research Action Plan, Section V, Pesticides and Toxins* made a clear distinction between population models for solitary bees compared to social bees. (Research Plan at p. 29).

fed directly on raw pollen and/or undiluted nectar,[19] which may contain higher concentrations of pesticide residues than brood food.

Managed bees have safeguards not shared by native bees. Beekeepers are able to help avoid and respond to pesticide exposures by moving honey bee hives. Honey bees can be provided supplemental food sources as needed. A queen bee killed or sterilized by pesticide exposure can be replaced for managed honey bees, not so for native bees. Bumble bees are also more susceptible to early-season pesticide applications than honey bees because their success is dependent on queens foraging and establishing new colonies in the spring.[20]

While little information is available on native bee abundance, existing data shows population declines for many species. A recent assessment by the International Union for Conservation of Nature's Bumblebee Specialist Group found that 28 percent of North American bumble bee species are at risk of extinction.[21] In fact, the U.S. Fish and Wildlife Service recently announced a proposal to list the rusty patched bumble bee under the Endangered Species Act.[22] Overall, habitat loss, introduced parasitoids and pathogens, and pesticides are among the threats facing native pollinators.

- We recommend that state pollinator plans provide detail about unique concerns faced by native pollinators.

Include Actions to Encourage Habitat Conservation and Enhancement

A key factor in both managed and native pollinator declines is the lack of foraging habitat. Many native bees also lack sufficient nesting habitat. Natural areas as well as many semi-natural areas such as roadsides and utility rights of ways can provide valuable foraging and nesting habitat for native pollinators.[b]

Conserving or creating pollinator habitat on farms has demonstrated value for crops. For example, wildflower plantings established adjacent to blueberry fields increased the abundance of wild pollinators and enhanced pollination and yield. Yield increased by 12 percent and costs for plantings were recovered in three years.[23]

- We recommend that, where appropriate, states require conservation, creation, and/or enhancement of pollinator habitat featuring native plants on state lands, including parks, natural areas, and roadsides.

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[b] See The Federal Highway Administration's Literature Review: *Pollinator Habitat Enhancement and Best Management Practices in Highway Rights-of-Way*. Available at: http://www.environment.fhwa.dot.gov/ecosystems/documents/pollinators_BMPs_in_highway_ROW.pdf.

- We also recommend that landowners are encouraged to conserve and/or enhance pollinator habitat. For example, states can facilitate partnerships with the USDA Natural Resources Conservation Service and Farm Service Agency to increase support for pollinator habitat plantings on private agricultural lands. Opportunities for financial assistance from voluntary programs such as the Conservation Stewardship Program or Environmental Quality Incentives Program should be encouraged.

Habitat resources that can also be integrated in the plans include:

- Xerces Pollinator Conservation Resources[c]
- Xerces Pollinator Plant Lists[d]
- Xerces Guide to Establishing Pollinator Meadows from Seed[e]
- Xerces Conserving Bumble Bees[f]
- Xerces Guide to Farming for Bees[g]
- The Federal Highway Administration's Literature Review: *Pollinator Habitat Enhancement and Best Management Practices in Highway Rights-of-Way*[h]
- Using 2014 Farm Bill Programs for Pollinator Conservation[i]

Create a Robust Pesticide Risk Mitigation Component

The use of pesticides is one of the factors linked with pollinator decline. With new research expanding our understanding of pesticides and their risks to pollinators we recommend that state plans acknowledge these findings and include them in pesticide risk mitigation recommendations. More specifically, the following issues should be addressed in plans:

1. Include actions to limit the use of harmful pesticide mixtures during bloom

The federal government evaluates each pesticide individually. Yet there is growing information on the additive and even synergistic toxicity of some pesticide mixtures.[24,25,26] The U.S. Environmental Protection Agency has acknowledged the risks of some pesticide mixtures in its *Proposal to Mitigate Exposure to Bees from Acutely Toxic Pesticide Products,*[27] but has yet to take action in response to these concerns.

