Draft Insecticide Strategy

to Reduce Exposure of Federally Listed Endangered and Threatened Species and

Designated Critical Habitats

from the Use of Conventional Agricultural Insecticides

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Office of Pesticide Programs
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1 Executive Summary

When the Environmental Protection Agency (EPA or Agency) takes an action on a pesticide registration (*i.e.,* registers a pesticide or reevaluates it in registration review) under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), the Agency has a responsibility under the Endangered Species Act (ESA) to ensure that the pesticide registration is not likely to jeopardize the continued existence of federally threatened or endangered (referred to as "listed") species, or result in the destruction or adverse modification of their designated critical habitats. Chemical stressors, such as pesticides, are one of many factors that can contribute to population declines of listed species. Meeting this ESA responsibility is a formidable task, considering the tens of thousands of pesticide products and registration amendments for which EPA is required to review potential effects for over 1,700 U.S. listed species.

Given these challenges, in April 2022, EPA released a workplan (USEPA, 2022a) and an update in November 2022 (USEPA, 2022b) on how it plans to meet its ESA obligations as part of pesticide registration processes conducted under FIFRA. The update also describes strategies for identifying early mitigation measures to address potential population-level impacts to listed species across groups of chemicals (*e.g*., herbicides, rodenticides, insecticides) or in certain regions across the U.S. These strategies intend to more efficiently determine whether, how much, and where mitigations may be needed to protect federally listed species from many uses of conventional pesticides. This draft Insecticide Strategy is another key step for EPA in implementing early, practical protections for listed species and increasing the efficiency of meeting its ESA obligations. This strategy is similar to the draft Herbicide Strategy that was released for public comment in July 2023, and includes improvements gained from public comments provided on that draft.

This draft Insecticide Strategy covers conventional insecticides, insect growth regulators, and miticides that are used in agriculture. Insecticides are important, widely used tools to prevent crop damage from insect and mite pests. In 2022, approximately 83 million acres of cropland were treated with insecticides according to the Census of Agriculture.[1] This draft focuses on agricultural uses, which account for more than half of the U.S. "land base".[2] In addition, there are over 850 listed species in the contiguous U.S. Therefore, the draft identifies mitigations that would provide early protections for hundreds of species

[1] www.nass.usda.gov/AgCensus

[2] https://www.ers.usda.gov/topics/farm-economy/land-use-land-value-tenure/

listed by the U.S. Fish & Wildlife Service (FWS).[3] Those mitigations would address potential impacts to aquatic and terrestrial listed invertebrates, which are the types of species likely to be most impacted by insecticides. By identifying mitigations to protect listed invertebrates, the draft would also protect listed species that depend on invertebrates. This includes terrestrial plants that depend on insect pollination, and listed vertebrates that rely on invertebrates for food. The draft Insecticide Strategy when finalized and incorporated into regulatory decisions would likely reduce population-level impacts to over 850 listed species in the lower 48 states.

The draft Strategy does not include ESA effects determinations, but is meant to identify proactive, mitigations that can be applied in registration and registration review actions to reduce pesticide impacts and exposures to listed species. The draft Strategy is intended to provide similar and consistent mitigations for insecticides with similar characteristics (*e.g.*, exposure, toxicity, application method) that are applied to the same crops. This approach creates equitable mitigations based on objective criteria and more predictability for growers and other stakeholders.

The draft includes a three-step framework for EPA to use when considering FIFRA actions for insecticides (such as new chemical registrations and registration review), including how to apply mitigations from the strategy. Step 1 establishes the potential for population-level impacts to the listed species as not likely, low, medium, or high. The low, medium, and high categories indicate a potential concern for population-level impacts that may need mitigation. The first step relies on a refined assessment of potential impacts to invertebrates that builds off of EPA's longstanding ecological assessments (uses the typical fate and toxicity data submitted by registrants and EPA's standard models for estimating exposures). This draft refines that approach by considering more realistic and less conservative[4] toxicity endpoints that represent impacts to populations and communities of invertebrates. The refined assessment also considers whether EPA's standard exposure models represent a listed species' habitat and adjusts the identified mitigations to address overly conservative assumptions.

The refined assessment considers direct impacts to listed invertebrates in terrestrial areas and aquatic areas. The assessment also considers indirect impacts on listed animals and plants from loss of their invertebrate diet or pollinators. EPA begins by considering the proposed and registered uses of the insecticide (*e.g.,* application rates, crops, application methods), fate in the environment (*e.g.,* major transport routes off field, degradation), likely exposures for listed species to the pesticide, and the toxicity of the insecticide to listed species and habitats of listed species.

In Step 2 of the framework, EPA uses the potential of population level impacts to invertebrates from Step 1 to identify levels of mitigations needed to reduce spray drift and runoff/erosion to non-target habitats. EPA developed menus of spray drift and runoff/erosion mitigations from practices - which EPA has deemed effective at reducing drift or runoff— that are available to growers and other applicators in different parts of the country. The menus in the draft Insecticide Strategy improve on those in the draft Herbicide Strategy by incorporating public comments and feedback from stakeholders. The mitigations identified in Step 2 differ from each other based on differences in the potential of population level

[3] EPA is separately addressing potential impacts of insecticides to the listed species and their critical habitat under the jurisdiction of the National Marine Fisheries Service (NMFS) through programmatic consultation.
[4] The screening level assessment relies on toxicity endpoints representing individuals or small groups of individuals.

impacts (*e.g.,* low impacts would be addressed with less mitigations than medium or high potential impacts). EPA incorporated several refinements into the mitigation approach, including considering differences in runoff intensity across the U.S. to account for differences in runoff mitigation needed.[5]

In Step 3 of the framework, EPA identifies where in the contiguous U.S. the mitigations identified in Step 2 would apply. In some cases, EPA expects the mitigations would apply across the full spatial extent of a use pattern (*e.g.,* specific crops) within the contiguous U.S. In those cases, EPA would specify the mitigations on the general pesticide product label. In other cases, EPA plans to require mitigations in only geographically specific areas (referred to as Pesticide Use Limitation Areas or PULAs). Pesticide applicators would need to review these specific areas using Bulletins located in EPA's Bulletins Live! Two (BLT) website. Further, EPA is developing a process to refine maps for these PULAs so that any resulting mitigations are targeted to protect listed species and minimize impacts to applicators.

Taken together, the three-step framework includes many refinements to EPA's standard process to assess the potential for population-level impacts for listed species and identifying mitigations to address the impacts. The refinements in the framework consider concepts such as variability in exposure across geography, usage, and differences in listed species impacts and habitats. The framework will allow EPA to confidently identify when the uses of an insecticide are likely to cause impacts to listed species populations. These refinements minimize the need for pesticide restrictions in situations that do not benefit the species.

The framework was informed by case studies of insecticides representing diverse modes of action, agricultural uses, and environmental fate and impacts. EPA illustrates how the framework could be applied to example chemicals through these case studies. The case studies also allowed EPA to develop, evaluate, and revise the framework. For example, the case studies helped EPA to identify differences in the sensitivity of different taxa (*e.g.,* for some insecticides, mussels were less sensitive to the same chemical compared to shrimp or aquatic insects; for one insecticide, butterflies were more sensitive than bees and beetles). The case studies also illustrate how these differences in sensitivity can allow EPA to identify more mitigation for more sensitive species and less mitigation for other species. This allows EPA to protect listed species from population-level impacts while minimizing impacts of mitigation on growers in areas with less sensitive species. Not all insecticides will have the same amount of data, so it is not possible to differentiate sensitivities and mitigation levels of all species in those cases. However, the framework is flexible enough to allow for a refined evaluation of insecticides where these data are available.

The draft Strategy, when finalized, will not be self-implementing. The draft explains how EPA plans to apply the final Strategy to conventional new active ingredient registration actions and conventional registration review actions. As is common practice under FIFRA, its implementing regulations, and policy, EPA will seek public comment on these actions that would include, among other things, descriptions of how any applicable strategy was applied.

[5] This approach incorporated concepts from EPA's refined assessment methods, such as the Spatial Aquatic Model, to identify areas where lower levels of exposure compared to its conservative screening models would result in less need for mitigation.

When appropriate, for spray drift mitigation, EPA plans to include them on the pesticide product label, whereas for run-off/erosion mitigation, EPA plans to direct applicators to an EPA website with a menu of those measures. Using a website allows EPA to update the menu over time with additional mitigations, which allows applicators to use the most up to date mitigations without amending pesticide product labels. Further, EPA may determine that additional mitigations would be appropriate for some listed species beyond the mitigations on the general pesticide product label. Those additional mitigations would be identified using BLT. EPA has been and continues to develop educational outreach and training to inform the public of potential changes and help applicators understand mitigation needs. EPA may also apply other ESA strategies (*e.g.,* Hawaii Strategy) and the Vulnerable Species Pilot to an insecticide action if they are final. EPA continues to work with stakeholders to develop offsets as an additional mitigation measure for insecticides and other types of pesticides.

This strategy is intended to increase the efficiency of future pesticide consultations with FWS. EPA has coordinated with FWS on the development of this draft. Once final, EPA and FWS expect to formalize their understanding of how this strategy can inform future biological evaluations and consultations. Thus, the Insecticide Strategy would provide earlier protections for the listed species most impacted by insecticides even before effects determinations are made or consultations are completed, thereby accelerating EPA's ability to meet its ESA obligations for all conventional insecticides, reduce the legal vulnerability of EPA's pesticide decisions, and better ensure the continued availability of pesticides.

2 Introduction

2.1 Background

EPA regulates the sale, distribution, manufacture, and use of all pesticides under the FIFRA and the Federal Food, Drug, and Cosmetic Act. EPA considers applications for pesticide products containing new active ingredients and new uses of currently registered pesticides and decides whether to register these products. If the application meets the standard for registration under FIFRA section 3, EPA approves the application with any necessary restrictions on its sale, distribution, or use. FIFRA section 3(g) requires that EPA periodically reevaluates existing registered pesticides as part of registration review. In addition to EPA's obligations under FIFRA to regulate pesticides, EPA also has obligations under the ESA. Under ESA Section 7(a)(1), all federal agencies shall "utilize their authorities in furtherance of the purposes of this Act by carrying out programs for the conservation of endangered species and threatened species." Under Section 7(a)(2), federal agencies shall insure that their actions are "not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of habitat of such species." Where appropriate for a FIFRA action, EPA may be required to consult with the FWS and National Marine Fisheries Service (NMFS) (the Services) to ensure that the relevant actions are not likely to jeopardize the continued existence of listed species or adversely modify their designated critical habitats.

In past decades, the Agency has had trouble meeting its Section 7(a)(2) obligations for the thousands of pesticide actions it completes annually under FIFRA. The entire process, including consulting with the Services to implement protections they determine are necessary through biological opinions, can take years for a single pesticide. EPA expects that there could be thousands of FIFRA actions that could require an ESA review over the next decade. EPA has been unable to keep pace with its ESA workload, resulting in the need for more efficient approaches for integrating listed species evaluations and protections into pesticide registration activities even before effects determinations are made or necessary consultations with the Services are completed.

In its April 2022 workplan (USEPA, 2022a), "Balancing Wildlife Protection and Responsible Pesticide Use: How EPA's Pesticide Program Will Meet its Endangered Species Act Obligations" (the "workplan"), EPA described several challenges to implementing timely and effective strategies for specifically protecting listed species from possible pesticide impacts. The workplan also described how EPA is working to 1) improve assessment of potential impacts to listed species in its pesticide evaluations, 2) increase efficiency of the consultation processes, and 3) implement through registration and registration review actions protections for listed species prior to completion of effects determinations or consultations, if necessary. In November 2022, EPA released an update to the workplan (USEPA, 2022b) which described EPA's efforts to reduce pesticide exposure to non-target organisms, including listed species, during the FIFRA registration and registration review processes.

As described in the update, EPA is developing a series of strategies that group mitigations by pesticide type, use site, location, or other consideration. These strategies are intended to inform EPA's registration and registration review decisions to address landscape level exposures and impacts to listed species. The draft Insecticide Strategy is intended to provide early protections for hundreds of FWS listed species. The protections would substantially improve the efficiency of mitigating and consulting on pesticides, and result in conservation actions being implemented sooner and at a landscape scale. As part of the development of this strategy, EPA worked in cooperation with FWS and continues to do so. This coordination lays a foundation for further efficiencies in the FIFRA-ESA consultation process. The draft Insecticide Strategy focuses on listed species under the jurisdiction of FWS as they have authority over approximately 95% of the listed species in the contiguous U.S. Listed species under the authority of NMFS are not in the scope of the draft Strategy because these are being addressed through a separate programmatic consultation between EPA and NMFS.

Similar to the draft Herbicide Strategy, which EPA issued for public comment in July 2023 which focuses on early protections for over 900 listed species and critical habitats from conventional herbicides, the draft Insecticide Strategy supports EPA's commitment to achieve early protections for over 850 listed species potentially affected by conventional insecticides. This draft Insecticide Strategy builds on concepts and analyses that EPA included in the draft Herbicide Strategy that EPA released for public comment in 2023. The draft Insecticide Strategy incorporates improvements based on public comments on the draft Herbicide Strategy, including to increase flexibility and improve ease of implementation while still protecting federally listed species. Similar to the draft Herbicide Strategy, this draft Insecticide Strategy focuses mitigations on reducing spray drift and runoff/erosion transport to non-target areas. Both strategies focus on agricultural uses in the contiguous U.S. and on mitigating impacts to species that are similar to the target pests of the pesticides (*i.e.,* for insecticides, mitigations focus on non-target invertebrates; for herbicides, mitigations focus on non-target plants).

Both strategies approach mitigating direct impacts to listed species that are taxonomically similar to the target pests differently compared to mitigating impacts to listed species that only have a general reliance on plants or invertebrates in the Herbicide and Insecticide Strategies, respectively (**Table 1**). Often less mitigation is identified for listed species that depend broadly on directly impacted species compared to the amount of mitigation identified to protect listed species that are taxonomically similar to the target pests or that are "obligate" listed species that rely on one (or a small number) of specific species. The literature may refer to obligate species using different terms, such as 'specialist.' This document will refer to these types of species as obligates. Further, the Draft Insecticide Strategy considers habitats or exposure routes relevant to listed invertebrate species that listed plants do not rely on. For example, this draft Insecticide Strategy considers exposures to terrestrial listed insects, like butterflies, that may eat contaminated food sources or come into direct contact with spray drift, while the draft Herbicide Strategy focused on direct contact and root uptake exposures from spray drift and runoff/erosion for terrestrial plants. Both strategies consider aquatic environments. Additionally, in the draft Herbicide Strategy, EPA assumed that listed plants or other non-target plants did not need on field mitigations because the majority of species are not likely to occur on highly managed agricultural areas. For the draft Insecticide Strategy, EPA is considering whether there are any listed terrestrial invertebrate species (*e.g.,* adult butterflies) that are likely to occur on field to levels that warrant concern for population-level impacts and potential mitigations.

Table 1. Key comparisons between the draft Insecticide and draft Herbicide Strategies.

	On-field effects	**Direct effects**	**Indirect effects**
Draft Insecticide Strategy	Considers for listed terrestrial invertebrate species	Considers for listed terrestrial and aquatic invertebrate species	Considers for listed animal and listed plant species that rely on invertebrates
Draft Herbicide Strategy	Did not consider for listed plant species	Considers for listed terrestrial, wetland and aquatic plant species	Considers for listed animal species that depend on plant species

2.2 Scope and Goals of the Draft Insecticide Strategy

This draft Strategy covers conventional insecticides, insect growth regulators, and miticides (referred to as "insecticides" throughout this document) and is focused on agricultural uses[6] of insecticides in the contiguous United States (CONUS). The draft Strategy focuses on mitigating population-level impacts on listed species that may be caused by impacts to invertebrates. The two major mitigation components for listed species are: mitigating direct impacts on listed invertebrates and mitigating impacts on listed plants or vertebrate animals that depend on invertebrates for pollination or diet. Based on this, EPA included in this draft Strategy more than 210 listed invertebrate species[7,8] (**Figure 1A)**, most of which are mussels, snails, shrimp, and butterflies. There are nearly 660 listed species in the contiguous U.S. that depend on aquatic or terrestrial invertebrates for prey (also referred to as "food" or "diet") or

[6] To include cultivated land (including orchards, vineyards, Christmas trees, row crops, specialty crops, and flooded crops) but not pasture/grass or range lands.

[7] This total reflects the number of unique listed species as of February 2022. Panel A of Figure 1 includes 3 species that are represented twice due to having both aquatic and terrestrial phase insects. Updated species lists will be used as the Insecticide Strategy is implemented.

[8] Listed species being considered under EPA's Vulnerable Specie Pilot are also excluded from consideration in the Insecticide Strategy.

pollination (**Figure 1B**). Among these, listed plants are most numerous due to their dependency on terrestrial invertebrates for pollination.

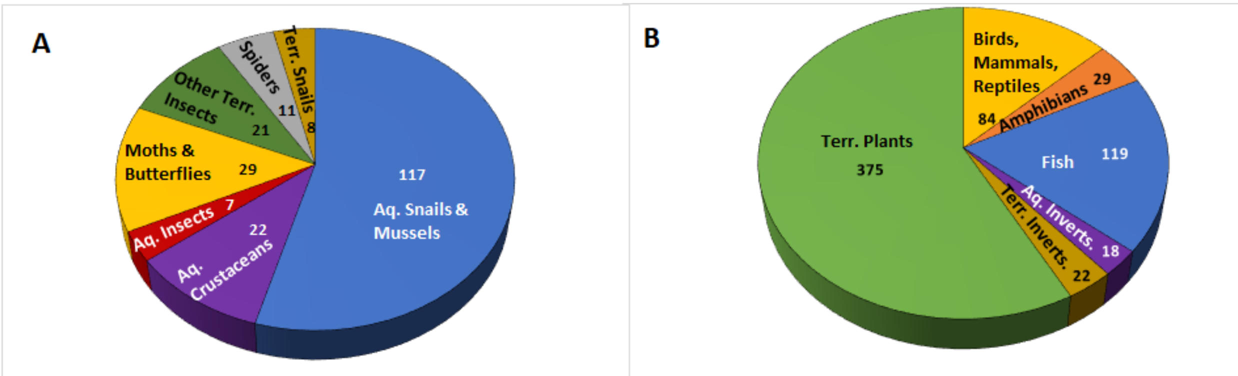

Figure 1. Number of listed aquatic and terrestrial-phase invertebrates in CONUS (panel A) and listed species that broadly depend on aquatic or terrestrial invertebrates for survival (Panel B) within the scope of the draft Insecticide Strategy

The draft Insecticide Strategy focuses on agricultural uses (*e.g.,* row crops, orchards) given the high degree of insecticide usage in these areas and the similarity of mitigation measures that apply to these uses. In 2022, approximately 83 million acres of cropland were treated with insecticides according to the Census of Agriculture.[9] This draft Insecticide Strategy focuses on agricultural uses, which account for more than half of the U.S. land base.[10] While covering only agricultural uses, this Strategy is expected to make great strides in protecting listed species. The primary goals of the Insecticide Strategy include:

1. Identifying mitigations for listed species likely impacted at the population-level by the agricultural use of conventional insecticides;
2. Considering mitigations that would reduce major routes of insecticide exposure to listed species;
3. Improving the efficiency of future ESA consultations on conventional insecticides including, where appropriate, applying the final strategy to future registration and registration review actions; and
4. Increasing regulatory certainty for growers and other stakeholders regarding the use and availability of conventional insecticides.

Each of these goals is discussed more below. Goal three is described in the implementation section of this document.

Identifying Early Protections. This draft Strategy focuses on developing and implementing mitigations to protect listed species earlier in the registration and registration review process before ESA effects determinations or the completion of any necessary consultation with FWS for more than 210 listed aquatic and terrestrial invertebrates. It also includes developing and implementing mitigations to

[9] www.nass.usda.gov/AgCensus
[10] https://www.ers.usda.gov/topics/farm-economy/land-use-land-value-tenure/

protect nearly 660 listed species that depend on aquatic or terrestrial invertebrates for diet or pollination. The goal of the proposed mitigations is to minimize exposure from the use of conventional agricultural insecticides that EPA registers or reevaluates, and thereby reduce the potential for population-level impacts, which could reduce the likelihood of future jeopardy or adverse modification and increase efficiency in future consultations with FWS. When finalized, EPA expects that implementation of the strategy would protect listed species from potential population-level insecticide impacts.

Reducing Major Routes of Exposure. EPA is identifying mitigation measures for conventional agricultural insecticides that have the potential to reduce off-field pesticide exposure via spray drift (pesticide movement as spray droplets at the time of application) and runoff and/or erosion (pesticide movement with water and/or soil) that would likely result in exposure of listed species. EPA is focusing on measures to reduce spray drift, runoff, and erosion transport because FIFRA risk assessments commonly identify risk concerns for invertebrates in terrestrial, wetland, and/or aquatic habitats due to offsite transport of insecticides via these exposure pathways. This strategy does not cover other potential exposure routes for a chemical or species (*e.g*., volatilization, bioaccumulation in aquatic food webs, consumption of treated seeds by birds or mammals, abraded seed dust-off). These pathways may be addressed in the FIFRA registration or registration review actions with all other non-target exposures excluded from this strategy, as appropriate for the specific chemical and use. EPA is also considering whether on-field mitigation may be appropriate to address population-level impacts to any listed terrestrial invertebrates (*e.g.,* butterflies).

Improving Efficiency of ESA Consultations. EPA expects this strategy would help improve the efficiency of future pesticide consultations with FWS.[11] Currently, the process for assessing and mitigating effects to listed species takes many years to complete. This process typically starts with EPA conducting a chemical-specific effects determination that is included in a biological evaluation. The assessment analyzes the potential effects of the FIFRA action (*e.g.,* assessment of all uses for a particular active ingredient) to one or more individuals of all listed species. If EPA finds that effects may occur to one or more individuals of a listed species or to the physical and biological features of designated critical habitat, EPA initiates consultation (informal or formal) with the responsible Service. EPA initiates informal consultation when it concludes that its action may affect but is not likely to adversely affect listed species or their designated critical habitat. At the end of informal consultation, the Service will either provide concurrence with EPA's finding that the effects are not likely to adversely affect a listed species or destroy or adversely modify designated critical habitat and the process ends, or the Service may recommend EPA initiate formal consultation.

EPA initiates formal consultation when it concludes that its actions are likely to adversely affect one or more listed species or its designated critical habitat. More recently, consistent with the ESA counterpart regulations[12], EPA provides to the Service(s) predictions of the potential likelihood of future jeopardy or adverse modification for such species in the biological evaluation or during formal consultation. During formal consultation, the Service(s) determine whether the action is likely to result in jeopardy to the

[11] Listed species overseen by the National Marine Fisheries Service are currently being address through programmatic consultation.

[12] 50 CFR Part 402, subpart D

listed species or destruction or adverse modification of designated critical habitat. In addition, during formal consultation, EPA, the Service(s), and the pesticide applicant/registrants discuss needed measures to mitigate likely jeopardy or destruction or adverse modification determinations made by FWS in the draft Biological Opinion. At the end of formal consultation, the Service will generate a final biological opinion where it documents its evaluation, including agreed upon conservation measures, reasonable and prudent measures, and/or reasonable and prudent alternatives as applicable.

Historically, EPA and the Services have completed the consultation process for relatively few conventional insecticides due in part to the complexity and length of the ESA consultation process. This draft Strategy involves a substantial and necessary change in process to identify and mitigate potential impacts from agricultural uses of conventional insecticides using a streamlined analysis even before EPA makes effects determinations or initiates/completes consultation. To this end, FWS provided input on the development of this draft Strategy and EPA intends to continue to seek and will incorporate feedback from them as it moves forward with development of the strategy.

Once final, EPA and FWS expect to formalize their collective understanding of how this strategy can be used to inform future biological evaluations and consultations. EPA is working with FWS to develop a plan to 1) help further the conservation and recovery of listed species (ESA section 7(a)(1)) by reducing pesticide exposures and resultant impacts to listed species, which includes this strategy and 2) streamline section 7(a)(2) consultations on specific actions based on the analysis described in this strategy. Implementation of the final Insecticide Strategy would identify mitigations to be used in FIFIRA actions to protect the listed species most impacted by insecticides more quickly and accelerate the EPA's ability to meet its ESA obligations for particular insecticides and across the insecticide classes.

Regulatory Certainty. The draft Strategy, once finalized, would also provide greater regulatory certainty about mitigation measures EPA would consider in future registration and registration review decisions. EPA further expects these efforts could reduce the legal vulnerability of the pesticide actions that include them, and thus lead to continued availability of these insecticides.

2.3 Organization of This Document and Supporting Documents

This draft Strategy document is composed of two major parts: the framework for identifying mitigations and the plan for implementing the final strategy. **Section 3** explains the three-step framework that EPA expects to use to identify potential population-level impacts, identify mitigation measures to address these impacts, and determine the geographic extent of the mitigation measures. **Section 4** describes EPA's plan for implementing the final Strategy.

This document includes several supporting appendices with more information on the 3-step framework. The document also has several supporting materials summarized in **Table 2**. This draft Strategy is informed by Version 1.0 of the *Ecological Mitigation Support Document to Support Endangered Species Strategies* (referred to throughout this document as the "**Ecological Mitigation Support Document**"). The **Ecological Mitigation Support Document** contains supporting information on potential mitigation measures EPA identified to date and for which EPA has data on their efficacy in reducing exposure. The development of the support document includes consideration of stakeholder feedback and information collected during the development of the draft Herbicide Strategy. EPA took comment on the earlier version of this document during the proposal of the draft Herbicide Strategy. EPA expects these strategies to evolve as the Agency obtains additional information on potential mitigations to add to the strategies and expects to provide updated versions of the **Ecological Mitigation Support Document** in the future.

Table 2. Additional documents supporting draft Insecticide Strategy.

Document Title	Short Title	Summary of Document
Draft Insecticide Strategy Framework to Reduce Exposure of Federally Listed Endangered and Threatened Species and Designated Critical Habitats from the Use of Conventional Agricultural Insecticides (this document)	Draft Insecticide Strategy Framework (this document)	Describes the analyses conducted to estimate exposure and assess the potential impacts of a pesticide to species groups with similar characteristics, and the nature and extent of mitigations that would apply for a particular insecticide to protect listed species groups.
Draft Insecticide Strategy Species Overlap and Characteristics (Appendix D)	Species critical habitat Overlap and Characteristics	Supporting materials for selecting species with potential population-level impacts and determining Pesticide Use Limitation Areas.
Draft Insecticide Strategy Case Studies Summary and Process	Case Studies Summary and Process	Representative insecticide examples to illustrate the process for identifying and selecting the level of mitigation that would apply for each representative chemical. These case studies also identified the potential level of mitigation to protect listed aquatic and terrestrial invertebrates, their critical habitat, and invertebrate-dependent listed generalist species from conventional agricultural insecticides.
Draft Insecticide Strategy Case Studies Appendix B	Case Studies Appendix B	Exposure modeling files that support the Case Studies Summary and Process document
Draft Insecticide Strategy Case Studies Appendix C	Case Studies Appendix C	Outputs documenting the Magnitude of Difference (MoD) calculated for each example insecticide for terrestrial and aquatic habitats.
Ecological Mitigation Support Document to Support Endangered Species Strategies Version 1.0	Ecological Mitigation Support Document Version 1.0	Describes mitigations that EPA has identified to date that reduce offsite transport of pesticides in spray drift, surface water runoff (referred to as runoff), and soil erosion (referred to as erosion) to address impacts to non-target species, and describes their efficacy in terms of their design, empirical data (e.g., observations from the scientific literature) and computer model simulations.

3 Draft Insecticide Strategy Framework for Identifying Mitigation Measures

The decision framework in the draft Insecticide Strategy identifies the need for, level of, and extent of mitigation that EPA would determine applies to conventional agricultural insecticide FIFRA decisions (**Figure 2**). EPA developed this framework to identify mitigation measures that could be applied consistently to decrease pesticide exposure, and thereby reduce the potential for population-level impacts to listed species from the use of conventional agricultural insecticides. The strategy case studies that accompany this strategy apply this three-step process to illustrate its potential for future application across a broad range of decisions for insecticides.

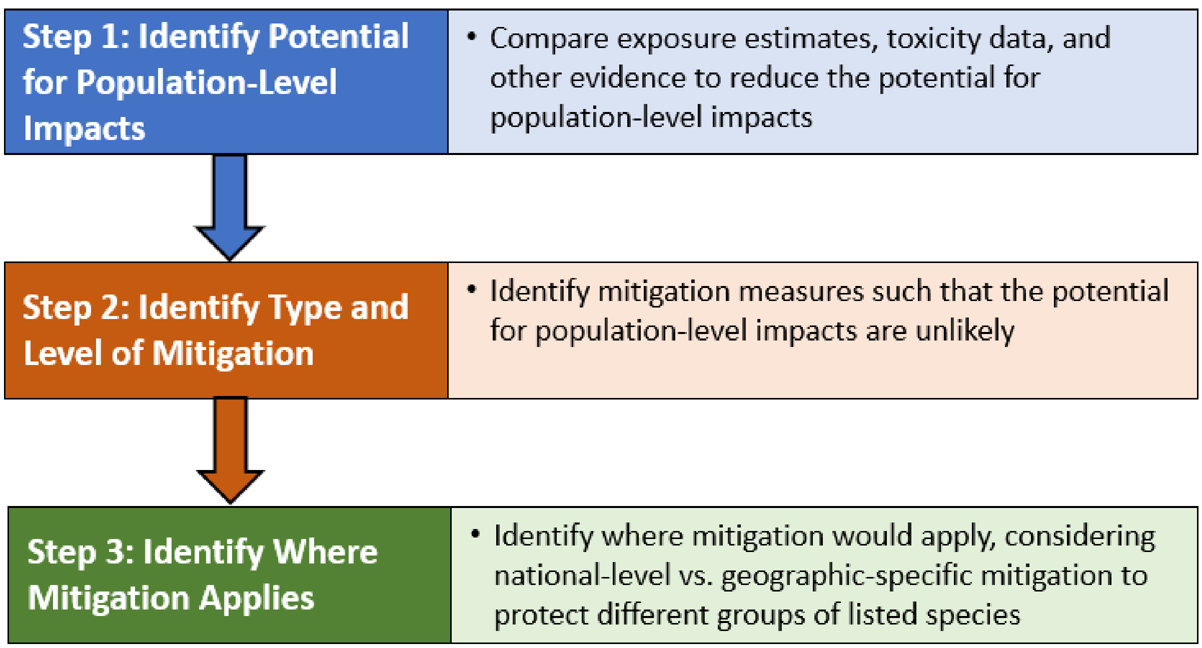

Figure 2. Overview of the Draft Insecticide Strategy Framework

Step 1 establishes the process for assessing the potential for population-level impacts to the listed species. This step is based on long standing FIFRA risk assessment approaches EPA uses to identify potential ecological risk to non-target species, with additional considerations to refine the typical FIFRA risk assessment. In the Insecticide Strategy, EPA considers the use pattern and environmental fate characteristics of an insecticide to estimate exposures in aquatic and terrestrial environments. EPA then compares these exposure estimates to toxicity data that are most relevant to the insecticide and relevant listed species. This comparison of exposure to toxicity is considered by EPA for determining the potential for population-level impacts to occur from an insecticide's registered or proposed use to listed species. In the assessments, EPA supplements this analysis with other information including available incident and monitoring data in addition to how well exposure and toxicity estimates reflect important characteristics of the listed species. This process results in the designation of not likely, low,[13] medium or high potential for population-level impacts to the grouped listed species, which are commensurate with a level of mitigation (Step 2).

In Step 2, EPA identifies the level of mitigation to reduce exposure via drift or runoff/erosion to address the potential for any population-level impacts. EPA identified a greater level of mitigation where the potential for population-level impacts is higher, and less mitigation where there is a lower potential for population-level impacts. For reducing exposure from spray drift transport, EPA typically identifies a buffer. The distance associated with that buffer increases with the level of mitigation (low, medium, and high). If a buffer is identified, EPA plans to provide other mitigation measures that a pesticide applicator could use to reduce that buffer distance. For reducing exposure from insecticide runoff and erosion, EPA identifies a level of mitigation (none, low, medium, and high) as points, up to 9 points of mitigation. The point system allows for greater flexibility and inclusion of mitigation measures that have different levels of efficacy to address pesticides with different levels of potential impacts to different species. With few exceptions, the mitigations available to insecticide applicators are expected to be the same as those available to herbicide applicators because the application methods and approaches for reducing off-site transport are similar for both types of pesticides. The goals for spray drift and runoff/erosion mitigations are the same, which are to mitigate potential for population level impacts. Different approaches are used to communicate the level of mitigations and flexibility of options because of differences in the types of mitigations available, effectiveness of practices, and nature of exposure.

Step 3 involves identifying where in the contiguous U.S. the different the mitigations for listed species identified in Step 2 would apply. In some cases, EPA expects the mitigations would apply across the full spatial extent of a use pattern (*e.g.,* specific crops) within the contiguous U.S., specifying the mitigations on the general pesticide product label. In other cases, EPA plans to require mitigations in geographically specific areas only (referred to as Pesticide Use Limitation Areas or PULAs) through Bulletins using its web-based system, Bulletins Live! Two (BLT).

Taken together, the 3-step framework includes many refinements to EPA's standard process for assessing potential impacts and to identify mitigations to protect listed species from potential population-level impacts. The framework considers higher tier concepts such as variability in exposure across geography and differences in listed species impacts and habitats beyond the typical FIFRA ecological assessment for non-target organisms. This draft framework is intended as a process for EPA to confidently identify when the uses of an insecticide have the potential for population-level impacts to listed species and how to identify effective and reasonable mitigations that are flexible and practical for growers of different crops and different parts of the country. Additional information on each step is provided below.

EPA incorporated elements of FWS's approach to developing biological opinions for pesticides and identifying mitigations (*e.g.,* USFWS 2022a) into the 3-step framework. For example, FWS assesses potential population-level effects by considering multiple factors such as pesticide exposures and

[13] A low potential for population level impacts is a concern because there is a potential of impacts. Only a low level of mitigation is identified for this concern.

impacts from direct toxicity and loss of prey or pollinators, overlap with potential use sites, and usage of pesticides. FWS uses a combination of species-specific mitigations on pesticide product labeling by directing applicators to EPA's BLT system as well as general label mitigations. EPA incorporated elements from FWS's approaches to align this draft Strategy where there is a potential for population-level impacts and what early mitigations could be applied to address those impacts.

