Draft Herbicide Strategy Framework to Reduce Exposure of Federally Listed Endangered and Threatened Species and Designated Critical Habitats from the Use of Conventional Agricultural Herbicides

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1 Executive Summary

When the Environmental Protection Agency (EPA) 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 registrations do not jeopardize the continued existence of federally threatened or endangered (listed) species or adversely modify their designated critical habitats (CH). 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 amendments that require EPA to review potential effects for over 1,700 U.S. listed species.

EPA's Pesticide Program has been unable to keep pace with its ESA workload, resulting not only in inadequate protections for listed species but also successful litigation against the Agency that has increased in frequency in recent years. Historically, it can take between 4-12 years of analysis and consultations with the Fish and Wildlife Service (FWS) and National Marine Fisheries Service (NMFS) in order to meet ESA obligations for a pesticide. Even if EPA completed this work for all of the pesticides that are currently subject to court decisions and/or ongoing litigation, that work would take until the 2040s, and even then, would represent only 5% of EPA's ESA obligations.

This situation creates significant uncertainty for farmers, other pesticide users, and pesticide registrants. For example, if a court vacates a pesticide action, users may lose access to the pesticide for the several years likely needed for EPA to meet its ESA obligations for that action. Without certain pesticide products, farmers could have trouble growing crops that feed Americans and public health agencies could lack the tools needed to combat insect-borne diseases.

EPA recognizes that it needs to fundamentally change the way it approaches its ESA-FIFRA work and has taken several steps in the last 18 months to do so. In January 2022, the Agency committed to fully complying with the ESA before registering any new conventional pesticides. In April 2022, the Agency released a workplan (USEPA, 2022a) on how it will address the ESA-FIFRA challenge, including by working to improve how EPA assesses effects to listed species in its pesticide evaluations and consultation processes, and how it plans to implement early protections for listed species in its FIFRA process (before EPA has made effects determinations or, if necessary, completed consultation). And, in November 2022, the Agency released a workplan update (USEPA, 2022b) which describes the Agency's efforts to reduce pesticide exposure to nontarget organisms, including listed species, during the FIFRA registration review process and through other FIFRA actions. The update also describes other planned strategies to expedite implementation of the ESA Workplan, including strategies for identifying and implementing early ESA mitigation across groups of chemicals (*e.g.*, herbicides, rodenticides, insecticides).

Today's proposed Herbicide Strategy (referred to as the Strategy) is another key step forward for EPA in implementing early, practical protections for listed species and increasing the efficiency of meeting its ESA obligations. The Strategy covers conventional herbicides – an important, widely used tool that growers use to prevent or eliminate weeds that would otherwise compete for light, moisture, and nutrients with the crops, affecting the quality and quantity of produce. This proposed Strategy, once finalized, would provide early protections for over 900 listed species and their critical habitats from agricultural uses of conventional herbicides in the lower 48 states. The mitigations proposed by the Strategy would address potential impacts to the group of species (plants and species that depend on plants) likely to be most sensitive to herbicides, and would thus, likely reduce the potential for population-level impacts to the over 900 listed species in the lower 48 states from herbicide use.

The proposed Strategy describes an efficient approach to determine the need for, the level of, and geographic extent of early mitigations for listed species from agricultural uses of conventional herbicides. The proposed mitigations reflect measures that can be readily, and are often already, implemented by growers and identified by pesticide applicators. The proposed Strategy is structured to provide flexibility to growers to choose mitigations that work best for their situation. Additionally, the draft Strategy may require more or less mitigation for growers/pesticide applicators depending on their location. For example, less mitigation would be needed where crops are grown on relatively flat lands or in the Western United States, which experience less rain. The proposed Strategy also describes EPA's current thinking on how it could add other mitigation measures in the future, particularly to incorporate emerging technology or new information on the effectiveness of additional common practices used by growers. In addition, it describes some potential approaches for growers/pesticide applicators to reduce or potentially meet the mitigation requirements based on their existing practices. For example, EPA is considering exempting growers from certain runoff/erosion requirements in the proposed Strategy when they participate in conservation programs designed for that purpose such as United States Department of Agriculture's (USDA) National Resource Conservation Service (NRCS) program.

Later sections of the proposed Strategy describe a more efficient approach for implementing geographically specific mitigations associated with the Strategy, and EPA's current thinking on how it would update the areas identified for such restrictions as additional, more refined species maps and/or critical habitat information becomes available. It also describes how EPA plans to implement the Strategy in its registration and registration review decisions; and how the Agency envisions the interplay between this Strategy and others such as the recently proposed Vulnerable Species Pilot (June 2023) and FIFRA Interim Ecological Mitigations (IEM) described in the ESA Workplan Update.

EPA also provides case studies for representative herbicides to illustrate the process and ascertain the appropriateness of the criteria (fate properties of a chemical such as the tendency to sorb to soil, and potential effects to non-target species) for selecting the level

of mitigation for each representative chemical. The proposed Strategy, once finalized, would ensure herbicides with similar characteristics have consistent mitigations, creating a level playing field. In addition, because the Strategy would establish a consistent approach for identifying the need and extent of mitigations across herbicides, it would also be more predictable for growers than EPA's current approach.

Another benefit of the proposed Strategy, once finalized, is that it could help increase the efficiency of and expedite future pesticide consultations with the Fish and Wildlife Service (FWS). EPA and FWS are considering whether a pesticide programmatic consultation, or other efficiency measure similar to the proposed Strategy can be used in the development of a programmatic consultation process. Once completed, a programmatic approach would protect the listed species most impacted by herbicides more quickly, accelerate the EPA's ability to meet its ESA obligations for particular herbicides and across the herbicide classes, thus reducing the legal vulnerability of EPA's pesticide decisions, and better ensuring the continued availability of important pest management tools.

Finally, this document describes EPA's current thinking on how it may implement the Strategy through registration and registration review decisions for particular herbicides. EPA acknowledges that it is not feasible to implement the Strategy on all currently registered herbicide products at the same time. EPA updated its registration review schedule on April 10, 2023 to align with the strategies discussed in the ESA Workplan Update. Several conventional herbicides in registration review are now scheduled for a proposed interim decision in calendar year 2024.

In addition to this Herbicide Strategy Framework, EPA is releasing multiple supporting documents including a *Draft Technical Support for Runoff, Erosion, and Spray Drift Mitigation to Protect Non-Target Plants and Wildlife* (referred to throughout this document as "**Technical Support for Mitigation**") with supporting information on potential mitigation measures EPA identified to date and for which EPA has data on their efficacy in reducing exposure. The Agency welcomes stakeholder feedback on the proposed Strategy and the supporting documents.

2 Introduction

2.1 Background

Under section 7(a)(2) of the ESA, EPA must ensure that any action authorized, funded, or carried out by the Agency (referred to as an "agency action") is not likely to jeopardize the continued existence of Federally threatened and endangered (referred to as listed) species or destroy or adversely modify CH. In fulfilling the requirements of ESA section 7(a)(2), EPA must use the best scientific and commercial data available. When appropriate for the agency action, EPA consults with the Fish and Wildlife Service (FWS) and the National Marine Fisheries Service (NMFS; hereinafter the Services). Through consultation, EPA must ensure that these actions are not likely to jeopardize the continued existence of listed species or adversely modify their CHs.

In past decades, the Agency has met those obligations for less than 5% of the thousands of pesticide actions it completes annually under FIFRA. The entire process, including consulting with the Services to adopt protections, can take at least four years for a single pesticide and up to 15 years in rare cases. In total, thousands of FIFRA actions will require an ESA review over the next decade alone. EPA's Pesticide Program has been unable to keep pace with its ESA workload, resulting not only in inadequate protections for listed species, but also litigation against the Agency that has increased in frequency in recent years. Courts are increasingly impatient with EPA over its non-compliance with ESA obligations and have even vacated certain registrations. EPA can no longer ignore its ESA obligations, especially if we want to ensure the availability or pesticides for growers and other pesticide users.