- We recommend that states encourage the use of the online pesticide ranking tool from University of California Statewide Agricultural & Natural Resources Integrated Pest

[c] Available at: http://www.xerces.org/pollinator-resource-center/.
[d] Available at: http://www.xerces.org/pollinator-conservation/plant-lists/.
[e] Available at: http://www.xerces.org/establishing-pollinator-meadows-from-seed/.
[f] Available at: http://www.xerces.org/bumblebees/guidelines/.
[g] Available at: http://www.xerces.org/guidelines-farming-for-bees/.
[h] Available at: http://www.environment.fhwa.dot.gov/ecosystems/documents/pollinators_BMPs_in_highway_ROW.pdf.
[i] Available at: http://plants.usda.gov/pollinators/Using_2014_Farm_Bill_Programs_for_Pollinator_Conservation.pdf.

Management Program (UC IPM)[j] to inform growers and applicators of the potential risks posed by various chemical mixtures.

- We recommend that states implement new rules to reduce or eliminate the use of harmful pesticide mixtures on pollinator attractive plants shortly before and during bloom.

2. Respond to the concerns posed by systemic insecticides

While the various systemic insecticides all have their own unique attributes, they also have similarities, which increase their risk to pollinators. Due to their systemic nature, neonicotinoids and other systemic insecticides, such as sulfoxaflor and flupyradifurone, can move through plants and into pollen and nectar. Many of these insecticides are long-lived, persisting in soil and in plants for months to years after applications.[k] This combination of systemic activity and persistence facilitates pollinators receiving chronic low-dose exposures. While additional research is ongoing, there is significant research demonstrating that foraging pollinators can be exposed to harmful levels of neonicotinoids.[l; 28,29,30] In their recent listing proposal for the rusty patched bumble bee, the U.S. Fish and Wildlife Service noted that neonicotinoids were implicated "due to the contemporaneous introduction of neonicotinoid use and the precipitous decline of the species."[31]

Furthermore, new research is expanding our understanding of how neonicotinoid insecticides can magnify the impact of pathogens and parasites.[32,33] Multiple studies have demonstrated the combined effects of infection by honey bee gut parasites (*Nosema apis* and *N. ceranae*) and sublethal levels of neonicotinoids.[34,35]

Lastly, there is a growing body of information that shows that systemic insecticides, namely neonicotinoids, could impact monarchs and other butterflies. Unlike bees, monarchs and other butterflies have the added concern of larval exposure while feeding on contaminated milkweed plants. A 2015 study assessed potential harm to monarch larvae from eating contaminated milkweed. The study suggests that field-realistic levels of the neonicotinoid clothianidin could act as a stressor to monarch populations.[36] More specifically, the study found that the amount of clothianidin detected on milkweed plants adjacent to a field planted with clothianidin-coated seed overlapped with the exposure level that caused reduced monarch larval size. Another study out of the United Kingdom used models to evaluate the associations between butterfly population levels and various factors including summer temperatures, spring rainfall, and neonicotinoid use. The researchers found a strong negative association between increasing neonicotinoid use and the decline of 15 of the 17 resident butterfly species studied.[37] A similar study conducted in northern California found a negative association between neonicotinoid use

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[j] Bee Precaution Pesticide Rating available at: http://www2.ipm.ucanr.edu/beeprecaution/.

[k] For an extensive list of citations noting persistence of neonicotinoids, see pages 17–20 in *Are Neonicotinoids Killing Bees?*, published by the Xerces Society. Available at: http://www.xerces.org/neonicotinoids-and-bees/.

[l] For an extensive list of citations noting toxicity of neonicotinoids to bees, see pages 8–16 in *Are Neonicotinoids Killing Bees?*, published by the Xerces Society. Available at: http://www.xerces.org/neonicotinoids-and-bees/.

and butterfly populations.[38] At the level of individual species, the strongest negative associations with neonicotinoid use were for species that were smaller bodied with fewer generations per year.

- We recommend that plans include more extensive best management practices to minimize risk. Furthermore, incentives and regulation should be established to help limit the use of neonicotinoids to those times when pests that are managed by the use of neonicotinoids are known to be present. This is especially important for the use of neonicotinoid coated seed, as the efficacy of this practice in soybean production has been questioned.[39,40]

3. Promote greater caution with fungicide use

Research suggests that fungicides, commonly considered of low toxicity to pollinators, can harm bees. More specifically, one study evaluating the impact of pesticides on native bees in fruit tree pollination concluded that fungicide use could render orchards "risky environments" for native bees.[41] A second study found that bumble bee colonies exposed to fungicides produced fewer workers, lower total bee biomass, and had lighter queens than control colonies, concluding that their results, "suggest that fungicides negatively affect the colony success of a native bumble bee species and that the use of fungicides during bloom has the potential to severely impact the success of native bumble bee populations foraging in agroecosystems."[42]

Furthermore, a recent scientific review showed a trend that ergosterol-inhibiting fungicides significantly contribute to the spread and abundance of honey bee pathogens and parasites. The authors of this review also stated that these same concerns are likely to exist for bumble bees and many other wild insects.[43] This link between fungicides and honey bee pathogens and parasites is important as disease and pesticide use are often described as two separate factors in pollinator decline. Yet, this review suggests that combined effects should be considered in risk mitigation efforts.