3.1 Step 1. Identify Potential for Population-level Impacts

The first step in the draft Insecticide Strategy framework is to identify potential population-level impacts of an insecticide's agricultural uses to listed invertebrates (*i.e.,* direct impacts) and listed species that depend on invertebrates (*i.e.,* indirect impacts). The population-level refined analysis in this strategy builds on EPA's standard FIFRA ecological risk assessment process for pesticides. Similar to the FIFRA ecological risk assessment (which generally assess impacts at an individual-level), the analysis for this strategy includes calculations of ratios of exposure to toxicity estimates for species grouped by toxicity and different exposures by habitat for population-level impacts.

A key component of this step is calculating the Magnitude of Difference (MoD) for each of the assessed insecticide uses. The MoD is the ratio of the insecticide exposure, known as the estimated environmental concentration (EEC), to its corresponding toxicity threshold value. MoDs are calculated for different types of exposures (spray drift, runoff/erosion), different environmental media (*e.g.,* as water or sediment concentrations for aquatic species, concentrations in the diet of terrestrial species), different types of habitats (*e.g.,* small vernal pools, wetlands, ponds, terrestrial areas), and different groupings of species (referred to as "taxa", grouped based on taxonomic categories such as order or phylum) when they differ substantially in their sensitivity to an insecticide. MoDs are also typically calculated for each labeled use (or

Key Definitions for Step 1 of the Draft Insecticide Strategy Framework

Magnitude of Difference (MoD): The MoD is the ratio of pesticide exposure to toxicity. Higher MoDs indicate greater potential for species/population-level impacts. For listed invertebrates with direct impacts from insecticides (and listed obligate species), the denominator reflects the relevant population-level toxicity threshold. The MoD informs the potential for population-level impacts. For species that are generalists, the denominator reflects the relevant community-level impact threshold (*i.e.,* multiple species populations) since generalists depend on a community of species.

Direct Impacts: Adverse impacts to listed aquatic or terrestrial invertebrates that may occur from direct exposure to insecticides. Examples include contact with insecticide spray droplets on their bodies, eating contaminated food and respiring contaminated water for aquatic species.

Indirect Impacts to Obligates: In this analysis, obligate listed species are those that depend exclusively on an aquatic or terrestrial invertebrate species or genus to survive. For example, the Furbish lousewort (*Pedicularis furbishiae*) depends exclusively on the half black bumble bee (*Bombus vagans*) for pollination and is considered an obligate listed species to the half black bumble bee.

Indirect Impacts/Generalists: In this analysis, generalist listed species are those that depend broadly on aquatic or terrestrial invertebrates for its survival. For example, the Indiana bat (*Myotis sodalis*) relies on many different types of flying insects in its diet and is considered to have a generalist relationship with terrestrial insects.

groups of uses) of a pesticide, which may consider different application methods.

MoDs for assessing direct impacts to listed invertebrates are based on toxicity thresholds for population-level impacts to a single species. Examples of listed invertebrate species relevant to the draft Strategy include mussels; snails and shrimp in pools, ponds, streams and rivers; and butterflies and beetles in grasslands near agricultural areas (**Figure 3**). MoDs for assessing indirect impacts to listed species which obligately depend on one or a few species of invertebrates for survival (*i.e.,* "obligates") are also based on the same population-level toxicity thresholds as those for assessing direct impacts, since the survival of obligates depends on one or a few populations of invertebrates. An example of an obligate species is the Everglade snail kite, a bird that eats only one type of aquatic invertebrate: the apple snail (**Figure 3**).

Figure 3. Examples of listed species of invertebrates or obligates that EPA identified potential population level concerns from insecticides. Upper left: Karner blue butterfly.[14] Upper right: purple bankclimber (mussel).[15] Lower: Everglade snail kite[16] (obligate to apple snail, which is in talon of pictured bird). Images from FWS.

[14] https://www.fws.gov/media/karner-blue-butterfly-female
[15] https://ecos.fws.gov/docs/species_images/doc6801.jpg
[16] https://ecos.fws.gov/docs/species_images/doc5039.jpg

Listed species of animals or plants that generally depend on many different invertebrate species for prey/diet or pollination are referred to as "generalists" (**Figure 4**). MoDs for assessing indirect impacts of insecticides on generalists are based on toxicity thresholds for community-level impacts for invertebrates. Typically, as EPA moves from protecting populations to communities (*e.g.,* protecting terrestrial insects, broadly, that the Florida scrub jay relies on generally for diet), the relevant toxicity endpoints increase in concentration (*i.e.,* are less sensitive), and MoDs decrease; however, sometimes the population- and community-level toxicity thresholds (and associated MoDs) are similar due to factors such as high toxicity across multiple invertebrate species.

Figure 4. Examples of listed species of generalists that depend on invertebrate communities for diet or pollination. Left: Florida scrub jay[17] is a listed bird species that eats many species of terrestrial insects. Right: western prairie fringed orchid[18] is a listed plant species pollinated by hawkmoths. Images from FWS.

The MoD is comparable to the risk quotients (RQs) that EPA calculates and compares to regulatory Levels of Concern (LOC) in FIFRA assessments. RQs and MoDs are similar in that they both are a ratio of exposure to toxicity; however, they differ by the toxicity endpoint, estimated exposures, and how they are interpreted. RQs typically rely upon toxicity information more representative of potential effects to an individual organism. RQs also include exposure estimates in terrestrial environments that represent agricultural fields with upper bound pesticide exposures compared to other treated fields. EPA's standard LOC also looks at potential effects to an individual of a species (USEPA, 2004). When interpreting RQs, if the LOC is exceeded, EPA concludes that there is a potential risk and additional refinement is needed to determine the potential that adverse effects will occur. The RQ approach is

[17] https://www.fws.gov/media/banded-florida-scrub-jay

[18] https://www.fws.gov/media/western-prairie-fringed-orchid

conservative, deterministic, and intended to be used as a screen, where additional refinements can be done if appropriate.

MoDs and their interpretation for identifying mitigations (in Step 2) represent a more refined approach. MoDs use toxicity information, such as endpoints from a species sensitivity distribution as described later in this document, to represent potential population- or community-level impacts. Interpretation of MoDs consider concepts relevant to variability in exposures and responses, and to where the EPA standard FIFRA models may overpredict exposures (bias of the model's parameters in representing exposures to small ponds and wetlands when applied to other habitats, such as fast-moving streams and large rivers used by listed species). This refined approach is intended to help EPA confidently identify pesticide uses that have the potential for population-level impacts to a listed species. This refined approach also establishes the potential level of impacts (not likely, low, medium and high) to listed species' populations. That way, EPA can adjust the levels of mitigations to address the potential levels of impacts associated with the specific pesticides use.

EPA investigated the degree of variability of various data and analyses (*e.g.,* variability in laboratory testing, exposure estimates). Based on these sources of variability, EPA determined that when levels of potential population-level impacts are more than an order of magnitude (10x) different from each other, EPA has higher confidence that the impacts are actually different. Ultimately, EPA uses the MoD and other information to determine the potential population-level (or community-level) impacts according to **Table 3**.

Table 3. Relationship Between the Magnitude of Difference and Potential for Population-Level Impacts.

Magnitude of Difference (MoD)[1]	Potential for Population-Level Impacts[2]
<1	Not Likely
1 to <10	Low
10 to <100	Medium
≥100	High

[1] The MoD is the ratio of the exposure estimate to the relevant toxicity threshold value for population-level impacts (listed invertebrates and listed obligates) or community-level impacts (listed generalists).
[2] Other evidence being considered in the analysis may alter the assignment of categories of population/community-level impacts to the MoD ranges shown here. In some cases, bias in exposure or toxicity estimates, typically due to modeling assumptions, may increase the categories by 10X. In rare cases, the categories may be lowered by 10X.

MoDs that are >1 but less than 10 are classified as 'low' potential for population-level impacts to species. The term "low" can be misleading in this context because the MoD is based on refined endpoints, and population-level impacts may still occur. EPA considers other factors such as how EPA's standard modeling approach relates to species' habitats as described in the following paragraph when determining if a low level of mitigation is appropriate for a 'low' MoD.

In addition to the MoD ranges, EPA considers other information such as the level of confidence and bias in exposure or toxicity threshold estimates when assigning the potential for population/community-level impact to a listed species. For example, EPA's EECs for the standard farm pond are used as a proxy to represent exposure of listed species in rivers and streams since EPA currently lacks a reliable exposure model for these flowing water systems. Previous analyses indicate that EPA's pond-based EECs tend to overestimate exposures in rivers and streams by an order of magnitude or more (USEPA 2016). Similarly, the models used to estimate spray drift also tend to overestimate exposure for some habitats where substantial interception of spray droplets is expected (*e.g.,* forests, shrubland). Therefore, for listed species that live in such habitats, the potential for population-level impact categories shown in **Table 3** are assigned higher MoD ranges by one category (*i.e.,* an MoD range of 10 to <100 would equate to low potential for population-level impacts, representing the lower exposure and potential for population-level impacts in these habitats).

3.1.1 Developing Exposure Estimates for the MoD

The first step in estimating exposures for MoD ratios is to estimate the exposure level or EEC for a particular exposure route. EPA starts its exposure analysis by considering the currently registered or proposed uses of an insecticide. This includes the relevant crops, application rates, and methods of application. EPA also considers any existing or proposed mitigations that the registrant(s)/applicant(s) included on the pesticide product label or committed to in writing to amend their registration or application.

EPA uses its models to calculate EECs to which listed species may be exposed. EPA uses different models to calculate EECs depending on the exposure route and whether the species resides in an aquatic or terrestrial habitat. More specifically, EPA evaluates exposures for listed species using established standardized exposure models[19] to calculate aquatic and terrestrial EECs based on:

- Relevant application parameters (*e.g.,* application rates, application method, equipment) for the chemical
- Chemical-specific fate characteristics (*e.g.,* ability to bind to soil particles or remain in aqueous solution, half lives in soil and water)
- Ecological scenario (based on soil, climatic and agronomic practices to determine runoff)
- Modeled habitat where the listed species lives (*e.g.,* vernal pool, stream, forest)
- Degree to which the habitat for a given listed species reflects EPA's modeling assumptions.

A list of exposure models that EPA typically uses is provided in **Table 4.** When this strategy is finalized and implemented to inform a particular registration or registration review decision, EPA will use the most recent version of each exposure model. Additional details on the exposure modeling approaches included in the draft Insecticide Strategy can be found in **Appendix A**. Specific examples are included in the Case Study Summary and Process document.

[19] Current models and their user guides can be found at https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/models-pesticide-risk-assessment and https://www.epa.gov/endangered-species/models-and-tools-national-level-listed-species-biological-evaluations

Table 4. EPA's Standard Models Currently Used to Assess Exposure to Insecticides.

Environment	Exposure/transport Pathway (relevant habitat)	Models or assumption
Terrestrial	Off-field spray drift exposure (point deposition to terrestrial habitat off the field)	AgDRIFT T-REX Bee-REX
Aquatic	Runoff and drift for EPA farm pond or larger waterbody (includes low flow waters, medium/fast flowing waters, lakes, reservoirs, karst systems)	PWC
	Runoff and drift for waterbody smaller than EPA farm pond (includes vernal pools and other wetlands)	PWC with PAT Edge of Field Calculator
	Spray drift only to body of water (all aquatic habitats)	AgDRIFT
	Runoff concentrations in rice paddy/cranberry bogs (flooded agricultural fields)	PFAM

In the draft Insecticide Strategy, EPA aims to rely on these standard, conservative EECs to calculate MoDs. Variability associated with exposures and the conservative bias of the model estimates are all considered when interpreting the MoDs. EPA also considers cases where the habitat of a listed species is likely overestimated due to the type of habitat of the species and lower expected exposures compared to EPA's standard models. So, although the MoD includes conservative exposures, EPA includes refinements when it interprets these MoDs.

For listed invertebrate species in terrestrial habitats (and listed species that have an obligate relationship to a terrestrial invertebrate), EPA assumes the primary route of exposure is from spray drift off a field. EPA estimates dietary exposure through consumption of contaminated food sources such as pollen, nectar, plants, and invertebrates. EPA also estimates contact exposure. EPA uses the AgDrift model to estimate deposition of pesticides via spray drift onto downwind areas to allow for a calculation of dietary and contact exposures estimates at various distances from the application site. Dietary and contact exposures are estimated using the T-REX and BeeREX models. For the MoD, EECs represent exposures at the edge of the treated area.

EPA currently uses the Pesticide in Water Calculator (PWC) and the Wetland Plant Exposure Zone (WPEZ) module of the Plant Assessment Tool (PAT) to calculate runoff/erosion insecticide concentrations in the identified aquatic habitats. EPA then coupled standard agricultural crop scenarios with weather information to assess runoff/erosion potential from vulnerable agricultural use sites. The PWC model generates high-end EECs associated with a particular pesticide, aquatic habitat, and use pattern within a specific geographic region. Each scenario is specific to an area where the use occurs (*i.e.*, where a crop is commonly grown). The EECs generated represent maximum annual concentrations that occur once every 10 years and consider the runoff/erosion and spray drift pathways of exposure. For listed aquatic invertebrates inhabiting small vernal pools, EPA estimates runoff exposure based on edge of field concentrations from PWC. For species living in larger vernal pools and wetlands, EPA uses the wetland module from PAT. EPA also uses AgDRIFT to model spray drift exposures into each aquatic habitat from the spray drift route of exposure alone. EPA considered the habitat requirements of currently listed aquatic invertebrates and any obligates and identified which of EPA's standard model waterbodies is most representative of the expected exposures for that species. In some cases, the standard model is a reasonably good fit for the habitat of the species (*e.g.,* standard wetland is a good fit for vernal pools and wetlands) and in other cases, EPA expects that the model will overestimate exposures to the species' habitat (*e.g.,* the standard pond will likely have much higher exposures than rivers with larger volumes, dilution and flow). When interpreting MoDs, EPA considers how well or how poorly the models estimate exposures for listed aquatic invertebrates.

Similarly, the AgDRIFT model for spray drift assumes a bare field with no interception which will overestimate site-specific exposures if the landscape contains features that would intercept spray drift. For example, spray drift exposure from a treated field to a listed species located in a forest is unlikely because the trees would intercept the spray drift. Therefore, before deciding on the potential for population-level impacts, EPA would consider the habitat of the species (and the representativeness of the exposure estimates from its models).

The scope of the draft Insecticide Strategy includes insecticide applications via broadcast spray made with ground or aerial equipment, soil treatment, treated seeds, and granular formulations. Runoff/ erosion transport pathways are a potential concern for all application methods. For spray drift, as described in the **Ecological Mitigation Support Document,** several application methods would not likely result in population-level impacts irrespective of the characteristics of a particular insecticide. Therefore, EPA would not evaluate the potential for population-level impacts for these application methods (**Table 5**).

Table 5. Insecticide Application Methods and Relevant Exposure Pathways for this Strategy

Application Method	Spray Drift	Runoff
Foliar Applications[1]	Yes	Yes
Soil Treatment	Yes[2]	Yes
Treated Seed	No	Yes
Granular formulations	No	Yes

[1] Foliar applications include those made by aerial broadcast spray, ground broadcast spray, airblast and chemigation.
[2] As described in the **Ecological Mitigation Support Document**, soil treatment with certain equipment (*e.g.,* drip tape, in-furrow sprays) are not expected to result in meaningful exposures of spray drift that would have the potential to result in population-level impacts.

3.1.2 Developing Toxicity Thresholds for the MoD

The toxicity values selected for MoD calculations are intended to represent either potential impacts to (1) a population for direct toxicity or impacts to a species with an obligate relationship to an invertebrate or (2) a community (*i.e.,* multiple species' populations) for species with a general relationship with invertebrates. In general, different toxicity thresholds are used to represent population and community level impacts, where population-level impacts are assumed to occur at lower levels of exposure.

EPA relies on standardized toxicity data that are submitted to the Agency during the registration (or registration review) process for deriving its toxicity threshold values used to calculate an MoD.[20] EPA also supplements these submitted toxicity data with data obtained from the scientific (open) literature.[21] For invertebrates, a variety of toxicity data are available from submitted data and the open literature. These studies involve different types of species habitats (aquatic and terrestrial), exposure routes (water, sediment, contact, diet), durations (short term[22] or long term[23]), life stages (larvae and adults) and type of species (crustacean, mollusk, insects).

EPA matches up the available toxicity data to represent different types of listed species. For example, available honey bee toxicity data (which are typically available for insecticides) are used to represent the sensitivities of larval and adult life stages of listed species of bees. Honey bee toxicity data account for contact exposures to adults and dietary exposures of both larvae and adults. If toxicity data are not available for other types of terrestrial invertebrates, EPA will use the honey bee toxicity data to represent the sensitivities of other listed terrestrial invertebrates (*e.g.,* butterflies and beetles). If robust toxicity data are available for butterflies and/or beetles, and they differ in sensitivity compared to the honey bee, EPA will use available butterfly and/or beetle toxicity data to represent these types of listed species.

A similar approach is used for aquatic invertebrates, where available insect, crustacean and mollusk toxicity data are considered and matched to these types of listed species. In some cases, larger amounts of data are available to represent the toxicity of an insecticide to multiple species within a taxon. In that case, EPA will consider the full set of data in a species sensitivity distribution (a ranking of the different species toxicities). This distribution is helpful in selecting population level endpoints that represent more sensitive species and community level endpoints that represent levels where multiple species need to be impacted to represent an impact to a generalist.

The following sections summarize the process for deriving toxicity thresholds for calculating MoD values.

3.1.2.1 Assessing Species Sensitivity Differences

EPA relates the sensitivity of particular groups of listed invertebrates to species that have toxicity test data available if those data show meaningful differences in sensitivity to an insecticide. As summarized in **Section 2.2**, the listed aquatic and terrestrial invertebrates in the contiguous U.S. consist of a wide range of species types, including beetles, crustaceans, snails, mussels, butterflies, dragonflies, bees, and

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[20] EPA's standard ecological toxicity data requirements are defined in 40 CFR Part 158 subpart G (https://www.ecfr.gov/current/title-40/chapter-I/subchapter-E/part-158/subpart-G)

[21] Toxicity data obtained from the open literature are reviewed according to OPP's open literature guidelines and classified as to whether they are of sufficient quality to be used in deriving toxicity thresholds in regulatory risk assessment (https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/evaluation-guidelines-ecological-toxicity-data-open).

[22] Shorter term exposures are referred to as "acute." These studies typically include 2-4 days exposure and observation.

[23] Longer term exposures are referred to as "chronic." These studies typically include multiple weeks exposure and observation.

others. Because the physiology of a species may be linked to the type of species, it is reasonable to expect that some groups of listed invertebrates may differ in their sensitivity to a given insecticide compared to other invertebrate groups. Furthermore, some insecticides are developed to target specific groups of pests (*e.g.,* mites, flies, butterflies), which supports the notion that differences in sensitivity of different invertebrate groups may occur. Given this expectation of broad sensitivity differences among listed invertebrate groups for some insecticides, it is prudent to ensure that any identified mitigations for an insecticide also reflect such differences in sensitivity (*i.e.,* for the same exposure, greater mitigation would generally be appropriate for more sensitive species types vs. less sensitive species types).

When deriving toxicity thresholds for MoD ratios, EPA determines whether the toxicity data for various groups of species (*e.g.,* butterflies, beetles, and bees) suggests different sensitivity to the pesticide, or if they could be lumped together (*e.g.,* all terrestrial invertebrate species). The extent to which EPA is able to assess potential different sensitivities to a pesticide is limited by the available data. EPA considers available information to identify if differences in sensitivity likely exist across taxonomic groups of listed invertebrates. These differences are particularly impactful if an insecticide's mode of action (MoA) targets certain groups of invertebrates. In some cases, additional information may be used to supplement available toxicity data. Additional details are provided in **Appendix A**.

EPA makes a decision, based on the available dataset, whether it is appropriate to derive separate toxicity thresholds (and MoD) for different invertebrate groups. Aquatic and terrestrial invertebrates are distinguished here because the exposure routes for these types of habitats are different and so are the toxicity data. As illustrated in the various case studies (see **Case Study Summary and Process Document**), different toxicity thresholds and MoDs may be calculated for the following groups:

- Aquatic
  - Insects (*e.g.,* dragonfly larvae)
  - Crustaceans (*e.g.,* shrimp)
  - Mollusks (mussels and snails)
- Terrestrial
  - Butterflies
  - Beetles
  - Bees

EPA may calculate MoDs for additional groups in the future as data allow. Such MoDs may be informed by ongoing work with EPA's Office of Research and Development, which is investigating sensitivity differences among different types of terrestrial invertebrates. With some case study insecticides, EPA combined toxicity data for different invertebrate groups (*e.g.,* butterflies/moths and other terrestrial invertebrates) because of a lack of difference in sensitivity or limited available toxicity data. Therefore, the toxicity thresholds and MoDs for these groups are equivalent.

3.1.2.2 Toxicity Thresholds Supporting MoDs for Assessing Impacts to Listed Invertebrates and Obligates

Once EPA determines whether or not the toxicity data support calculating distinct toxicity thresholds for different listed invertebrate groups, EPA then calculates toxicity thresholds for supporting MoDs for direct population level impacts to listed invertebrates. The approach for setting these toxicity thresholds depends on how much toxicity data are available for the invertebrate species within each group. These toxicity thresholds are also calculated separately for acute (short-term) and chronic (long-term) exposures and their corresponding MoDs. They are also calculated separately for different types of exposures (*i.e.,* aquatic – water column, aquatic – sediment, terrestrial – contact, terrestrial - diet). MoDs generated for aquatic organisms are used in Step 2 to consider runoff/erosion and spray drift mitigations. MoDs generated for terrestrial invertebrates are used to consider spray drift mitigations.

When toxicity data are available for enough species within a group for a given insecticide, EPA uses a species sensitivity distribution (SSD)[24] to set the toxicity threshold used in the MoD for evaluating direct population level impacts on listed invertebrates. SSDs reflect a ranking of species by their sensitivity from most sensitive to least sensitive. A statistical procedure is used to describe this ranking such that a concentration can be identified which corresponds to a desired percentile of the SSD. For example, a concentration corresponding to the 5th percentile of an SSD means that 5% of the tested species are equally or more sensitive than this concentration and 95% are less sensitive. Therefore, setting a toxicity threshold at the 5th percentile of an SSD would be protective of 95% of tested species. SSDs require toxicity data from a relatively large number of species to be scientifically robust (*e.g.,* generally 8 or more species within a group). As a result, SSDs are almost always limited to acute toxicity data because chronic toxicity data are rarely plentiful enough to develop SSDs. For acute SSDs, EPA uses standard toxicity endpoints such as the acute LD_{50} and LC_{50} values[25] and sets the acute toxicity threshold at the 5th percentile of the SSD which is also called the HC_{05} (*i.e.,* hazard concentration corresponding to the 5th percentile of sensitivity). Since species can vary widely in their sensitivity to chemicals and toxicity data are mostly available for standard test species rather than listed species themselves, the HC_{05} is considered protective in that it assumes the listed species are highly sensitive with respect to most of the tested species.

When data are not sufficient to derive an SSD, consistent with common risk assessment practice, EPA sets the acute invertebrate toxicity threshold using data on the most sensitive species for which reliable toxicity data are available. Furthermore, EPA bases the acute toxicity endpoint for that species on LC_{10} or LD_{10} which corresponds to a concentration or dose that causes 10% mortality to the tested individuals. The 10% effect threshold is considered appropriate for evaluating population level impacts since it is reasonably low and corresponds to the acceptable amount of mortality in controls of acute toxicity tests.

For chronic toxicity thresholds for the population, EPA bases toxicity thresholds used to support the chronic MoD on the Maximum Acceptable Toxicant Concentration (MATC) obtained from the most sensitive species for which reliable chronic toxicity data are available. The MATC is the geometric mean

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[24] Species Sensitivity Distributions (SSD) are a common tool used for setting limits on exposure to a chemical or stressor. SSDs model the variation in the sensitivity of different species to a chemical and fit equations to understand the distribution of species sensitivity to a chemical. EPA uses the SSD Toolbox to generate SSDs. The Toolbox is available at: https://www.epa.gov/chemical-research/species-sensitivity-distribution-ssd-toolbox.

[25] LD_{50} is the lethal dose (*e.g.,* mg a.i./kg-body weight) that results in 50% mortality of the tested individuals (usually with terrestrial species). The LC_{50} is the lethal concentration (*e.g.,* mg a.i./L water) that results in 50% mortality of the tested individuals (usually with aquatic species).

between the No Observed Adverse Effect Concentration (NOAEC) and the Lowest Observed Adverse Effect Concentration (LOAEC) from a chronic toxicity test. The NOAEC represents the highest concentration in a chronic toxicity test where statistically significant effects do not occur while the LOAEC represents the lowest concentration where statistically significant effects occurred in the test. Biological effects begin to occur between these two endpoints. Thus, the MATC is intended to reflect the onset of adverse effects from chronic exposure to a chemical.

The same toxicity thresholds used for assessing direct impacts to populations of listed invertebrates are also used for listed species that obligately depend on one or a few species of invertebrates. The rationale for using the same toxicity endpoints determined for assessing direct impacts to populations reflects the expectation that population-level impacts to obligate listed species only requires impacts to one or a few invertebrate species. Therefore, the protection goals for assessing direct impacts to populations of listed invertebrates and listed obligate species are the same.

3.1.2.3 Toxicity Thresholds Supporting MoDs for Assessing Impacts to Listed Generalists

Toxicity thresholds used to assess indirect population-level impacts to listed generalists that depend on invertebrates broadly (rather than a specific invertebrate species) are intended to be protective of impacts to the invertebrate community as a whole since listed generalists depend on many different invertebrate species for survival. When sufficient data are available to develop an SSD, EPA uses the 25^{th} percentile (also called the HC_{25}) to set this toxicity threshold. A higher percentile (lower sensitivity) of the SSD is used to evaluate potential population level impacts to listed generalists compared to direct impacts described in **Section 3.1.2.2** because such impacts are presumed to occur at the community level, rather than for a population of a single species. As indicated previously, SSDs are almost always limited to acute toxicity data and are not typically available for chronic toxicity data.

If available toxicity data are not sufficient to derive an SSD, EPA sets the toxicity threshold for listed generalists at a level that most closely approximates the expected lower quartile of species sensitivity. In many cases, this represents the most sensitive LC_{50} or LD_{50} value when very few species have been tested. However, EPA considers other information (*e.g.,* ECOTOX data and SSDs published in the scientific literature) when selecting the most appropriate LC_{50} or LD_{50} value to represent a threshold for community-level impacts. The goal is to select a species that can reasonably represent the lower quartile of the acute SSD (HC_{25}).

3.1.3 Assigning Potential for Population-Level Impacts

MoDs represent numerical comparisons of estimated exposure levels to population-level toxicity thresholds. A list of exposure estimates and toxicity thresholds used to calculate MoD values in this draft strategy framework is shown in **Table 6.** EPA is using MoDs to inform the potential for population-level impacts to listed invertebrate species and community-level impacts to species that rely on multiple invertebrate species for food. For this strategy, EPA plans to calculate MoDs for each labeled use (or groups of labeled uses) as well as for the major exposure routes associated with mitigation (spray drift, runoff/soil erosion). MoDs are categorized into 4 levels associated with the potential for population-level impacts to a listed species. The levels range from “not likely” to “high” (**Table 3**). Before deciding on the potential for population-level impacts, EPA also considers several lines of evidence, including the habitat of the species (and the representativeness of the exposure estimates).

Table 6. Exposure estimates and toxicity thresholds used to calculate MoD values for listed aquatic and terrestrial invertebrates.

Exposure Source	Exposure Estimates (Model)	MoD Toxicity Thresholds
Listed Terrestrial Invertebrates		
Spray Drift	**Dietary Exposure:**[1] • Residues on arthropods and foliage (T-REX) • Residues in pollen and nectar (Bee-REX) **Direct Contact Exposure:**[1] • Residues on arthropods (T-REX) **Soil Exposure:** • Residues in soil (screening model) Note: spray drift deposition at the edge of the treated area is estimated using AgDRIFT.	**<u>Direct Impacts & Listed Obligates</u>:** **Acute:** • 5th percentile of SSD of species LC_{50} values, or • LC_{10} from most sensitive terrestrial invertebrate [2] **Chronic:** • MATC (geometric mean of NOAEC and LOAEC) **<u>Listed Generalists</u>**: • 25th percentile of SSD of acute LC_{50} values, or • Most appropriate surrogate LC_{50} for terrestrial invertebrates [2]
Aquatic Invertebrates		
Combination of Spray Drift and Runoff/ Erosion and Spray Drift Only	**Small Vernal Pools:** • Edge of Field concentrations (PWC)[3] **Wetlands:** • Concentrations in water and sediment (PAT wetland) [3] **Ponds/Larger Waterbodies:** • Concentrations in water and sediment (PWC farm pond) [3]	**<u>Direct Impacts & Listed Obligates</u>:** **Acute:** • 5th percentile of SSD of species LC_{50} values, or • LC_{10} from most sensitive aquatic invertebrate species[2] **Chronic:** • MATC (geometric mean of NOAEC and LOAEC) **<u>Listed Generalists</u>**: • 25th percentile of SSD of acute LC_{50} values, or • Most appropriate LC_{50} for aquatic invertebrates[2]

[1] Based on estimated exposure concentrations (EECs) from mean Kenaga residues in T-REX.
[2] Used when sufficient data are not available to develop an SSD.
[3] Acute and chronic EECs are based on the yearly maximum daily average and 21-d average concentration, respectively, with a 1 in 10-year occurrence frequency.
SSD = species sensitivity distribution; LC50 & LC10 = lethal concentration to 50% and 10% of tested individuals, respectively; MATC = maximum acceptable toxicant concentration; NOAEC = no observed adverse effect concentration; LOAEC = lowest observed adverse effect concentration

Looking closer at the listed invertebrate species within the scope of the draft Insecticide Strategy, there is a large diversity of habitats where these listed species can occur. For example, aquatic species can be found in small vernal pools that seasonally dry up, prairie potholes that are interspersed with agriculture, small and large wetlands, ponds, lakes, and streams and rivers. Terrestrial species can be found in meadows adjacent to agriculture, at high elevation mountainous regions, remote areas like cliff faces and waterfalls, and in nearby forests. Since EPA has a finite set of exposure models to represent such a large diversity of aquatic and terrestrial habitats of listed invertebrates, an important consideration when assigning the potential for population-level impacts is how well its models represent these habitats. For example, EPA's previous analyses indicate that its exposure estimates for the farm pond have a high tendency to overestimate concentrations in streams and rivers with substantial flow regimes by an order of magnitude or more (USEPA 2016). Since exposure estimates for the farm pond are used as a proxy for other larger aquatic waterbodies including rivers and streams, the potential for population-level impacts begins at a MoD of 10 in these environments rather than 1 as shown previously in **Table 3** in recognition of the upward bias in the farm pond exposure estimates for these habitats. A similar situation exists when considering estimates of spray drift for species that live in areas where pesticide sprays may be intercepted by trees, shrubs, and other obstacles to direct contact with spray droplets. EPA's spray drift estimates assume relatively little or no interception of spray droplets as they move from the treated field. In such cases, EPA also assigns higher thresholds of MoDs to the various categories for assigning the potential for population-level impacts.

With respect to toxicity, EPA also considers the uncertainty and potential bias in toxicity data when assigning the potential for population-level impacts. The MoD ranges shown in **Table 3** could conceivably be lowered when other information indicates the available toxicity test data does not adequately capture the expected sensitivity of one or more types of listed invertebrates. Conversely, the MoD ranges may be increased if information suggests the opposite situation is likely to occur.

Finally, EPA considers information such as data on pesticide residues in environmental media (*i.e.,* monitoring data) in conjunction with model-based estimates of exposure. Generally, monitoring data can support the model-based exposure estimates when concentrations are reasonably similar; however, monitoring data often are not targeted to when and where insecticides are applied, so lack of agreement does not usually impact the MoD ranges associated with the potential for potential population-level impacts. Ecological incident data reported to EPA also represent a similar confirmatory line of evidence as monitoring data.

In summary, EPA decides on the potential for population level impacts (not likely, MoD<1; low, MoD 1 to <10; medium, 10 to <100; high, >100) by considering multiple factors, including:

- MoDs
- Representativeness (or lack thereof) of exposure estimates of species habitat
- Representativeness of toxicity estimates of surrogate test species
- Monitoring and incident data as confirmation

The potential for population-level impacts is used to identify the level of mitigation in Step 2 of the framework, which is discussed in the next section.

3.2 Step 2. Identify Type and Level of Mitigation Measures

Step 2 of the draft IS framework involves relating the MoD to the appropriate level and type of mitigation measures. The mitigation goals are to reduce spray drift, erosion, and runoff exposure pathways such that population-level impacts are not likely. In this step, as described earlier, EPA also considers any existing or proposed mitigations that the registrant(s) included on the pesticide product label or committed to in writing. When EPA identifies the potential for population-level impacts for a particular exposure pathway to be low, medium, or high, it similarly identifies mitigations to address those impacts as shown in **Table 7**. If EPA identifies the potential for population-level impacts to be unlikely, it will not identify mitigations. The mitigations associated with a low, medium, or high level of identified mitigation depend on the exposure route and are described below in **Sections 3.2.1** and **3.2.2**.

Table 7. Relationship Between the Potential for Population-Level Impacts and Mitigation Identified

Potential for Population-Level Impacts[2]	Level of Mitigation Identified	Magnitude of Reduction in Exposure to Result in a Not Likely for Population-Level Impact Conclusion
Not Likely	None	None
Low	Low	10x
Medium	Medium	100x
High	High	1000x

When identifying mitigations to reduce the off-field transport of insecticides in spray drift, runoff and erosion, EPA considered whether the mitigation measures would be effective at reducing exposure and would not in themselves be so burdensome to prevent the intended use. EPA identified mitigations that are already used by various applicators and growers and included as many measures as possible (meaning EPA had enough information to evaluate it for potential inclusion here) to ensure flexibility and allow growers to use mitigations that are economically and technologically feasible to them. The mitigations identified in this strategy improve on those in the FIFRA Interim Ecological Risk Mitigations (IEM) measures discussed in the ESA Workplan Update and the draft Herbicide Strategy by incorporating public comments and feedback from stakeholders.

As detailed in the **Ecological Mitigation Support Document,** for each of these mitigation measures, EPA evaluated their effectiveness at reducing offsite transport. EPA relied upon multiple sources of information about mitigations that are commonly utilized in agriculture for spray drift, runoff and erosion. EPA also included information about other landscape management practices that may effectively achieve similar reductions in exposure. While runoff/erosion mitigation practices may have previously been installed to reduce transport of nutrients and/or soil, they would also be effective in reducing transport of pesticides. This also applies to mitigation measures such as windbreaks which can be installed to protect wind-sensitive crops and control soil-wind erosion, but they can also be effective in reducing pesticide spray drift. The process EPA followed for considering the inclusion of a mitigation in this draft strategy was based on the following:

- Scientific principles, the mitigation is likely to result in meaningful reductions in pesticide spray drift, runoff or erosion based upon the design, placement, and characteristics of the mitigation;
- Existing EPA models indicate a potential reduction in environmental exposure if the mitigation were in place;
- Empirical studies describe the reductions in pesticide concentration as a result of the mitigation;
- The mitigation is similar to other mitigations such that they are functionally equivalent.