The EPA's Office of Pesticide Programs (OPP) faces the decades-long challenge of meeting its ESA obligations for the large number of actions taken annually under the FIFRA. EPA's April 2022 ESA Workplan describes several challenges that have made it difficult for EPA to implement timely and effective strategies that specifically address protecting listed species from possible pesticide effects. To better protect listed species, the workplan also describes how EPA is working to improve how EPA assesses effects to listed species in its pesticide evaluations and consultation processes, and how it plans to implement early protections (before EPA has made effects determinations or completed consultation, if necessary) for listed species. In November 2022, EPA released an update to the workplan (USEPA, 2022b)[1], which describes EPA's efforts to reduce pesticide exposure to non-target organisms, including listed species, during the FIFRA registration review process and through other FIFRA actions. In the workplan update, EPA also described several strategies that EPA is developing to expedite progress on the ESA Workplan initiatives. One of the strategies included in the workplan update is the proposed Strategy.

This Strategy focuses on developing and implementing early protections for more than 900 listed species and designated CH from potential exposure from conventional herbicides with

[1] https://www.epa.gov/system/files/documents/2022-11/esa-workplan-update.pdf

agricultural uses. The goal of the proposed mitigations is to minimize exposure, and thereby reduce the likelihood of a future jeopardy or adverse modification (J/AM) determination and minimize potential take[2] from the ongoing use of registered conventional agricultural herbicides. EPA focused the Strategy on agricultural crop uses in the lower 48 states because hundreds of millions of pounds of herbicides (and plant growth regulators) are applied each year (USEPA, 2017), which is substantially more than non-agricultural uses and for other pesticide classes (*e.g.*, insecticides, fungicides). Additionally, hundreds of listed species in the lower 48 states occur in habitats that are adjacent to agricultural crop sites. Therefore, minimizing the most common exposure routes of concern from the use of conventional agricultural herbicides in the lower 48 states is expected to provide early protections for hundreds of listed species. Through the Strategy, EPA would be able to protect listed species now rather than wait decades for it to complete consultation on the hundreds of currently registered herbicides, and thus ensure these tools remain available to the nation's growers.

Definition Box 1.
For the Strategy, EPA uses the following definitions of three key types of habitats:

A **terrestrial** habitat is dry or upland areas that do not have standing water. Examples include grasslands, shrublands and forests. Areas where crops occur are not included.

A **wetland** is a shallow waterbody that may include permanently or intermittently flooded areas. Examples include wet meadows, marshes, swamps, and riparian areas. For the proposed Strategy, EPA is not referring to a wetland as defined under the Clean Water Act.

An **aquatic** habitat is an area with permeant standing or flowing water. Examples include lakes, reservoirs, rivers, streams, ponds, and estuaries.

See **Appendix A** for more detailed descriptions of waterbodies.

In particular, EPA developed mitigation options for conventional agricultural herbicides to reduce pesticide transport via spray drift (pesticide movement by air/wind at the time of application) and runoff/erosion (pesticide movement with water/soil) that could result in exposure to listed plants and listed animals that depend on plants. To support the Strategy mitigation options, EPA is also releasing a document titled, *Draft Technical Support for Runoff, Erosion, and Spray Drift Mitigation to Protect Non-Target Plants and Wildlife* (USEPA, 2023a) (referred to throughout this document as "**Technical Support for Mitigation**") with supporting information on potential mitigation measures EPA identified to date and for which EPA has data on their associated efficacy in reducing exposures[3]. EPA focused on reducing spray drift, runoff, and erosion transport because FIFRA risk assessments commonly identify risk concerns for plants in terrestrial, wetland, and/or aquatic habitats due to offsite transport in these exposure pathways. If other exposure routes are relevant to a chemical or species

[2] Take as defined under the ESA means "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct" (ESA § 3(19), 16 U.S.C. § 1532(19)). Incidental take is an unintentional take "that result[s] from, but [is] not the purpose of, carrying out an otherwise lawful activity, but not unexpected, taking." See 50 C.F.R. § 402.02.

[3] This is the same draft document EPA released with the draft Vulnerable Species Pilot as it supports both efforts.

that are not covered in this Strategy (*e.g.*, on field risks to mammals or bioaccumulation exposure pathways), they will be addressed in future assessments.

Another primary goal of the Strategy is to help increase the efficiency of future pesticide consultations with FWS. The Strategy is focused on listed species under the jurisdiction of FWS as they have authority over the majority of listed species that could benefit from the Strategy. EPA's typical process for assessing and mitigating effects to listed species takes many years. This process typically starts with a chemical-specific biological evaluation (BE) that assesses effects to all listed species. If EPA finds that effects to a listed species or CH is reasonably likely to occur to one or more individuals of a listed species, EPA initiates consultation (informal or formal) with the responsible Service. At the end of informal consultation, the Service will either provide concurrence with our finding that the effects are not likely to adversely affect a listed species or CH and the process ends, or recommend EPA initiate formal consultation. During formal consultation, EPA, the Service(s), and the pesticide applicant/registrants discuss possible options to mitigate any likely J/AM. At the end of formal consultation, the Service(s) will generate biological opinions (BiOp) when they review EPA's assessment for each species where the EPA finds that the proposed action is likely to adversely affect an individual or CH. The Service(s) determine whether J/AM is likely for any species or designated CHs potentially exposed from the EPA's registration. From start to finish, this process usually takes four to 12 years. The proposed Strategy involves a substantial and necessary change in process to identify and mitigate potential impacts from agricultural uses of conventional herbicides even before EPA makes effects determinations or initiates/completes consultation. To date, EPA has completed its ESA obligations for no more than a handful of conventional herbicides. This is exacerbated by the fact that, in the United States between 2008 and 2012, an average of 1.1 billion pounds of pesticides were applied annually, with about 50% of those being herbicides and 90% of herbicide applications occurred in the agricultural sector (USEPA, 2017). This change is needed so EPA and the Services can use their limited resources to better meet ESA obligations for conventional herbicides and provide protections in a timely manner.

To this end, EPA and FWS have been collaborating during the development of the Strategy. EPA and FWS are considering whether a pesticide programmatic consultation, or other efficiency measure similar to the Strategy framework can be used in the development of a programmatic consultation process. EPA expects that once the programmatic consultation process is developed, individual chemical consultations and evaluations would be much faster. In the meantime, EPA is proposing to start implementing the Strategy once it is finalized so that the finalized mitigations can be applied earlier in the ESA-FIFRA process. EPA is describing these proposals for implementing the Strategy to provide some regulatory certainty for how the Agency expects to adopt mitigation measures under the Strategy, to reduce the legal vulnerability for the pesticide actions that include them, and thus to better ensure the continued availability of these pesticides for those who need them.

2.2 Guiding Principles

There are several major guiding principles that EPA considered when developing the Strategy, including:

- Focusing on minimizing impacts to non-target listed plants and listed animals that depend on plants.
- Focusing on major routes of exposure for the majority of herbicides (*i.e.*, spray drift and runoff/erosion).
- Developing and proposing mitigation measures that could be readily implemented by growers and identified by pesticide applicators, and to provide flexibility to growers to choose mitigations that work best for their situation.
- Proposing consistent mitigation measures across conventional agricultural herbicides.
- Providing options for adding other mitigation measures in the future, particularly to incorporate emerging technology or new information on the effectiveness of additional common measures used by growers.

In developing the Strategy, EPA also considered what it has learned from conducting ESA analyses for multiple pesticides and is proposing a more efficient approach to provide earlier mitigation to protect listed species. This approach is based on analyses EPA currently uses to estimate exposure and assess impacts of a pesticide, and it uses a taxa level assessment, where species with similar characteristics and habitat are evaluated as a group. Through the Strategy, EPA determined the listed species associated with each species group and defined where those species would be located in the lower 48 states. EPA is proposing to identify mitigation to reduce exposure for each species group.

The Strategy proposes a mitigation menu to be used to reduce exposure to listed species from spray drift, runoff, and erosion from the use of conventional agricultural herbicides. The proposed spray drift and runoff/erosion mitigations included in the menu are agricultural measures known by growers and applicators. EPA anticipates receiving efficacy data on additional measures and emerging technologies as the data become available and, as discussed later in this document, is proposing to implement the Strategy such that it can efficiently add other mitigation measures to the menu in the future.