- In response to these concerns we recommend that states include information about the potential links between fungicides, pathogens, and parasites in their plans.
- We recommend that to avoid harm from fungicide use the plans include language that requires applicators to avoid fungicide use during bloom whenever possible.

4. Ensure pollinators are protected from the indirect effects of herbicides

Semi-natural areas in the agricultural landscape are often important forage habitat for managed and native bees, but new research is demonstrating that drift of the synthetic-auxin herbicide dicamba can damage important pollinator plants and reduce pollinator visitations.[44] The study, by researchers at Pennsylvania State University, is especially relevant as the use of syntheticauxins are expected to rise significantly due to the deregulation of new transgenic crops resistant to these herbicides. The researchers conclude that the findings "strongly support the need for enhanced stewardship of synthetic-auxin herbicides, like dicamba and 2,4-D, to minimize their influence on non-target plant species."

- We recommend that state plans take action to mitigate these harmful indirect effects.

5. Make note that night applications can be harmful to some beneficial insects

Night applications are often recommended as a mitigation measure to limit pollinator exposure from products known to have short residual toxicity to bees. Still, this mitigation measure can have unintended consequences because some predators of crop pests are most active at night, including beetles and spiders that help control pests of many crops. Therefore, switching the timing of applications to avoid treating during daylight hours could negatively impact some beneficial insects.

The potential for unintended consequences from mitigating risk by switching the timing of application to night should be included in state plans in order for land managers and applicators to have this information available to them as they make pest management decisions.

6. Promote the inclusion of pesticide use setbacks and vegetative buffers to limit movement of pesticides to pollinator habitat

A recent study evaluated the contamination of wildflowers located within 1 to 2 meters of agricultural fields. Focusing on the contamination of neonicotinoid insecticides and fungicides, the authors found that both flowering crops and adjacent wildflowers were "heavily" contaminated with a broad range of pesticides.[45]

Another study showed native bees in agricultural areas, including semi-natural areas close to agricultural fields, were contaminated with multiple pesticides. Eighteen pesticides, and one pesticide breakdown product, were detected in the 54 samples collected. Seventy percent of the bee samples contained pesticides.[46]

- Recognizing the potential for pesticides to move off site, we recommend that state plans promote vegetative buffers of *non-attractive species* to function as drift fences between habitat area and sprayed areas.
- We also recommend that states promote pesticide application setbacks, where pesticides are not applied, around pollinator habitat. The U.S. Department of Agriculture's Natural Resources Conservation Service already recommends pesticide free setbacks of 125 feet from monarch habitat.[47]

7. Include a list of resources regarding best management practices to mitigate pesticide risks

Two online resources that provide good information are:

- 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*.[m]
- University of California IPM program's online pesticide rating for bees.[n]

Include Recommendations for Use of Conservation Biological Control

Conservation biological control (CBC) is a strategy that integrates beneficial arthropods into crop systems for natural pest control, and CBC recommendations included in state pollinator plans can work hand-in-hand with many pollinator conservation strategies. For example, the creation of pollinator habitat also acts as habitat for valuable pest predators and parasitoids. Communities of native predators and parasitoids work together to regulate pests in healthy agroecosystems. Such interactions are enhanced by conserving and restoring habitat.