Sections 3.2.1 and Sections 3.2.2 discuss the spray drift mitigation measures and run-off/erosion mitigation measures that EPA identified in this draft Strategy to address potential population-level impacts to listed species.

For spray drift, as described in the **Ecological Mitigation Support Document,** EPA is not identifying spray drift mitigations for seed treatments. Since exposures seed treatment via runoff/erosion are analogous to other insecticide formulations (*e.g.,* granular, liquid sprays), EPA is also identifying the mitigations discussed in the runoff/erosion section below to address potential runoff/erosion for seed treatments. EPA is not addressing potential exposures via drift from abraded seed (*i.e.,* dust-off) from seed treatments in this strategy because the Agency is taking other actions[26] outside of the strategy including stewardship efforts and recommending fluency agents to address this potential exposure pathway.

In addition, as described in the scope in **Section 2.2**, this strategy also considers listed species that may be exposed via direct contact with an insecticide application on the field. EPA is currently evaluating (with input from the FWS) the potential and extent to which some species of listed terrestrial invertebrates may be exposed on the treated field (*e.g.,* adult butterflies foraging for nectar in a nectar-producing crop). If such exposures are considered to have the potential to cause population-level impacts, then mitigations to address such 'on-field' exposure may be identified. Such mitigations may include restrictions on timing of application relative to the bloom period of the crop, limitations on the time of day in which applications are made, creation of pollinator habitat adjacent to fields, and conditions for airblast applications of insecticides to orchard trees (*e.g.,* dormant vs. full canopy applications).

3.2.1 Spray Drift Mitigation Measures

Spray drift exposures are a potential concern for pesticide applications made via broadcast spray (aerial and ground equipment), airblast, and some chemigation methods (overhead sprayers such as center pivot and traveler sprayers). This section first describes a suite of baseline mitigation measures that EPA generally includes on pesticide product labels to reduce spray drift exposure to non-target species). The remainder of this section discusses the use of a combination of identified buffers and/or other mitigations to reduce the identified low, medium, or high potential for population-level impacts associated with spray drift identified in Step 1. The spray drift mitigations identified to address potential population-level impacts are expressed as a distance from the edge of the application site (*e.g.,* field) where exposures have been identified and there are potential population-level impacts. **Section 3.2.1.2** explains how EPA identified that distance based on the MoDs calculated in Step 1, and **Section 3.2.1.3** discusses mitigation measures for reducing exposures to address the potential for population-level impacts to listed species. **Section 3.2.1.4** also explains how, if a buffer is identified to represent that distance, what types of areas can represent that buffer.

There are insecticide application methods in additon to ground, aerial, airblast, and overhead/traveler sprayer chemigation. EPA's evaluation described in the **Ecological Mitigation Support Document**

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[26] https://www.epa.gov/pesticides/epa-issues-advanced-notice-proposed-rulemaking-public-comment-seek-additional

indicates that spray drift exposure from these application methods would be limited and thus the potential for population-level impacts is unlikely. These application methods include:

- Chemigation methods, including: micro-sprinklers, drip-tape, drip emitters, subsurface or flood, and under non-permeable plastic surfaces;
- In-furrow sprays when nozzle height is $\leq$8 inches above soil surface;
- Tree trunk drench, tree trunk paint, tree injection;
- Soil injection;
- Solid formulations that are used as a solid; and
- Less than 1/10 acre (<4356 square feet) treated and Spot treatment: <1000 sq ft treated (e.g. when applied with backpack or hand held sprayers).

3.2.1.1 Baseline Spray Drift Mitigations

EPA has identified several measures that it generally includes on pesticide product labels to reduce spray drift exposure to non-target species. Because these measures are common mitigations included on pesticide product labels, EPA's evaluation for the potential for population-level impacts incorporates and reflects these mitigations. These mitigations typically include:

- restricting the maximum windspeed to 15 miles per hour,
- prohibiting applications during temperature inversions,
- boom length restrictions and swath displacements for aerial applications,
- maximum release heights for ground and aerial applications, and
- directing sprays into the canopy for airblast and turning off the outer nozzles at the last row.

3.2.1.2 Spray Drift Mitigation Distances

If EPA identifies a potential for population-level impacts (MoD category) associated with spray drift exposure to be low, medium, or high, EPA then identifies the level of mitigation to address the potential for population-level impacts. EPA typically identifies a spray drift buffer to address concerns related to spray drift. For this strategy, for aerial, ground, and airblast sprays, EPA identified buffers to address the potential for population-level impacts. The distance associated with that buffer increases with the level of mitigation (low, medium, and high) and that the buffer be located on the downwind edge of the application site (*e.g.,* field). EPA also identified mitigation measures (described in **Section 3.2.1.3**) that a pesticide applicator could employ to reduce any identified buffer distance because these mitigation measures also reduce exposure within that buffer distance. The **Ecological Mitigation Support Document** describes how EPA determined the efficacy of the mitigation measures, which EPA expresses as a percentage decrease for an identified buffer distance. For chemigation, EPA did not identify a spray drift distance, but rather identified other mitigation measures for overhead and impact sprinkler chemigation equipment when it identifies a potential for population-level impacts to listed species (See **Section 3.2.1.5**).

To address a low potential for population-level impacts for aerial, airblast and ground applications, EPA identifies what it refers to as lower limit buffers. If EPA identifies a medium potential for population-level impacts for aerial, airblast and ground applications, EPA identifies a buffer distance by calculating a chemical specific distance based on the toxicity of the pesticide and estimated deposition. If EPA identifies a high potential for population-level impacts aerial, airblast and ground applications, the

Agency identifies a maximum buffer distance by calculating a maximum buffer that varies depending on the application method. See **Table 8**.

EPA recognizes that for a pesticide application, droplet size can impact the distance which spray drift travels, with larger droplets generally not traveling further than finer droplet sizes. As shown in **Table 8**, to simplify product labels, EPA identified a single spray drift distance based on how pesticides are typically applied for each type of application method. If a smaller droplet size is needed for a particular pesticide, EPA may identify a larger buffer distance. If a pesticide applicator can use a larger droplet size or a low boom, as described in **Section 3.2.1.3**, they would be able to decrease the identified buffer distance. The text below and the **Ecological Mitigation Support Document** provides additional discussion and details about the distances identified to mitigate potential low, medium and high population-level impacts.

Table 8. Potential for Population-Level Impacts Identified in Step 1 and Corresponding Spray Drift Distance to Reduce Impacts.

Potential for Population-Level Impacts from Step 1	**Distance from edge of treated area (in feet)**		
	Aerial Spray[1]	**Ground[2] Spray**	**Airblast**
Not Likely	None	None	None
Low	50	10	25
Medium	Calculated for specific chemical[3]		
High	320	230	160

[1] EPA based aerial distances on the assumption that most aerial applications will use a medium droplet size distribution. If very fine or fine applications are needed for a pesticide, EPA may increase the distance. There are mitigation measures for reducing this distance when using droplets larger than medium.
[2] EPA based these distances on the assumption that ground applications are made using a high boom and very fine to fine droplet size distribution. There are mitigation measures for reducing this distance when using larger droplets and a low boom.
[3] EPA anticipates that chemical specific buffers will be between the lower limit (used for low potential population level impacts) and at or lower than the maximum (used for high impacts) buffer distances.

Where there is a low potential for population-level impacts, EPA identifies a low level of mitigation for aerial, airblast, and ground applications using a lower limit distance. EPA based the identified distances in **Table 8** on the distance where the deposition fraction is estimated to be 10% of the application rate for the different application methods. This equates to 50, 20, and 10 feet, for aerial, airblast, and ground applications, respectively. EPA based these distances on the common droplet size distribution for aerial (medium), the common droplet size distribution for ground (fine) and high boom, and on the sparse orchard setting for airblast.

Where EPA identifies medium potential for population-level impacts, for aerial, airblast, and ground applications the Agency plans to use AgDRIFT to calculate the chemical specific buffer distance when considering a registration or registration review action. This calculation would be the distance to where the deposition exposure is equal to the toxicity threshold (discussed above for Step 1, **Section 3.1.3**). This distance is anticipated to be between the lower limit distance and at or lower than the maximum buffer distance.

Where EPA identifies high potential for population-level impacts, the Agency identifies a maximum spray drift distance at a distance beyond which exposure does not substantially change using the AgDRIFT model for aerial, airblast, and ground applications. The main reasons for determining a maximum buffer distance include: 1) the impact of the buffer in reducing exposure decreases with distance, such that at distances far offsite, there is only a small change in the spray drift deposition, 2) the uncertainty that exposure will be similar to what is predicted by the model increases with distance, and 3) the larger a buffer is, the less feasible it is for many applicators. In many cases, the likelihood that spray drift will be partially intercepted by a drift barrier (*e.g.,* trees, crop canopy or other vegetation, buildings) increases with distance, and as such, the model may over-estimate the maximum spray drift buffer because it assumes a bare treated area with no obstructions to intercept spray droplets that drift off-field. The maximum spray drift buffer will be different for different application equipment (*i.e.,* aerial, ground and airblast).

3.2.1.3 Spray Drift Mitigation Measures for Reducing Buffer Distance

EPA reviewed available mitigation measures for reducing the distance of any identified spray drift buffer on a site-specific basis. Mitigation measures for reducing the distance include application parameters (such as specific equipment, application rate, droplet size distribution), the width of the treated area, use of a windbreak/ hedgerow or forested/shrubland area as a physical barrier, or the relative humidity. While many of these measures apply to all spray drift application methods, some application parameters are specific to the type of application. For example, the applicator could choose larger droplet size distributions to reduce the aerial or ground distances. For ground applications, the applicator could reduce the distance by using hooded sprayers or drop nozzles that result in applications under the crop canopy. For all types of applications, the buffer distance can be reduced by using a lower application rate than the maximum rate on the label or by using a windbreak or hedgerow on the downwind side of the application area. **Tables 9-11** summarize the spray drift mitigation measures for reducing the distances associated with aerial, ground and airblast applications to reduce exposure. The **Ecological Mitigation Support Document** has detailed information describing the basis for each percent reduction in distance.

Table 9. Mitigation measures identified when making broadcast aerial applications.

Mitigation measure	% reduction in distance
Application parameters	
Reduced single application rate	% reduction corresponds to application rate reduction from maximum on pesticide product label
Coarse DSD[1]	20%
Very coarse DSD[1]	40%
Spray drift reducing adjuvants	Under evaluation[2]
Reduced proportion of field treated (number of airplane/helicopter passes[3])	
1 pass	55%
2-4 passes	20%
5-8 passes	10%
Other mitigation measures	
Downwind windbreak / hedgerow / riparian / forest/ woodlots/shrubland	50% for basic windbreak/hedgerow 75% for advanced windbreak/hedgerow 100% for riparian/forests/woodlots/shrubland ≥60ft width
Relative humidity is 60% or more at time of application	10%

DSD = droplet size distribution

[1]This % reduction assumes baseline of using medium droplet size for aerial.

[2] EPA anticipates receiving spray drift reduction adjuvant data for insecticide formulations and will be evaluating this as a mitigation measure for insecticides prior to finalizing the Insecticide Strategy.

[3]A spray drift buffer applies to downwind non-target areas. The reduced number of passes applies to the upwind part of the treated field.

Table 10. Mitigation measures identified when making broadcast ground applications.

Mitigation measure	% reduction in distance
Application parameters	
Reduced single application rate	% reduction corresponds to application rate reduction from maximum on pesticide product label
High boom, fine to medium-coarse DSD[1]	55%
High boom, coarse DSD[2]	65%
Low boom, very fine to fine DSD[1]	40%
Low boom, fine to medium-coarse DSD[1]	65%
Low boom, coarse DSD[2]	75%
Over-the-top Hooded Sprayer	50%
Row-middle Hooded Sprayer	75%
Sprays below crop using drop nozzles or layby nozzles	50%
Spray drift reducing adjuvants	Under evaluation[3]
Reduced proportion of field treated (number of ground application equipment passes[4])	
1 pass	75%
2-4 passes	35%
5-8 passes	15%
Other mitigation measures	
Downwind windbreak / hedgerow / riparian / forest / shrubland/woodlots	50% for basic windbreak/hedgerow 75% for advanced windbreak/hedgerow 100% for riparian/forests/woodlots/shrubland ≥60ft width
Relative humidity is 60% or more at time of application	10%

DSD = droplet size distribution
Low boom height=release height is less than 2 feet above the ground
high boom=release height is greater than 2 feet above the ground
[1]This % reduction assumes baseline of using high boom, very fine to fine droplet size for ground.
[2] Based on evaluation of additional ground spray drift data for an additional 10% reduction in distance beyond fine/medium DSDs.
[3] EPA anticipates receiving spray drift reduction adjuvant data for insecticide formulations and will be evaluating this as a mitigation measure for insecticides prior to finalizing the Insecticide Strategy.
[4]A spray drift buffer applies to downwind non-target areas. The reduced number of passes applies to the upwind part of the treated field.

Table 11. Mitigation measures identified when making airblast applications.

Mitigation measure	% reduction in distance
Application parameters	
Reduced single application rate	Divide % reduction in application rate by 2
Reduced proportion of orchard treated (number of treated rows)[1]	
1 row	70%
2-4 rows	30%
5-10 rows	15%
Other mitigation measures	
Downwind windbreak / hedgerow / riparian / forest / woodlots/shrubland	50% for basic windbreak/hedgerow 75% for advanced windbreak/hedgerow 100% for riparian/forests/woodlots/shrubland ≥60ft width

[1]A spray drift buffer applies to downwind non-target areas. The reduced number of treated rows applies to the upwind part of the treated field.

For aerial, ground and airblast applications, EPA based the spray drift buffer distances (**Table 8**) on assumed swath widths and the number of passes, flight lines, or rows treated. EPA assumes the size and number of pesticide application equipment passes for the airplane/helicopter, tractor and airblast sprayer results in spray drift that deposits on the downwind side of the field/orchard. On a site-specific basis for a broadcast application, if the number of rows treated for an orchard is fewer than EPA's assumptions, there will be less spray drift deposition in the non-target area on the downwind side of the field. For aerial, ground and airblast applications, the applicator could reduce any identified spray drift buffer by the percent shown in **Tables 9-10** depending on the number of passes or treated rows (parallel to the wind direction, perpendicular to the downwind side of the treated field/non-target area). **Figure 5** illustrates such an example. **Tables 9-11** include the percent reductions associated with different numbers of passes/treated rows of the treated field/orchard.

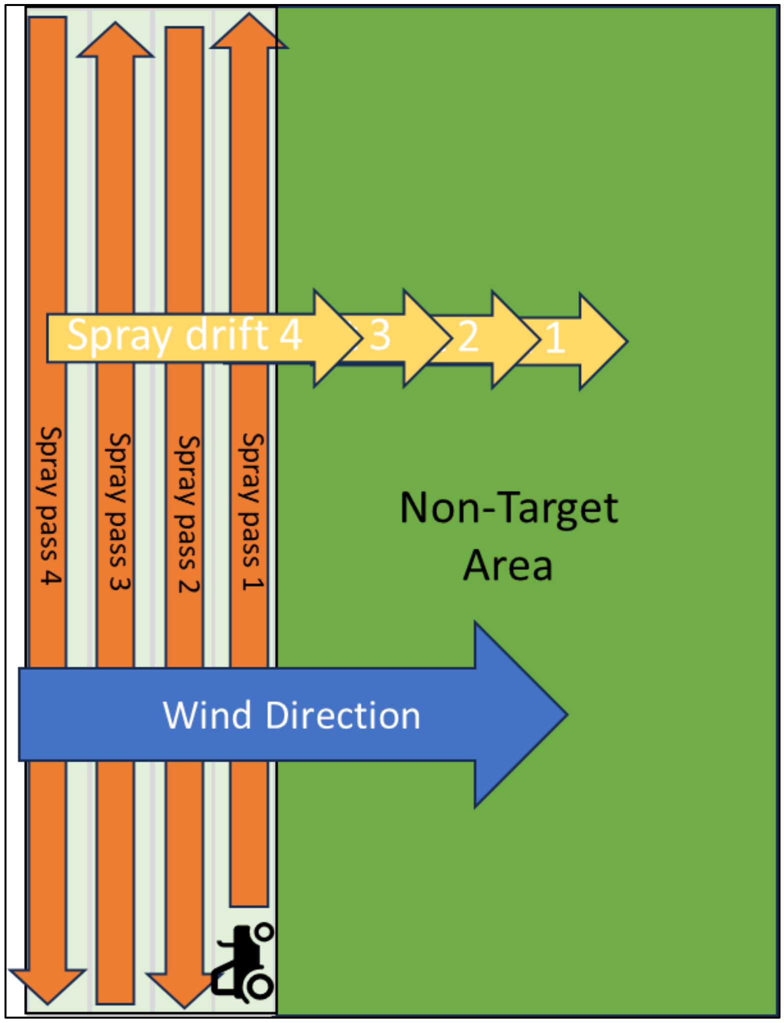

Figure 5. Cumulative spray drift in non-target area from tractor passes on 4 parallel rows on treated area. For example, if this was a ground application and the applicator only made 4 passes of their field, then they could reduce identified spray drift buffer distance by 35%.

To use mitigation measures to reduce the spray drift distance (**Tables 9-11**), the applicator should first consider the application equipment that they plan to use for the application. With this information and the pesticide label, the applicator could identify the appropriate spray drift distance for the pesticide and use (determined by EPA as either lower limit, chemical specific or maximum, **Table 8**). The applicator could then select from any of the appropriate mitigation measures relevant to the application type (either aerial, airblast, or ground). The applicator could add up the corresponding percent reductions for all the mitigation measures selected. This total percent could be applied to the spray drift buffer distance. If the percent is 100% or more, the applicator would not need a buffer as the mitigations put in place already address the potential for population-level impacts. If the percent is above zero and less than 100%, the applicator would need a buffer but the distance would be reduced from that specified on the pesticide product label. For example, if the pesticide product label specifies a 230-foot buffer and there is a downwind windbreak (50% reduction) and the relative humidity is 70% at the time of the application (10% reduction), the distance that was identified on the product label could be reduced by 60% (50%+10%). The remaining spray drift distance would be 90 feet (100%-60% = 40% * 230 ft). If the applicator used a low boom instead of a high boom, an additional 40% reduction in distance could be used and no buffer distance would be identified (50%+10%+40% = 100%).

3.2.1.4 Description of Managed Areas that can be Subtracted from Spray Drift Distances

As described above, EPA relies upon the AgDRIFT® model for ground and aerial spray drift estimations. The models for ground and aerial drift were developed based on several underlying assumptions, including drift depositing onto a bare field, no obstructions to intercept spray droplets that drift off-field, and a prevailing wind direction. In practice, farms may have managed lands in areas adjacent to a pesticide application. While these managed practices may not be intentionally created for the purpose of mitigating pesticides, their composition and size on the landscape could act like a buffer (*e.g.,* roads) or intercept spray drift (which the model does not take into account) and reduce the distance it may travel. Therefore, to the extent that such managed areas are downwind and immediately adjacent to a pesticide application (and they themselves not being treated with the pesticide), EPA has included these areas in what can be considered within the buffer distance. In other words, grower/applicators could subtract managed areas immediately adjacent to treated field from their identified buffer distance. See **Table 12.**

Table 12. Downwind managed areas that can represent spray drift buffers.

When spray drift buffers are identified as mitigations, the following managed areas can be included in the buffer if they are immediately adjacent/contiguous to the treated field in the downwind direction and people are not present in those areas (including inside closed buildings/structures). If the pesticide product label has a requirement that prohibits or restricts spray drift in any of these specific managed areas, that prohibition/restriction must be followed. a. Agricultural fields, including untreated portions of the treated field; b. Roads, paved or gravel surfaces, mowed grassy areas adjacent to field, and areas of bare ground from recent plowing or grading that are contiguous with the treated area; c. Buildings and their perimeters, silos, or other man-made structures with walls and/or roof; d. Areas maintained as a mitigation measure for runoff/erosion or drift control, such as vegetative filter strips (VFS), field borders, hedgerows, Conservation Reserve Program lands (CRP)[1], and other mitigation measures identified by EPA on the mitigation menu; e. Managed wetlands including constructed wetlands on the farm; and f. On-farm contained irrigation water resources that are not connected to adjacent water bodies, including on-farm irrigation canals and ditches, water conveyances, managed irrigation/runoff retention basins, and tailwater collection ponds.

[1] Applicators may need to ensure that pesticide use does not cause degradation of the CRP habitat.

In some cases, areas maintained as a mitigation measure for drift or run-off/erosion control, managed areas, and CRP lands could potentially represent habitat for listed species. There can be significant benefits of these habitats to listed species, with a net gain to the species when considering benefits vs. impacts of pesticides. Not all of these areas represent high quality habitat for listed species (e.g., listed plants are not expected to occur within these areas). In some cases, individuals of a species may be attracted to an area that represents habitat (e.g., insects may be attracted to habitat created for pollinators); however, not enough individuals are expected to be impacted within the portion of the exposed area of the habitat such that there would be an impact on the population that would outweigh the overall benefit provided by creation of the habitat. EPA does not want to disincentivize grower/applicators from providing such habitats, which may have considerable benefits to species, their environment, and pesticide use reductions. Therefore, managed areas that include habitat may be part or all of the spray drift buffer.

Figure 6 and **Figure 7** represent examples of how spray drift buffers can be reduced where a pesticide product label identifies a 50-foot downwind spray drift buffer. The applicator could subtract the 10 foot off-field area downwind where the grower/applicator has CRP land and the 20-foot-wide downwind windbreak, leaving only a 20 foot in-field buffer to meet the identified buffer distance (**Figure 6**). In contrast, if the off-field downwind areas of the CRP land and windbreak totaled 50 feet or more this would equal the identified spray drift buffer distance (as shown in **Figure 7**).

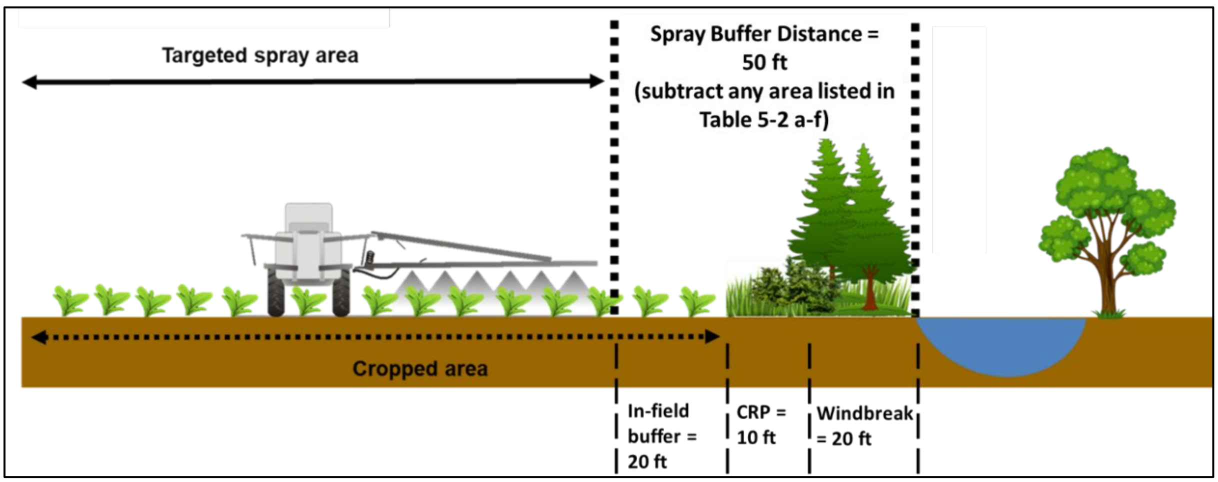

Figure 6. Diagram of the field (cropped area) with a downwind spray drift buffer[27] which includes a portion of the cropped area because the adjacent managed areas are less than the identified spray drift buffer distance.

[27] This figure is based on a diagram from the Pest Management Regulatory Agency of Health Canada (2020), which EPA was permitted to reproduce. The original figure is available at: https://www.canada.ca/en/health-canada/services/consumer-product-safety/pesticides-pest-management/growers-commercial-users/drift-mitigation/protecting-habitats-spray-drift.html. EPA has edited the original figure to provide an example of the areas that can be subtracted from spray drift buffer distances.

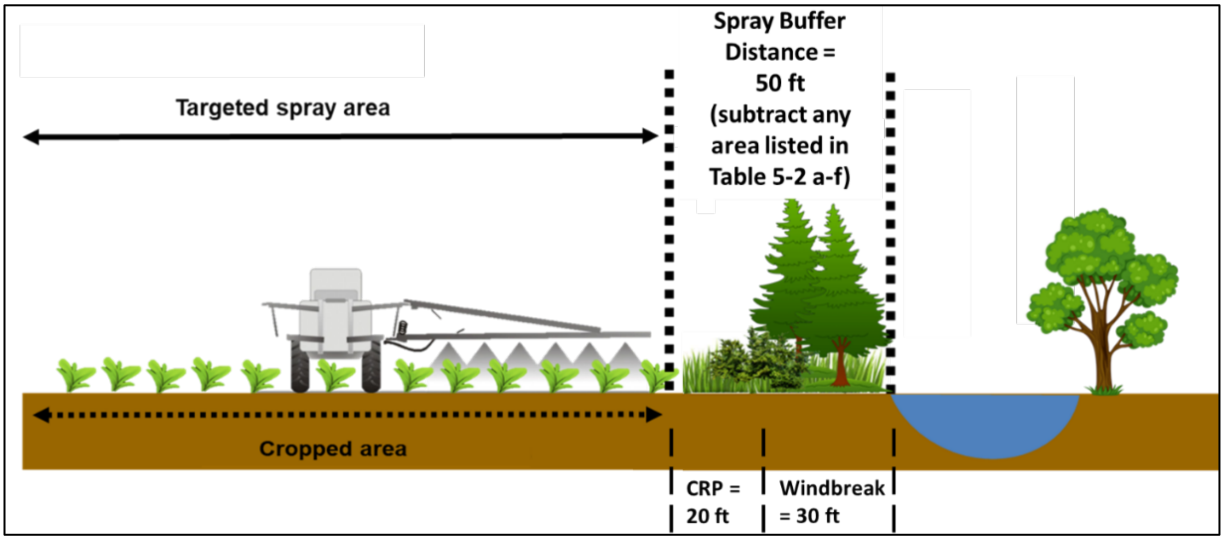

Figure 7. Diagram of the field (cropped area) with no cropped area included in the downwind spray drift buffer because adjacent managed areas are equal to the identified spray drift buffer distance.[27]

3.2.1.5 Spray Drift Exposure Associated with Overhead and Impact Sprinkler Chemigation Systems

Overspray from overhead and impact sprinkler chemigation systems can expose non-target species to insecticides. EPA identified mitigation measures for overhead and impact sprinkler chemigation equipment when it identifies a potential for population-level impacts to listed species. The measures are listed below in **Table 13**. Unlike aerial/ground or airblast applications, it does not include identified spray drift distances (buffers), but rather measures intended to reduce the potential for irrigation overspray into non-target areas. The type and extent of the identified measures depends on the level of the potential for population-level impacts as well as the type of chemigation equipment. The table below and the **Ecological Mitigation Support Document** provides additional discussion and details about the measures identified to mitigate low, medium and high population-level impacts.

Table 13. Mitigation Measures Identified When Making Pesticide Applications via Overhead and Impact Sprinkler Chemigation Systems

Potential for Population- Level Impacts from Step 1	Mitigation Measures	
	Overhead Chemigation[1]	Non-End Gun Impact Sprinklers
Not Likely	None	None
Low	No end gun	Limit throw distance to edge of field (treated area)[2]
Medium	No end gun and one of the following: reduce pressure (<20 psi); reduce release height (<5 ft); have a windbreak[3]	
High	No end gun and two of the following: reduce pressure (<20 psi); reduce release height (<5 ft); have a downwind windbreak[3]	Limit throw distance to edge of field (treated area) AND have downwind windbreak[3]

[1] Refers to center pivot, overhead systems, traveler systems that have sufficient pressure/end guns
[2] This can be accomplished by either reduced pressure and/or reduced throw angle

[3] This can be a windbreak/hedgerow/riparian/forest/shrubland/woodlots. See Mitigation Support Document for additional details.

3.2.2 Runoff/Erosion Mitigation Measures

EPA developed a runoff/erosion mitigation menu that would apply whenever EPA identifies mitigations for non-target species, including listed species. EPA elected to develop a mitigation menu to reduce off-site pesticide exposure via runoff and/or erosion to provide flexibility for grower/applicators to use mitigations that are best for their situation when a pesticide product they want to use includes mitigations. These measures are identified in **Table 15** and described in more detail in the **Ecological Mitigation Support Document** Version 1.0. EPA categorized these runoff/erosion mitigation measures as follows:

- **Application Parameters** that grower/applicators may elect to employ to reduce potential pesticide runoff and erosion (annual application rate reduction, partial field treatment, soil incorporation).
- **Field Characteristics** that are likely to indicate the field will have less runoff and erosion than other fields and thus need fewer mitigation measures to reduce runoff/erosion transport (*e.g.,* fields with a low slope likely have less runoff/erosion, permeable sandy soils have less runoff than high clay content soils).
- **In-field Mitigation Measures** that applicators may elect to employ to reduce potential pesticide runoff and erosion are those that involve the management of the field. (*e.g.,* management of irrigation water, cover crops, or reduced tillage).
- **Adjacent to the Field Mitigation Measures** are those that occur next to the field and down-gradient from where the pesticide application occurs and between the treated field and species' habitat (*e.g.,* grassed waterway, VFS). Some measures may occur on the field and also adjacent to the field, so they are included in both categories (*e.g.,* VFS).
- **Systems that Capture Runoff and Discharge** are those that capture, collect, and discharge runoff through discrete conveyances (*e.g.,* water retention systems such as ponds and sediment basins).
- **Other Mitigation Measures** are those that may be considered but that do not fit into the categories above.

Additional considerations associated with the extent of mitigation associated with any particular field/area includes:

- **Pesticide Runoff Vulnerability**: an analysis of pesticide runoff vulnerability across the lower 48 states that may influence the amount of runoff/erosion mitigation for a particular site.
- **Areas 1000 feet Down-Gradient from Application Areas**: areas where there is not a potential for population level impacts from off-site exposure to runoff/erosion from pesticide applications.
- **Conservation Program and Runoff/Erosion Specialists/Mitigation Tracking:** recognition that growers/applicators that work with a runoff/erosion specialist or participate in a conservation program would likely achieve higher than average mitigation measure efficacy and benefits of mitigation tracking.

As described in **Section 3.2.2.5**, EPA has identified several mitigation measures that when employed on a field by themselves, would result in runoff/erosion exposures that would not likely have a potential for population-level impacts. If the mitigation measures are employed, then no further runoff/erosion mitigations would be needed:

- Systems with Permanent Berms
- Tailwater Return Systems
- Subsurface Tile-drains, *with* Controlled Drainage Structures

In addition, EPA's evaluation indicated the run-off/erosion exposure from several insecticide application methods would be limited and thus the potential for population-level impacts is unlikely. These application methods include the following:

- tree injection;
- chemigation methods, including: subsurface and under non-permeable plastic surfaces;
- soil injection: and
- less than 1/10 acre (<4356 square feet) treated and spot treatment (<1000 sq ft treated) (e.g. when applied with backpack or hand held sprayers;

As detailed in the **Ecological Mitigation Support Document,** for each of the measures included in the run-off/erosion mitigation menu, EPA evaluated their effectiveness at reducing offsite transport via runoff/erosion (high, medium, or low). In general, a mitigation with a low, medium, or high efficacy achieves an average of 10-30%, 30-60%, and greater than or equal to 60% reduction, respectively. EPA's evaluation of the efficacy for each mitigation measure is ultimately based on EPAs best professional judgment of the mitigation's potential to be effective at reducing offsite transport of pesticides.

In order to include as many options as feasible across dozens of measures with varying degrees of efficacy, EPA is planning to utilize a point system for runoff/erosion mitigations to: (1) associate the number of points with each MoD category for runoff/erosion; and (2) assign lower or higher point values to mitigation practices that are less or more effective, respectively, in reducing runoff/erosion. EPA assigned efficacy points to each of the measures on the runoff/erosion mitigation menu based on the efficacy of reducing exposure of the mitigation measure. High efficacy mitigation measures are worth 3 points, medium efficacy measures are worth 2 points, and low efficacy measures are worth 1 point (**Table 15**).

3.2.2.1 Level of Mitigation Identified for Runoff/Erosion

Where EPA determines a potential for population-level impacts associated with runoff/erosion to be low, medium, or high, EPA would identify the level of mitigation needed to reduce exposures so that population level impacts are no longer likely. EPA determines this first based upon the MoDs associated with the use of the pesticide being evaluated, which are related to the potential for population-level impacts. Mitigation measures (or combination of mitigation measures) that achieve three points are functionally equivalent to approximately an order of magnitude reduction in off-field exposure concentrations of pesticides transported via runoff. For erosion-prone chemicals and those bound to sediment, EPA adjusts the points to achieve an order of magnitude reduction. For erosion, 2 points are generally equivalent to an order of magnitude reduction given the lower mobility of soil particles relative to water and increased effectiveness of mitigation practices in reducing soil in runoff. This order of magnitude reduction is equivalent to the reduction needed to drop from one category of potential for population-level impacts to a lower category (*e.g.,* from high to medium). **Table 14** presents the number of points EPA has identified to address potential for population-level impacts of runoff/erosion to aquatic habitats used by invertebrates (*e.g.,* mussels, insects).

Table 14. Number of Mitigation Points Identified to Reduce Exposure via Runoff and Erosion.

Potential for Population Level Impacts	Magnitude of Reduction in Exposure Needed to Result in a Not Likely Potential for Population-Level Impacts Conclusion	Mitigation Points Identified	
		Runoff-Prone [K_{OC} <1000 or K_d <50][1]	Erosion-Prone [K_{oc} $\geq$1000 or K_d $\geq$50][1]
Not Likely	None	None	
Low	10x	3	2
Medium	100x	6	4
High	1000x	9	6

[1] The soil-water distribution coefficient (K_d) and organic-carbon normalized soil-water distribution coefficient (K_{OC}) are measures of the propensity of a chemical to be dissolved in water or sorbed to soil or sediment. K_{OC} and K_d values are measured in studies conducted under OPPTS Guideline 835.1230 (USEPA, 2008). The average K_{OC} or K_d is used to distinguish between runoff-prone and erosion-prone pesticides.