Concurrent with the Strategy, EPA has been working on other initiatives to reduce exposure to non-target wildlife, such as the recently proposed Vulnerable Species Pilot (USEPA, 2023d) and updates to the FIFRA IEM that were proposed in November 2022 and received extensive public comment (USEPA, 2022b). Because of the differing timelines for these initiatives, there are inconsistencies in the mitigation and label language proposed among them. However, EPA is continually working to improve and harmonize the ecological mitigation and label language across these efforts to the extent appropriate. EPA anticipates that the mitigation and label language for runoff/erosion and spray drift proposed across the Strategy, Vulnerable Species Pilot, and FIFRA IEM would have the same

options and consistent descriptions; however, the level and extent of mitigation would change as appropriate for their purposes. This document has some example language to illustrate the mitigation options that build on EPA's proposals in the FIFRA IEM and the vulnerable species pilot (USEPA, 2023d).

2.3 EPA's Approach to Identify Where Mitigation Would Apply

Where EPA identifies geographically specific listed species protections (as opposed to protections that apply more broadly, which would be on the pesticide label), it delineates pesticide use limitation areas (PULAs). PULAs are the geographic areas where a pesticide limitation specific to listed species applies. These geographic-specific restrictions are located in Endangered Species Protection Bulletins that are accessed through EPA's Bulletins Live! Two (BLT) website. Put simply, the information on BLT is designed to tell the grower/applicator if additional restrictions or mitigations must be followed to protect listed species for a particular location.

PULAs can represent the spatial extent of a single listed species range or CH, or can represent the combined ranges and CHs of multiple listed species. EPA develops PULAs with multiple species ranges/CHs when the locations all share the same pesticide use limitations (*i.e.*, mitigations). To efficiently and effectively implement geographically specific mitigations for the Strategy, EPA is not proposing to develop single species PULAs and bulletins, but rather to produce four bulletins, each of which represents multiple species that have common taxonomy and habitats and thus need the same mitigations.

For the proposed Strategy, EPA used species-specific location information (species range and CH, if applicable) provided by FWS to establish proposed PULAs. Species range maps show where listed species live, are suspected to live, and areas that impact the species' survival or recovery in some way. EPA's default is to use the species' ranges and/or CHs to identify protection areas. For the Strategy, EPA used species range and CH information available in the FWS Environmental Conservation Online System (ECOS)[4]. FWS has embarked on an effort to refine its species range maps and now has refined range maps for about half of the listed species under its jurisdiction. Additionally, for the consultation with FWS on malathion (USFWS 2022), species experts at FWS provided alternative, even more refined areas where protections are needed for select species. Recognizing the efforts FWS has been undertaking to refine species ranges and areas where protections are most needed for certain species, EPA's current thinking is that it would update any PULAs developed for the final Strategy on a periodic and known basis (*e.g.*, once per year in a given month), ensuring its geographic restrictions reflect the best available information not only today but into the future.

[4] Here, EPA used spatial data representing the listed species range and designated CH locations provided by the FWS as of February 16, 2022 (USFWS, 2022), as this was the most up to date information at the time EPA began developing the Strategy.

2.4 Case Studies to Illustrate the Strategy

EPA conducted case studies of representative herbicides to identify the level and extent of mitigation that would apply to protect the listed species covered by this effort. EPA used representative herbicide examples to illustrate the process and ascertain the appropriateness of the criteria (*i.e.*, combinations of magnitude of difference and pesticide physical-chemical properties) for selecting the level of mitigation measures for each representative chemical. Within the case studies, EPA also identified potential groups of listed species and CHs of listed plants and animals in the 48 conterminous United States where there may be population-level impacts. The purpose of this analysis was to support future streamlined consultation with FWS. The case studies are not intended to be part of the implementation of the Strategy for chemical specific assessments, but rather to illustrate how this Strategy appropriately identifies the mitigation measures that would apply to protect listed plants and impacts to animals due to effects to plants. Details on the method, models, and tools used in these case studies are in *Herbicide Strategy Case Study Summary and Process* (referred to as **Case Study Summary and Process**).

2.5 Organization of This Document

This document is intended to explain the proposed Strategy to a wide range of stakeholders including registrants/applicants, FWS, herbicide applicators, pesticide regulators, conservation specialists, risk assessors, risk managers, nonprofit organizations, and the public. EPA is currently requesting public comments on this proposed Strategy. EPA plans to issue a final Strategy after receiving and incorporating this feedback.

EPA explains the scope of the Strategy (**Section 3**) and decision framework EPA is proposing to determine the level of mitigation that would apply for a particular conventional agricultural herbicide (**Section 4**). The decision framework has three steps:

1) identify potential population-level impacts (**Section 5**);
2) identify mitigation measures (**Section 6**); and
3) identify geographic extent of mitigation measures (**Section 7**).

EPA describes the types of habitats where mitigation measures would apply for listed species in **Section 6.3**. EPA's case studies are described in **Section 8** and includes examples of how the Strategy mitigation would apply for a subset of the representative herbicides for which EPA conducted case studies. EPA's proposed implementation plan is discussed in **Section 9**. The Strategy effort has a number of materials supporting this work. Each of these are described in **Table 2-1** and are available in the docket for comment.

Table 2-1. Summary of the Herbicide Strategy Supporting Materials

Document Title	Short Title	Summary of Document
Draft Herbicide Strategy Framework to Reduce Exposure of Federally Listed Endangered and Threatened Species and Designated Critical Habitats from the Use of Conventional Agricultural Herbicides (this document)	Strategy Framework Document (this document)	The framework describes the analyses conducted to estimate exposure and assess the potential impacts of a pesticide to species groups with similar characteristics, and the extent of mitigations that would apply for a particular herbicide to protect listed species groups. The Strategy proposes a mitigation menu to reduce exposure to listed species from spray drift, runoff, and erosion that would apply to conventional agricultural herbicides. Finally, the Strategy provides information on identifying the geographic extent of mitigation measures and describes the implementation plan.
Draft Technical Support for Runoff, Erosion, and Spray Drift Mitigation Measures to Protect Non-Target Plants and Wildlife	Technical Support for Mitigation	This document provides information for the mitigation measures that EPA identified to date to reduce offsite transport of pesticides in spray drift, aqueous runoff (referred to as runoff), and erosion and to communicate to the public and stakeholders the efficacy of mitigation measures to protect non-target plants and wildlife.
Herbicide Strategy Case Study Summary and Process	Case Study Summary and Process	The case studies helped EPA identify the level and extent of mitigation measures for the Strategy. EPA used representative herbicide examples to illustrate the process and ascertain the appropriateness of the criteria (*i.e.*, combinations of magnitude of difference and pesticide physical-chemical properties) for 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 species and CHs based on effects to plants only from future impacts from conventional agricultural herbicides.
Case Study Magnitude of Difference Calculations	Case Study MoD Calculations	This document provides supporting information on the calculation of the Magnitude of Difference (MoD) for each example herbicide.
Crosswalk Of Species Habitat Assumptions, Aquatic Bins, and Hydrologic Unit Code (HUC) 2 regions	Crosswalk of Species and Aquatic Bins	This Excel spreadsheet includes information on all currently listed species and CHs under the authority of FWS that are in the conterminous US. This spreadsheet includes information on the habitats and taxa assumptions for each species and CH.
List of Species in Each Grouped Species Pesticide Use Limitation Area (PULA)	List of Species in PULAs	This Excel workbook includes information on which species and CHs are included in each of the four proposed PULAs for the Strategy.
Herbicide Strategy Species Overlap and Characteristics	Species CH Overlap and Characteristics	Supporting materials for selecting species with potential population-level impacts for case studies.
Application of EPA's Draft Herbicide Strategy Framework Through Scenarios that Represent Crop Production Systems	Strategy Applied to Crop Production Scenarios	This document describes examples of how runoff and erosion mitigation measures proposed in the Strategy might be employed in various crop production systems.

3 Scope of the Herbicide Strategy

The scope of the Strategy is to develop an efficient approach to implement mitigation measures[5] for agricultural uses of all conventional herbicides in the lower 48 states to minimize exposure from spray drift and runoff/erosion to the main group of species affected by herbicides—plants—and animals that depend on plants. The Strategy focuses on listed plants and animals under the jurisdiction of FWS.