CBC resources that can be integrated in the plans include:

- Xerces Conservation Biological Control Resources[o]
- Xerces Guide to Farming for Pest Management[p]

Ensure Native Bumble Bees are Protected from Risks Posed by Managed Bumble Bees

Diseases transferred from commercially managed bumble bees can pose a significant challenge to populations of wild native bumble bees.[48,49] Commercially produced bumble bees are not routinely tested for pathogens and parasites. When they have been tested, commercially managed bumble bees have been found to contain numerous pathogens and parasites that are harmful to wild bumble bees.[50,51]

- We recommend that states prohibit the use of nonnative commercial bumble bees.
- When native bumble bee species are used in commercial operations, we recommend that the state ensure that they are produced within their native ranges.
- We further recommend that each state develop a screening system to ensure that any managed bumble bees are free of pathogens and parasites.
- Lastly, we suggest state plans include best management practices for growers. More specifically, commercial bumble bees should not be used for open field pollination.

[m] Available at: http://directives.sc.egov.usda.gov/OpenNonWebContent.aspx?content=34828.wba
[n] Available at: http://www2.ipm.ucanr.edu/beeprecaution/
[o] Available at: http://www.xerces.org/conservationbiocontrol/
[p] Available at: http://www.xerces.org/wp-content/uploads/2008/09/farming_for_pest_management_brochure_compressed.pdf

Commercial bumble bees should only be used in secure indoor facilities, such as screened greenhouses, in which they are not able interact with wild bumble bees. If managed bumble bees are used, growers should only use native species that are produced within their native ranges and they should carefully screen or seal vents and other greenhouse entrances to prevent individual bumble bees from entering or exiting the facility. After crop bloom, none of the commercially acquired bumble bee colonies should be released into the wild.

Encourage Efforts to Reduce the Impacts of Tillage on Ground Nesting Bees

Roughly 70 percent of native bees nest underground, therefore tillage, an important component of many cropping systems, is detrimental to both actively nesting bees, and dormant or developing bee larvae.

- We recommend that states suggest use of no-till seed bed preparation where possible, and leaving areas fallow where large numbers of ground nesting bees are concentrated. Often these will be sandy areas with poor cropping potential anyway.

Furthermore, some growers rely on secondary tillage for weed control. This can also be detrimental to ground-nesting bee populations.

- We recommend that states suggest light surface disking, basket weeding, and raking as opposed to deep running (more than ~3 inches) secondary tillage implements such as heavy spring-tooth harrows, which are more disruptive to underground nesting bees.

Include Information for Backyard Gardeners

Backyard gardeners can also contribute to helping restore pollinator populations. Therefore, states should include sections outlining what they can do to increase healthy habitat and limit toxic exposures to pollinators, which are well worth the time they take to create. The Wisconsin Pollinator Protection Plan[q] includes a section for backyard gardeners that could be used as a template.

Review Wisconsin's Pollinator Protection Plan

Above we outline specific issues and actions that state plans should include to better represent the needs of the state's pollinators. We further recommend that other states incorporate

[q] The Wisconsin Pollinator Protection Plan is available at: https://datcp.wi.gov/Pages/Programs_Services/PollinatorProtection.aspx

information provided in Wisconsin's pollinator protection plan, which could be considered a model for other states. The Wisconsin plan presents a broad view of pollinator concerns and provides readers with numerous resources, many of which would also be applicable for other states.

Conclusions

We are pleased that many states are creating pollinator protection plans to help reverse the current trend of pollinator decline. The diverse needs of pollinators require a multi-pronged approach. We hope that these recommendations can inform states as they create their plans to result in strong protections for managed and native pollinators.

In summary, we recommend that state pollinator protection plans include key facts about native bees, their value, and unique risk factors; robust information on habitat conservation and enhancement; techniques to mitigate pesticide risks; recommendations to protect native bees from disease; and information for backyard gardeners to support pollinators.

About the Xerces Society for Invertebrate Conservation

The Xerces Society is a global leader in pollinator conservation. With 24 technical and support staff working on pollinator conservation issues, Xerces has the largest pollinator conservation team worldwide. The Society's work is based on the latest science and is increasingly recognized as the standard for pollinator conservation by organizations such as the United Nations Food and Agriculture Organization, the White House, the U.S. Department of Agriculture's Natural Resources Conservation Service, members of the U.S. Congress, the organic and natural foods industry, and the sustainable agriculture community, including farmers and farm organizations from across the United States and abroad.

Since 2008, our work has led to the creation of more than 245,000 acres of pollinator habitat. We have also conducted hundreds of workshops and short courses on native pollinators, training more than 60,000 people. Working with the International Union for the Conservation of Nature (IUCN) Bumblebee Specialist Group, we have evaluated the extinction risk of all bumble bees native to North America.

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