While a multitude of factors determine the fate and transport of a pesticide in the environment, one fundamental physio-chemical property is the sorption coefficient, otherwise known as the Koc[28]. This property describes whether a chemical tends to adsorb to soil particles or remain in water (USEPA, 2008). Chemicals with a higher Koc tend to adsorb to soil and are more likely to be transported by soil erosion, while chemicals with lower Koc tend to partition to water and are more likely to be present in runoff. Several of the runoff/erosion mitigation measures listed in the **Ecological Mitigation Support Document** function by removing soil, and therefore soil-sorbed pesticides, from runoff. This difference between chemicals results in runoff and erosion mitigations being inherently more effective for erosion-prone pesticides. Examples of this phenomena can be seen in the literature for various mitigation measures, including vegetative filter strips, sedimentation basins, and cover crops/mulching. Across these three examples, sediment prone pesticides were found to be 20-30% more efficacious than runoff prone pesticides (**Ecological Mitigation Support Document**). EPA used this difference as the basis for the reducing the number of mitigation points erosion-prone pesticides.

[28] The organic-carbon normalized soil-water distribution coefficient (K_{OC}) is a measure the propensity of a pesticide to be dissolved in water or sorbed to soil or sediment. For some pesticides, sorption is described using the soil-water distribution coefficient (K_d) without organic-carbon normalization. K_{OC} and K_d values are measured in studies conducted under OPPTS Guideline 835.1230 (USEPA, 2008).

3.2.2.2 Runoff and Erosion Mitigation Measures Menu

EPA developed a runoff/erosion mitigation menu that would apply whenever EPA identifies mitigations for non-target species, including listed species. EPA assigned efficacy points to each of the measures on the runoff/erosion mitigation menu based on the efficacy of reducing exposure of the mitigation measure. The menu assigns points to each of the mitigation briefly, as of July 2024, the mitigation measures included on the menu and associated point values are presented in **Table 15**.

Menu measures that have been identified as of July 2024 are described in the **Ecological Mitigation Support Document** Version 1.0, and the mitigation list and point system outlined in that document are expected to be incorporated into the mitigation menu website later in 2024.

On the mitigation menu, EPA has included all runoff/erosion mitigations for which efficacy data is available in an effort to provide options and flexibility in the mitigation measures for the grower/applicator.[29] EPA welcomes efficacy data on additional measures that grower/applicators may be using that are not included here. EPA acknowledges that the mitigation menu will continue to evolve over time and EPA will continue to update the mitigation menu as new information becomes available.

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[29] The draft Insecticide Strategy would allow grower/applicators to get credit for measures they already employ if the measures are known to be efficacious for reducing runoff/erosion. If a grower/applicator is already implementing a mitigation measure on the menu, they would be able to implement fewer additional measures on their field to achieve the identified by the draft Insecticide Strategy.

Table 15. Runoff/Erosion Mitigation Measures and Associated Point-Values for Reducing Exposures. [30]

Mitigation Measure Title[1]	Conditions that Qualify[1,2]	Efficacy Classification	Points
Application Parameters			
Reduction in Pesticide Application Rate	Any application 10% to <30% less than the maximum labeled annual application rate	Low	1
	Any application 30% to <60% less than the maximum labeled annual application rate	Medium	2
	Any application ≥60% less than the maximum labeled annual application rate	High	3
Reduction in Proportion of Field Treated[31]	10 to <30% of Field Area treated (Banded application, partial treatment, precision sprayers)	Low	2
	30 to <60% of Field Area treated (Banded application, partial treatment, precision sprayers)	Medium	3
	≥60% of Field Area treated (Banded application, partial treatment, precision sprayers)	High	4
Soil incorporation	Watering-in or mechanical incorporation before runoff producing rain event	Low	1
Field Characteristics[3]			
Field with slope ≤ 3%	Naturally low slope or flat fields; flat laser leveled fields	Medium	2
Predominantly Sandy Soils[4]	Not applicable	Medium	2
In-Field Mitigation Measures[3]			
Conservation Tillage	Reduced tillage, mulch tillage, ridge tillage	Medium	2
	No-till	High	3
Reservoir Tillage	Reservoir tillage, furrow diking, basin tillage	High	3
Contour Farming	Contour farming, contour tillage, contour orchard and perennial crops	Medium	2
In-field Vegetative Strips	Inter-row vegetated strips, strip cropping, alley cropping, prairie strips, contour buffer strips, contour strip cropping, prairie strip, alley cropping, vegetative barrier (occuring in a contoured field)	Medium	2
Terrace Farming	Terrace farming, terracing, field terracing	Medium	2
	Cover crop, double cropping, relay cropping	Low (Tillage used)	1

[30] Current as of Draft Insecticide Strategy Publication Date. The actual menu should be consulted from the website: https://www.epa.gov/pesticides/mitigation-menu.

[31] See the **Ecological Mitigation Support Document** for an explanation of the points for this mitigation measure.

Mitigation Measure Title[1]	**Conditions that Qualify[1,2]**	**Efficacy Classification**	**Points**
Cover Crop/Continuous Ground Cover		Medium (No tillage, short term)	2
		High (No tillage, long term)	3
Irrigation Water Management	Use of soil moisture sensors/evapotranspiration meters with center pivots & sprinklers; above ground drip tape, drip emitters; micro-sprinklers	Medium	2
	Below tarp irrigation, below ground drip tape; dry farming, non-irrigated lands	High	3
Mulching with Natural and Artificial Materials	Mulching with artificial materials	Low	1
	Mulching with natural materials	High	3
Erosion Barriers	Wattles, Silt Fences	Medium	2
Adjacent to Field Mitigations[5]			
Grassed Waterway	Grassed waterway	Medium	2
Vegetative Filter Strips (VFS) – Adjacent to the Field	Vegetative barrier, field border 20 to <30 ft	Low	1
	Vegetative barrier, field border 30 to <60 ft	Medium	2
	Vegetative barrier, field border >60 ft	High	3
Vegetated Ditch	Vegetated ditch	Low	1
Riparian Area	Riparian forest buffer, riparian herbaceous cover 20 to <30 ft	Low	1
	Riparian forest buffer, riparian herbaceous cover 30 to <60 ft	Medium	2
	Riparian forest buffer, riparian herbaceous cover ≥60 ft	High	3
Wetland and Riparian Habitat Improvement	Constructed wetlands, Wetland and Riparian Landscape/Habitat Improvement	Medium	2
Landscape/Habitat Improvement	Terrestrial landscape/habitat improvement 20 to <30 ft	Low	1
	Terrestrial landscape/ habitat improvement 30 to <60 ft	Medium	2
	Terrestrial landscape/ habitat improvement ≥60 ft	High	3
Filtering Devices with Activated Carbon or Compost Amendments	Filters, sleeves, socks, or filtration units containing activated carbon	High	3
	Filters, sleeves, socks containing compost	Low	1
Systems that Capture Runoff and have Controlled Discharges			
Water Retention Systems	Retention pond, sediment basins, catch basins, sediment traps	Medium	2

Mitigation Measure Title[1]	Conditions that Qualify[1,2]	Efficacy Classification	Points
Subsurface Drainages and Tile Drainage Installed *without* Controlled Drainage Structure	Subsurface tile drains, tile drains	Low	1
Other Mitigation Measures			
Mitigation measures from multiple categories (*i.e.*, in-field, adjacent to the field, or water retention systems) are utilized.[6]	See measures in categories above.	Low	1

[1] EPA's mitigation menu and measure descriptions specific to pesticides are available in the following websites: https://www.epa.gov/pesticides/mitigation-menu and https://www.epa.gov/pesticides/menu-measure-descriptions. If the state has a more restrictive requirement, that may be followed instead. Not all measures are applicable to all fields and crops.

[2] Only one of the measures that qualify from a 'mitigation menu item' can be used. For example, a user could get mitigation points for cover cropping or double cropping but not both.

[3] Multiple field characteristics may apply to an individual field.

[4] Soil texture is as defined by USDA's soil classification system. See USDA's Web Soil Survey tool to determine soil texture: https://websoilsurvey.nrcs.usda.gov/app/.

[5] Adjacent to the field mitigations should be located downgradient from a treated field to effectively reduce pesticide exposure in runoff and erosion.

[6] For example, if a cover cropping and adjacent to the field VFS are both utilized, the efficacy of the mitigation measures in combination may be increased.

3.2.2.3 Mitigation Relief based on Pesticide Runoff Vulnerability

The amount of runoff and erosion transport differs across the contiguous U.S., especially due to differences in frequency and amount of rainfall. EPA evaluated the scientific literature and developed analyses to differentiate geographical areas by rainfall and reduced the amount of runoff/erosion mitigation identified in those areas. As described in more detail in the **Ecological Mitigation Support Document**, EPA evaluated the relative vulnerability of areas across the lower 48 states to pesticide runoff using PWC. EPA used a generic runoff-prone chemical with approximately three million scenarios across the lower 48 states to rank runoff vulnerability relative to the modeled maximum scenario. The scale of this modeling simulation was conducted at a much finer resolution than that of EPA's standard aquatic modeling for regulatory actions (*i.e.,* 2-digit HUC resolution).

The evaluation of this information resulted in a determination that pesticide runoff vulnerability can be defined at a county level with four categories (very low, low, medium and high) representing spatially where exposures of pesticides in runoff may be representative of EPA's upper bound estimates (*e.g.,* high pesticide runoff vulnerability counties) compared to areas where concentrations in pesticide runoff are likely being overestimated (*e.g.,* counties with very low pesticide runoff vulnerability). The relative level of pesticide runoff vulnerability that EPA expects for each of these categories is summarized in **Table 16**.

Counties classified as highly vulnerable to pesticides occurring in runoff would reflect those that have the potential for population-level impacts. EPA chose the county level scale to communicate runoff vulnerability to balance ease of communication, data resolution, and environmental variability. For medium, low, and very low vulnerability areas, EPA's evaluation shows the potential for population-level impacts may be increasingly overestimated. To account for this overestimation, EPA will provide mitigation relief in the form of points. EPA assigned relief[32] points to all counties with medium (2 points), low (3 points), or very low (6 points) pesticide runoff vulnerability (**Figure 8**). This county-level relief reduces the amount of additional mitigation that would be identified in areas that do not have high pesticide runoff vulnerability. This approach represents a spatially refined analysis (compared to EPA's national-level screening assessments) where EPA can consider differences in exposure across the country and the amount of relief points align with the magnitude of difference methodology described in Step 2. Just as in Step 2, each order of magnitude reduction is equivalent to 3 relief points, so EPA assigned areas with very low pesticide runoff vulnerability 6 relief points (approximately to 2 orders of magnitude reduction), 3 relief points to areas with low pesticide runoff vulnerability (approximately 1 order of magnitude reduction), and 2 relief points to areas with medium pesticide runoff vulnerability (approximately ½ order of magnitude reduction).

EPA estimates that these relief points may reduce the additional runoff mitigation burden (level of mitigation points identified) for approximately 80% of cultivated agriculture acres and 95% of specialty and minor crop production acres. Relief points can be used when mitigations are applied across the full

[32] EPA defines relief as a level of reduction for required points of a given pesticide and is based on a field's geographic location.

spatial extent of a use pattern (*e.g.*, specific crops) on the general pesticide product label or in PULAs that fall within counties where relief points are available.

Table 16. Categories of magnitude of difference from nationwide maximum pesticide runoff vulnerability score with corresponding associated percentiles and classifications.

Order of Magnitude Lower than Max	Pesticide Runoff Vulnerability	
	Percentile	Classification
~2	0 – 9%	Verv low
~1	10 – 49%	Low
Half	50 – 84%	Medium
Maximum	85 – 100%	High

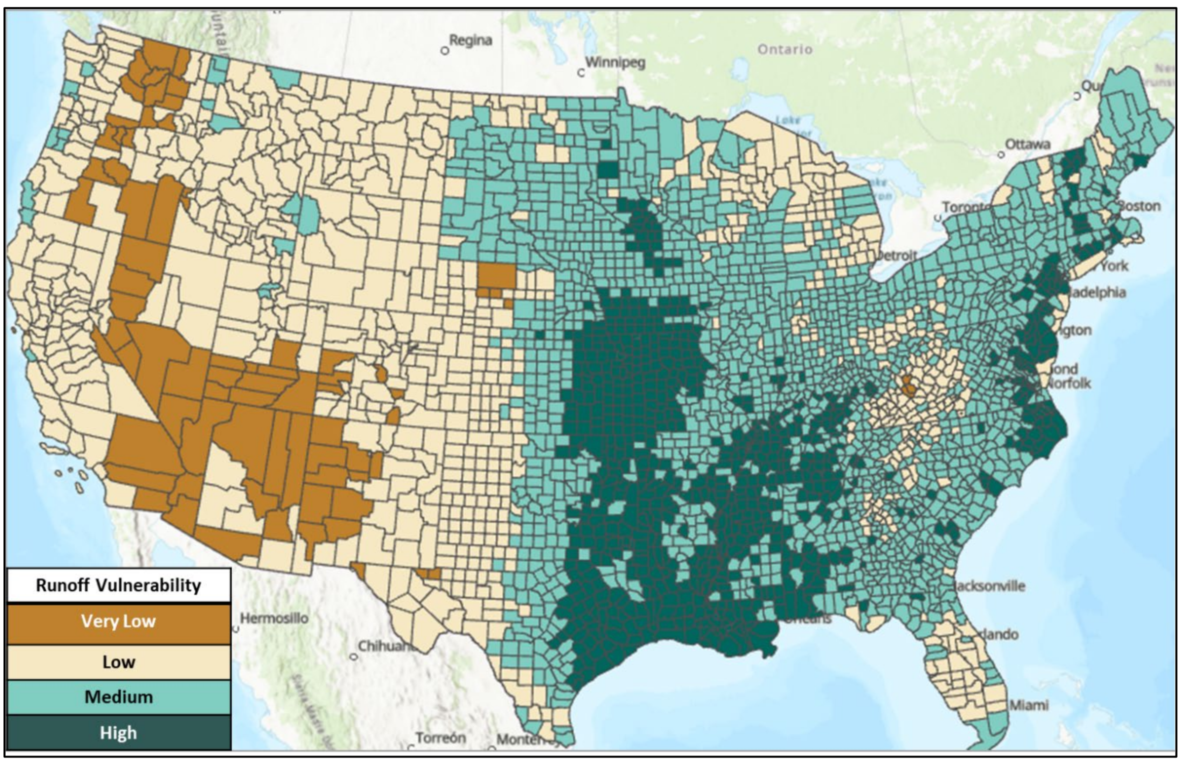

Figure 8. Pesticide runoff vulnerability at the county level.

3.2.2.4 *Run-Off/Erosion* Mitigation Relief for Areas 1000 feet Down-Gradient from Application Areas

Pesticide exposure to non-target organisms and their habitat via runoff/erosion is highest the closer the non-target species are to the pesticide application area. Runoff and erosion are directional, meaning off-site transport occurs when an adjacent area is at a lower elevation than a pesticide application area. As described in the **Ecological Mitigation Support Document**, based on an analysis of overland flow and sheet flow and the distance to various watersheds and waterbodies, EPA concluded that pesticide concentrations in runoff that has the potential to rise to population-level impacts can extend up to 1,000 feet downslope from a pesticide application. Accordingly, areas beyond 1,000 feet are likely to receive less runoff and erosion from the treated field, if at all, making the potential for population-level impacts unlikely. EPA does not expect to identify runoff/erosion mitigations for pesticide applications areas more than 1,000 feet downwind from a terrestrial or aquatic habitat for listed species. EPA has received comments from a wide variety of stakeholders that EPA should not rely on habitat descriptions to determine if an application is within 1,000 feet of such habitats because stakeholders could not readily identify them based on those descriptions. When EPA develops PULAs for geographically specific run-off/erosion mitigations, it ensures the geographic extent of the mitigations does not extend beyond 1,000 feet from those areas it identifies for conservation of a listed species and its critical habitat (See **Section 3.3.3** for additional information on PULA development). However, in Step 3 of the Insecticide Strategy framework and as described in **Section 3.3.1**, in some cases, EPA expects to identify mitigations for listed species that would apply across the full spatial extent of a use pattern (*e.g*., specific crops) within the contiguous U.S., specifying the mitigations on the general pesticide product label. In this case, EPA similarly does not want growers/applicators to implement mitigations unless they are within 1,000 feet of habitat or a waterbody. To account for this and in light of the stakeholder comments, rather than describe habitats, EPA is relying on managed lands as described in **Section 3.2.1.4** above for spray drift. Many farms have highly managed lands in areas adjacent to a pesticide application and EPA does not expect these managed lands to contain sufficiently suitable species habitat that enough individuals would be exposed to rise to a potential population-level impact. This similarly extends to mitigation measure for drift or run-off/erosion or drift control, and CRP lands. Therefore, to the extent that managed areas represent the entirety of 1,000 feet downslope and immediately adjacent to a pesticide application (and they themselves not being treated with the pesticide), EPA concludes that growers/applicators would not need to implement run-off/erosion mitigations. **Table 17** describes the managed areas that EPA has identified for purposes of run-off/erosion mitigation.

Table 17. Downslope managed areas within 1000 feet downslope of treated area where runoff/erosion mitigations would not be needed.

a. Agricultural fields, including untreated portions of the treated field;
b. Roads, paved or gravel surfaces, mowed grassy areas adjacent to field, and areas of bare ground from recent plowing or grading that are contiguous with the treated area;
c. Areas occupied by a building and its perimeter, silo, or other man-made structure with walls and/or roof;
d. Areas maintained as a mitigation measure for runoff/erosion or drift control, such as vegetative filter strips (VFS), field borders, hedgerows, Conservation Reserve Program lands (CRP)[1], and other mitigation measures identified by EPA on the mitigation menu;
e. Managed wetlands including constructed wetlands on the farm; and
f. On-farm contained irrigation water resources that are not connected to adjacent water bodies, including on-farm irrigation canals and ditches, water conveyances, managed irrigation/runoff retention basins, and tailwater collection ponds.

[1] Grower/applicators may need to ensure that pesticide use does not cause degradation of the CRP habitat.

3.2.2.5 Mitigation Measures That In and Of Themselves Reduce Exposure Such That Potential Population-level Impacts Are Unlikely.

In some instances, EPA may determine that grower/applicators would not need additional runoff/erosion mitigation measures because a particular measure in and of itself reduces exposure such that potential population-level impacts are unlikely. Each of these measures is described in more detail in the **Ecological Mitigation Support Document** and summarized below.

Systems with permanent berms are treated fields that are surrounded by an elevated border or perimeter (*i.e.,* berms) at the time of application and carried through the cropping season. Under these conditions rainfall and irrigation water is expected to be kept on the treated field. Example cropping systems include cranberry bogs, rice paddies, and drainage ditch & berm systems.

For treated fields with irrigation tailwater return systems, all runoff water from rainfall or irrigation is collected and stored on site for later use. Thereby, runoff and/or erosion offsite from the field is not expected. Tailwater return systems are frequently paired with furrow and border-strip irrigation systems in both row and field crop agriculture.

If the field has subsurface drainage installed and maintained (*e.g.*, tile drains), runoff from the field will be greatly reduced. In order to maintain protection of non-target taxa, the subsurface tile drains must release the effluent (water) into water-controlled drainage structures or a saturation buffer zone that do not release water into downstream off-farm aquatic areas. Runoff from the entire field would need to be controlled and directed into a pond/saturation zone.

3.2.2.5 Conservation Program, and Runoff/Erosion Specialist, and Mitigation Tracking

EPA's evaluation of available efficacy data for many of the runoff/erosion mitigation measures demonstrates that the efficacy of many mitigations is highly variable from one study to the next (and from site to the next). For example, for some measures, studies show that efficacy may range from 0% to 100%. For any given mitigation measure, a range of efficacy is expected depending on the specific implementation of the measure, the environmental conditions of the area, site and soil characteristics of the treated field, maintenance, upkeep of the mitigation measure, and the physical-chemical properties of the pesticide.

Often, grower/applicators work with a technical expert in runoff/erosion control or a conservation program with a goal of reducing runoff/erosion. Because these experts consider and make recommendations for the site-specific conditions, when a grower/applicator installs a runoff/erosion measure to the specifications from such an expert, EPA has higher confidence that mitigation measures identified and implemented at the field level would achieve the higher end of the available efficacy data. As such, EPA is providing mitigation points for growers/applicators that work with a qualifying technical expert **or** participate in a qualifying conservation program.

A grower/applicator may receive mitigation points working with a technical expert or participating in a conservation program, but not both. The grower/applicator would receive points for any of their fields that are included in the expert consultation or conservation program, which could be an entire farm or a fraction of it (e.g., some fields, but not all within a farm). The grower/applicator would not get additional points for both working with an expert/specialist and for participating in a conservation program, since the expert/specialist is inherently part of the program. Additionally, these points are not applicable to each mitigation measure but rather would be in addition to the points a grower/applicator obtains from other mitigation menu items (*e.g.*, if the farm is located in an area of low run-off vulnerability) and for implementing mitigation measures. Each of these options and the associated mitigation points are described in more detail below.

3.2.2.5.1 Follow Recommendations from a Runoff/Erosion Specialist

Grower/applicators may work with a technical expert to develop mitigation plans that work for their field and that are efficacious in reducing runoff and/or erosion. As described above, when a grower/applicator is working with a technical expert who embodies the characteristics below, EPA expects that the mitigation measures would be selected and implemented considering site-specific conditions, including the soil type, field slope, hydrology, local climate, crop(s) grown, pest concerns, drainage systems, irrigation needs, and equipment availability. Specific cropping systems and regions have established norms and practices based on real-world experience that on-site professionals (*i.e*., technical experts) can account for in the planning process. In this case, EPA expects the efficacy of runoff/erosion mitigation measures would be on the higher end of the range of efficacy. To account for this, EPA is providing one runoff/erosion mitigation point to grower/applicators that work with a runoff/erosion technical expert that meets the characteristics described below. The point for working with the technical expert is in addition to the points for implementing mitigation measures identified in the strategy.

EPA has reviewed available information regarding characteristics that often apply to meet the description of a technical expert. At a minimum, there is usually an education (and a continuing education) and an experience component. Based on this review, EPA identified three benchmarks for technical experts, which include:

- Have technical training, education and/or experience in an agricultural discipline, water or soil conservation, or other relevant discipline that provides training and practice in the area of runoff or erosion mitigation technologies/measures; **And**
- Participate in continued education or training in the area of expertise which should include run off and erosion control; **And**
- Have experience advising on conservation measures designed to develop site specific runoff and erosion plans that include mitigation measures described in EPA's Mitigation Website.[33]

EPA has identified the following examples of technical experts: NRCS and similar state or regional level program staff, Certified Crop Advisor, Pesticide Control Advisor, Certified Professional Agronomist, National Alliance of Independent Crop Consultants (NAICC), EnviroCert International, Inc., Certified

[33] EPA's mitigation menu is available at: https://www.epa.gov/pesticides/mitigation-menu and a description of the mitigations is available at https://www.epa.gov/pesticides/menu-measure-descriptions.

Professionals in Erosion and Sediment Control, Technical Service Providers, and extension agents. **EPA acknowledges that this list is not exhaustive, and the inclusion of an organization should not be construed as an endorsement of any particular group by EPA.**

3.2.2.5.2 Participate in a Conservation Program

Conservation programs provide technical expertise as described above, as well as additional support to grower/applicators. Based on EPA's review of available information on existing programs, this support may include oversight in the form of a review of design, installation, and upkeep/maintenance plan for the identified mitigations. In addition, the programs typically include documentation demonstrating the site-specific plan meets any program requirements.

While conservation programs are not solely designed to reduce offsite transport of pesticides, several of the same types of mitigations that reduce offsite transport of nutrients and/or soil erosion from an agricultural field also reduce offsite transport of pesticides. Evaluating a field for the purpose of reducing nutrients in runoff and/or soil erosion is likely to result in similar recommended mitigations as those included in the runoff mitigation menu.

However, with few exceptions, EPA is not aware of any conservation programs that are designed specifically to reduce offsite transport to an extent where population-level impacts to listed species are unlikely. Therefore, while existing conservation programs may recommend similar mitigation measures, these measures may or may not be enough to address potential impacts to listed species. In addition, data is not readily available on the extent to which grower/applicators that participate in these conservation programs (and participation is voluntary) implement all program recommendations. For these reasons and given the goals of the strategies, EPA is not able to provide a full exemption for these programs at this time. Rather, EPA is providing two runoff/erosion mitigation points to grower/applicators that participate in a conservation program. The additional mitigation point provided for participation in a conservation program over consulting a technical expert is because programs include some additional minimum characteristics summarized below.

EPA has developed the following minimum characteristics for a conservation program:

- The program has to provide advice from individuals who meet the same benchmarks provided above for technical experts; **And**
- The program provides <u>site-specific guidance</u> tailored to the grower/applicator's crop and/or location; **And**
- The program focuses on <u>reducing or managing runoff and/or erosion</u> (including for example, soil loss, soil conservation, water quality protection) from agricultural fields or other pesticide use sites; **And**
- The program provides <u>documentation</u> of program enrollment. EPA is **<u>not</u>** suggesting that this documentation be provided to EPA; **And**

- The program includes verification of implementation of the recommended measures or activities (measures were established and maintained). Verification can be done through the conservation program and provided to the program enrollee. Verification is **not** required to be submitted to EPA.

Note: Past participation in programs that meet the minimum characteristics also allows users to claim these mitigation points, provided that measures are currently on the field, have been maintained over time, and are recertified by a runoff and erosion technical expert [federal, state, or local; *e.g.*, Certified Crop Advisor, Pesticide Control Advisor, Conservation Crop Protector, Certified Professional Agronomist, National Alliance of Independent Crop Consultants (NAICC), agronomists that are part of grower cooperatives].

3.2.2.5.3 Mitigation Tracking

All of the mitigation measures identified in in this support document (and any associated strategy) have been determined by EPA to provide some level of reduction of the potential for population-level impacts to listed species from pesticide exposure in runoff/erosion. Keeping track of the mitigations a grower/applicator employs at the field and farm level could provide several benefits to the grower/applicator. Tracking of the employed mitigation measures could help a grower/applicator ensure that they are achieving the number of points to satisfy any labeling requirements that include mitigations to address population-level impacts. Additionally, tracking the mitigations employed could assist with future planning of farm needs, and is generally aligned with the concepts of agricultural best management practices (commonly known as BMPs). Where a grower/applicator has a well thought out plan for the growing season which includes the tracking of mitigation measures employed EPA would have increased confidence that measures have been implemented and properly accounted for. Therefore, EPA is assigning one available point for any grower/applicator who tracks their mitigations in addition to any points for working with a specialist or participating in a conservation program. Working with a runoff/erosion specialist and/or participation in a program is not required to be eligible for this point, and therefore this point is available for any grower/applicator that tracks their mitigation measures.

3.2.3 Mitigation Measures and Additional Considerations for Listed Terrestrial Invertebrates from On-Field Exposure

While **Sections 3.2.1** and **3.2.2** describe mitigations to address potential off-field exposures that may result in population level impacts, EPA also considered the extent to which listed terrestrial invertebrate species are likely to be on the field at the time of an agricultural use insecticide application such that exposures might lead to potential population-level impacts. To evaluate on-field species that might raise to the level of population-level impacts, EPA first conducted a screen based on the extent of overlap of a species range with USDA's Cultivated Cropland Data Layer (CDL)[34] and incorporated known areas of insecticide usage (based on the Census of Agriculture (CoA) and California Department of Pesticide

[34] https://www.nass.usda.gov/Research_and_Science/Cropland/SARS1a.php

Regulation (CDPR) usage data). If that overlap for a species was less than 5%, EPA did not consider that species to have a potential for population-level impacts which is consistent with recent Biological Evaluations for insecticides including sulfoxaflor and cyantraniliprole (USEPA 2023a; 2023b). For the remaining species, EPA considered: (1) if a species (larvae or adult) is expected to use agricultural fields for habitat or food (*e.g.,* feed on crop leaves or nectar, feed on insects) such that enough of individuals would be exposed and impacted to affect the population; and (2) whether enough individuals would shelter or feed on a treated crop such that there would be a potential for population-level impact. These considerations include an evaluation of readily available species information from FWS, such as habitat, preferred food sources (*e.g.,* larval host plants, nectar sources), life cycle timing relative to insecticide exposures, available information on whether a species is known to use agricultural crops or fields/orchards and Physical Biological Features (PBFs) defined for designated critical habitat.

Based on its review, EPA identified the following nine species of butterflies and beetles that may be exposed such that there may be potential population-level impacts:

- Karner blue butterfly (*Lycaeides melissa samuelis*)
- Mitchell's satyr Butterfly (*Neonympha mitchellii mitchellii*)
- Bartram's hairstreak Butterfly (*Strymon acis bartrami*)
- Fenders blue butterfly (*Icaricia icarioides fender)*
- Kern primrose sphinx moth (*Euproserpinus euterpe*)
- Delta green ground beetle (*Elaphrus viridis*)
- Valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*)
- American burying beetle (*Nicrophorus americanus*)
- Salt Creek Tiger beetle (*Cicindela nevadica lincolniana)*

EPA welcomes comments from stakeholders, particularly any information that could inform the likelihood that these nine species would be on the field during an insecticide application. EPA will consider such information and any additional information provided by FWS to make a determination on the likelihood and the potential for population level impacts for these ten species in the final Strategy. If EPA identifies exposure for any of these nine species and a potential for population-level impacts, the Agency will similarly identify mitigations to reduce exposures on field and the potential for population-level impacts. The types of mitigations that EPA has identified depend on the species. If EPA identifies a potential for population-level impacts for any of the listed terrestrial invertebrates identified above for a particular crop or group of crops, EPA may identify timing restrictions for insecticide applications relative to a crop's blooming period to address potential population-level impacts. EPA has implemented such measures previously for selected insecticides to reduce potential on-field exposure of bees. EPA has so developed mitigation measures to minimize risk of acute risk to bees, some of which include targeting applications to early morning/late evening times when bees are less likely to visit a treated crop (USEPA 2017). For many butterfly species, EPA is less concerned for the larval life stage which tends to feed on specific plant species that would not be on an agricultural field. Adult butterflies typically have limited lifecycles (*e.g.,* present for 2-4 weeks of the year) and EPA may identify insecticide timing restrictions to protect adult butterflies based on the listed species' lifecycle. EPA may also identify time of day restrictions for the terrestrial invertebrates and/or the butterflies depending on when the species in active. Most adult butterflies are active during the day while beetles are active during the night.

3.3 Step 3. Identify Geographic Extent of Mitigation

For the draft Insecticide Strategy, EPA is proposing to apply mitigations, when appropriate, broadly across the full spatial extent of a use pattern (*e.g.,* specific crops) within the contiguous U.S., specifying the mitigations on the general pesticide product label. In other cases, EPA plans to require mitigations in geographically specific areas only (referred to as Pesticide Use Limitation Areas or PULAs). Depending on the insecticide, EPA may use both or one or the other option or a combination of both. As discussed below, EPA is proposing to implement mitigations on the general label when mitigations are identified for listed generalists, and using BLT when additional mitigations are identified for listed invertebrates.

EPA generally prefers that applicants/registrants include mitigations on the general pesticide product label, if practical. This is most appropriate where mitigations broadly apply (*e.g.,* cover large geographic areas) instead of to certain geographic areas.

Where EPA identifies mitigations specific to certain geographic areas, it generally uses Geographic Information System (GIS) mapping information to identify where a pesticide limitation applies to a listed species or group of species. Such areas, along with a description of the use directions applicable to that area for a pesticide, are called pesticide use limitation areas (PULAs). PULAs focus on areas where pesticide exposures are likely to impact the continued existence of a listed species, which may include a reduction in survival or recovery of the species. Thus, the purpose of a PULA is to identify geographic areas where pesticide mitigations apply to conserve a listed species and designated critical habitat. EPA develops PULAs to allow applicators to determine if their intended pesticide application falls within a location where additional use restrictions apply to protect listed species or critical habitat. These geographic-specific restrictions are published Bulletins that are accessed through the BLT website. In other words, where the pesticide product labeling directs an applicator to BLT, the information in BLT

Key Definitions for Step 3 of the Draft Insecticide Strategy Framework

Bulletins Live! Two (BLT): BLT is the web-based application to access Endangered Species Protection Bulletins (Bulletins). EPA uses BLT to communicate where additional pesticide use directions may be needed to protect listed species in geographically specific areas.

Pesticide Use Limitation Areas (PULAs): A PULA is the specific geographic area associated with particular pesticide mitigations for a listed species, groups of listed species, or designated critical habitat. PULAs are used in BLT to provide pesticide applicators with specific locations where use restrictions may apply to their intended pesticide application to protect listed species or their designated critical habitat.

Endangered Species Protection Bulletins: A Bulletin is the printed copy from the BLT application that provides the geographically specific mitigations for the pesticide application. The general pesticide product labeling directs applicators to the BLT system. Bulletins typically include both the PULA and the mitigations that apply within that PULA. For the draft Insecticide Strategy, EPA is proposing to include mitigations for each PULA # on the general pesticide product label and the BLT system will be used to help the applicator identify which PULA # applies to their location. When directed by the label to comply with Bulletins these become enforceable pesticide use limitations to protect listed species or designated critical habitat.

informs the applicator where and what additional restrictions or mitigations must be followed to protect listed species for a particular location. To date, EPA has typically used this system to mitigate for specific pesticide products and individual species. Pesticide product labels direct applicators to BLT and follow any applicable Bulletins. The BLT system allows EPA to reduce complexity on pesticide product labels and limit geographically specific listed species protections to only where they would apply. Bulletins typically include: 1) the geographic extent (PULA) of the area where the same set of mitigations apply, and 2) a description of additional mitigations that apply within the PULA (referred to as "pesticide use limitations"). In this draft strategy, when the mitigation measures apply only to a limited geographic area for an insecticide use, EPA would publish a specific PULA representing the area that would have additional use restrictions in BLT.

EPA has identified approximately 660 listed species that are listed generalists for the Insecticide Strategy (**Figure 1B**). These species range across the majority of the contiguous U.S. (**Figure 9**), therefore, as explained above, when EPA determines a potential for community-level impacts for a listed generalist species (or groups of listed generalist species), EPA plans to implement mitigations for listed generalists broadly across the full spatial extent of a use pattern within the contiguous U.S. In addition, as described in **Section 3.3.2**, EPA identified 73 listed invertebrates (or obligate species) that may have a potential for population-level impacts from direct exposures to off-site transport of spray drift or runoff/erosion. To the extent that EPA identifies additional mitigations to address any identified impacts for these species or to on field species (**Section 3.2.3**), the Agency expects to identify geographically specific mitigations and communicate these areas through PULAs. The following sections describe EPA's current thinking on how the general pesticide product label and PULAs (using BLT) may both be used to identify mitigations associated with this strategy. This geographic framework is relevant to both runoff/erosion mitigation measures and spray drift mitigation measures.