The Strategy would make major strides in protecting listed species from agricultural uses of conventional herbicides. As explained earlier, the pounds of herbicides applied each year for agricultural uses is substantially more than for non-agricultural uses and other pesticide classes (*e.g.*, insecticides, fungicides). In effect, the mitigations proposed by the Strategy would likely be effective at reducing the potential for population-level impacts to the over 900 listed species in the lower 48 states from the use of herbicides. In addition, the Strategy would enable EPA and the Services to use their limited resources to better meet ESA obligations for the many registered conventional herbicides for which EPA has not yet met its ESA obligations. EPA would still need to conduct more thorough ESA analyses during consultations for listed species not covered by the Strategy (*e.g.*, listed species located on the field or candidate species). EPA expects that the Strategy would provide a more efficient process for making any future effects determinations, predictions of the likelihood of J/AM in BEs, and consultations with FWS for herbicides for the 900+ listed species covered by the Strategy.

EPA's Workplan Update covers (USEPA, 2022b) other strategies to help fulfill the Agency's ESA responsibilities, including those focused on other use patterns (*i.e.*, non-agricultural use patterns), geographies (*i.e.*, Hawaii and the territories), or species (vulnerable listed species). A key strategy is the FIFRA IEM that applies to outdoor use of conventional pesticides. IEMs do overlap with the proposed mitigation measures in the Strategy. As described in **Section 9**, EPA expects that the level of mitigation to reduce exposure from spray drift and/or runoff/erosion in the final Strategy would supersede the IEM for all uses covered by the Strategy, because the mitigations for the Strategy would be at least as stringent as those for the IEMs. The IEM would still apply to agricultural uses of other pesticides not covered by this Strategy.

4 Overview of Decision Framework for Identifying Mitigation Measures

EPA developed a proposed decision framework to identify the level and extent of mitigation that would apply to conventional agricultural herbicides. EPA developed this framework to efficiently and consistently apply mitigation measures to minimize pesticide exposure, and thereby reduce the potential for population-level impacts from the ongoing use of

[5] Mitigation measures are changes to the action that will reduce the likelihood of exposure and risk to listed species.

registered conventional agricultural herbicides. This process would be applied to Agency actions after the Strategy is finalized, consistent with the implementation plan described in **Section 9**. The Strategy case studies used a similar process to that described here; however, there were some differences to support the development of the Strategy, and identification of species in species groups. See the **Case Study Summary and Process** for details. This section provides a high-level overview of the framework with the detailed information in the remaining sections of this document.

The general decision framework for a particular herbicide involves the following steps (**Figure 4-1**):

1. **Identify population-level impacts:** Conduct a streamlined analysis to determine which groups of plant species are expected to have the potential for population-level impacts from direct exposure to herbicides, and which groups of animals could be affected because they rely on listed plans for their diet or habitat . If at least one group of listed species is potentially impacted, proceed to step 2 to identify mitigations that would apply. This streamlined analytic process is described in **Section 5** below.

2. **Identify type and level of mitigation:** Determine the level of mitigation measures that would apply to reduce exposure via drift and/or runoff/erosion (as described in **Section 6**). Mitigation measures are identified specific to an herbicide active ingredient, formulations[6], use site, application parameters, and maximum use rates.

3. **Identify geographic extent of mitigation:** Determine the spatial extent of the mitigation measures that would apply. In some situations, mitigation would apply to target the areas where groups of listed species occur. In those situations, EPA expects to use its web-based system, BLT, to post geographically specific mitigation for listed species. See **Section 7**.

[6] Spray drift exposure is evaluated for applications of liquids via aircraft, airblast, or ground boom equipment. Spray drift mitigation measures are not applicable to granule formulations.

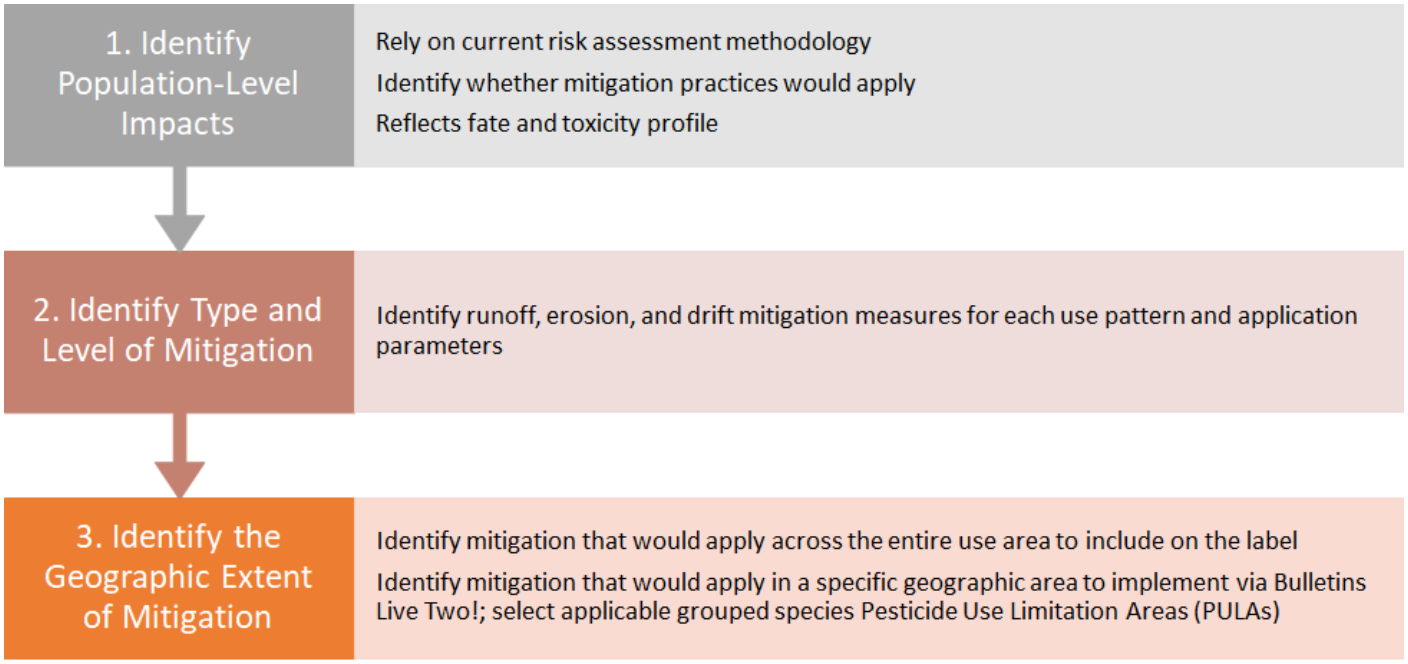


Figure 4-1. Overview of the Draft Herbicide Strategy Process

4.1 Overview of Step 1. Identify Population-level Impacts (Strategy Analysis)

While potentially applicable to a broad range of conventional agricultural herbicide FIFRA actions, the population-level this streamlined analysis builds on the standard ecological risk assessment process for plants that EPA uses to support a new active ingredient registration action and registration review. The analysis is similar to the FIFRA ecological risk assessment where EPA calculates ratios of exposure to toxicity estimates for species grouped by characteristics (dicot, monocot, vascular, non-vascular; obligate versus generalist) and

habitat (terrestrial, semi-aquatic, aquatic) to predict the potential for population-level impacts and identify the level of mitigation that would apply to reduce the potential for population-level impacts. However, there are differences in the proposed approach from the standard FIFRA ecological risk assessment described in **Section 5**. A key concept in this analysis is the exposure to toxicity ratio, which this document refers to as the Magnitude of Difference (MoD). The MoD is analogous to the risk quotients (RQs) that EPA calculates and compares to regulatory Levels of Concern in FIFRA assessments. RQs and MoDs are similar in that they both involve a ratio of exposure to toxicity; however, they differ by the toxicity endpoint. In this case, EPA is using the term "MoD" instead of "RQ" because EPA is using toxicity information to represent plant population or community level impacts, whereas the RQ typically relies upon toxicity information more representative of potential effects to an individual. EPA is not using the standard Level of Concern, which also looks at impacts to the individual of a species (USEPA, 2004). Rather, EPA is comparing estimated environmental concentrations (EECs) which represent the estimated level of a pesticide in the environment, to toxicity endpoints that are appropriate to identify potential species-level impacts or impacts to a population or habitat. Because the level in the environment would affect one or more populations of a species (rather than only one individual of a species), EPA believes that EECs are the correct measurement to use for population-level assessments. As the Strategy is focused on reducing the likelihood of potential population-level impacts, EPA calculates MoDs using toxicity endpoints that are protective of a population of a single species or a community of species. EPA relied on MoDs to determine the potential for population-level impacts and to identify mitigations to reduce the potential for impacts to individuals, populations of individuals, or communities made up by multiple species. Typically, as you move from protecting individuals to protecting populations and communities, the relevant toxicity endpoints increase in concentration (*i.e.,* are less sensitive), and RQs or MoDs decrease;

Definition Box 2.