3.3.1 Mitigations Implemented Broadly

When EPA identifies listed species mitigation that would cover an entire use area in the contiguous U.S., such restrictions would likely appear on the general pesticide product label. In general, EPA expects listed species mitigations would apply broadly when there is potential for population-level impacts to entire invertebrate communities (*e.g.,* multiple species with impacts) that would lead to impacts to listed species of generalists (listed species that depend on invertebrates). EPA expects to identify less mitigation for such generalists compared to listed invertebrate species that are directly affected by insecticides or obligate listed species that depend on a single (or very few) invertebrate species. This is because a population-level impact to generalists is expected to occur only when more than just a very few species of invertebrates within a community are impacted whereas a population-level impact to a listed invertebrate or obligate is expected to occur when just a single, or very few, species are impacted. Figure 9 below shows the distribution (based on range data from FWS) within the contiguous U.S. of the 640 listed animal and plant generalists that depend on invertebrates for diet or pollination. This does not mean that EPA has determined that a particular insecticide would have a potential for population-level impacts to these species as that determination is chemical-specific as described in Step 1 of the framework and could result in a determination that the potential for population level impacts for some or all of these species is unlikely. Rather, it means that these 640 listed generalist species represent the maximum number of generalists species where EPA may find a potential for population-level impacts for a particular insecticide and to demonstrate the geographic extend of generalists and why it may be appropriate to include such mitigations on the general product label.

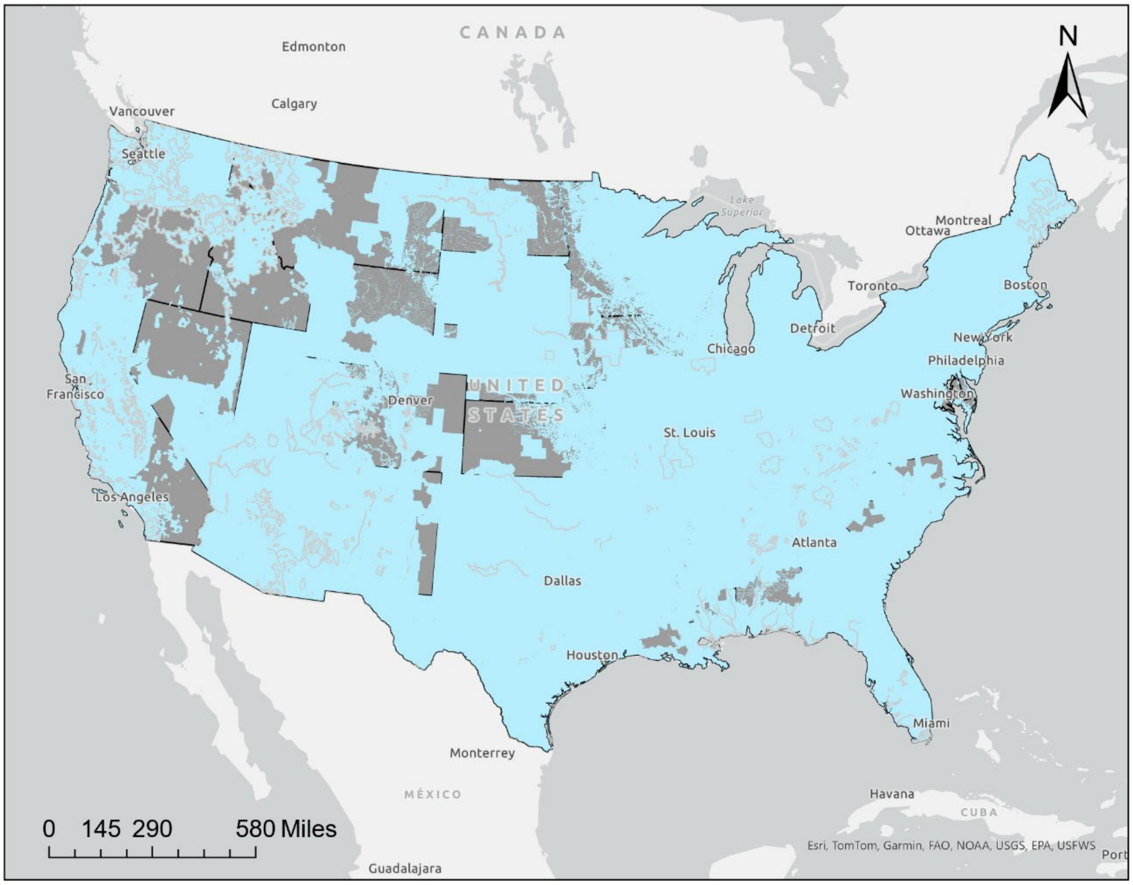

Figure 9. Blue areas represent the distributions within the contiguous U.S. of listed animal and plant generalists that depend on invertebrates for diet or pollination. This map includes the ranges and Critical Habitats of approximately 640 listed species under the jurisdiction of FWS.

3.3.2 Mitigations Implemented in Geographically Limited Areas (identified using BLT)

3.3.2.1 Listed Species Potentially Needing More Restrictive Mitigations than Generalists

There are currently 210 listed (endangered, threatened and proposed) invertebrate species under FWS authority. This includes species of insects (*e.g.,* butterflies, beetles), mussels, snails, crayfish and shrimp. EPA expects that insecticides are likely to cause population-level impacts from direct exposures for some of these species, but not all. This depends on numerous factors including species characteristics, pesticide properties, and use patterns. In this draft strategy, EPA's evaluation of the potential for population-level impacts for these listed species is based on similar analyses that EPA conducted in recent biological evaluations (*e.g.,* Sulfoxaflor Biological Evaluation, USEPA 2023a). To evaluate if a listed species might rise to the level of population-level impacts from agricultural uses of insecticides, EPA first conducted a screening level analysis by considering the degree of overlap of a species range with cultivated land (areas reported by USDA where agriculture is grown). If that overlap for a species was less than 5% after taking into account available usage data from Census of Agriculture and California Department of Pesticide Regulation, EPA did not consider that species to have a potential for population-level impacts. For those species with a 5% or higher overlap, EPA also considered whether there were species-specific factors that would limit exposure such that there would not be a population-level concern.[35,36] EPA similarly applied this approach to listed animals and plants with obligate relationships to invertebrates. EPA identified 73 species of listed invertebrates or obligate species that may have a potential for population-level impacts, meaning EPA would likely identify mitigations to address those impacts (**Table 18**). This does not mean that EPA has determined that a particular chemical would have a potential for population-level impacts to these species. Rather, it means that these 73 listed species represent the maximum number of species where EPA may find a potential for population-level impacts and therefore, identify mitigations. **Figure 10** shows this overlap. The figure shows that the spatial extent of these species is much smaller than the spatial extent of the generalist species, so where EPA finds a potential for population-level impacts for these species, EPA expects to communicate additional mitigations to address these impacts in limited geographic areas only and communicate the locations where mitigations would apply in BLT. In this case, the pesticide product label would direct applicators to the BLT system. **Appendix D** includes more detail on how EPA evaluated the 210 listed invertebrate species and any obligate species to identify the 73 species that could have a potential for population-level impacts. EPA notes that **Figure 10** represents the maximum spatial extent because it is currently developing a process to refine PULAs and EPA expects the result will be that many PULAs will be smaller than the species ranges. See **Section 3.3.3** for more information.

Table 18. Summary of number of species of listed invertebrates where mitigations may involve Bulletins on Bulletins Live! Two. Also included are listed animals and plants that are obligate to invertebrate species for diet and pollination.

Taxon	**Habitat type**	**Number of species**
Listed invertebrate species with direct impacts		
Beetles	Terrestrial	6
Butterflies	Terrestrial	12
Dragonflies	Aquatic and terrestrial	1
Mussels	Aquatic	36
Shrimp and Amphipods	Aquatic	9
Snails	Aquatic	7
Listed species with impacts to invertebrates that are obligate		
Birds (obligate to snail)	Aquatic	1
Plants (obligate to bumble bee)	Terrestrial	1
Total		**73**

[35] EPA used spatial data representing the listed species range and designated critical habitat locations provided by the FWS as of February 16, 2022 (USFWS, 2022b).

[36] This is referred to as "modifiers" because we considered factors relevant to species life history and habitats that could modify the standard exposure assumptions such that exposure would be limited.

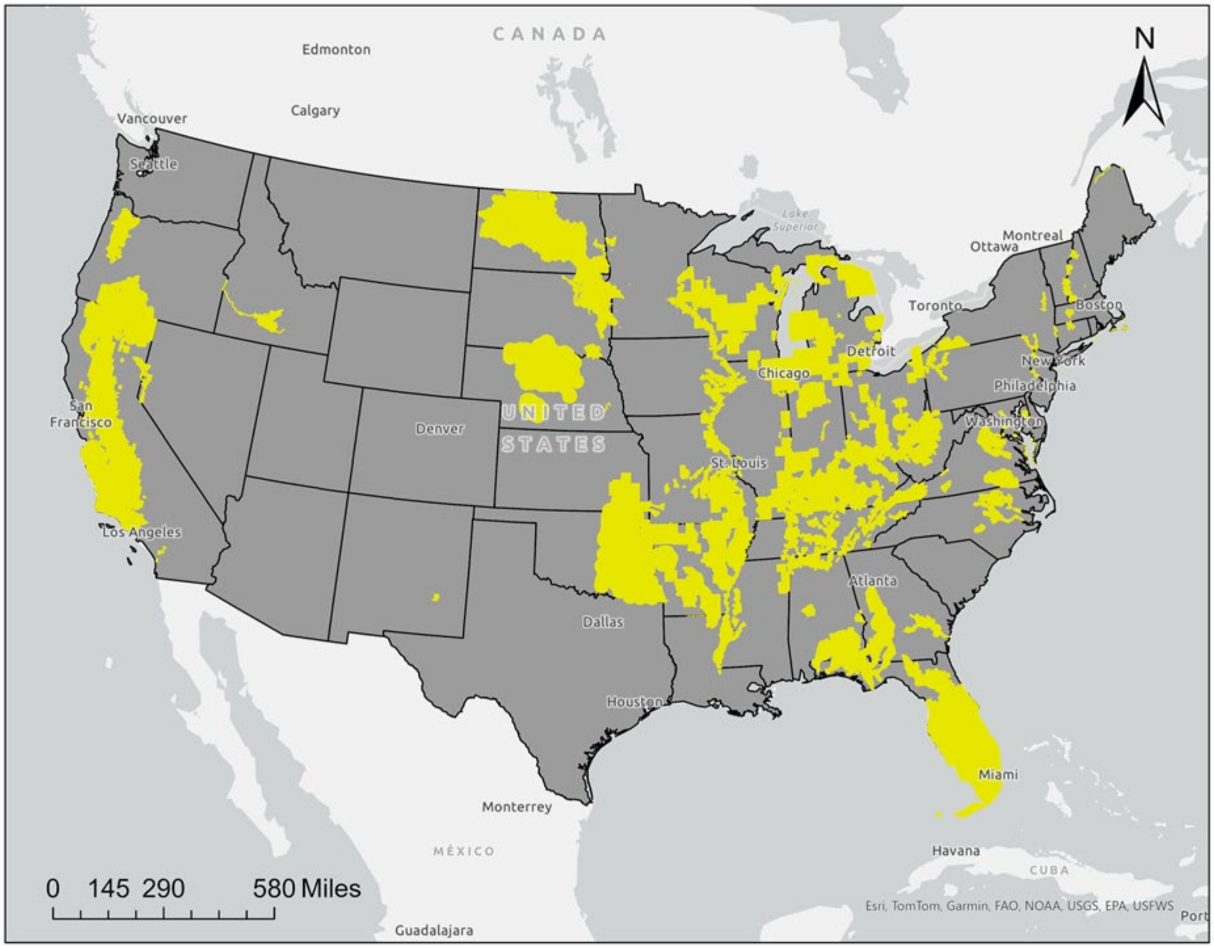

Figure 10. Yellow Areas Represent Geographic Extent of Species Range and Designated Critical Habitats for Listed Species in the Insecticide Strategy that May Be in Bulletins

3.3.2.2 PULAs Representing Groups of Species with Similar Mitigations

Many of the 73 listed species described above will likely share the same level of mitigation for a particular insecticide. This is because they share similar modeled habitats and/or population-level endpoints based on the assessment of sensitivity differences among species groupings. While the mitigations identified may vary across insecticides, EPA anticipates the level of mitigation for a particular pesticide would be the same. Therefore, EPA is planning to group these species into common PULAs. Where multiple species share the same levels of mitigations, EPA is expecting to group the areas important for the conservation of each of those species into one aggregated PULA. EPA's current thinking on how to appropriately group those PULA are described in this section. EPA may develop different PULA groups for spray drift and/or runoff/erosion mitigations. EPA has identified 10 possible groups where listed species would generally have the same mitigations due to similarity of habitat and taxonomy. Specific species that fall into each group are included in Appendix C. Where possible, EPA grouped species that allow for the appropriate level of mitigation when identified including areas where less mitigation may be appropriate as EPA's standard modeling is expected to overestimate population-level impacts due to factors such as spray drift interception or larger waterbodies with greater dilution potential, as described in **Section 3.1.1**. EPA also grouped species when toxicity data may be available to differentiate between sensitivities of different types of invertebrates. These groupings are based on the concepts incorporated in Step 1 where EPA identifies the potential for population-level impacts based on different considerations of exposure, species habitat, taxonomy and characterization of the expected differences in EPA's exposure models and exposures in species habitats.

Spray drift mitigations: For this draft strategy, EPA has identified multiple species of beetles and butterflies and one dragonfly where the same level of spray drift mitigations may be appropriate for some agricultural insecticide uses to address a potential for population-level impacts in habitats off of the treated field. There is also one listed plant species (Furbish lousewort) that is obligate to a bumble bee species, so EPA would likely identify the same level of spray drift mitigations for this species. Spray drift mitigations may also be needed for this bumble bee in some cases due to the potential for population-level impacts on the Furbish lousewort. EPA is currently investigating differences in insect sensitivities at the order level. For most insecticides, honey bee toxicity data are available. In some cases, toxicity data are also available for butterflies and/or beetles. Data are rarely (if ever) available for dragonflies. When toxicity data are available for an insecticide, EPA plans to consider if it can identify different levels of mitigations for bees, butterflies (and moths) and beetles.[37] EPA is proposing planning to group terrestrial species by the following three taxa: butterflies, beetles, and bees to allow for cases where toxicity data are available for an insecticide that shows different sensitivities across these species' groups. In cases where only honey bee toxicity data are available, EPA expects to use the honey bee as a surrogate for all insect orders. In those cases, the mitigations will be the same for insect species regardless of order. **Table 19** summarizes these 3 groups. As EPA begins to apply the Insecticide Strategy to pesticide registration decisions, EPA may determine that different groupings are more appropriate.

[37] For example, the methoxyfenozide case study indicated that lepidoptera are much more sensitive compared to bees and beetles. Therefore, less mitigation may be identified for bees and beetles, compared to butterflies.

Table 19. Summary of 10 potential invertebrate species groups for draft Insecticide Strategy PULAs.

IS Group (PULA) #	Habitat description	Taxon	Toxicity surrogate used to derive buffer	EPA standard habitat used to calculate EECs	MoD Level where there is potential for population-level impacts	Types of mitigations[1]
1	Terrestrial areas near treated fields	Bees and Dragonflies	Bee	Near field	≥1	Spray drift
2		Butterflies	Butterfly	Near field	≥1	
3		Beetles	Beetle	Near field	≥1	
4	Vernal pools	Crustaceans	Crustacean	Edge of field and Wetland	≥1	Spray drift and runoff/erosion
5	Wetlands	Aquatic insect	Aquatic Insect	Wetland	≥1	
6	Small water bodies and Wetlands	Mussels/snails	Mussel	Wetland	≥1	
7	Wetlands and ponds	Crustaceans	Crustacean	Wetland and Pond	≥1	
8	Low flow waters, ponds	Mussels/snails	Mussel	Pond	≥1	
9	Medium/large flowing waters, lakes, reservoirs	Mussels/snails	Mussel	Pond	≥10	
10	Karst systems (caves, pools)[2]	Crustaceans	Crustacean	Pond	≥10	

[1] For this type of mitigations, applicators would use BLT to identify the mitigations needed (in place of the mitigations on the general label).

[2] For the PULA representing species in Karst Systems, EPA is considering specifying that mitigations would only apply to applications within a certain distance of sinkholes. This approach is consistent with FWS's previous mitigations for species in these types of habitats (USFWS 2022).

Spray drift and runoff/erosion mitigations: EPA may have sufficient toxicity data to differentiate impacts to listed aquatic insects, crustaceans, and mollusks. This depends on a chemical by chemical (or chemical class) basis where data is available. These taxa represent different types of listed species that use aquatic habitats. There are many more listed mollusks (there are 43 species of mussels and snails) identified as possibly needing PULAs compared to aquatic-phase insects (one species) and crustaceans (9 species). Also, the everglade snail kite is a listed bird that is obligate to an aquatic snail (a mollusk). When considering the different types of habitats used by listed aquatic invertebrates or obligates and the three taxonomic categories that can be used to distinguish toxicity and impacts, EPA has identified 7 potential groups for aquatic invertebrates where potential spray drift and runoff/erosion mitigations have been identified (**Table 19**).

Over time, EPA expects the list of species to change (as the listing status of species change) or as available information and categories for a species changes (*e.g.,* through consultation, through PULA development). Therefore, EPA expects to revisit the species included in the grouped PULAs and update them as needed. EPA may also change the groupings based on public comments or after it gains experience in implementing ESA strategies. If EPA identifies a need for on field mitigations to address potential for population-level impacts to a subset of species that feed on treated crops, EPA plans to consider adding a PULA group for on-field mitigations. EPA is currently developing a process on how best to communicate the groupings and associated mitigations on pesticide product labels, BLT, and other possible platforms (such as EPA's website).

3.3.3 Plan for Developing PULAs for the Insecticide Strategy

EPA is developing an approach to refine maps that EPA plans to use for PULAs. EPA received comments on the draft Vulnerable Species Pilot and the draft Herbicide Strategy that asked EPA to reconsider the maps that EPA plans to use when identifying geographically specific locations where mitigations may be needed for a given listed species. Commenters stated that using entire species ranges as the basis for a PULA overburdens pesticide applicators unnecessarily because this captures many areas that are not needed to protect listed species at a population level. Commenters requested that EPA refine PULAs that are overly broad, such that they minimize impacts on agriculture. In response, EPA is developing an approach to refine maps to develop PULAs so that they identify those areas where mitigations are needed (and minimize extraneous areas) to conserve a listed species and its critical habitat (if designated). This approach is being developed with input from FWS, USDA and other technical experts. EPA expects that for many species, the refined PULAs would represent parts of the range, not the entire range. Therefore, refining the PULAs would provide more realistic locations and lessen their impact for grower/applicators. This approach focuses on identifying those areas most critical to conserve a listed species and then adding buffers (1000 feet or less) to account for potential offsite transport from a treated field). Most of these species are not expected to occur on agricultural fields, so, EPA would identify mitigations only for those parts of fields located within the extent of the buffered PULA.

Once this approach is developed, PULAs would be created for the species relevant to the insecticide strategy. EPA would then create grouped PULAs by combining the species specific PULAs where the same mitigations have been identified (groups described above, species in each group provided in

Appendix B. EPA expects to apply this approach to its other strategies (*e.g.,* herbicide strategy) and the Vulnerable Species Pilot.

As EPA further works on the Vulnerable Species Pilot, Herbicide Strategy, Insecticide strategy and other strategies, EPA expects hundreds of PULAs would need to be developed. EPA is currently prioritizing PULA development for the Vulnerable Species Pilot and Herbicide Strategy. EPA expects to develop any remaining Insecticide Strategy PULAs afterwards. If needed, EPA may revise the specific species included in the Insecticide strategy or the groupings based on lessons learned from development of the species-specific PULAs. EPA will provide updates on its progress in the development of all PULAs across the different strategies on its website.

3.4 Case Study Results Summary

EPA conducted case studies of nine representative insecticides to help develop the draft insecticide strategy. These nine insecticides were chosen to represent different insecticide modes of action, physical-chemical properties, use sites, levels of agricultural usage, application methods, and toxicity to invertebrate species. Use of these representative insecticides allowed EPA to explore any differences among these pesticides relevant to exposure and effects for identifying when and where different types of mitigations may or may not be needed for individual insecticides.

These insecticide case studies are not intended to support a specific regulatory action for the representative insecticides and do not replace existing mitigations implemented on any of the currently EPA-approved product labeling. Furthermore, the current analyses supporting the case studies do not consider mitigations implemented after the finalization of the most recent ecological risk assessment nor are they comprehensive of all registered uses. The case studies developed to inform the draft strategy and could inform future FIFRA actions on the representative pesticides as well as other related actions.

These case studies also provide illustrative examples to help explain the draft strategy, in particular the proposed three step decision process for identifying the potential for population-level impacts to listed species, which mitigation measures to consider, and where such mitigation measures may be applied. The following summary provides a broad overview of the trends in the level and extent of identified mitigation from these case studies. This information is provided in *Insecticide Strategy Case Study Summary and Process* (referred to as **Case Study Summary and Process Document**). Overall, the case studies show that the level of potential mitigation depends on the direct or indirect nature of the potential for population-level impacts to listed species, their differences in sensitivity to insecticides, variation in species habitat, and the method of insecticide application.

3.4.1 Level of Mitigation Identified for Generalists vs Directly Impacted Listed Species

Based on the nine case study insecticides, the level of mitigation identified for listed generalist species (which would be implemented on the national labels) is generally less than that for direct impacts to listed invertebrates (which would be implemented through geographic-specific PULAs/IS species groups. For example, based on the range of runoff mitigation points identified for listed aquatic invertebrates inhabiting low flow/wetland environments, two of the nine insecticides have no mitigation points identified; four insecticides have four or fewer mitigation points identified, and the remaining two insecticides have 6 or fewer mitigation points identified (**Table C-2 in Appendix C).** In contrast, for listed aquatic crustaceans inhabiting low flow/wetland environments (IS species group 7), one insecticide has no mitigation points identified; one insecticide has three or fewer mitigation points identified, the remaining seven insecticides have a maximum of 4 or more mitigation points identified depending on use (**Table C-4 of Appendix C).** The lower mitigation identified for listed generalists primarily results from the higher (less sensitive) toxicity endpoints used to represent the threshold for indirect (community level) impacts to listed generalists compared to population-level toxicity thresholds used for assessing direct impacts to listed invertebrates (see **Section 3.1** for details). A similar pattern is observed when comparing spray drift buffer distances identified for listed generalists invertebrates (**Table C-8 of Appendix C**) compared to those for direct impacts to listed butterflies near agricultural fields (IS species group 2; **Table C-10 of Appendix C**).

3.4.2 Differences Among Different Listed Species Groups and Habitats

The case studies illustrate that one of the driving factors for the potential for population-level impacts and therefore the level of mitigation identified for listed invertebrates is differences in their sensitivities to insecticides. For seven of the nine case study insecticides, aquatic mollusks (mussels, snails) are much less sensitive than other aquatic listed species groups (crustaceans, insects) meaning the MoDs for the aquatic mollusks are much lower than the MODs for the crustacean/insects. As a result, the level of mitigation EPA identifies for listed mollusks is generally lower compared to other listed insects or crustaceans. Specifically, EPA identifies runoff/erosion mitigation for three of the nine case study insecticides for listed mollusks inhabiting low flow wetland type systems (mostly snails; IS species group 6). For listed crustaceans inhabiting these same systems, EPA identifies runoff/erosion mitigation for eight of nine case study insecticides (IS species group 7) as indicated in **Table C-4 of Appendix C.** In addition, the maximum level of runoff/erosion points per chemical would be lower for listed mollusks (3 to 6 points) compared to crustaceans (mostly 6 points or more) in these systems. With the other two case study insecticides (methoxyfenozide, propargite), EPA does not have sufficient data available to distinguish sensitivity differences among listed aquatic species groups and as a result, potential runoff mitigations for these chemicals are based on all available data for aquatic invertebrates. As described in **Section 3.1.3**, EPA also identifies a lower level of mitigation for species inhabiting moderate to fast flowing streams and rivers as compared to other aquatic habitats.

The case studies also illustrate that EPA's ability to evaluate potential species sensitivity differences depends on the availability of data to do so. For example, for foliar applications of methoxyfenozide, EPA has data that demonstrate that listed butterflies (IS species group 2; **Table C-10 of Appendix C)** have much greater sensitivity than other listed terrestrial invertebrates (bees, beetles, dragonflies; IS species groups 1 and 3; **Table C-9 of Appendix C)**. EPA does not have data for the 8 other case study insecticides to differentiate differences in sensitivity among listed terrestrial invertebrates.

3.4.3 Impact of Application Method on Mitigations

The case studies also illustrate that the application method can also be a driving factor for identifying potential for population-level impacts and the resulting mitigation identified. The application method can lead to different exposure potentials. For example: for imidacloprid, for exposures from runoff/erosion, EPA identifies none or a lower level of mitigation for soil and seed treatment methods compared to mitigation for foliar spray applications (**Table C-7 of Appendix C**). For chlorantraniliprole, EPA identifies a low level of runoff/erosion mitigation (3 points) for foliar spray applications and no mitigation for seed treatment applications. For both of these example insecticides, the differences in runoff exposure are likely due to less pesticide mass in runoff and erosion for most soil/seed treatment applications compared to foliar spray treatments. With spray drift, a greater level of potential mitigation is identified for aerial application methods compared to ground or airblast which is consistent with greater expected spray drift from aerial vs. ground spray applications.

4 Plan for Implementing the Final Insecticide Strategy

The strategy itself is not self-implementing. Rather, EPA plans to consider the applicability of the final strategy to inform conventional new active ingredient registration actions and conventional registration review actions. This section describes EPA's plan for implementing the Final Insecticide Strategy through registration and registration review actions.

As EPA considers applications for new conventional active ingredients and works on conventional registration review actions, the Agency expects to continue its current practice of providing opportunities for public input on proposed decisions, including mitigation that may come from a final strategy. The labeling language EPA proposes in a decision and subsequently may approve and may direct the user to access the BLT website for potentially relevant geographically-specific mitigations through Bulletins. In addition to directing users to the BLT website, when considering the applicability of this strategy to a FIFRA action, EPA may propose mitigation in a decision that could appear on labels depending on whether any identified mitigation to protect a listed species is applicable beyond geographically-specific areas. EPA may also propose in a decision that labeling language is necessary that directs the user to a mitigation menu website where mitigation measures can be found to meet the requirements on the label referring to a necessary level of mitigation. EPA expects to update this website regularly.[38] The current mitigation menu website only reflects ecological mitigation for FIFRA IEM. EPA plans to revise the website to reflect how it could be used with final strategies (*e.g.*, the final Herbicide Strategy expected to be issued by the end of August). EPA also plans to provide educational outreach and support to stakeholders as EPA begins implementing this strategy through FIFRA actions.

EPA also plans to continue its discussions with FWS to streamline ESA consultations. The development of this strategy and the future issuance of final strategies is expected to inform these processes. Finally,

[38] The website is available at https://www.epa.gov/pesticides/mitigation-menu. Currently the website provides information relevant to FIFRA IEM and has not yet incorporated information for any strategies.

this section describes how the Strategy interplays with FIFRA IEMs and other strategies and efforts (*e.g*., the Herbicide Strategy, the Vulnerable Species Pilot, offsets).

4.1 Registration Review and Registration Decisions

For conventional insecticide active ingredients with agricultural uses, EPA expects to begin considering the applicability of the Insecticide Strategy for new active ingredient registration decisions and registration review decisions once the strategy is final. EPA would use this strategy to inform whether mitigations are necessary as part of these FIFRA decisions to reduce insecticide exposures to the listed species covered by this strategy.

The conventional pesticide registration review workload includes hundreds of pesticide active ingredients, which represent thousands of individual products. EPA is regularly updating its registration review schedule, which takes into consideration the expected timing of the issuance of final strategies. However, there may be instances where the timing of insecticide reviews does not coincide with the timing of the final strategy due to other risk mitigation priorities (*e.g.*, human health protection), existing consultation schedules, litigation, and/or Agency resource constraints. Overall, however, the Agency's efforts to align its registration review schedule with the timing of the final strategy should improve efficiency and consistency in the consideration and application of early mitigations for the protection of listed species in EPA's registration review work.

As part of the registration review process, EPA issues a Proposed Interim Registration Review Decision (PID) or Proposed Final Registration Review Decision (PFD) with proposed mitigation measures before issuing an Interim Registration Review Decision (ID) or Final Registration Review Decision (FD). Stakeholders have the opportunity to comment on proposed decisions that would include proposed mitigation measures, including those that will be informed by a final insecticide strategy. After comments received on the PID or PFD are considered, EPA would determine whether any changes are needed to what was proposed before issuing any ID or FD.

As indicated in its April 2022 Workplan, EPA is prioritizing making effects determinations, and consulting as appropriate, for new conventional active ingredient actions. Typically, as part of the process for reviewing a new active ingredient, EPA takes comment on a proposed decision. The proposed decision would include any mitigation determined to be necessary, including measures to protect listed species. EPA would then consider comments received before making the final registration decision.

When levels of mitigation measures for insecticides are identified to address population-level impacts EPA expects that, where applicable, proposed decisions would include information on any necessary mitigations, informed by this strategy. EPA may propose the need for product labeling to include spray drift restrictions on use, such as spray drift buffers based on the application method, as well as runoff/erosion mitigation. As described in **Section 3.3**, in some cases, EPA expects to propose that the mitigations would apply across the full spatial extent of a use pattern (*e.g*., specific crops) within the contiguous U.S., specifying the mitigations on the general pesticide product label. In other cases, EPA plans to propose mitigations in geographically specific areas only.

When EPA identifies the need for runoff/erosion mitigation for a particular conventional insecticide registration or registration review action, the proposed decision would include any necessary product labeling statements related to these mitigations. EPA may propose that the labeling include directions for use that include employing mitigation measures that achieve a number of points. There could be a reference to the mitigation menu website and/or BLT. EPA may also propose that the labeling include specific mitigation measures to be followed. The mitigation points on product labeling would be specific to the approved agricultural uses for that product.

To determine what mitigation measures a pesticide user could choose from (and the points associated with each measure) to meet the total required points on the labeling, EPA expects product labeling to direct the user to access EPA's mitigation menu website for detailed information. The mitigation menu website is also expected to contain options that provide mitigation relief and their corresponding points once strategies are finalized. Currently, the website has a helpful section describing many of the mitigation measures being considered in this strategy.[39] The current version of the mitigation menu website does not have the associated points for each mitigation measure. Therefore, please refer to **Table 15** and **Section 3.2.2.2** in this document for that information.

For example, a product label could include a requirement that three runoff/erosion mitigation points must be achieved prior to an application (*e.g*., corn) across the lower 48 states, but could also direct the user to BLT where a Bulletin requires six points to be achieved prior to applications to fields located in a PULA. This same label could state a different number of points to be achieved for a different crop (*e.g*., soybean).

When a product label directs a user to the mitigation menu website for measures to meet the associated points on the label, the measure would need to be employed consistent with the description on the website. EPA has been working with USDA on the descriptions of the mitigation measures. In the future, EPA will provide information on the Agency's descriptions and the cross-references to relevant NRCS conservation practices., Providing a mitigation measure menu on a website allows EPA to update and expand the menu as the Agency receives more information on the efficacy of additional potential mitigation measures and also to incorporate emerging and future technologies. EPA can therefore provide up-to-date available mitigations and use restrictions in a timely manner, providing for more flexibility for grower/applicators. As a result, grower/applicators would likely have multiple options when deciding what mitigation measures to apply to achieve the total number of points required by a product's labeling. Communication from EPA to applicator, farm manager, and landowners in the agricultural community is essential, as is communication among applicators, farm managers, and landowners on necessary mitigation measures when planning an application.

EPA acknowledges that many pesticide applicators use multiple pesticides on the same field at the same time. In this case, if a pesticide user applies more than one pesticide at the same time to a field, then the user would need to comply with the most restrictive set of mitigations among the pesticides that they plan to apply. This principle applies to listed species mitigation as well as all other use restrictions on the label, as these other use restrictions may be associated with ecological and/or human health risks identified by the agency.

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[39] Available at this pinpoint site https://www.epa.gov/pesticides/mitigation-menu#measures

EPA understands that the spray drift and runoff/erosion mitigation the Agency anticipates proposing in its actions is complicated. While complex, providing a mitigation menu allows for much greater flexibility to grower/applicators to meet the mitigation needs for individual pesticides. To help grower/applicators to consider their options, EPA is also developing a calculator that grower/applicators could use to help them determine what mitigation relief measures apply to them and their associated points, what mitigations they already have in place and their associated points, and what further actions they may need to take to meet the total required points. EPA plans to develop other resources that could further help applicators, farm managers, and landowners work through the label complexity.

4.2 Mitigation Tracking

It is a violation of FIFRA to use a registered pesticide inconsistent with its labeling. This includes failure to comply with any mitigation requirements for the application prior to use of the product.

4.3 Education and Training

EPA acknowledges the critical need for additional education and outreach as this strategy and others are finalized and subsequently implemented in pesticide decisions. This section describes EPA's education and outreach efforts over the past two years and describes EPA's next steps.

Various educational webinars were held in 2022 and 2023 that pertain to early listed species mitigation efforts under FIFRA and help users navigate Bulletins Live! Two. In November 2022, EPA organized a webinar to present the Workplan Update. The webinar covered the FIFRA Interim Ecological Mitigation measures, draft section 3 label language that directs users to the BLT system for implementing geographically specific mitigation measures, and current and future initiatives to prioritize mitigation for listed species. The Workplan Update webinar can be accessed online at: https://www.youtube.com/watch?v=ENMUQdPdvyY.

In July 2023, EPA and USDA OPMP held a webinar to introduce the Draft VSP. The webinar covered the pilot species, the draft mitigation measures, the draft implementation plan, and a StoryMap demonstration (where a vulnerable species range is overlapped with crop data and draft pesticide use limitation areas). The VSP webinar recording can be accessed online at: https://www.youtube.com/watch?v=H8FmuN7AEY4.