Obligate: Listed species that cannot survive and/or complete their life-cycle without another species are called obligates. For example, wild blue lupine (*Lupinus perennis*) is the only plant Karner blue butterfly (*Lycaeides melissa samuelis*) larvae, or caterpillars, can eat. Thus, Karner blue butterflies have an obligate relationship to blue lupine.

Generalist: Species with a generalist relationship to plants (for the purposes of the HS) or animals. These species do not have an obligate relationship to another species. For examples, species that rely on a range of different plants in their diet or habitat.

Magnitude of Difference (MoD): The MoD is the ratio of the estimated environmental concentration (EEC) to the relevant toxicity threshold. The MoD informs the potential for population-level impacts.

Population-Level Impacts: These impacts refer to potential for impacts to a population of an individual species.

Community-level Impacts: These impacts refer to the potential for impacts to multiple different species within an ecosystem.

however, sometimes the toxicity endpoints and exposure to toxicity ratios are similar due to limited data. Additional information on this approach is included in **Section 5**.

For the Strategy, EPA proposes to use the MoD for each species group along with other lines of evidence (e.g., presence of an unexpected number of incidents, number of exposure scenarios that support a conclusion) to determine the potential for population-level impacts as described in **Table 4-1**. While EPA considers lines of evidence in all analyses for the evaluation of the potential for population-level impacts, the lines of evidence would most frequently influence the result when the MoD is between 1 and 10. This is because when the MoD is less than one, evidence, such as a large set of reported incidents, that would support greater concern and change that determination, is uncommon in EPA's experience. When the MoD is greater than 10, EPA would make a determination that there is a potential for population-level impacts if additional information is not available to support this conclusion. When the MoD is less than one and lines of evidence do not refute a conclusion that impacts are generally not likely, then EPA would not identify additional mitigation. When the MoD is between 1 and 10, the lines of evidence are evaluated to determine whether or not the MoD indicates population-level impacts are likely. When the MoD is greater than 10 and lines of evidence confirm or do not refute this finding, additional mitigation would generally apply. See **Section 5.3** for additional discussion.

Table 4-1. Relationship Between the Magnitude of Difference and Potential for Population-Level Impacts

Magnitude of Difference (MoD)[1]	Potential for Population-Level Impact[2]
<1	Not likely
1 – <10	Not likely or likely depending on lines of evidence described in **Section 5.3**
10 or higher	Likely

[1] The MoD is the ratio of the exposure estimate to the relevant toxicity endpoint for population-level impacts as described in **Section 5.1**.

[2] Lines of evidence are considered in all analyses for the evaluation of the potential for population-level impacts; however, it is most common that the lines of evidence would influence the result when the MoD is between 1 and 10. There are rare cases where the lines of evidence would influence the potential for population-level impacts when the MoD <1 or the MoD is greater than 10.

4.2 Overview of Step 2. Identify Type and Level of Mitigation Measures

4.2.1 Identify Spray Drift Mitigation Measures

EPA is proposing a decision framework to identify mitigation measures that would apply for mitigating spray drift (**Figure 4-3**). When identifying the level of spray drift mitigation measures, EPA would consider the maximum single application rate, application equipment, droplet size distribution (DSD), release height, and any wind speed restriction for the evaluated use. For the Strategy, EPA is proposing a spray drift buffer between an application and an adjacent area (see **Section 6.3** for a description of listed species habitat) where listed

species could be exposed when the MoD (as described in **Section 5**) is greater than one at the edge-of-the field. The buffer reduces the potential for deposition of drift where listed species could be exposed and other mitigation measures can further reduce the potential for deposition of drift (*e.g.*, windbreaks). EPA uses AgDRIFT® to identify the buffer distance for aerial, ground boom, and airblast application equipment. EPA is proposing buffers up to a maximum distance that represents the reasonable and prudent upper bound distance beyond which the reduction in exposure is small over a large distance (<1% change in the fraction of applied over 100 feet). See **Figure 4-2** below for an illustration of the field and mitigation measures described above.

For efficiency, as described for the example case study herbicides and three generic examples below **Figure 4-2**, EPA is first comparing the calculated drift distances for a particular herbicide to the maximum drift distance as a screen. If drift distances for a particular herbicide are all greater than the maximum distance, then the drift buffer for that herbicide would default to the maximum distance, possibly with some additional measures (*e.g.*, windbreak).

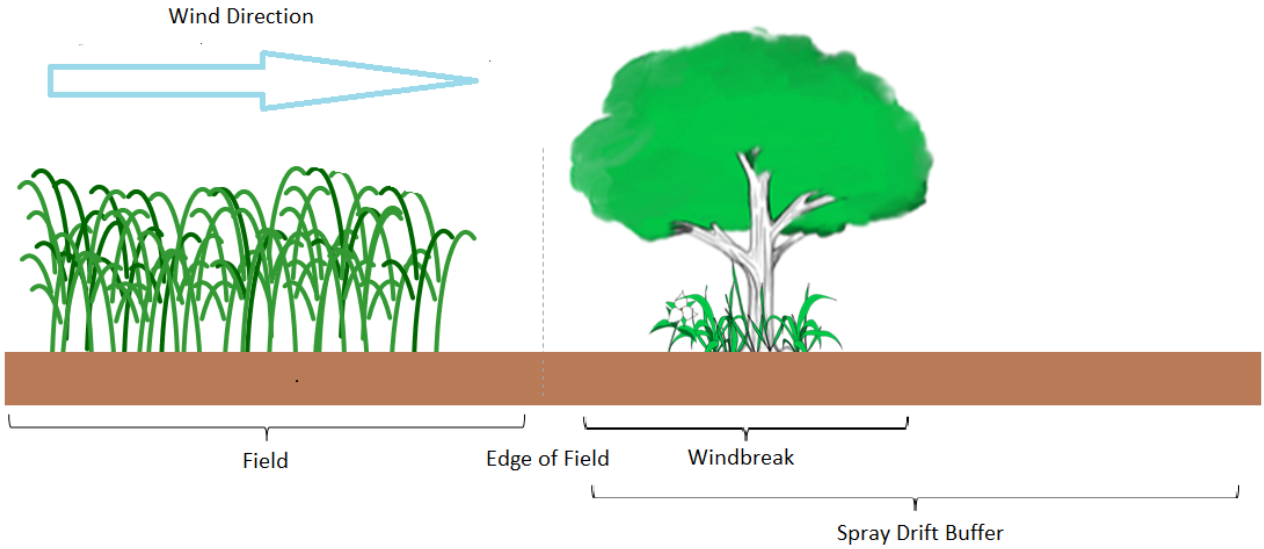


Figure 4-2. Spray Drift Exposure and Mitigation Measure Conceptual Model

EPA is proposing to compare the spray drift deposition at the edge-of-the-field and at the maximum buffer distance to the relevant toxicity endpoint used to calculate the MoD to identify the level of the spray drift mitigation that would apply as described in **Figure 4-2** The examples in **Table 4-2** match the examples of the potential combination of spray drift mitigation measures that may apply as described in **Figure 4-3**.

Example 1: EPA would identify one of two options to minimize the potential for impacts to populations when the spray drift deposition exceeds the relevant toxicity endpoint by more than 10x at the maximum buffer distance. The two options involve 1) a maximum buffer

and windbreak or hooded sprayer, or 2) a maximum buffer and windbreak or hooded sprayer plus rate reductions and/or prohibition of application equipment. EPA would identify option 2 when option 1 is unlikely to minimize impacts.