In August 2023, another similar webinar was held by EPA and USDA OPMP to introduce the draft Herbicide Strategy. The webinar covered the draft Herbicide Strategy, including draft mitigation measures, implementation plan, example crop scenarios, and topics for public comment. The draft Herbicide Strategy webinar recording can be accessed online at: https://www.youtube.com/watch?v=vmm_oTmxdLU.

In November 2023, EPA organized a webinar to provide an overview of the BLT system. The November 2023 webinar described how Bulletins relate to the general label, explained how to use BLT, demonstrated how to look for geographically specific mitigation, and addressed frequently asked questions. Materials from the November 2023 webinar can be accessed online at: https://www.epa.gov/endangered-species/materials-november-2023-bulletins-live-two-webinar.

In 2023 and 2024, EPA also met with affected stakeholders, including various crop/commodity groups, to understand the grower/applicator perspective and potential land/crop management challenges associated with implementation of the strategy.

In spring 2024, EPA and USDA hosted a workshop on ecological risk mitigation. EPA also hosted stakeholder workshops to discuss PULA refinements and offsets.

On June 18, 2024, EPA held another public webinar to introduce the first version of the mitigation menu website (currently being used for FIFRA IEM) and seek stakeholder feedback.

Additional educational webinars are being considered as other strategies are finalized and as the strategies are implemented in pesticide decisions.

EPA continues to work with external stakeholders, such as the states through the State FIFRA Issues Research and Evaluation Group (SFIREG) and the Association of American Pesticide Control Officials (AAPCO), to discuss the enforcement perspective and potential implementation challenges.

EPA plans to compile existing and develop new communication, training, and education materials. These materials are intended to support awareness of new label requirements resulting from registration review and of the new types of mitigations included in the strategies and efforts. Because pesticide users may have been using these products for several years or decades, awareness of any changes in how these pesticides may be used is key to their ability to comply.

EPA has developed or is planning to create various educational materials, including handouts, presentations, webpages, and informational webinars. EPA also recognizes that the main sources of information for many grower/applicators are the states, crop consultants, extension agents, and pesticide distributors and that it needs to partner with them to improve grower/applicator awareness. EPA believes that providing the appropriate support materials to the professionals that advise pesticide applicators will help improve compliance with label restrictions, including Bulletins, and thus help decrease pesticide exposures to listed species. EPA is planning to create a training webpage that will serve as a repository of education and training materials.

4.4 Consultation with FWS

One of the goals of the Insecticide Strategy is to help increase the efficiency of the pesticide section 7(a)(2) consultation process. EPA is planning to use these strategies and other proposed activities, as outlined in the Workplan (and Update), to develop a conservation plan consistent with Section 7(a)(1) of the ESA that outlines EPA's overall strategy for furthering the recovery of listed species. This will be accomplished, in part, by working with FWS to proactively protect listed species from pesticides, resulting in a streamlined section 7(a)(2) consultation process on specific actions.

EPA expects that its work with the Services will result in a more efficient tiered approach that includes both ESA section 7(a)(1) (proactive conservation for many species and groups of pesticides) and ESA section 7(a)(2) consultations that could include mitigation for specific species that are informed by the strategies. EPA has been working with FWS on broad landscape scale approaches in a section 7(a)(1) plan to reduce pesticide exposure in ways that can benefit the recovery of many species and designated critical habitat within the U.S. Identification and implementation of these approaches earlier in the FIFRA and ESA process could serve as a filter where impacts to many species can be reduced, leaving a limited number of remaining impacts to focus upon in a streamlined section 7(a)(2) consultation. This approach would also be a more effective and efficient use of agency resources to maximize protections of listed species in a timely manner. **Figure 11** depicts how EPA envisions the incorporation of strategies into registration review decisions and how this could help streamline section 7(a)(2) consultations because mitigations could be incorporated into the action prior to initiating or completing any necessary consultation process. Throughout this process, there are multiple opportunities for input from the public during comment periods. This will allow EPA and FWS to consider important feedback from stakeholders on assessments and mitigations.

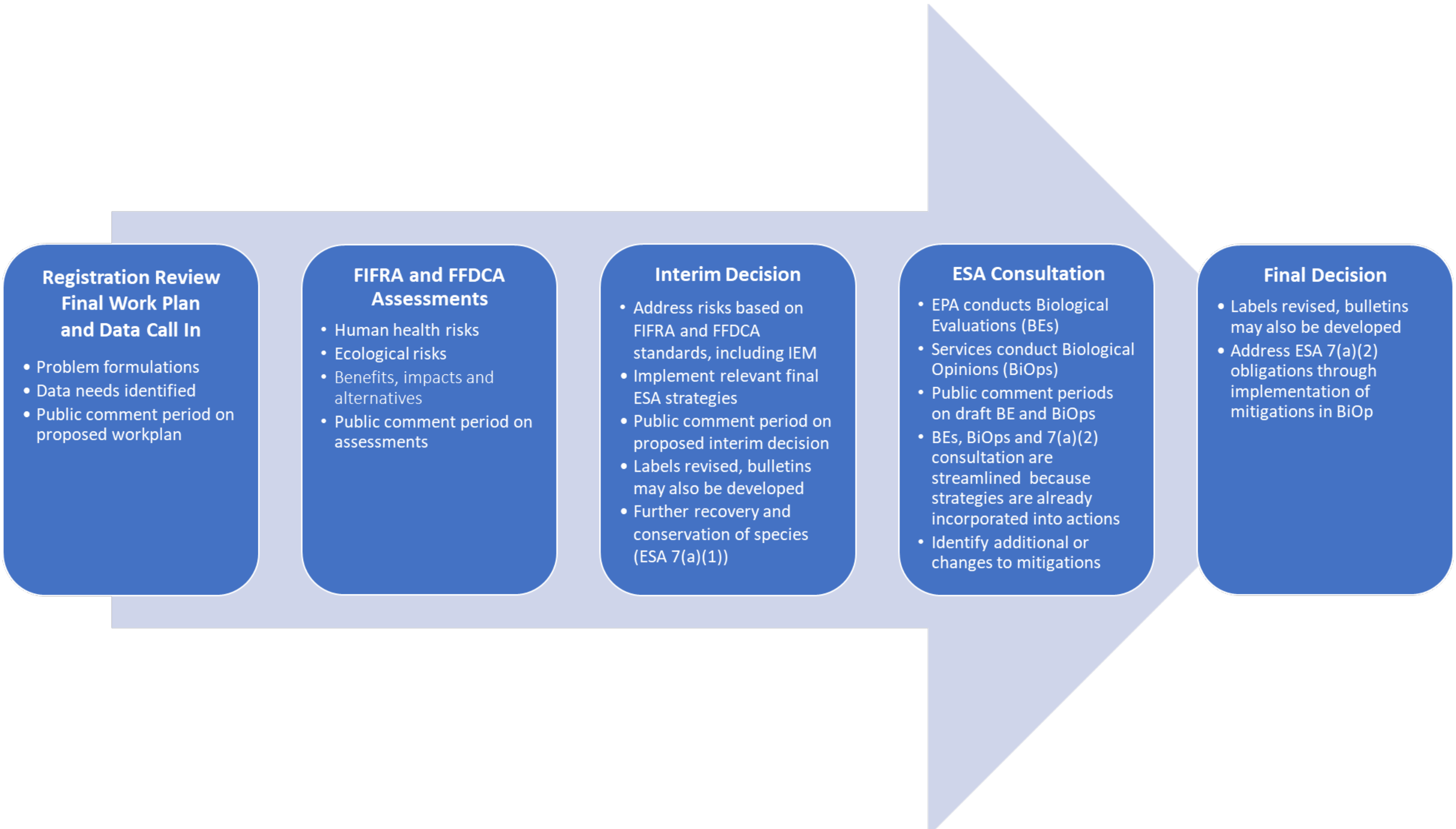

Figure 1111. Tiered approach where mitigation strategies are incorporated into registration review of specific pesticides (individual or groups). The application of pesticide exposure reduction strategies early in the process allows EPA to further the recovery and conservation of species (section 7(a)(1)) and streamline section 7(a)(2) consultations.

4.5 Interaction between FIFRA Interim Ecological Measures and the Insecticide Strategy

EPA released in its Workplan Update the FIFRA Interim Ecological Mitigation (IEM) that may be identified as necessary in registration review decisions and registration actions. The FIFRA IEM was released for public comment from November 16, 2022 to February 14, 2023. EPA received comments from over 100 individual stakeholders and stakeholder groups as well as two mass mail campaigns for a total of over 7,700 public comment submissions. EPA subsequently reviewed the comments received and updated the FIFRA IEM measures. EPA considered the need to be consistent across the FIFRA IEM and strategy mitigations to the extent appropriate. To that end, EPA is using the same runoff/erosion "mitigation menu" for FIFRA IEM and the strategies and is considering how the "mitigation menu" approach could work for other types of mitigation across strategies.

There are differences between the FIFRA IEM measures and the strategy mitigations related to the factors considered in determining the type, level, and extent of mitigations. For example, when considering whether mitigations are identified for conventional agricultural uses on insecticides, EPA expects that the level of mitigation in the strategy would supersede the FIFRA IEM for those uses. Refining the example further, both the strategy and FIFRA IEM include mitigations for spray drift and runoff/erosion exposure. For most insecticides, EPA expects to apply any spray drift, runoff/erosion requirements, and/or on-field exposure restrictions based on the strategy, instead of the FIFRA IEM, because the mitigations for the strategy focused on addressing the potential for population-level impacts to listed species would be at least as stringent as mitigation identified under FIFRA IEM for all non-target species. It is possible that other parts of FIFRA IEM may be appropriate for insecticides, even if the spray drift and/or runoff/erosion requirements were superseded by the strategy (e.g., seed treatment labeling). EPA plans to make clear in its regulatory decision documents, which mitigations EPA considered appropriate for the insecticide and why, given the context of different yet overlapping efforts of FIFRA IEM and the strategies. Ultimately, applicators will only need to follow the label directions as the process involved leading to label mitigation requirements will generally not be apparent on the label.

Lastly, EPA is in the process of finalizing the Herbicide Strategy, which is currently scheduled to be published in August 2024, which does not impact insecticides directly, but may impact pesticide applications in general, particularly when pesticides are tank-mixed in the field. As already the case, when tank-mixing multiple pesticide products, users will need to check requirements across all products being tank-mixed and comply with the most restrictive measures.

4.6 Consideration of Other Strategies

This draft strategy is one of a series of strategies that EPA is developing to group mitigations by pesticide type, use site, location, or other consideration. These strategies are intended to inform EPA's registration and registration review decisions when addressing population-level exposures and impacts relevant to listed species. FWS has authority over the majority of listed species including plants, insects, mussels, fish, birds, mammals, reptiles and amphibians. These species are diverse in their life history, locations, and potential for pesticide exposures. However, many species can be grouped in terms of what types of impacts may be expected from types of pesticides and similar mitigations can be identified. Pesticide impacts to a given species may vary based on its life history (*e.g.*, diet, migration).

Pesticide uses and potential impacts also vary across the U.S. based on crops grown, non-agricultural use sites (*e.g.,* forestry, residential areas) and associated pest pressures. For example, pesticide usage in the Continental US (CONUS) is much different than in Hawaii. Pesticide impacts vary from pesticide to pesticide, with unintended survival, growth or reproductive effects to non-target animals and plants (*e.g.,* an herbicide may cause reproductive effects to fish, multiple insecticides with the same mode of action may decrease survival in birds). Often classes of chemicals have similar impacts, especially considering their target pests (*e.g.*, rodenticides may impact non-target mammals, herbicides may impact non-target plants). The various strategies are intended to account for the characteristics of the individual chemical and identify landscape scale mitigations, as appropriate, based on location, pesticide class, species or use site (**Table 20**). Grouping species or pesticide uses based on their similarities will allow EPA to more efficiently and effectively identify and implement mitigations at a landscape scale through FIFRA registration and registration review actions. This will allow EPA to further its goals to reduce pesticide exposures and impacts to listed species, further the conservation of listed species and streamline 7(a)(2) consultations on specific actions. Like this draft insecticide strategy, EPA plans to implement the other strategies as they become final. The final strategies are expected to inform registration and registration review decisions. For more information on the strategies identified in **Table 20**, see EPA's website.

Table 20. Summary of mitigation strategies that EPA is developing or has committed to develop.

Mitigation Strategy	**Location**	**Use site**	**Conventional pesticide type**
Currently under development or EPA has committed to develop			
Herbicides	CONUS	Agriculture	Herbicides
Insecticides	CONUS	Agriculture	Insecticides
Rodenticides	U.S. and territories	All	Rodenticides
Fungicides	CONUS	Agriculture	Fungicides
Vulnerable species pilot	CONUS	Agriculture Mosquito adulticide Rights of Way Forestry Rangeland	All
Hawaii	Hawaii	All	All

CONUS = contiguous U.S.

4.7 Consideration of Offsets

The draft insecticide strategy includes mitigations that focus on minimization of exposure and impacts. At times, other federal agencies have used offsets to meet ESA obligations[40] (also known as compensatory mitigation) to address the impacts of their actions that cannot be avoided or minimized. Offsets are considered after feasible avoidance and minimization measures have been exhausted but more is needed to protect species. This could include actions such as habitat preservation or restoration,

[40] FWS defines offsets as measures to *"compensate for, or offset, remaining unavoidable impacts after all appropriate and practicable avoidance and minimization measures have been applied by replacing or providing substitute resources or environments through the restoration, establishment, enhancement, or preservation of resources and their values, services, and functions…." (USFWS, 2023b)*.

invasive species control, and species reintroductions. These actions can directly further species recovery (sometimes more than on-site avoidance and minimization) and can provide even greater flexibility by creating more options for EPA to meet its ESA obligations. For example, if EPA identifies any listed invertebrate species that have the potential for population-level impacts due to on field insecticide exposures, offsets may be an important mitigation measure for cases where insecticide applications to fields cannot be avoided. EPA plans to identify opportunities for offsets to complement traditional avoidance and minimization measures. Although a process still needs to be developed, EPA plans to do so through a multi-step process that would include working with the Services to develop general guidance on using offsets for pesticide consultations, working with registrants and/or other stakeholders to identify and adopt offsets for specific pesticides and species, ensuring that adopted offsets are legally binding as a condition of a FIFRA registration, and working with the Services to oversee implementation of offsets.

5 Conclusions and Next Steps

EPA developed the draft insecticide strategy to identify and implement early protections for listed species by reducing the potential for population-level impacts associated with invertebrates. This draft strategy has two components: a framework and an implementation plan. The framework is intended to provide EPA a process for confidently identifying when the uses of an insecticide have a potential for population-level impacts and how to identify effective and reasonable mitigations that are flexible and practical for grower/applicators of different crops and different parts of the country. This strategy is designed to reduce exposure to listed invertebrates (and listed species that depend on invertebrates from spray drift and runoff/erosion. In addition to directly addressing the spray drift and runoff exposures, EPA is currently considering possible on field mitigations for a limited number of species where additional mitigations may be needed (**Section 3.2.3**). For these species, EPA invites input from stakeholders as to the potential for these species to be on-field when insecticide applications are made. The draft implementation plan discusses EPA's current thinking on how the Final Insecticide Strategy can be applied to FIFRA registration and registration review actions. This strategy includes EPA's implementation expectations on how pesticide applicators will be able to understand necessary mitigations by using the general pesticide product label, a mitigation menu website, and BLT. EPA plans on communicating and educating stakeholders and applicators so that they understand applicable mitigations for their intended insecticide applications. This draft strategy is one of many other ESA strategies and efforts that EPA is developing to efficiently identify early mitigations for listed species. EPA will continue to develop additional mitigation measures, such as offsets, that may increase the types of mitigations that effectively protect listed species and flexibility available to grower/applicators. This strategy is part of a process that EPA has undertaken with FWS, where EPA will identify early protections for listed species that should result in more efficient and effective insecticide specific consultations under ESA 7(a)(2). EPA is soliciting public comments on this draft Insecticide Strategy. After considering public comments, EPA plans to update the Strategy and finalize it in early 2025.

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7 Abbreviations and Nomenclature

a.e.	acid equivalents
ACEP	Agricultural Conservation Easement Program
APEZ	Aquatic Plant Exposure Zone
BE	Biological Evaluation
BiOp	Biological Opinion
BLT	EPA's Bulletins Live! Two website
CFR	Code of Federal Regulations
CH	designated critical habitat
CRP	Conservation Reserve Program
DSD	Droplet size distribution
ECOS	FWS Environmental Conservation System
EEC	Estimated Environmental Concentration
EFED	Environmental Fate and Effects Division
EPA	United States Environmental Protection Agency
ESA	Endangered Species Act
FD	Final Decision
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
ft	feet
FWS	United States Fish and Wildlife Service
GIS	Geographic Information System
ha	hectare
HUC	Hydrologic Unit Code
IEM	Interim Ecological Mitigations
in	inch
ID	Interim Decision
K_d	solid-water distribution coefficient where the solid is soil or sediment
K_{OC}	organic-carbon normalized solid-water distribution coefficent where the solid is soil or sediment
lb	pound
m	meters
MAgPIE	Model of Agricultural Production and its Impact on the Environment
MCPA	2-methyl-4-chlorophenoxyacetic acid) and its salts and esters
MOA	Mode of Action
MoD	Magnitude of Difference/ratio of exposure estimate to population level toxicity endpoint
MoE	Magnitude of Effect
mph	miles per hour
NASS	National Agricultural Statistics Service
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NRCS	National Resource Conservation Service
^{o}F	degrees Fahrenheit

OPP	Office of Pesticide Programs
PAT	Plant Assessment Tool
PBF	Physical and Biological Features
PFAM	Pesticide in Flooded Applications Model
PFD	Proposed Final Decision
PID	Proposed Interim Decision
PULA	Pesticide Use Limitation Area
PWC	Pesticide in Water Calculator
RH	Relative Humidity
RQ	Risk Quotient
SSD	Species Sensitivity Distribution
TPEZ	Terrestrial Plant Exposure Zone
U.S.	United States
UDL	Use Data Layer
USDA	United States Department of Agriculture
USEPA/ EPA	U.S. Environmental Protection Agency
VFS	vegetative filter strip
VSP	Vulnerable Species Pilot
WPEZ	Wetland Plant Exposure Zone

Appendix A

Detailed Explanation of Step 1: Identify Potential for Population-Level Impacts

This appendix provides a detailed explanation of Step 1 of the draft Insecticide Strategy which is summarized in **Section 3.1**. Detailed information is provided here on:

- Calculating Magnitudes of Difference (MoD),
- Estimating exposure,
- Deriving toxicity thresholds, and
- How other information is considered when determining the potential for population-level impacts to listed species.

A.1 Calculating the Magnitude of Difference (MoD)

EPA calculates the MoD as the ratio of the estimated environmental concentration (EEC) divided by the relevant toxicity threshold concentration:

$$\boldsymbol{Magnitude\ of\ Difference} = \frac{\boldsymbol{Estimated\ Environmental\ Concentration}}{\boldsymbol{Toxicity\ Threshold\ Concentration}}$$

The EEC used to calculate the MoD differs depending on several factors including:

- Application parameters (*e.g.,* rate, crop, method, frequency),
- The type of habitat being assessed (*e.g.,* terrestrial ares, small vernal pools, larger wetlands, ponds, rivers and streams),
- The type of exposure being assessed (*e.g.,* water column, sediment, diet, soil, and direct contact exposure),
- The duration of exposure being assessed (short-term acute vs. longer term chronic exposures),
- The species group being assessed, if differences in sensitivity are indicated, and
- Whether the MoD is being used in assessment of direct impacts on listed invertebrates or indirect impacts to listed generalist species that depend on invertebrates for diet or pollination.

Once calculated, the MoD is then used in conjunction with other information to assign a potential for population-level impacts for the species being assessed. The MoD values reflect order of magnitude (10X) ranges to match the level of precision EPA considers in the underlying toxicity and exposure information.

To account for different species habitats, EPA uses a variety of exposure models to determine EECs. These models are further explained in this appendix. When information indicates that different listed species groups vary in their sensitivity to an insecticide, the toxicity threshold concentration is determined separately. The process for evaluating sensitivity differences among listed species groups is described in a subsequent section of this appendix. Once the MoD is calculated, EPA considers other information including uncertainty/bias in exposure or toxicity estimates when assigning the potential for population-level impact categories (not likely, low, medium, high) to the MoD ranges.

A.2 Derivation of the Estimated Environmental Concentration (EECs) for the MoD

A.2.1 Exposure Model Descriptions

EPA uses various standard exposure models[41] to calculate aquatic and terrestrial EECs for calculating the MoD. A summary of the models used in the draft Insecticide Strategy Case Studies Summary and Process document is provided below. When the Insecticide Strategy is final and implemented to inform a particular registration or registration review decision for a given insecticide, the most recent version of EPA's pesticide exposure models will be used.

On-Field Exposure Modeling

Terrestrial Residue and Exposure Model (T-REX)

EPA used the Terrestrial Residue Exposure Model (T-REX) v1.5.2 to evaluate potential exposures to listed terrestrial invertebrates following a foliar application. Since the strategy is designed to evaluate the potential for population-level impacts, the mean rather than upper-bound Kenaga residues reported from T-REX were used to assess potential exposures. This refinement is considered appropriate considering the population-level focus of the Insecticide Strategy (exposures relevant to populations are likely relevant to multiple fields, where an average exposure is representative, rather than single fields represented by an upper bound). Two levels of exposure were considered from T-REX: 1) residues in or on exposed arthropods, which can represent either the residues expected to be encountered by a flying terrestrial invertebrate on the field at the time of a spray application (contact toxicity) or the oral exposure represented by an insectivorous insect (such as the Delta green ground beetle, *Elaphrus viridis*, consuming other recently exposed insect prey and 2) residues on exposed plant matter, representing oral exposure either via exposed nectar or pollen (to pollinators) or exposed leafs/stems (typically to larval insects such as butterflies). The estimates generated by T-REX are compared to empirical data where available.

Modeling Soil Applications and On-Field Residues

Following a soil application, soil-dwelling terrestrial invertebrates (*e.g.,* American burying beetle, *Nicrophorus americanus*) may be exposed. Pollinators or herbivorous invertebrates may also be exposed following a soil application of a systemic insecticide and systemic uptake into the plant. To evaluate residues in the soil, EPA assumed the chemical is uniformly distributed in the top six inches (~15 cm) of the soil. Concentrations are based on application rate, soil depth and soil bulk density and result in estimated concentrations of 0.5 mg ai/kg-soil per one pound ai per acre application rate (USEPA 2012).

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[41] Current models and their user guides can be found at https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/models-pesticide-risk-assessment.

For systemic uptake within the plant, EPA used the soil module within Bee-REX model (version 1.0, USPA 2014) to derive concentrations based on the application rate, the K_{OC}, and the log K_{OW}. As noted in EPA's Pollinator Risk Assessment Guidance (USEPA *et al*., 2014), there are a number of limitations in this model including the limited dataset used to derive concentrations (one plant species and two classes of non-ionic pesticides), and the limited relevance for either ionic compounds whose transport may not be predicted well using the log K_{OW} and K_{OC} or for chemicals that are more likely to be phloem transported than xylem transported. The estimates based on the model are compared to empirical data where available (*e.g.,* imidacloprid case study).

Off-field Exposure Modeling Resulting from Spray Drift

Spray Drift to Terrestrial Habitats

As noted in the draft Insecticide Strategy, when the on-field residues calculated above from T-REX result in low potential for population-level effects, EPA identifies a lower limit buffer distance based upon the application method parameters (*e.g.*, aerial, medium droplet spectra). When the on-field residues calculated in T-REX result in high potential for population-level effects, EPA identifies a maximum buffer distance as appropriate for the application method parameters. In those cases where EPA identifies a medium potential for population-level effects, EPA identifies a chemical-specific buffer.

To derive the chemical-specific buffer, EPA uses the AgDRIFT™ model (version 2.1.1) and the terrestrial toxicity endpoints to estimate off-field spray drift EECs and the distance where exposures would not be likely to result in population-level impacts. Drift analysis assumed a single application at the listed maximum single application rate. The exposure estimate represents the 90th percentile point deposition estimates (lb a.i./A) for ground applications and 50th percentile point deposition estimates for airblast applications[42] and was generated for aerial, ground boom and airblast application methods. EPA employed the Tier I exposure methods within AgDRIFT for ground boom and airblast applications and the updated tier III AgDRIFT™ deposition curve[43] was used to calculate the drift fraction from aerial applications. For airblast, the off-field exposure estimates reflect mean deposition (limitation of the model) using the sparse orchard setting, which reflects young and/or dormant trees. In cases where EPA identifies a medium potential for population-level effects, and the resultant distance in AgDRIFT is either below the lower limit buffer or above the maximum buffer distance (typically, this occurs when MoDs were close to the thresholds for either low or high potential for population-level effects, respectively), EPA identifies the lower limit or maximum buffer distance, respectively, as the chemical-specific buffer.

Spray Drift to Aquatic Habitats

Similar to the terrestrial spray drift modeling that begins with on-field residues, for aquatic spray drift modeling, EPA first determines exposures in the waterbody (either the EPA pond, EPA wetland or the

[42] Only 50th percentile estimates are available in AgDRIFT™ for airblast applications.
[43] Updated default spray drift modeling assumptions for aerial pesticide applications is described in the **Mitigation Support Document**.

small vernal pool) that is considered immediately adjacent to the treated field using the AgDRIFT spray drift model. When these exposures would result in a low potential for population-level effects, EPA identifies a lower limit buffer distance based upon the application method parameters (*e.g.* ground, very fine to medium droplet spectra, high boom). When these exposures result in high potential for population-level effects, EPA identifies a maximum buffer distance as appropriate for the application method parameters. In those cases where EPA identifies a medium potential for population-level effects, EPA identifies a chemical-specific buffer.

To derive the chemical-specific buffer, EPA uses the AgDRIFT spray drift model and the aquatic toxicity endpoints to estimate off-field distances to the different receiving waterbodies (*i.e.,* small vernal pools, EPA farm pond, EPA wetland) that result in exposures that would not be likely to result in population-level impacts. The EECs generated represent 90th percentile estimates (µg a.i./L) for ground applications and 50th percentile for airblast applications. EPA employs the Tier I exposure methods within AgDRIFT for ground boom and airblast applications and the updated tier III AgDRIFT™ deposition curve**Error! Bookmark not defined.** was used to calculate the drift fraction from aerial applications. In cases where EPA identifies a medium potential for population-level effects, and the resultant distance in AgDRIFT is either below the lower limit buffer or above the maximum buffer distance (typically, this occurs when MoDs were close to the threshold for either low potential or high potential for population-level effects), EPA identifies the lower limit or maximum buffer distance, respectively, as the chemical-specific buffer.

Off-field Exposure Modeling Resulting from Runoff

Pesticide in Water Calculator

EPA generates surface water EECs using the PWC v2.001, which combines the Pesticide Root Zone Model (PRZM) and the Variable Volume Water Model (VVWM) in a single graphical user interface.[44] For the case studies considered in this draft Insecticide Strategy, aquatic modeling was conducted using PWC scenarios approved for use in ecological risk assessment and released in April 2023. Consistent with EPA's standard FIFRA-based ecological risk assessments, EPA selects standard crop scenarios coupled with weather information to assess runoff potential from vulnerable agricultural use sites. Each standard crop scenario is comprised of information from many thousands of sites with soil, climatic, crop, and agronomic data as inputs for PWC. Each PWC crop scenario is based on up to 54 years of daily weather values that are applicable to a given the location. Furthermore, each standard PWC crop scenario is based on the 90th percentile estimated exposure within each 2-digit HUC hydrologic region[45] (**Figure A-1**). For each PWC crop scenario, the EEC is calculated as the maximum annual concentration of a specified duration (acute = 1-day average; chronic = 21-d average) that has a return frequency of 1 in 10 years. Thus, within a PWC crop scenario, the EEC is considered a conservative (high end) estimate

[44] https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/models-pesticide-risk-assessment#PWC

[45] Watersheds in the United States were delineated by the U.S. Geological Survey (USGS) based on surface hydrologic features and are classified by hydrologic unit. Each hydrologic unit is identified by a unique hydrologic unit code (HUC) consisting of two to twelve digits based on the level of classification in the hydrologic unit system (these levels range from region to subwatershed). Two-digit HUCs are the first level of classification and represents specific hydrologic regions distributed across 21 HUC-02 regions of the United States, eighteen of which are within the contiguous 48 states. HUC-02 regions 3 and 10 were subdivided into multiple smaller subregions.

of exposure. To generate the range of potential EECs, EPA modeled both the lowest and highest annual application rate for registered uses within each Use Data Layer (UDL). To account for areas where concentrations in pesticide runoff are likely being overestimated, EPA will provide mitigation relief in the form of points as described in **Section 3.2.2.3.**

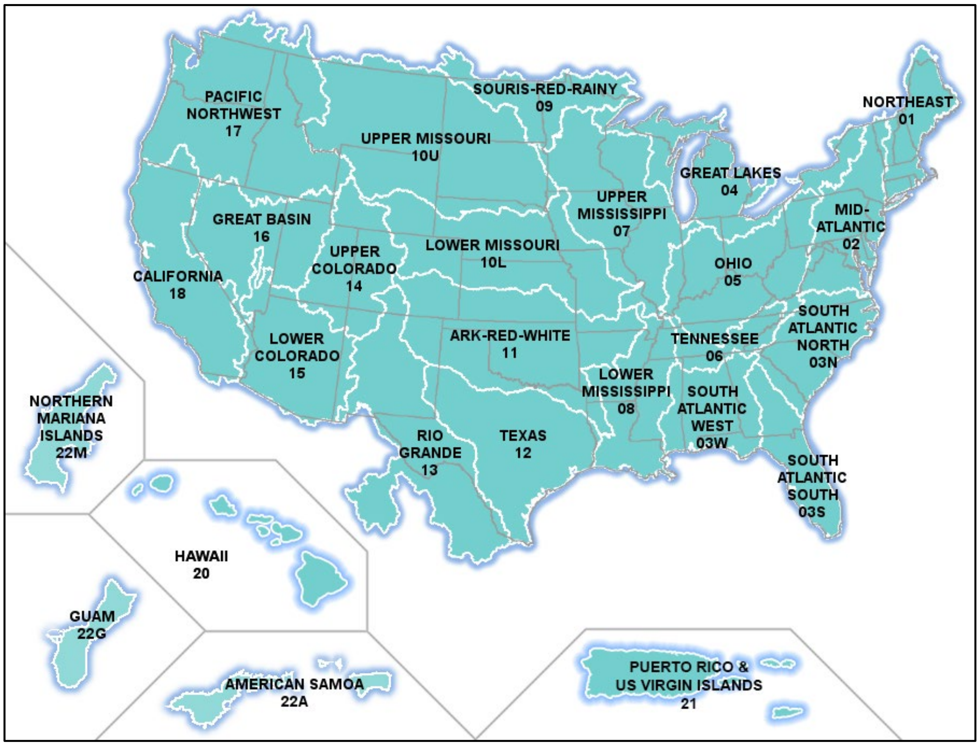

Figure A-1. Map of the High-Resolution National Hydrography Dataset (NHD Plus) Hydrologic Regions (USGS, Undated)[46].

Crops are grouped into different PWC scenarios based on agronomic practices to reduce the level of uncertainty in the spatial footprint for individual minor crops. In order to determine exposure scenarios to calculate MoDs, a single 90th percentile scenario is then selected for each crop/group of crops within each hydroregion or subregion where the crop is present, based on Cropland Data Layer (CDL) data, for a total of up to 21 scenarios to represent each group of crops on a national scale. The 90th percentile is intended to represent a conservative scenario to begin the analysis for potential population-level impacts. The variability in exposures across different scenarios and geographies and how that is addressed in the varying mitigation identified is addressed in Step 2 which utilized PWC model output, including geographic variability in runoff exposure to develop the relief point approach.

Since pesticides with different K_{OC} values behave differently in the different scenarios, separate sets of 90th percentile scenarios are selected for each crop/group of crop scenarios to represent chemicals based on three ranges of organic carbon (OC)-normalized sorption coefficient (K_{OC}) values: K_{OC}<100 L/kg-OC, K_{OC} from 100 to 3000 L/kg-OC, and K_{OC}>3000 L/kg-OC.

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[46] Map of the HUC-02 Water Resource Regions was downloaded from the National Hydrography Dataset Plus United States Regional Dataset (https://www.usgs.gov/media/images/epas-nhdplus-us-regional-dataset-map).

Plant Assessment Tool (PAT)

EPA used the PAT (v 2.8) model for estimating environmental exposure in aquatic habitats considered representative of wetland habitats, large vernal pools, backwater habitats, and shallow/slow moving streams. PAT is a mechanistic model that incorporates pesticide environmental fate (*e.g.*, degradation) and transport (*e.g.*, sorption) data that are typically available for conventional pesticides to estimate concentrations in wetland aquatic habitats. EPA modeled wetlands using outputs from PRZM and the VVWM, which are then processed in PAT to estimate aquatic concentrations. Specifically, the WPEZ module of PAT is intended to represent a non-target wetland waterbody that is exposed to pesticides via overland flow[47] and spray drift. The wetland can be immediately adjacent to the treated field or some unspecified distance away. The WPEZ is intended to represent a location that can exist as a saturated to flooded environment (*e.g*., a depression or shallow wetland that would collect and hold runoff from an upland area). This wetland system is considered protective of other surface-fed wetland systems (*e.g.*, permanently flooded; riparian) such that it is allowed to dry-down (concentrating contaminants), has a finite volume (considers standing water exposure), and would receive all the runoff from an adjacent treated field. The WPEZ is defined as a one-hectare (ha) wetland receiving inputs from an adjacent 10-ha field. Within the WPEZ, two depth zones are defined: a standing water zone and a saturated soil pore-water (benthic) zone. The maximum depth of the standing water is set to 15 cm, but the water is allowed to dry down to a minimum depth of 0.5 cm using algorithms from the VVWM. The saturated soil pore-water zone is a fixed 5-cm depth. This model excludes comparisons of standing water concentrations to aquatic taxa when water depth is less than 0.5 cm.

Edge of Field (EoF) Calculator

The EoF concentrations are used to represent runoff exposure to listed species that may inhabit small vernal pools (1 m^2 x 0.1 m deep based on the aquatic "bin 5" used in previous EPA biological evaluations) and provide direct comparisons with the WPEZ modeling. These concentrations are calculated based on the total runoff flux and runoff depth provided by the .zts output file of PWC using the EoF calculator version 2.2.1. These values represent complete displacement of the water in a confined receiving waterbody by the runoff from the treated field. While these values do not incorporate spray drift, they are considered conservative estimates of the exposure from runoff since they do not include degradation or dilution in the receiving waterbody. Spray drift exposure to vernal pool species was calculated and assessed separately using AgDRIFT version 2.1.1.

Pesticides in Flooded Applications Model (PFAM)

For applications to intermittently flooded fields such as rice grown in flooded fields and cranberries harvested via flooding, EPA used either the Pesticide in Flooded Applications Model (PFAM; version 2) or the Tier 1 Rice Model to generate water column EECs in the rice paddy or cranberry bog, in tailwater leaving the rice paddy or cranberry bog, and in larger order lotic environments (*e.g.,* Sacramento and Black Rivers) to provide a bounding of potential exposure in downstream rivers. As the overland sheet-

[47] Water flow that moves in swales, small rills, and gullies

flow runoff is not expected to occur in fields with levees or berms around the fields and in situations where water movement off of the field is controlled with a weir, EPA did not evaluate runoff risks to aquatic organisms for these types of cropping systems.

PFAM is not appropriate for estimating exposures from some cultivation methods of rice and cranberry. Specifically, some rice and cranberry crops are not grown or harvested in flooded fields. For example, rice grown in the mid-South is sometimes grown similar to row crops[48] ("furrow irrigated rice" or "row rice"), and high bush cranberries are not flood harvested. For these non-flooded crops, traditional runoff models (PWC) are appropriate for evaluating this exposure pathway. In future assessments, EPA may use PAT to evaluate the potential for exposure of terrestrial and wetland invertebrates for insecticide use on row rice in the mid-South. Rice is not currently grown in this manner in California.

A.2.2 Considering Listed Invertebrate Habitats in Exposure Model Selection

For each of the approximately 140 listed aquatic-phase invertebrate species covered in the draft Insecticide Strategy, the types of habitats described by FWS is specifically considered for determining the most applicable exposure model to use to estimate the EEC. In **Table A-1**, EPA classifies listed aquatic invertebrates according to various types of aquatic habitats that vary by their size and hydrologic features. The applicable standard exposure model used to estimate EECs for these species is also shown in **Table A-1**. In addition, separate modeling is conducted for flooded agricultural uses (rice, cranberry) using the Pesticides in Flooded Applications Model version 2 (PFAM).

Table A-1. Habitat types of listed aquatic-phase invertebrates and associated exposure models

Common Habitat Characteristics	# Listed Aquatic Invertebrartes[1]	Exposure Model[3] (Route of Exposure)
Small vernal pools[2]	4	PWC EoF Calculator (runoff) AgDRIFT® (spray drift)
Larger vernal pools, wetland areas, spring fed seeps and marshes, low gradient streams with slow current/flow, spring fed pools, backwater pool areas	27	PAT-Wetland (runoff + spray drift) AgDRIFT® (spray drift only)
Ponds, lakes, reservoirs, streams and rivers with moderate to fast flow regimes, karst systems	125	PWC - Standard Farm Pond (runoff + spray drift) AgDRIFT® (spray drift only)

[1] Species listed as of Feb. 2022 in the contiguous US under FWS jurisdiction. Species counts reflect listed invertebrates that occur in multiple habitat types.
[2] Approximately 100ft^2 or smaller; Species count in small vernal pools excludes 2 species included in the Vulnerable Species Project.
[3] PWC = Pesticides in Water Calculator version 2.001 available online at: https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/models-pesticide-risk-assessment;
EoF = Edge of Field calculator version 2.2.1;
PAT = Plant Assessment Tool version 2.8 available online at: https://www.epa.gov/endangered-species/provisional-models-and-tools-used-epas-pesticide-endangered-species-biological#pat;

[48] https://www.uaex.uada.edu/farm-ranch/crops-commercial-horticulture/rice/ArkansasFurrowIrrigatedRiceHandbook.pdf

AgDRIFT® version 2.1.1 available online at: https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/models-pesticide-risk-assessment#AgDrift

For listed terrestrial-phase invertebrates, the primary route of exposure considered is spray drift and subsequent exposure through:

- Direct contact with spray droplets
- Consumption of contaminated diet (pollen, nectar, foliage, other invertebrates)
- Contact with contaminated soil (*e.g.,* burrowing species)

Table A-2 summarizes the exposure routes and applicable exposure model used in calculating the MoD values for terrestrial invertebrates.

Table A-2. Terrestrial exposure routes assessed for listed terrestrial-phase invertebrates and associated exposure models

Terrestrial Exposure Route (*Common Taxa Represented*)	# Listed Terrestrial Invertebrartes[1]	Exposure Model[3]
Direct Contact *(all taxa)*	51	T-REX v. 1.5.1 (residues on arthropods)
Consumption of Plant Foliage *(larval butterflies/moths, terrestrial snails)*	43	T-REX v. 1.5.1 (residues on broadleaf plants)
Consumption of Nectar (*adult butterflies/moths/bees*)	31	Bee-REX v. 1.0 (application method specific residues in nectar)
Other invertebrates (*beetles, dragonflies, arachnids*)	7	T-REX v. 1.5.1 (residues on arthropods)
Contact with Soil	5	Soil screening-level exposure model

[1] Excludes 17 listed terrestrial invertebrate species that are restricted to caves where no/negligible exposure is expected to occur and precludes likely population-level impacts.

Details of the habitat descriptions for each listed aquatic- and terrestrial-phase invertebrate are provided in **Appendix D (Listed Species Information and Overlap Calculations).**

A.3 Derivation of Toxicity Thresholds for the MoD

The overall approach for considering the aforementioned factors when deriving toxicity endpoints for calculating MoD ratios (hereafter termed MoD toxicity thresholds) is shown in **Figure A-2**.

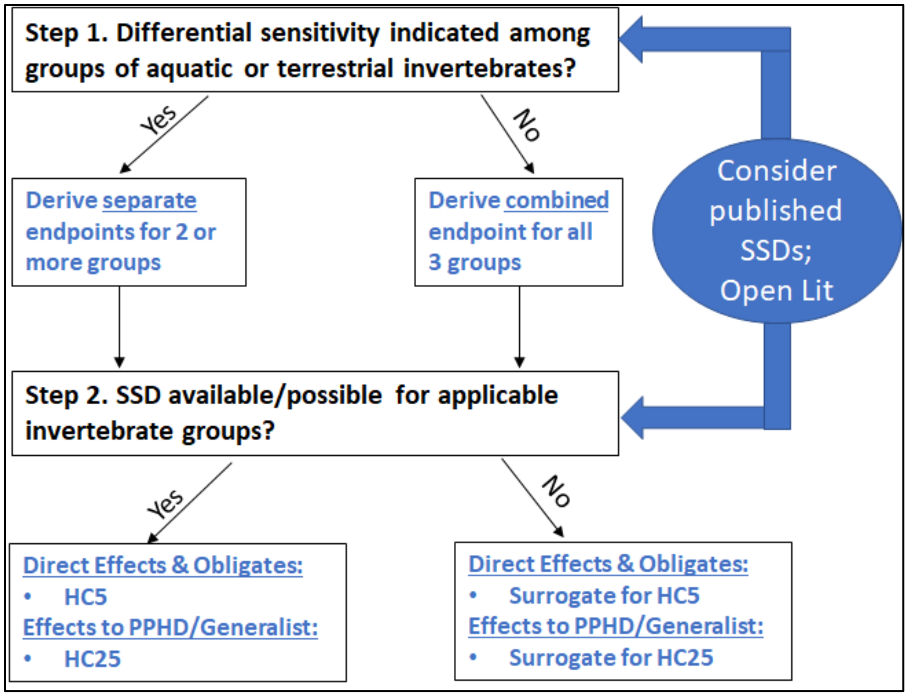

Figure A-2. Generalized Approach for Deriving Toxicity Endpoints used for Magnitude of Difference Ratios

A.3.1 MoD Toxicity Threshold Step 1: Assessing Sensitivity Differences Among Listed Taxa

The first step in deriving MoD toxicity endpoints involves identifying whether differential sensitivity among applicable taxonomic groups of listed invertebrates is likely. Notably, many insecticides are developed with Modes of Action (MoA) that target specific pests (*e.g.,* mites, mosquitoes, flies, moths, nematodes). Therefore, systematic differences in sensitivity of species among different taxonomic groups are expected at least for some insecticides due to varying physiological, genetic, and biological attributes which affect a species' susceptibility. In these cases, separate MoD toxicity endpoints are derived for the appropriate taxonomic groups.

In step 1, all available information is considered to identify if systematic differences in sensitivity likely exist between taxonomic groups of listed invertebrates. Multiple lines of evidence are considered including:

- The insecticidal MoA,
- Variability in toxicity data used in previous EPA risk assessments, and
- Variability in toxicity data published and curated in USEPA's ECOTOX database.[49]

In addition, mechanistic-based models may be considered on a case-by-case basis, such as SeqAPASS,[50] which can inform the likelihood of broad sensitivity differences among various taxonomic groups. The

[49] https://cfpub.epa.gov/ecotox/

[50] Sequence Alignment to Predict Across-Species Susceptibility (https://www.epa.gov/comptox-tools/sequence-alignment-predict-across-species-susceptibility-seqapass-resource-hub)

SeqAPASS tool has also been used to infer sensitivity differences among various taxa based on comparison of key amino acid sequences of target receptor proteins (Lalone *et al*., 2016).

Importantly, determining whether systematic differences in sensitivity to an insecticide exist among different taxonomic groups depends on the magnitude, consistency and quantity of data available to support such conclusions. For example, if very few data are available within each taxonomic group being evaluated (*e.g.,* 1 or 2 species per group), then conclusions regarding taxonomic differences in sensitivity are unlikely to be scientifically robust, unless they are supported by other lines of evidence. In general, the greater the amount of data available for different species and taxonomic groups, the more likely that conclusions regarding taxonomic differences in sensitivity will be sufficiently robust for use in risk assessment. When sufficient toxicity data are present to evaluate taxonomic differences in sensitivity, at least 1 order of magnitude (10-fold) difference between toxicity endpoints for sensitive species among taxonomic groups is generally needed before separate MoD endpoints could be considered. Toxicity data from ECOTOX may provide a useful line of evidence in this step since registrant-submitted data are typically more limited in the breadth of species tested.

A.3.2 MoD Toxicity Threshold Step 2: Selecting Derivation Method

In the second step, EPA decides whether the available data are sufficient to develop a species sensitivity distribution (SSD). SSDs are a statistical representation of sensitivity differences among species to a given chemical exposure and are useful in setting toxicological thresholds that are protective of certain percentages of tested species (*e.g.,* the 5^{th} percentile in an SSD would be protective of 95% of tested species). EPA develops SSDs[51] for invertebrates using the acute LD_{50} and LC_{50} values when sufficient information is available.[52]

When sufficient data are available to generate an SSD for an active ingredient, EPA uses either the 5^{th} percentile of the SSD to set the MoD toxicity endpoint for evaluating direct, population-level impacts to listed invertebrates and obligately dependent listed animals or plants. The HC_5 is considered a conservative basis for evaluating direct effects to listed invertebrates since it assumes that the species is more sensitive than 95% of the tested species. For evaluating indirect impacts to listed generalists that depend on invertebrates for survival, the 25^{th} percentile (HC_{25}) of the SSD is selected. A higher percentile (lower sensitivity) of the SSD is used to evaluate potential effects to listed generalists because such effects are presumed to occur at the community level, rather than for a population of a single species.

When data are insufficient to derive an SSD, individual species toxicity data are used as a surrogate to the HC_5 and HC_{25} for setting the invertebrate MoD toxicity endpoints. For evaluating direct effects to

[51] Species Sensitivity Distributions (SSD) are a common tool used for setting limits on exposure to a chemical or stressor. SSDs model the variation in the sensitivity of different species to a chemical and fit equations to understand the distribution of species sensitivity to a chemical. EPA uses the SSD Toolbox to generate SSDs. The Toolbox is available at: https://www.epa.gov/chemical-research/species-sensitivity-distribution-ssd-toolbox.

[52] LD_{50} is the lethal dose (*e.g.,* mg ai/kg-body weight) that results in 50% mortality of the tested individuals (usually with terrestrial species). The LC_{50} is the lethal concentration (*e.g.,* mg a.i./L water) that results in 50% mortality of the tested individuals (usually with aquatic species).

listed invertebrates and obligate dependents, the acute LC_{10} or LD_{10} is used to set the acute MoD endpoint for an appropriately sensitive species (generally, for the most sensitive species tested). The acute LC_{10} and LD_{10} are regression-based estimates that would be expected to result in 10% mortality to the tested individuals and are derived from the most sensitive LD_{50}[53] value when an SSD cannot be developed.

To evaluate chronic population-level endpoints for a listed invertebrate species, EPA uses the Maximum Acceptable Toxicant Concentration (MATC), which is the geometric mean between the NOAEC and the lowest tested dose that resulted in significant adverse effects (LOAEC). The MATC is set using data for the most sensitive species tested.

For evaluating potential indirect impacts to listed generalists that depend on invertebrates for survival, other lines of evidence (*e.g.,* ECOTOX data and SSDs published in the scientific literature) are considered when selecting the most appropriate LC_{50} or LD_{50} value to represent a threshold for community-level effects. The goal is to select a species that can reasonably represent the lower quartile of the acute SSD (HC_{25}).

Table A-3 summarizes the MoD and the groups of species with similar characteristics that are linked to that MoD. For terrestrial invertebrates, the relevant exposure pathways evaluated are for species on the treated field (including from contact with a foliar spray, deposition on or systemic uptake into attractive dietary matrices, and soil exposures) and those exposed via spray drift off the field. For aquatic invertebrates, exposure is evaluated via both runoff and spray drift.

Table A-3. Summary of Magnitude of Difference Calculations for Different Species Groups

<table>
<tr><th>Species Group
(also includes CH)</th><th>EEC (Model[2])</th><th>Toxicity Threshold[3]</th></tr>
<tr><td colspan="3">Treated field and adjacent terrestrial habitat (exposure off-field via spray drift only)</td></tr>
<tr><td>Listed terrestrial invertebrates and listed obligate species</td><td rowspan="2">Mean Kenaga Arthropod and Broadleaf plant EECs (T-REX)

Spray drift point deposition (AgDRIFT®)

Residues in pollen and nectar from systemic uptake (Bee-REX for soil treatment, upper bound empirical residue data for seed treatment)

Soil Exposures (screening model)</td><td>Acute:
• (With SSD): 5^{th} percentile of SSD of LD_{50}
• (Without SSD): LD_{10} from most sensitive terrestrial invertebrate

Chronic: MATC (geometric mean of NOAEC and LOAEC)</td></tr>
<tr><td>Listed generalist species that depend on terrestrial invertebrates</td><td>Generalists: 25^{th} percentile of SSD of acute LD_{50} values or most appropriate LD_{50} for terrestrial invertebrates</td></tr>
<tr><td colspan="3">Aquatic Habitats (EPA Pond, PAT wetland, small vernal pool; Runoff and/or Spray drift)</td></tr>
</table>

[53] When sufficient data are not available to derive an SSD, but there is sufficient information to derive different endpoints by taxa (*e.g.,* crustacea vs. mollusks), EPA may use different endpoints for the representative taxa.

<table>
<tr><th>Species Group
(also includes CH)</th><th>EEC (Model[2])</th><th>Toxicity Threshold[3]</th></tr>
<tr><td>Listed aquatic invertebrates and associated listed obligate species</td><td rowspan="2">Water Column: 1-in-10 year daily and 21-d average EEC (PWC, PAT, Edge of Field Calculator)

Sediment: 1-in-10 year 21-day average EEC (PWC and PAT)

Rice paddy/Cranberry bog: Concentration in water (µg ai/L) released after holding period for applications to intermittently flooded fields (PFAM)

Spray Drift Only: concentration based on waterbody area/volume and spray drift estimate (AgDRIFT®)</td><td>Acute:
• (With SSD): 5th percentile of SSD of LC_{50}
• (Without SSD): LC_{10} from most sensitive aquatic invertebrate

Chronic: MATC (geometric mean of NOAEC and LOAEC)</td></tr>
<tr><td>Listed generalist species that depend on aquatic invertebrates</td><td>Generalists: 25th Percentile of SSD of LC_{50} values or lowest LC_{50} for aquatic invertebrates</td></tr>
</table>

CH=designated Critical Habitat; EEC = estimated environmental concentration; LD_{10} (LC_{10}) = dose (concentration) resulting in 10% mortality. LD_{50} (LC_{50}) = dose (concentration) resulting in 50% mortality to tested organisms. SSD = species sensitivity distribution; HC_5 (HC_{25}) = hazard concentration estimated for 5th percentile (25th percentile) of the SSD. Model names are explained in the text.

A.4 Additional Information Considered for Assessing Potential Population-level Impacts

In addition to the MoD, EPA uses additional information as lines of evidence recommended in the *Revised Method for National Level Listed Species Biological Evaluations of Conventional Pesticides* and other ecological assessment guidance documents (USEPA, 1998; USEPA, 2004; USEPA, 2020 and USFWS, 2022) when evaluating the potential for population-level impacts. For the draft Insecticide Strategy, the level of confidence relates to the potential for terrestrial and aquatic invertebrate population-level impacts or terrestrial and aquatic invertebrate community-level impacts as well as potential impacts to diet and habitat for animals. Lines of evidence inform the reliability and variability of both exposure and impacts estimates.

EPA evaluates these lines of evidence in ecological impact assessments supporting registration actions. Thus, this information is readily available to support Step 1 of the Strategy analysis. When multiple lines of evidence are complementary (*e.g.*, laboratory and field-based data are consistent in terms of effect and exposure), potentially including monitoring or incident data which reinforce estimates of exposure and the potential for population-level impacts, then these increase EPA's confidence in predicting the potential for population-level impacts.

A.4.1 Representativeness of Exposure Estimates of Listed Species Habitats

In comparison to EPA's typical screening-level assessments that are more generic and broad taxa-based (*e.g.* freshwater invertebrates), for the draft Insecticide Strategy, the representativeness of the exposure estimates (*i.e.,* level of confidence and bias) for the types of listed invertebrate habitats is particularly impactful to assigning the potential for population-level impacts. As described previously in the draft Insecticide Strategy, there is a large diversity of habitats where the listed invertebrate species can occur. For example, aquatic species can be found in small vernal pools that seasonally dry up, prarie potholes that are interspersed with agriculture, small and large wetlands, ponds, lakes, and also streams and rivers. Terrestrial species can be found in meadows adjacent to agriculture, at high elevation mountainous regions, remote areas like cliff faces and water falls, and also in nearby forests. Since EPA has a finite set of exposure models to represent such a large diversity of aquatic and terrestrial habitats of listed invertebrates, an important consideration when assigning the potential for population-level impacts is how well our models represent these habitats. For example, EPA's previous analyses indicate that exposure estimates for the farm pond have a tendency to overestimate concentrations in streams and rivers with substantial flow regimes by an order of magnitude or more (USEPA 2016). Since exposure estimates for the farm pond are used as a proxy for other larger aquatic waterbodies including rivers and streams, the potential for population-level impacts begins at a MoD of 10 in these environments rather than 1 in recognition of the upward bias in the farm pond exposure estimates for these habitats. A similar situation exists when considering estimates of spray drift for species that live in areas where pesticide sprays may be intercepted by trees, shrubs and other obstacles to direct contact with spray droplets. EPA's spray drift estimates assume relatively little or no interception of spray droplets as they move from the treated field. In such cases, EPA is providing additional reductions in spray drift distances and associated mitigations for species that are expected to reside in areas where spray drift is expected to be substantially lower than model estimates. For evaluating impacts to generalists that depend on communities of aquatic invertebrates, EPA uses the more conservative of the exposures and MoDs generated for the EPA Wetland and the EPA Pond. EPA does not use the more conservative exposure values from the small vernal pool modeling for generalists as the small vernal pool represents a highly conservative scenario that would generally not be considered realistic for generalist species that may rely on communities of aquatic invertebrates throughout a diversity of aquatic habitats.

For evaluating the impact of the representativeness of EPA's exposure estimates of listed invertebrate habitats, EPA considers detailed information from FWS on the habitat characteristics of these species, ass summarized in **Table A-4**.

Table A-4. Consideration of Habitat Characteristics on the Potential for Population-level Impacts or Spray Drift Mitigation

Habitat Type and Characteristics	# of Listed Invertebrates[1]	Impact on MoD or Mitigation	Rationale
Listed Aquatic-Phase Invertebrates			
Moderate/fast flowing streams and rivers	84	Potential for population-level impact begins at MoD of 10 rather than 1	Extensive analysis of pond EECs indicates bias of 10X or more in representing these habitats (USEPA 2016)
Cave/karst aquatic systems	11	Potential for population-level impact begins at MoD of 10 rather than 1	Spray drift not expected; Groundwater dominated systems also expected to reduce exposure compared to EPA EECs
High elevation habitats (*e.g.,* glaciers, meltwater streams)	4	Species excluded from further evaluation	Exposure via runoff or spray drift is not expected
Listed Terrestrial-Phase Invertebrates[2]			
Interior forests	1	Species excluded from further evaluation	Exposure via spray drift is not expected
Remote locations (*e.g.,* cliff faces/rocky outcrops, falls)	4	Species excluded from further evaluation	Exposure via spray drift is not expected
Terrestrial invertebrates restricted to caves	16	Species excluded from further evaluation	Exposure via spray drift is not expected

[1] Note: the same species can be represented by multiple habitat types and characteristics. Includes species under FWS jurisdiction in the contiguous US excluding species represented in the Vulnerable Species Pilot Project.
[2] Also excludes listed species with less than 5% overlap with USDA cultivated land data layer and all insecticide usage information.

A.4.2 Representativeness of Toxicity Estimates and Other Considerations

Looking closer at the listed invertebrate species within the scope of the draft Insecticide Strategy, the habitats where these listed species can occur are highly diverse. For example, aquatic species can be found in small vernal pools that seasonally dry up, prairie potholes that are interspersed with agriculture, small and large wetlands, ponds, lakes, and streams and rivers. Terrestrial species can be found in meadows adjacent to agriculture, at high elevation mountainous regions, remote areas like cliff faces and waterfalls, and in nearby forests. Since EPA has a finite set of exposure models to represent such a large diversity of aquatic and terrestrial habitats of listed invertebrates, an important consideration when assigning the potential for population-level impacts is how well its models represent these habitats. For example, EPA's previous analyses indicate that its exposure estimates for the farm pond have a high tendency to overestimate concentrations in streams and rivers with substantial flow regimes by an order of magnitude or more (USEPA 2016). Since exposure estimates for the farm pond are used as a proxy for other larger aquatic waterbodies including rivers and streams, the potential for population-level impacts begins at a MoD of 10 in these environments rather than 1 as shown previously in **Table 3** in recognition of the upward bias in the farm pond exposure estimates for these habitats. A similar situation exists when considering estimates of spray drift for species that live in areas where pesticide sprays may be intercepted by trees, shrubs, and other obstacles to direct contact with spray droplets. EPA's spray drift estimates assume relatively little or no interception of spray droplets as they move from the treated field. In such cases, EPA also as signs higher thresholds of MoDs to the various categories for assigning the potential for population-level impacts.

With respect to toxicity, EPA also considers the uncertainty and potential bias in toxicity data when assigning the potential for population-level impacts. The MoD ranges shown in **Table 3** could conceivably be lowered when other information indicates the available toxicity test data does not adequately capture the expected sensitivity of one or more types of listed invertebrates. Conversely, the MoD ranges may be increased if information suggests the opposite situation is likely to occur.

EPA also considers information such as data on pesticide residues in environmental media (*i.e.,* monitoring data) in conjunction with model-based estimates of exposure. Generally, monitoring data can support the model-based exposure estimates when concentrations are reasonably similar; however, monitoring data often are not targeted to when and where insecticides are applied, so lack of agreement does not usually impact the MoD ranges associated with the potential for population-level impacts. Ecological incident data reported to EPA also represent a similar confirmatory line of evidence as monitoring data.

In summary, EPA decides on the likelihood of population-level impacts (not likely, MoD<1; low, MoD 1 to <10; medium, 10 to <100; high, >100) by considering multiple factors, including:

- MoDs,
- Representativeness (or lack thereof) of exposure estimates of species habitat,
- Representativeness of toxicity estimates of surrogate test species, and
- Monitoring and incident data as confirmation.

Based on the variability in the MoD estimation process, EPA expected there would be cases in which the MoDs for a single use (*e.g.,* corn) span more than one classification of potential for population-level impacts (*e.g.,* 1 ≤ MoD < 10 = low, 10 ≤ MoD < 100 = medium, ≥100 = high). When this occurred in the case studies, EPA completed a closer examination of the individual MoDs across modeled scenarios. If a higher potential for population-level impacts was identified at a low frequency of the individual modeled scenarios and/or MoDs were near the thresholds of the classification MoD range criteria, EPA concluded the potential for population-level impacts should be assigned as the lower-level classification. As an example, if a use had 2 of 23 scenarios assigned a high classification (i.e., MoD ≥ 100), and all other scenarios were assigned a medium classification (i.e., 10 ≤ MoD < 100), EPA reviewed the magnitude of the individual MoDs. If the two highest MoDs were close to the threshold between a medium and high classification (*i.e.,* 100), then EPA assigned that use a medium classification overall. If the MoDs were not near the threshold (*e.g.,* >200) then EPA generally scored the use as having a high potential for population-level impacts.

Appendix B

Listed Species Included in Draft Insecticide Strategy PULAs

EPA identified 73 listed invertebrates (or obligate species) that may have a potential for population-level impacts from direct exposures to off-site transport of spray drift or runoff/erosion. Many of these 73 listed species will likely share the same level of mitigation for a particular insecticide. This is because they share similar modeled habitats and/or population-level endpoints based on the assessment of sensitivity differences among species groupings. EPA is planning to group these species into common PULAs. Where multiple species share the same levels of mitigations, EPA is expecting to group the areas important for the conservation of each of those species into one aggregated PULA. EPA has identified 10 possible groups (**Table B-1**) where listed species would generally have the same mitigations due to similarity of habitat and taxonomy. The purpose of this appendix is to provide more information on species included in each group.

Table B-1. Summary of 10 potential invertebrate species groups for draft Insecticide Strategy PULAs.

IS Group (PULA) #	Habitat description	Taxon	# of species*
1	Terrestrial areas near treated fields	Bees and Dragonflies	2
2		Butterflies	12
3		Beetles	6
4	Vernal pools	Crustaceans	4
5	Wetlands	Aquatic insect	1
6	Small water bodies, Wetlands	Mussels/snails	7
7	Wetlands and ponds	Crustaceans	1
8	Low flow waters, ponds	Mussels/snails	13
9	Medium/large flowing waters, lakes, reservoirs	Mussels/snails	29
10	Karst systems (caves, pools)	Crustaceans	4

*Some species are included in multiple PULA groups because they have multiple types of habitat.

Spray Drift Mitigations

For this draft strategy, EPA has identified multiple species of beetles and butterflies and one dragonfly where the same level of spray drift mitigations may be appropriate for some agricultural insecticide uses to address a potential for population-level impacts in habitats off of the treated field (**Table B-2**). There is also one listed plant species (Furbish lousewort) that is obligate to a bumble bee species, so EPA would likely identify the same level of spray drift mitigations for this species. EPA is proposing to group terrestrial species by the following three taxa: butterflies, beetles, and bees to allow for cases where toxicity data are available for an insecticide that shows different sensitivities across these species' groups.

Table B-2. Species included in spray drift mitigation PULA groups.

Taxon	Common name	Scientific name	Entity ID	PULA #	Species habitat description (From FWS sources)
Bees	Furbish lousewort*	*Pedicularis furbishiae*	790	1	Riverbanks
Dragonflies	Hines emerald dragonfly**	*Somatochlora hineana*	445	1	Marshes, near streams
Butterflies (and moths)	Langes metalmark butterfly	*Apodemia mormo langei*	421	2	Sand dunes
	Callippe silverspot butterfly	*Speyeria callippe callippe*	430	2	Grassland
	Kern primrose sphinx moth	*Euproserpinus euterpe*	433	2	Sandy washes
	Bay checkerspot butterfly	*Euphydryas editha bayensis*	438	2	Grassland
	Fenders blue butterfly	*Icaricia icarioides fenderi*	450	2	Prairies
	Saint Francis satyr butterfly	*Neonympha mitchellii francisci*	455	2	Meadows
	Carson wandering skipper	*Pseudocopaeodes eunus obscurus*	462	2	Grassland
	Dakota Skipper	*Hesperia dacotae*	3412	2	Prairies
	Karner blue butterfly	*Lycaeides melissa samuelis*	420	2	Grasslands, old fields, sand dunes, savannas
	Mitchells satyr Butterfly	*Neonympha mitchellii mitchellii*	424	2	Fens, prairies, meadows, tamarack savannas, shrub-carr
	Bartrams hairstreak Butterfly	*Strymon acis bartrami*	5067	2	Pine rockland, rockland hammock, pine flatwoods
	Florida leafwing Butterfly	*Anaea troglodyta floridalis*	8083	2	Pine rockland
Beetles	Delta green ground beetle	*Elaphrus viridis*	435	3	Grassland-playa pool matrix
	Northeastern beach tiger beetle	*Cicindela dorsalis dorsalis*	442	3	Beach
	Salt Creek Tiger beetle	*Cicindela nevadica lincolniana*	4910	3	Wetlands, mud flats, banks of streams
	American burying beetle	*Nicrophorus americanus*	440	3	Grassland, meadows, partially forested canyons, shrubland
	Valley elderberry longhorn beetle	*Desmocerus californicus dimorphus*	436	3	Riparian forest
	Miami tiger beetle	*Cicindelidia floridana*	10909	3	Pine rockland

*Listed plant that is pollinated by the half black bumble bee (*Bombus vagans*). This plant is included because it is obligate to a specific insect species.
**Adult lifestage is terrestrial and may be exposed to spray drift.

Spray drift and runoff/erosion mitigations

EPA may have sufficient toxicity data to differentiate impacts to listed aquatic insects, crustaceans, and mollusks. This depends on a chemical by chemical (or chemical class) basis where data is available. These taxa represent different types of listed species that use aquatic habitats. When considering the different types of habitats used by listed aquatic invertebrates or obligates and the three taxonomic categories that can be used to distinguish toxicity and impacts, EPA has identified 7 potential groups for aquatic invertebrates where potential spray drift and runoff/erosion mitigations have been identified. **Table B-3** identifies the specific aquatic species and which PULA group would apply.

Table B-3. Species included in spray drift and runoff/erosion mitigation PULA groups.

Taxon	Common name	Scientific name	Entity ID	PULA #	PULA habitat description	Species habitat description (From FWS sources)
Insects	Hines emerald dragonfly	*Somatochlora hineana*	445	5	Wetlands	Marshes, near streams
Crustaceans	Conservancy fairy shrimp	*Branchinecta conservatio*	490	4	Vernal pools	Vernal pools
	Longhorn fairy shrimp	*Branchinecta longiantenna*	491	4	Vernal pools	Vernal pools
	Vernal pool fairy shrimp	*Branchinecta lynchi*	493	4	Vernal pools	Vernal pools
	Vernal pool tadpole shrimp	*Lepidurus packardi*	494	4	Vernal pools	Vernal pools
	Noel's Amphipod	*Gammarus desperatus*	1261	7	Wetlands and ponds	Shallow waters of streams, ponds, ditches, sloughs and springs
	Alabama cave shrimp	*Palaemonias alabamae*	480	10	Karst systems	Subterranean aquatic pools
	Kentucky cave shrimp	*Palaemonias ganteri*	482	10	Karst systems	Cave river passage
	Illinois cave amphipod	*Gammarus acherondytes*	484	10	Karst systems	Cave streams
	Squirrel Chimney Cave shrimp	*Palaemonetes cummingi*	487	10	Karst systems	One cave sinknole
Mussels/snails (mollusks)	Roswell springsnail	*Pyrgulopsis roswellensis*	1246	6	Small water bodies, wetlands	Spring-fed seeps and high volume springs near head runs
	Kosters springsnail	*Juturnia kosteri*	1247	6	Small water bodies, wetlands	Spring-fed seeps and high volume springs near head runs
	Fat pocketbook	*Potamilus capax*	342	6 & 8	Small water bodies, wetlands, Low flow waters, ponds	Streams/rivers (slow moving, depositional areas)
	Dwarf wedgemussel	*Alasmidonta heterodon*	363	6 & 8	Small water bodies, wetlands, Low flow waters, ponds	Creeks/rivers of varying sizes, slow to moderate current
	Gulf moccasinshell	*Medionidus penicillatus*	384	6 & 8	Small water bodies, wetlands, Low flow waters, ponds	Streams/rivers; wide variety of habitat with slight to moderate current
	Armored snail	*Pyrgulopsis (=Marstonia) pachyta*	402	6 & 8	Small water bodies, wetlands, Low flow waters, ponds	Streams; Slow to moderate current; associated with pool edges, tree roots, rocks
	Alabama lampmussel	*Lampsilis virescens*	326	8	Low flow waters, ponds	Small creeks to large rivers, low to moderate current.