Example 2: EPA would identify the maximum buffer or a lower recommended distance and options to reduce the buffer, when the spray drift deposition exceeds the relevant toxicity endpoint at the maximum spray drift buffer, but the deposition is not greater than 10x that endpoint. If lines of evidence indicate population level impacts (as described in **Section 5.3**) may occur at an MoD of 1, the maximum buffer distance would apply. If the lines of evidence indicate that population level impacts may occur at an MoD of 10, a buffer distance that results in exposure that is 10x the toxicity endpoint would apply.

Example 3: EPA would identify the spray drift buffer that would result in deposition similar to the relevant toxicity endpoint, and options to reduce the buffer would apply when the spray drift deposition divided by the relevant toxicity endpoint is greater than one at the edge-of-the field but less than one at the maximum buffer distance.

Table 4-2. Examples of the Options Resulting from the Decision Framework for Determining Spray Drift Mitigation Measures that Would Apply to Reduce Impacts to Listed Plants and Animals that Depend on Plants

Example and Mitigations that Would Apply	Spray Drift Deposition Divided by the Relevant Toxicity Endpoint (Similar to the MoD but Only Considering Drift)	
	At the Edge-of-the Field	At the Maximum Buffer Distance
1. Maximum buffer distance and additional mitigation would apply	>10	>10
2. The maximum buffer distance (or a lower recommended buffer based on lines of evidence) could be utilized and options to reduce the buffer distance are available	>1	Between 1 and 10*
3. Identify buffer distance to achieve the targeted deposition using AgDRIFT® and droplet size mitigation are identified and options to reduce the buffer are available.	>1	<1

MoD=magnitude of difference

* If lines of evidence indicate population level impacts (as described in **Section 5.3**) may occur at an MoD of 1, the maximum buffer distance would apply. If the lines of evidence indicate that population level impacts may occur at an MoD of 10, a buffer distance to result in exposure that is 10x the relevant toxicity endpoint would apply.

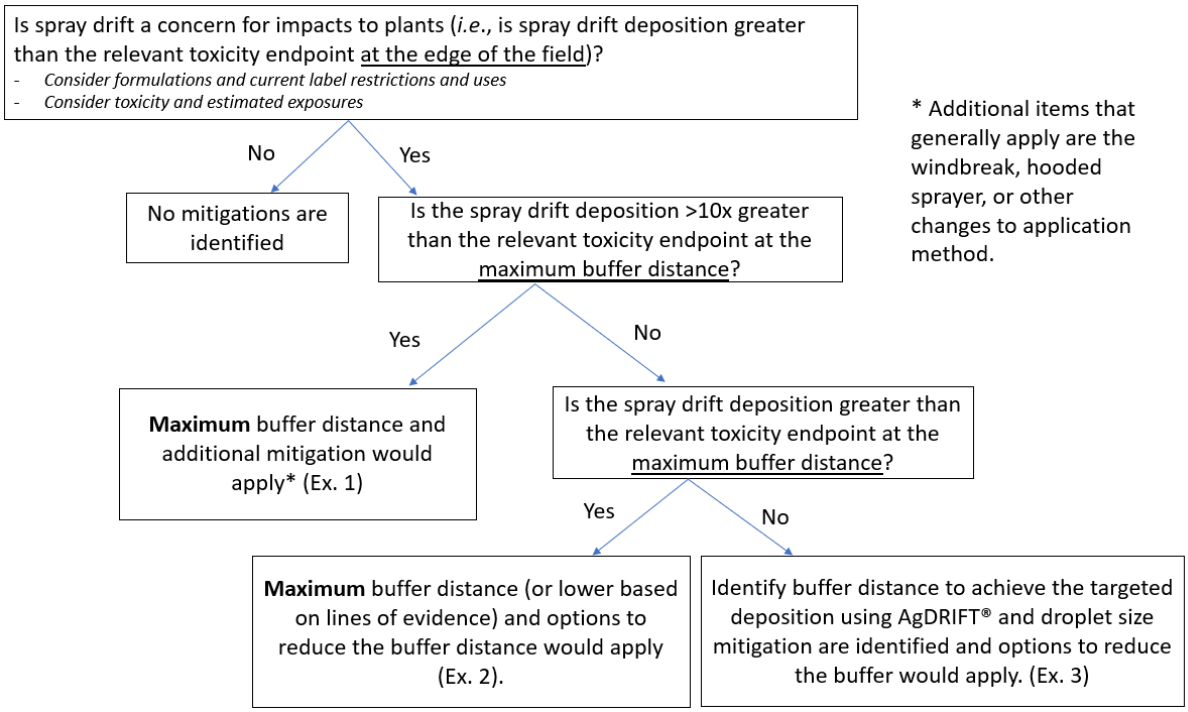


Figure 4-3. Decision Framework for Determining Spray Drift Mitigation Measures that would Apply to Reduce Impacts to Listed Plants and Listed Animals that Depend on Plants

4.2.2 Identify Runoff/Erosion Mitigation Measures

EPA similarly developed a decision framework for run-off/erosion (**Figure 4-4**). EPA developed a runoff/erosion mitigation menu of measures to reduce pesticide offsite transport due to runoff and erosion. EPA categorized the effectiveness of each measure at reducing offsite transport as high, medium, or low (referred to throughout this document as efficacy category). For the Strategy, EPA is currently assigning points to each of the measures on the runoff/erosion mitigation menu based on the efficacy category of the mitigation measure. High mitigation efficacy measures are worth 3 points, medium efficacy measures are worth 2 points, and low efficacy measures are worth 1 point. EPA is proposing that the number of points identified to reduce offsite transport would be determined based on the MoD (as calculated according to **Table 5-1**). Assigning points to measures based on their effectiveness encourages use of mitigation measures with higher efficacy while providing flexibility in terms of options to growers. It also allows for landowners to receive credit for implementing measures that reduce offsite transport of pesticides and could improve habitat for listed species. Additionally, the proposed approach would allow some growers to get credit for measures they already employ that are known to be efficacious for reducing runoff/erosion. With the point system approach, applicators would be able to choose mitigation measures from the runoff/erosion mitigation menu to arrive at a certain number of points identified to adequately reduce offsite transport of pesticides as determined through the MoD analysis. Overall, these mitigation options are expected to

reduce exposure potential for listed species and their habitats by targeting risk reduction measures that effectively reduce runoff/erosion to address population-level impacts and create more efficient analyses in future effects determinations and ESA consultations.

EPA summarizes the decision framework proposed to identify the level of runoff/erosion mitigation measures that would reduce runoff/erosion in **Figure 4-4**. EPA is proposing that runoff/erosion mitigation measures are needed when the MoD is greater than one. The number of points, as discussed in **Section 6.2,** to reduce offsite transport are based on 1) the MoD (as described in **Table 5-1** and **Table 4-3**), 2) the sorption coefficient [7] of the active ingredient and any residues of concern [8], and 3) the aerobic soil metabolism half-life of the active ingredient and any residues of concern. Runoff/erosion mitigation is more effective for chemicals with an organic carbon normalized solid-water distribution coefficient (K_{OC}) greater than 1000 L/kg-organic-carbon or solid-water distribution coefficient (K_d) greater than or equal to 50 L/kg-soil. Pesticides that have an aerobic soil metabolism half-life less than 10 days tend to have lower exposure and reduced offsite transport when the application does not occur within 48-hours of one inch of rain. Therefore, when all aerobic soil metabolism half-life values for the relevant residues are less than 10 days, one less runoff/erosion mitigation point is identified, assuming the label includes a 48-hour rain restriction (as expected to be included on the majority of pesticide labels). However, this would not be applicable if the 48-hour rain restriction was not included on the label. When the MoD is greater than 1000 or if the mitigation points identified are not achievable with points alone, additional mitigations may be identified (*e.g.*, rate reductions, use cancellations). The **Technical Support for Mitigation** provides information on the efficacy of different mitigation measures and **Section 6.2** describes how the points were assigned to different MoDs.

Table 4-3. Potential Number of Points Identified to Reduce Exposure via Runoff and Erosion

Magnitude of Difference (MoD)[1]	Points Identified[2]	
	Runoff Prone (K_{OC} <1000 L/kg-oc or K_d <50 L/kg-soil)[4]	Erosion prone (K_{OC} ≥1000 L/kg-oc or K_d ≥ 50 L/kg-oc)[4]
<1	No mitigation	No mitigation
1 – <10	1 if lines of evidence indicate population level impacts[3] may occur at an MoD of 10 3 if lines of evidence indicate population level impacts[3] may occur at an MoD of 1	
10 – <100	6	5
100 -<1000	9	7
1,000 or higher	9 plus other mitigations	

[7] The organic-carbon normalized solid-water distribution coefficient (K_{OC}) is a measure the propensity of an herbicide to be dissolved in water or sorbed to soil or sediment. For some pesticides, sorption is described using the solid-water distribution coefficient (K_d) without organic-carbon normalization. These are measured in OCSPP Guideline 835.1230 (USEPA, 2008).

[8] The residues of concern may include the parent and some transformation products (either degradates or metabolites) that are determined to be of toxicological concern based on lines of evidence (USEPA, 2018).

[1] The MoD is the ratio of the exposure estimate to the relevant toxicity endpoint for population-level impacts as described in **Section 5.1**.
[2] If the 48-hour rain restriction is on the label and the aerobic soil metabolism half-life for parent and residues of concern is less than 10-days, the number of mitigation points could be reduced by one point. The 48-hour rain restriction states, "Do not apply when soil in the area to be treated is saturated or if NOAA/National Weather Service (available at weather.gov) predicts a 50% chance or greater of 1 or more inches of rainfall to occur within 48 hours following application."
[3] **Section 5.3** describes the lines of evidence considered to determine whether population-level impacts may occur.
[4] The solid-water distribution coefficient (Kd) and organic-carbon normalized solid-water distribution coefficient (K_{OC}) are measures of the propensity of an herbicide to be dissolved in water or sorbed to soil or sediment. These are measured in OCSPP Guideline 835.1230 (USEPA, 2008).

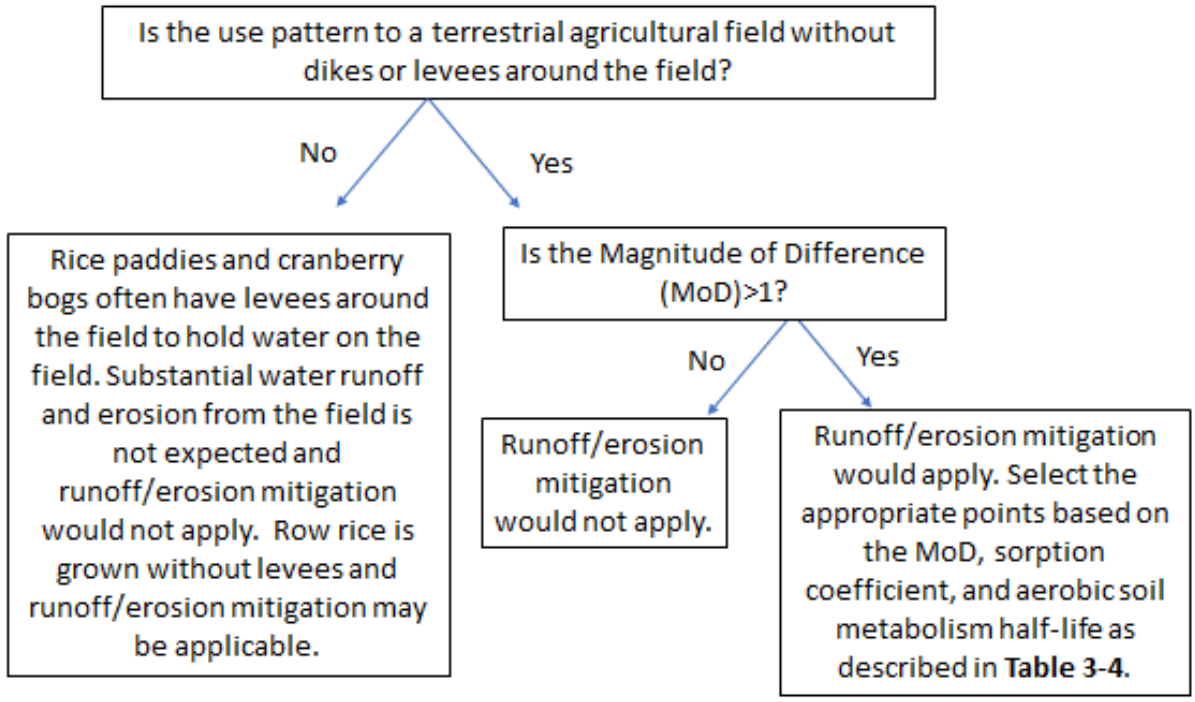


Figure 4-4. Decision Framework for Determining Appropriate Runoff/Erosion Mitigation Measures to Reduce Impacts to Listed Plants and Listed Animals that Depend on Plants

4.3 Overview of Step 3. Identify Geographic Extent of Mitigation

EPA summarizes the decision framework for determining the geographic extent of mitigation in **Figure 4-5**. As described more fully in the ESA Workplan Update, generally, EPA's preference is to have applicants/registrants include ESA mitigations on the general pesticide product label, if practical. This is most appropriate where ESA mitigations broadly apply (cover many species instead of a specific species). Where EPA identifies mitigations specific to certain geographic areas, it generally uses Geographic Information System (GIS) mapping information in combination with species location information to delineate PULAs. PULAs are the geographic areas where a pesticide limitation specific to listed species applies. PULAs allow users to determine if their intended pesticide application falls within a location where additional use restrictions or mitigations are necessary to protect listed species or their CH. These geographic-specific restrictions are located in Endangered Species Protection Bulletins that are accessed through BLT website. Put simply, the information on BLT is designed to tell the grower/applicator if additional restrictions or mitigations must be followed to protect listed species for a particular location. To date, EPA has used this system for such restrictions for specific pesticide products and individual species. In order to efficiently implement this proposed Strategy across all conventional herbicides and the relevant 900+ listed species if EPA identifies geographically specific mitigations, EPA expects to develop PULAs representing groups of species for which similar restrictions would apply (see **Section 7** for details). Where mitigations would apply across the full spatial extent of a use pattern (*e.g.*, corn, soybean, asparagus, *etc.*), EPA may determine that the restrictions should appear on the general pesticide product label rather than on BLT. As described in **Section 7**, to further inform its consideration of whether the limitations would apply over the full use area or a portion of the use area, EPA compared species areas to use site locations using ArcGIS, species range and CH files, and Use Data Layers or National Agricultural Statistics Service (NASS) Census of Agriculture data.[9]

Definition Box 3.

Bulletins Live! Two (BLT): BLT is the web-based application to access Endangered Species Protection Bulletins (Bulletins). These Bulletins contain enforceable pesticide use limitations that are necessary to ensure a pesticide's use will not harm a species listed as threatened or endangered (listed) under the Endangered Species Act or their designated critical habitat.

Pesticide use limitation areas (PULAs): PULAs are the geographic area where a pesticide limitation specific to listed species applies. PULAs allow users to determine if their intended pesticide application falls within a location where additional use restrictions or mitigations are necessary to protect listed species or their designated critical habitat.

Endangered Species Protection Bulletins: The Bulletin's Live! Two application, provides the limitation information for the application site and month in a Bulletin.