Taxon	Common name	Scientific name	Entity ID	PULA #	PULA habitat description	Species habitat description (From FWS sources)
	Oval pigtoe	*Pleurobema pyriforme*	371	8	Low flow waters, ponds	Medium creeks/small rivers, slow to medium current
	Shinyrayed pocketbook	*Lampsilis subangulata*	373	8	Low flow waters, ponds	Medium creeks/rivers; permanently flowing areas, intolerant of impoundment
	Chipola slabshell	*Elliptio chipolaensis*	386	8	Low flow waters, ponds	Large creeks to large river; slow/moderate current
	Fuzzy pigtoe	*Pleurobema strodeanum*	1369	8	Low flow waters, ponds	Medium size creeks/rivers; slow to moderate current
	Tapered pigtoe	*Fusconaia burkei*	6534	8	Low flow waters, ponds	Medium size creeks/rivers; slow to moderate currents
	Southern sandshell	*Hamiota australis*	7349	8	Low flow waters, ponds	Small creeks to larve rivers; slow to moderate currents; Hydrologic regime necessary to maintain well oxygenated waters.
	Suwannee moccasinshell	*Medionidus walkeri*	7372	8	Low flow waters, ponds	Large streams; slow/moderate currents
	Southern kidneyshell	*Ptychobranchus jonesi*	7949	8	Low flow waters, ponds	Medium size creeks/rivers; slow current
	Purple Cats paw (Purple Cats paw pearlymussel)	*Epioblasma obliquata obliquata*	323	9	Medium/large flowing waters, lakes, reservoirs	Large river species, shallow/Moderate depths, swift-moderate current
	White catspaw (pearlymussel)	*Epioblasma obliquata perobliqua*	324	9	Medium/large flowing waters, lakes, reservoirs	Small to moderate size rivers, riffle/run
	Pink mucket (pearlymussel)	*Lampsilis abrupta*	331	9	Medium/large flowing waters, lakes, reservoirs	Most often associated with large rivers, fast flowing; 0.5m to 8m depth
	Curtis pearlymussel	*Epioblasma florentina curtisii*	333	9	Medium/large flowing waters, lakes, reservoirs	Shallow stable riffles and runs; btw headwater lowland streams
	Tar River spinymussel	*Elliptio steinstansana*	351	9	Medium/large flowing waters, lakes, reservoirs	Swift creek, fast flowing areas

Taxon	Common name	Scientific name	Entity ID	PULA #	PULA habitat description	Species habitat description (From FWS sources)
	Clubshell	*Pleurobema clava*	352	9	Medium/large flowing waters, lakes, reservoirs	Small creeks to large rivers; intolerant of slackwater
	Fanshell	*Cyprogenia stegaria*	368	9	Medium/large flowing waters, lakes, reservoirs	Medium/large rivers, moderate current
	Northern riffleshell	*Epioblasma torulosa rangiana*	374	9	Medium/large flowing waters, lakes, reservoirs	Shallow streams to large rivers; preferred habitat appears to be swift flowing areas
	Ochlockonee moccasinshell	*Medionidus simpsonianus*	385	9	Medium/large flowing waters, lakes, reservoirs	Large creeks & River; moderate currents
	Bliss Rapids snail	*Taylorconcha serpenticola*	398	9	Medium/large flowing waters, lakes, reservoirs	Springs and riverine habitats; spring/rapids areas
	Snake River physa snail	*Physa natricina*	399	9	Medium/large flowing waters, lakes, reservoirs	Snake River, faster flowing areas; 0.5-3m depth
	Banbury Springs limpet	*Lanx sp.*	409	9	Medium/large flowing waters, lakes, reservoirs	Cold spring regions, 2-20 in depth with swift current
	Slender campeloma	*Campeloma decampi*	417	9	Medium/large flowing waters, lakes, reservoirs	Found in a variety of streams and rivers, sometimes in shallow depths
	Rabbitsfoot	*Quadrula cylindrica cylindrica*	3645	9	Medium/large flowing waters, lakes, reservoirs	Small/medium rivers, swift currents
	Choctaw bean	*Villosa choctawensis*	4042	9	Medium/large flowing waters, lakes, reservoirs	Large creeks/rivers, moderate currents
	Yellow lance	*Elliptio lanceolata*	4074	9	Medium/large flowing waters, lakes, reservoirs	Large creeks/rivers, moderate currents

Taxon	Common name	Scientific name	Entity ID	PULA #	PULA habitat description	Species habitat description (From FWS sources)
	Altamaha Spinymussel	*Elliptio spinosa*	4210	9	Medium/large flowing waters, lakes, reservoirs	Large rivers, fast flowing areas
	Snuffbox mussel	*Epioblasma triquetra*	5281	9	Medium/large flowing waters, lakes, reservoirs	Small creeks to larve rivers; lakes; swift currents
	Slabside Pearlymussel	*Pleuronaia dolabelloides*	6841	9	Medium/large flowing waters, lakes, reservoirs	Creeks/rivers; riffle fast flowing regions; shallow areas
	Higgins eye (pearlymussel)	*Lampsilis higginsii*	325	9	Medium/large flowing waters, lakes, reservoirs	Large rivers species, low velocity
	White wartyback (pearlymussel)	*Plethobasus cicatricosus*	336	9	Medium/large flowing waters, lakes, reservoirs	Shoals/riffles in large rivers
	Rough pigtoe	*Pleurobema plenum*	338	9	Medium/large flowing waters, lakes, reservoirs	Medium/large rivers (20m wide or greater)
	Orangefoot pimpleback (pearlymussel)	*Plethobasus cooperianus*	340	9	Medium/large flowing waters, lakes, reservoirs	Medium/large rivers
	Ring pink (mussel)	*Obovaria retusa*	341	9	Medium/large flowing waters, lakes, reservoirs	Prefers large rivers
	Purple bankclimber (mussel)	*Elliptoideus sloatianus*	366	9	Medium/large flowing waters, lakes, reservoirs	Small to large river channels
	Fat threeridge (mussel)	*Amblema neislerii*	375	9	Medium/large flowing waters, lakes, reservoirs	Small to large rivers; slow to moderate current
	Spectaclecase (mussel)	*Cumberlandia monodonta*	4490	9	Medium/large flowing waters, lakes, reservoirs	Large rivers; slow to swift current

Taxon	Common name	Scientific name	Entity ID	PULA #	PULA habitat description	Species habitat description (From FWS sources)
	Sheepnose Mussel	*Plethobasus cyphyus*	7816	9	Medium/large flowing waters, lakes, reservoirs	Medium-size rivers; deep water (> 2m)
	Everglade snail kite	*Rostrhamus sociabilis plumbeus*	1221	6& 9	Small water bodies, wetlands, Medium/large flowing waters, lakes, reservoirs	wetlands, including lowland freshwater marshes, shallow vegetated edges of lakes, and natural and man-made waterbodies.

*Listed bird that feeds on apple snails (*Pomacea paludosa*; a mollusk species). This bird is included because it is obligate to a specific aquatic invertebrate species.

Appendix C

Case Study Summary Tables

Development of Case Studies

EPA developed case studies of representative insecticides to inform and illustrate the three-step framework of the Insecticide Strategy. Case studies were developed concurrently with the framework using an iterative process considering the different toxicity data and use patterns for the selected insecticides discussed below. Conventional agricultural insecticides that represent a variety of 1) modes of action (MoAs; *e.g.*, acetylcholinesterase inhibitor, insect growth regulator, sodium channel modulator) 2) use patterns 3) physical-chemical properties and 4) toxicity to terrestrial and aquatic invertebrates were selected. EPA conducted case studies for the following insecticides:

1. Chlorantraniliprole
2. Diflubenzuron
3. Dimethoate
4. Ethoprop
5. Imidacloprid
6. Lambda-cyhalothrin
7. Methoxyfenozide
8. Propargite
9. Sulfoxaflor

These nine chemical example case studies reflect the draft framework that is presented in this document (**Section 3)** and illustrate how the framework could be applied to different insecticides and how chemical-specific information may influence the mitigations that are identified. In these analyses, EPA presents the three steps of the Insecticide Strategy, including the estimates of exposure and summary of population-level toxicity endpoints used to calculate Magnitude of Differences (MoDs), discussion of the level of mitigation needed for listed invertebrates in aquatic and terrestrial habitats, and identification of which spray drift and runoff/erosion mitigations would be proposed for the general label and for each proposed geographic-specific pesticide use limitation areas (PULAs). In the following tables, labeled uses are grouped into Use Data Layers (UDLs) for comparison purposes for these example case studies. When the draft Insecticide Strategy is implemented, proposed mitigations are intended to be use-specific. In some cases, EPA simplified the pesticide-specific information, including labeled use information, to concisely demonstrate the draft IS framework. The case studies are intended to be illustrative and are not intended to support regulatory actions for the specific insecticide active ingredients. The following sections summarize the mitigations that are identified for each of the nine insecticides presented in the **Case Study Summary and Process** document when EPA applied the draft IS framework.

Mitigation Results of Case Studies

Runoff/Erosion

For chemicals where EPA had the toxicity information to differentiate between the sensitivity of different aquatic taxa (insect, crustacea, mollusk), EPA used taxa-specific endpoints (as described in **Section 3.1**) to calculate MoDs and required mitigation points. For the chemicals where the available toxicity information did not allow for differentiating between the sensitivity of different listed species taxonomic groups, EPA relied on general aquatic invertebrate toxicity endpoints to calculate MoDs (and the required mitigation points). The mitigations identified to minimize exposure from runoff/erosion vary by insecticide and use pattern in two fundamental ways. The first difference is whether, and how the identified mitigations are implemented using the general label or the proposed geographic-specific PULAs developed for the draft Insecticide Strategy (also referred to as the insecticide strategy species groups; see **Section 3.3** of the draft strategy). The second difference is the level of mitigation identified as indicated by the number of mitigation points assigned to the different use patterns.

General Label Runoff Mitigation

Runoff mitigations that go on the nationwide label pertain to listed generalists which depend on aquatic invertebrates for survival due to the wide-ranging occurrences of these species throughout the contiguous US (**Section 3.3**). Such mitigations take the form of points that are to be achieved through various measures to reduce runoff/erosion of applied insecticides.

For listed generalist species that rely on aquatic invertebrates, when looking across all example case study chemicals, potential runoff mitigations are more frequently identified among the UDLs for wetland habitats (**Table C-2**) than for the EPA farm pond (**Table C-1**). Two exceptions are for methoxyfenozide and imidacloprid, which, as illustrated, would not require any mitigations for generalists in aquatic habitats from the assessed uses. Because listed generalist species may depend on invertebrate species in either the wetland or farm pond or larger water bodies, and these may not be easily determined in the landscape, EPA proposes to use the waterbody type with the highest mitigation value when determining the mitigation on the general label. For example, although chlorantraniliprole did not have any MoDs >1 for generalists in the farm pond (**Table C-1)**, EPA determined that exposures in the wetland would need to be reduced by up to an order of magnitude from chlorantraniliprole uses to vegetable and ground fruit uses to prevent population-level impacts to generalists, which results in mitigations of up to 3 points (**Table C-2**) that could be placed on the nationwide label for these uses. Typically, the mitigations in the case study chemicals would likely be based on the wetland MoDs, but for very persistent compounds, the farm pond may result in higher MoDs and resultant mitigations. In the case studies, the highest runoff mitigation needed on the label was found to be for dimethoate and ethoprop, which, as illustrated, would require up to 6 points for some uses to prevent population-level impacts to generalists.

Table C-1. Summary of Example Ranges of Mitigation Points for Generalists in the EPA Farm Pond by Chemical and UDL.

UDL	Chlorantraniliprole	Diflubenzuron	Dimethoate	Ethoprop	Imidacloprid	Lambda-Cyhalothrin	Methoxyfenozide	Propargite	Sulfoxaflor
Alfalfa	None	None	None	NA	NA	2	None	None	None
Citrus	None	0 - 2	None	NA	None	2-4	None	None	None
Corn	None	NA	NA	0 - 3	None	2-4	None	None	None
Cotton	None	None	None	NA	None	2-4	None	None	None
Grapes	None	NA	NA	NA	None	NA	None	None	NA
Other Crops	NA	None	NA	NA	NA	NA	NA	None	None
Other Grains	None	None	NA	None	None	NA	NA	None	None
Other Orchards	None	0 - 2	None	0 - 3	None	NA	None	0 - 2	None
Other Row Crops	None	None	NA	0 - 3	None	2-4	None	None	NA
Soybeans	None	None	NA	NA	None	2	NA	NA	None
Vegetables and Ground Fruit	None	None	None	0 - 3	None	2 - 4	None	None	None
Wheat	None	None	NA	NA	None	2	NA	NA	None
Xmas Trees	NA	NA	None	NA	None	NA	NA	None	None

UDL=Use Data Layer; NA=Not Applicable (either not registered or not modeled). Ranges in potential runoff mitigation points reflect different crop exposure scenarios modeled within each UDL and evaluation of acute and chronic exposures.

Table C-2. Summary of Example Ranges of Mitigation Points for Generalists in the EPA Wetland by Chemical and UDL.

UDL	Chlorantraniliprole	Diflubenzuron	Dimethoate	Ethoprop	Imidacloprid	Lambda-Cyhalothrin	Methoxyfenozide	Propargite	Sulfoxaflor
Alfalfa	0-3	None	0 - 3	NA	NA	2 - 4	None	0 - 2	0 - 3
Citrus	None	0 - 2	0 - 3	NA	None	2 - 4	None	0 - 2	None
Corn	None	NA	NA	0 - 6	None	2 - 4	None	0 - 2	None
Cotton	0-3	0 - 2	0 - 3	NA	None	2 - 4	None	0 - 2	0 - 3
Grapes	None	NA	NA	NA	None	NA	None	None	NA
Other Crops	NA	2 - 2	NA	NA	NA	NA	NA	2 - 2	None
Other Grains	None	0 - 2	NA	0 - 3	None	NA	NA	0 - 2	None
Other Orchards	None	0 - 2	0 - 3	3 - 6	None	NA	None	0 - 2	None
Other Row Crops	None	0 - 2	NA	3 - 6	None	2 - 4	None	0 - 2	NA

UDL	Chlorantraniliprole	Diflubenzuron	Dimethoate	Ethoprop	Imidacloprid	Lambda-Cyhalothrin	Methoxyfenozide	Propargite	Sulfoxaflor
Soybeans	None	0 - 2	NA	NA	None	2	NA	NA	None
Vegetables and Ground Fruit	0 - 3	None	0 - 6	0 - 6	None	2 - 4	None	0 - 2	0 - 3
Wheat	None	0 - 2	NA	NA	None	2	NA	NA	None
Xmas Trees	NA	NA	3 - 6	NA	None	NA	NA	2 - 2	None

UDL=Use Data Layer; NA=Not Applicable (either not registered or not modeled). Ranges in potential runoff mitigation points reflect different crop exposure scenarios modeled within each UDL and evaluation of acute and chronic exposures.

Geographic-Specific Runoff/Erosion Mitigations based on PULAs

The range of mitigations points needed for the seven aquatic PULAs (IS species groups 4-10) based on the case study UDLs and chemical is provided in **Table C-3** and **Table C-4**, respectively. Listed mollusks (*i.e.*, IS groups 6, 8, and 9) generally needed fewer mitigation points than for the other taxa with the exception of methoxyfenozide and propargite, which required up to 6 points of mitigation for the wetland mollusk IS group 6 (**Table C-4).** The aquatic invertebrate MoDs for methoxyfenozide, propargite, and chlorantraniliprole are based on invertebrate toxicity data combined across listed species groups as available data did not support taxa-specific toxicity endpoints. The taxa-specific endpoints resulted in lower mitigations on a narrower range of use patterns. This highlights the importance of having a robust toxicity database when determining mitigations to help identify the potential differential toxicity between aquatic taxa.

Table C-3. Summary of Runoff Mitigation Point Ranges Across Case Study Chemicals within each IS Species Group and UDL

IS GROUP	Crustaceans in vernal pools (IS Group 4)	Aquatic-phase Insects (IS Group 5)	Mollusks in small waterbodies/ wetlands (IS Group 6)		Crustaceans in wetlands/ ponds (IS Group 7)	Mollusks in low flow waters (IS Group 8)		Mollusks in med/fast flowing water and large waterbodies (IS Group 9)		Crustaceans in karst systems (IS Group 10)
Endpoint Used	Crustaceans	Aquatic-Phase Insects	Mollusks	General Inverts[1]	Crustaceans	Mollusks	General Inverts[1]	Mollusks	General Inverts[1]	Crustaceans
Alfalfa	0-9	0-9	None	0-6	0-9	None	0-6	None	0-3	0-3
Citrus	0-9	0-9	None	0-6	0-9	None	0-6	None	0-3	0-4
Corn	0-9	0-9	None	0-6	0-9	None	0-6	None	0-6	0-4
Cotton	0-9	0-9	None	0-6	0-9	None	0-6	None	0-3	0-4
Grapes	0-6	0-6	None	0-6	0-6	None	0-6	None	0-6	0-3
Other Crops	0-6	0-6	0-0	0-6	0-4	0-0	0-6	0-0	0-4	0-2
Other Grains	0-6	0-6	0-0	0-6	0-6	0-0	0-6	0-0	0-4	0-3
Other Orchards	0-9	0-9	0-3	0-6	0-9	None	0-6	None	0-6	0-3
Other Row Crops	0-9	0-9	0-3	0-6	0-9	None	0-6	None	0-6	0-6
Soybeans	0-4	0-6	0-0	0-3	0-6	0-0	0-3	0-0	0-3	0-2
Vegetables/ Ground Fruit	0-9+	0-9	None	0-6	0-9	None	0-6	None	0-6	0-6
Wheat	0-6	0-6	0-0	0-3	0-6	0-0	0-3	0-0	0-3	0-3
Xmas Trees	0-6	0-9+	None	0-6	0-9+	None	0-6	None	0-6	0-3

+ Indicates MoDs were >1,000 and additional mitigation may be needed to reduce exposures to approach population-level endpoints. Ranges in potential runoff mitigation points reflect different crop exposure scenarios modeled within each UDL and evaluation of acute and chronic exposures.

[1] Refers to case study chemicals where broad sensitivity differences among aquatic crustaceans, insects and mollusks are not identified; as such, the MoD values are based on toxicity data for all invertebrate taxa.

Table C-4. Summary of Mitigation Point Ranges Across IS Group by Chemical

Chemical	Crustaceans in vernal pools (IS Group 4)	Aquatic-phase Insects (IS Group 5)	Mollusks in small waterbodies/ wetlands (IS Group 6)	Crustaceans in wetlands/ponds (IS Group 7)	Mollusks in low flow waters (IS Group 8)	Mollusks in med/fast flowing water and large waterbodies (IS Group 9)	Crustaceans in karst systems (IS Group 10)
Chlorantraniliprole	0-6	0-3	0-3	0-3	0-3	None	None
Diflubenzuron	0-4	0-4	None	0-4	None	None	0-2
Dimethoate	0-9	0-9+	None	0-9+	None	None	None
Ethoprop	3-9+	0-9	None	0-9	None	None	0-6
Imidacloprid	0-3	0-6	None	0-6	None	None	0-3
Lambda-Cyhalothrin	2-6	4-6	None	4-6	None	None	2-4
Methoxyfenozide	0-6	0-6	0-6	0-6	0-6	0-3	0-3
Propargite	2-6	2-6	2-6	2-6	2-4	0-2	0-2
Sulfoxaflor	None	0-3	None	None	None	None	None

+ Indicates MoDs were >1,000 and additional mitigation may be needed to reduce exposures to approach population-level endpoints. Ranges in potential runoff mitigation points reflect different crop exposure scenarios modeled among UDLs and evaluation of acute and chronic exposures.

Examining the results in more detail for four case study chemicals (imidacloprid, sulfoxaflor, dimethoate and methoxyfenozide) further illustrates the influence of taxonomic differences in potential runoff/erosion mitigation points identified (**Table 5**). For simplification, the comparisons in **Table 5** focus on potential mitigations in wetland habitats only. Imidacloprid and sulfoxaflor are shown as examples, where MoDs and potential mitigations for each taxonomic group (crustaceans, insects, and mollusks) are evaluated separately. Dimethoate is included because it illustrates the case where crustaceans and insects could not be separated in terms of sensitivity and are therefore assessed collectively, but mollusks are evaluated separately due to their lower sensitivity. Methoxyfenozide illustrates the case where none of the three listed species groups could be evaluated separately based on lack of apparent sensitivity differences.

Across the selected chemicals in **Table C-5**listed mollusks would only potentially require mitigations for methoxyfenozide, where available toxicity data did not support the derivation of mollusk-specific MoDs. For imidacloprid and sulfoxaflor where listed crustaceans and insects are evaluated separately, the identified range of mitigation points is equal to or higher for aquatic insects relative to crustaceans. This is most apparent for the sulfoxaflor mitigation points in **Table C-5**. The illustrative analysis indicates that for sulfoxaflor, no mitigations would be needed to address direct impacts to listed crustaceans, but mitigations for listed aquatic-phase insects could potentially be needed.

Table C-5. Summary of Example Runoff/Erosion Mitigation Points for Aquatic Invertebrates by Taxa in the EPA Wetland.

UDL	Imidacloprid			Sulfoxaflor			Dimethoate		Methoxyfenozide
	Crustacean	Insect	Mollusk	Crustacean	Insect	Mollusk	Crustacean & Insect	Mollusk	General Invertebrate*
Alfalfa	NA	NA	NA	None	0 - 3	None	0 - 9	None	0 - 6
Citrus	0 - 6	0 - 6	None	None	None	None	0 - 9	None	0 - 3
Corn	None	None	None	None	0 - 3	None	NA	NA	0 - 6
Cotton	0 - 6	0 - 6	None	None	0 - 3	None	3 - 9	None	0 - 6
Grapes	0 - 3	0 - 3	None	NA	NA	NA	NA	NA	0 - 6
Other Crops	NA	NA	NA	None	None	None	NA	NA	NA
Other Grains	0 – 3	0 - 3	None	None	0 - 3	None	NA	NA	NA
Other Orchards	0 - 6	0 - 6	None	None	None	None	0 - 9	None	0 - 6
Other Row Crops	0 - 6	0 - 6	None	NA	NA	NA	NA	NA	0 - 6
Soybeans	0 - 3	0 - 3	None	None	0 - 3	None	NA	NA	NA
Vegetables and Ground Fruit	0 - 6	0 - 6	None	None	0 - 3	None	0 - 9	None	0 - 6
Wheat	0 - 3	0 - 3	None	None	0 - 3	None	NA	NA	NA
Xmas Trees	0 - 3	0 - 3	None	None	None	None	3 - 9	None	NA

UDL=Use Data Layer; NA=Not Applicable (either not registered or not modeled). Ranges reflect different crop exposure scenarios within each UDL and evaluation of acute and chronic exposures.
*Also includes consideration of benthic invertebrates in wetland environments.

Table C-6 summarizes the potential number of points needed to mitigate direct impacts to aquatic invertebrates across each modeled aquatic habitat (farm pond, small vernal pool, wetland) within the vegetables and ground fruit UDL. This UDL is shown because it is the only UDL that is shared by all case study chemicals. For direct impacts to listed aquatic invertebrates, when including small vernal pools, the trend regarding which waterbody type may lead to higher levels of mitigation is not as apparent as it seems for generalists (discussed above for the general label) where higher mitigation points are identified for wetlands compared to the farm pond. Notably, MoDs and potential runoff mitigation points for small vernal pools consider acute exposures only (a limitation of the edge of field modeling) whereas with the EPA wetland, both acute and chronic exposures and effects are considered. Based on the maximum mitigation points assigned across the subset of data in **Table 6**, potential mitigations for the farm pond are generally similar to or fewer than that for wetland habitats.

Table C-6. Summary of Example Runoff Mitigation Points for Listed Aquatic-Phase Insects by Waterbody based on Vegetables and Ground Fruit Uses.[1]

Chemical	EPA farm pond	Small Vernal Pool [2]	EPA Wetland
Chlorantraniliprole*	0 - 3	0 - 6	0 – 3
Diflubenzuron	0 - 2	0 - 4	2 – 4
Dimethoate	0 - 3	0 - 6	0 – 9
Ethoprop	0 - 9	3 - 9	0 - 9
Imidacloprid	0 - 6	0 - 6	0 - 6
Lambda-Cyhalothrin	4 - 6	4 - 6	4 - 6
Methoxyfenozide*	0 - 6	0 - 3	0 - 6
Propargite*	2 - 4	4	2 - 6
Sulfoxaflor	None	None	0 - 3

[1] Mitigation points presented here represent example mitigations for insects and general invertebrates.
[2] Since Edge of Field EECs for small vernal pools are available only for acute exposures from runoff, MoDs and potential mitigation points reflect acute exposures only. For larger vernal pools, both acute and chronic MoDs are assessed, thus resulting in higher potential mitigation points for some chemicals.
*Chemicals relying on general invertebrate data (as differential toxicity for aquatic insects and other organisms could not be determined)

Differences in the potential mitigation points identified for various application methods are illustrated in evaluated in **Table C-7** for chlorantraniliprole and sulfoxaflor where two or more application methods per assessed within one or more uses. Based on these examples, the impact of application method on potential mitigations appears chemical-specific. For chlorantraniliprole, the potential mitigations based on seed treatment are not indicated due to low estimated aquatic exposure from seed treatment applications. For foliar applications, potential mitigations could be required up to 3 points with the assessed uses of chlorantraniliprole. For imidacloprid, potential mitigations are identified for all application methods across all applicable UDLs. Based on the use-specific mitigation points identified for imidacloprid, the seed and soil application methods for imidacloprid have more uses where mitigations is not indicated (*i.e.,* mitigations points = 0) compared to foliar application methods, although this is not apparent when examining the overall ranges provided in **Table C-7**.

Table C-7. Summary of Example Mitigation Points for Aquatic Insects in the EPA Wetland by Application Method.

A.I.	Application Method	Corn	Other Grains	Wheat	Vegetables and Ground Fruit	Citrus	Cotton	Grapes	Other Orchards	Other Row Crops	Soybeans	Xmas Trees
Chlorantra-niliprole	Foliar	0 - 3	0 - 3	0 - 3	0 - 3	NA						
	Seed	None	None	None	None							
Imidaclo-prid	Foliar	NA			3 - 6	3 - 3	3 - 6	0 - 3	3 - 6	3 – 6	3	3
	Seed				0 - 6	NA	0 - 3	NA		0 - 6	0 - 3	NA
	Soil				0 - 3	0 - 6	0 - 3	0 - 3	0 - 3	0 - 6	NA	3 - 6

A.I.=Active Ingredient; NA=Not Applicable (not registered or not assessed)

Spray Drift

For all 9 insecticides in the illustrative case studies, EPA identified spray drift mitigations for liquid spray applications to registered uses. As indicated in **Section 3.2**, spray drift buffers for each insecticide are predicated on the likelihood of population-level impacts from spray drift. Buffer distances for each chemical vary by application rate, application method (*e.g.*, aerial, ground, or airblast), droplet size distribution, and the habitat (*e.g*., terrestrial, pond, or wetland), as well as for the listed species group being assessed.

A summary of the buffer mitigation categories for a subset of case study chemicals is shown in **Table C-8, Table C-9**, and **Table C-10**. Each chemical/UDL combination is assigned a likelihood for potential population impacts of "not likely," "low," "medium," and "high" based on the MoD at the edge of the treated field following the methods described in **Section 3.1**. Based on that category, EPA determines whether no buffer, a minimum buffer distance, a chemical-specific buffer distance, or the maximum buffer distance is identified to reduce exposure from spray drift. Of the case study insecticides, only methoxyfenozide has data with which EPA differentiates the sensitivity of lepidopterans (*i.e.*, butterflies) from other terrestrial invertebrates. Therefore, for all other case study insecticides, spray drift buffers to terrestrial areas are the same for IS species groups 1, 2, and 3.

EPA notes that all identified buffers may be reduced by any of the available mitigation measures outlined in **Section 3.2** (*e.g.*, hedgerows, hooded sprayers).

General Label Spray Drift Mitigation

Mitigations that go on the nationwide label are based on those needed to avoid population-level impacts to listed generalist species that broadly depend on aquatic or terrestrial invertebrates for survival. In terrestrial habitats, the case studies indicate that spray drift buffers are not identified for mitigating spray drift exposures to listed generalist species from labeled uses of chlorantraniliprole or methoxyfenozide (**Table C-8**). In contrast, potential chemical-specific buffers (based on application rate and toxicity) are identified for dimethoate for all assessed uses except Christmas trees and cherries, and imidacloprid would need a maximum spray drift buffer for all assessed uses.

Table C-8. Summary of Example Spray Drift Buffers for Listed Generalist Species that Broadly Rely on Invertebrates by UDL for General Label Mitigations.

UDL	Chlorantraniliprole	Dimethoate	Imidacloprid	Methoxyfenozide
Alfalfa	No Buffer	CS		No Buffer
Christmas Trees		Max Buffer	Max Buffer	
Citrus	No Buffer	CS	Max Buffer	No Buffer
Corn	No Buffer			No Buffer
Cotton	No Buffer	CS	Max Buffer	No Buffer
Grapes	No Buffer		Max Buffer	No Buffer
Other Grains	No Buffer			
Other Orchards	No Buffer	Max Buffer	Max Buffer	No Buffer
Other Row Crops	No Buffer		Max Buffer	No Buffer
Soybeans			Max Buffer	
Vegetables and Ground Fruit	No Buffer	CS	Max Buffer	No Buffer
Wheat	No Buffer		Max Buffer	

Minimum Buffer = 25 ft; Maximum Buffer varies by application method and droplet size; CS = Chemical Specific and is the distance calculated in AgDrift up to the maximum buffer distance.
Grayed areas indicate the use is not registered or not registered for foliar applications for a given chemical.

Geographic-Specific Mitigations based on PULA

A summary of geographic-specific spray drift mitigation buffers for IS species groups 1 and 3 (listed bees, dragonflies, and beetles) is shown **Table C-9** for four selected case study insecticides. For these proposed IS species groups, no buffer is indicated for the assessed methoxyfenozide uses, a minimum buffer is indicated for the chlorantraniliprole assessed uses, and most dimethoate uses required the maximum buffer. In contrast, a maximum buffer was indicated for all imidacloprid uses assessed (**Table C-9**).

As shown in **Table C-10**, the same spray drift buffers are identified for IS species group 2 (listed butterflies) as groups 1 and 3 (listed bees, dragonflies, beetles) for all chemicals except for methoxyfenozide. Methoxyfenozide is the only case study insecticide for which butterfly-specific MoDs (and mitigations) could be evaluated. A maximum buffer distances is identified for methoxyfenozide with IS group 2 given the high sensitivity of butterflies relative to other taxa for this chemical.

Table C-9. Summary of Example Spray Drift Buffers for Listed Species in Insecticide PULAs 1 and 3 (Bees, Dragonflies, Beetles) by UDL.

UDL	Chlorantraniliprole	Dimethoate	Imidacloprid	Methoxyfenozide
Alfalfa	Min Buffer	Max Buffer		No Buffer
Christmas Trees		Max Buffer	Max Buffer	
Citrus	Min Buffer	Max Buffer	Max Buffer	No Buffer
Corn	Min Buffer			No Buffer
Cotton	Min Buffer	Max Buffer	Max Buffer	No Buffer
Grapes	Min Buffer		Max Buffer	No Buffer
Other Grains	Min Buffer			
Other Orchards	Min Buffer	Max Buffer	Max Buffer	No Buffer
Other Row Crops	Min Buffer		Max Buffer	No Buffer
Soybeans			Max Buffer	
Vegetables and Ground Fruit	Min Buffer	CS	Max Buffer	No Buffer
Wheat	Min Buffer		Max Buffer	

Min Buffer = 25 ft; Max Buffer varies by application method and droplet size; CS = Chemical Specific and is the distance calculated in AgDrift up to the maximum buffer distance.
Grayed areas indicate the use is not registered or not registered for foliar applications for a given chemical.

Table C-10. Summary of Example Spray Drift Buffers for Listed Species in Insecticide PULA 2 (listed butterflies) by UDL.

UDL	Chlorantraniliprole	Dimethoate	Imidacloprid	Methoxyfenozide
Alfalfa	No Buffer	Max Buffer		Max Buffer
Christmas Trees		Max Buffer	Max Buffer	
Citrus	No Buffer	Max Buffer	Max Buffer	Max Buffer
Corn	No Buffer			Max Buffer
Cotton	No Buffer	Max Buffer	Max Buffer	Max Buffer
Grapes	No Buffer		Max Buffer	Max Buffer
Other Grains	No Buffer			
Other Orchards	No Buffer	Max Buffer	Max Buffer	Max Buffer
Other Row Crops	No Buffer		Max Buffer	Max Buffer
Soybeans			Max Buffer	
Vegetables and Ground Fruit	No Buffer	CS	Max Buffer	Max Buffer
Wheat	No Buffer		Max Buffer	

Min Buffer = 25 ft; Max Buffer varies by application method and droplet size; CS = Chemical Specific and is the distance calculated in AgDrift up to the maximum buffer distance.
Grayed areas indicate the use is not registered or not registered for foliar applications for a given chemical.

Summary of detailed levels of spray drift mitigation

For illustrative purposes, a summary of the downwind buffer distances EPA identified for dimethoate use patterns within each UDL are provided in **Table C-11 .** and **Table C-12** for terrestrial and aquatic organisms, respectively. Details for the other eight case study chemicals are provided in the **Case Study Summary and Process** document. EPA selected the highest buffer distance identified across all exposure pathways (contact and oral). For listed generalists that broadly depend on aquatic or terrestrial invertebrates for survival, EPA generally identified less restrictive downwind buffer distances to protect generalist species that rely on invertebrates compared to listed species within the proposed IS species groups 1-10. As expected, potential spray drift buffer distances are generally greater for aerial applications compared to ground application methods.

Table C-11. Spray Drift Mitigation Measures Identified for Listed Terrestrial Invertebrates, Animals that Obligately Depend on Terrestrial Invertebrates, and Generalist Animals (PPHD) as Related to Single Maximum Application Rate, Application Method, and Droplet Size.[1]

UDL	Use	Distance from Edge of Treated Area (ft)					
		IS Group 1 - 3			Listed Generalists		
		Aerial	Ground	Airblast	Aerial	Ground	Airblast
Alfalfa	Alfalfa	320*	230*	N/A	130	60	N/A
Christmas Trees	Douglas Fir	N/A	230	Max	N/A	230	160
Citrus	Citrus	N/A	230	Max	N/A	125	75
Cotton	Cotton	320*	230*	N/A	130	60	N/A
Other Orchards	Cherries	320	230	Max	160*	175	80
Vegetables and Ground Fruit	Broccoli	320*	230*	N/A	130	60	N/A
	Peppers	320*	200	N/A	100	45	N/A

*Chemical-specific buffer determined to be at the maximum allowable buffer distance.
Max=Maximum Allowable Buffer Distance; N/A=Application method not registered for specific use.

Table C-12. Spray Drift Mitigation Measures Identified for Listed Aquatic Invertebrates, Animals that Obligately Depend on Aquatic Invertebrates, and Generalist Animals (PPHD).

UDL	Use	Distance from Edge of Treated Area (ft)											
		Crustaceans/Insects						Mollusks			Generalists		
		IS Group											
		4, 5, & 7			10			6, 8, & 9					
		A	G	AB	A	G	AB	A	G	AB	A	G	AB
Alfalfa	Alfalfa	320*	230*	N/A	None	None	N/A	None	None	N/A	None	None	N/A
Christmas Trees	Douglas Fir	N/A	230	160	N/A	10	25	N/A	None	None	N/A	10	25
Citrus	Citrus	N/A	230*	160*	N/A	None	None	N/A	None	None	N/A	None	None
Cotton	Cotton	320*	230*	N/A	None	None	N/A	None	None	N/A	None	None	N/A
Other Orchards	Cherries	320*	230*	160*	None	None	None	None	None	None	10	10	25
Vegetables and Ground Fruit	Broccoli	320*	230*	N/A	None	None	N/A	None	None	N/A	None	None	N/A
	Peppers	320*	230*	N/A	None	None	N/A	None	None	N/A	None	None	N/A

*Chemical-specific buffer determined to be at the maximum allowable buffer distance.
A=Aerial; G=Ground; AB=Airblast; Max=Maximum Allowable Buffer Distance; Min=Lower Limit Buffer Distance; N/A=Application method not registered for specific use.