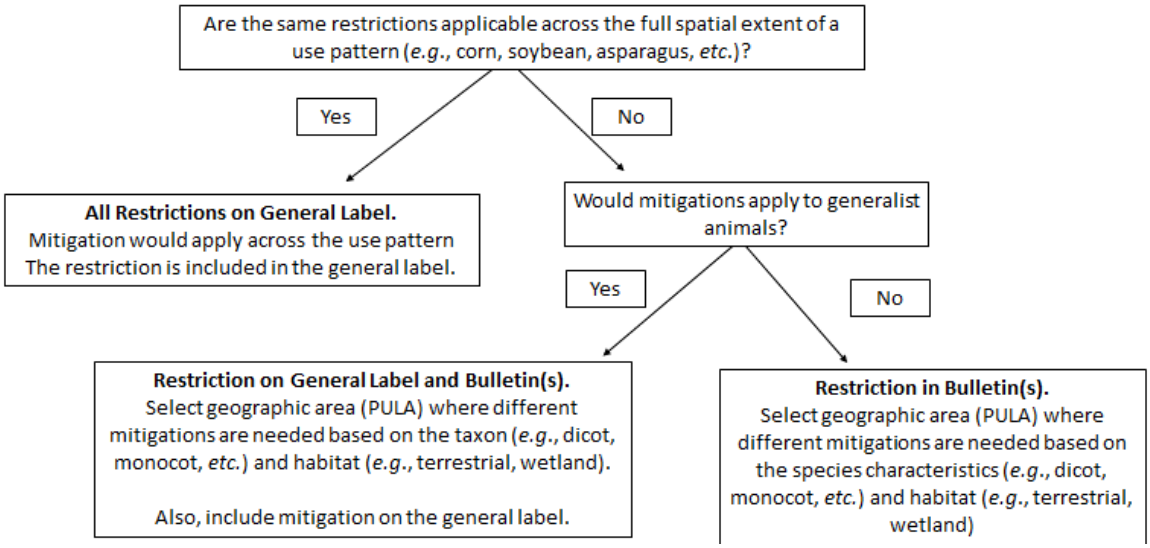


Figure 4-5. Decision Framework for Identifying the Extent of Mitigation

[9] USDA NASS data are available at: https://www.nass.usda.gov/AgCensus/.

5 Detailed Explanation of Step 1: Identify Potential Population-level impacts

5.1 Calculating Magnitude of Difference (MoD)

EPA is proposing to calculate MoDs for different habitats (terrestrial, wetland, or aquatic), species characteristics (*e.g.,* dicot vs. monocot plant; obligate vs. generalist animal), and herbicide use patterns. EPA is proposing to link these calculated MoDs to groups of species that would be represented by the corresponding MoD. EPA would then use the MoDs to identify mitigation measures for that group of species. See **Section 6** for details on identifying the mitigation measures and **Section 7** for the species in each species group.

Definition Box 4.

A **dicotyledon (dicot)** is a flowering plant species that has 2 seed leaves and flower parts are in 4s or 5s. Dicots are often referred to as "broadleaves." Examples of dicots are sunflowers and milkweed.

A **monocotyledon (monocot)** is a flowering plant species with one seed leaf and flower plants are in 3s. Examples of monocots include grasses, orchids, lilies.

A **non-flowering plant** does not produce flowers. Examples of non-flowering plants are ferns and lichens.

Aquatic bins: The EPA, FWS, and NMFS developed generic aquatic habitats to be utilized to estimate exposure to listed species (USEPA, 2020). The FWS identified the relevant aquatic bins for each listed species. EPA uses the bins to determine which aquatic habitat exposure estimates are relevant to calculate the MoD for the aquatic species.

EPA is proposing to calculate 10 MoDs for each herbicide use (**Table 5-1**). EPA's ecological risk assessments for plants estimate a MoD for species that may occur in dryland areas (represented by the Terrestrial Plant Exposure Zone, TPEZ), in semi-aquatic areas (represented by the Wetland Plant Exposure Zone, WPEZ), and in aquatic areas. The FWS identifies which aquatic bins each listed species is associated with to determine which exposure estimates are relevant to the species (USEPA, 2020). Representative exposure in aquatic bins smaller than the EPA farm pond [10] are represented by the Plant Assessment Tool (PAT) wetland as specified in **Appendix A**. Aquatic bins similar to or larger than the EPA farm pond are represented by the EPA farm pond. Most species are associated with multiple aquatic bins. Exposures may vary across uses so EPA calculates different MoDs for different uses.

[10] The EPA farm pond is a conceptual model for estimating exposure in water in ecological risk assessment that assumes a 1-hectare surface area, a 2-meter depth resulting in a pond volume of 20,000 kiloliters, and a 10-hectare drainage area. The EPA farm pond was developed using specifications for construction of ponds in Georgia and is utilized with the Pesticide in Water Calculator (PWC) to estimate exposure in aquatic waterbodies similar to or larger than the EPA pond.

EPA utilizes different toxicity endpoints in the MoD calculations depending on whether the MoD reflects the potential for 1) direct impacts to populations of plants[11], or 2) impacts to plants that may reduce the diet or habitat quality of listed animals that depend on those plants. Regarding the second type, animals may have an obligate[12] or generalist[13] relationship to plants, which EPA uses to determine the appropriate toxicity endpoint for the MoD calculation. EPA can calculate the MoD using either a species sensitivity distribution (SSD) or the most sensitive reliable endpoint that is available that is utilized to calculate the SSD, when data are not sufficient to calculate the SSD. EPA develops SSDs for terrestrial plants using the IC_{25} values and SSDs for aquatic plants using the IC_{50} values. For population-level impacts to listed plants and obligate animals, EPA uses either the 5th percentile of a SSD or the most sensitive IC_{25} value when an SSD cannot be developed. [14] EPA uses the 25th percentile of a SSD to represent an impact to the plant community used by that listed animal because that threshold indicates that on average 25% of plant species tested (a surrogate for the community of plant species) would be impacted at that level.

Table 5-1 summarizes the MoD and the groups of species with similar characteristics that are linked to that MoD; however, **Table 5-1** does not currently include the links between the community-level plant MoDs to all of the corresponding animals that could be impacted. EPA is proposing that all mitigation measures to reduce impacts to diet and habitat and subsequent effects on animals would be included on the general label, so the specific group of species that would be linked to those MoDs were not designated.

[11] Different toxicity endpoints may be considered in BEs when assessing direct effects to individual plants; however, the Strategy focuses upon population-level effects for listed plants.

[12] Listed species that cannot survive and/or complete their life-cycle without the specific species are called obligates.

[13] Generalist listed species do not have an obligate relationship to another species.

[14] Species Sensitivity Distributions 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.

Table 5-1. Summary of Magnitude of Difference Calculations for Different Species Groups

Species Group[1] (also includes CHs)	Magnitude of Difference (MoD) = Ratio of the Estimated Environmental Concentration (EEC) to the Toxicity Endpoint	
	EEC (Model[2])	Toxicity Endpoint[3]
Terrestrial Habitats (Terrestrial Plant Exposure Zone)		
Listed **terrestrial dicots** and listed animals with an obligate relationship to terrestrial dicots	1-in-10 year daily average Terrestrial EEC in units of lbs a.i./A (PWC and PAT) Spray drift point deposition in units of lbs a.i./A (AgDRIFT®)	5^{th} percentile of SSD of IC_{25} or lowest IC_{25} for dicots
Listed **terrestrial monocots** and listed animals with an obligate relationship to terrestrial monocots		5^{th} percentile of SSD of IC_{25} or lowest IC_{25} for monocots
Listed **terrestrial non-flowering plants** and listed animals with an obligate relationship to terrestrial non-flowering plants[4]		Most sensitive 5^{th} percentile of SSD of IC_{25} or lowest IC_{25} across monocots and dicots
Listed **animals** that use terrestrial habitats and have a generalist relationship to plants in these habitats[6]		25^{th} Percentile of SSD of IC_{25} values or lowest IC_{25} for terrestrial plants
Wetland Habitats (Represented by the Wetland Plant Exposure Zone)		
Listed **wetland dicots** and listed animals with an obligate relationship to wetland dicots	1-in-10 year daily average Wetland EEC in units of lbs a.i./A (PWC and PAT) Spray drift point deposition in units of lbs a.i./A (AgDRIFT®)	5^{th} percentile of SSD of IC_{25} or lowest IC_{25} for dicots
Listed **wetland monocots** and listed animals with an obligate relationship to wetland monocots		5^{th} percentile of SSD of IC_{25} or lowest IC_{25} for monocots
Listed **wetland lichens & non-flowering plants** and listed animals with an obligate relationship to wetland lichens & non-flowering plants[4]		Most sensitive 5^{th} percentile of SSD of IC_{25} or lowest IC_{25} across monocots and dicots
Listed **animals** that use wetland habitats and have a generalist relationship to plants in these habitats[6]		25^{th} Percentile of SSD of IC_{25} or lowest IC_{25} for dicot or monocot plants
Aquatic Habitats (Represented by the Wetland Plant Exposure Zone, EPA Pond, or PFAM tailwater)		
Listed **animals** that use small volume/low flow aquatic habitats and have a generalist relationship to plants in these habitats[5, 6]	1-in-10 year daily average Wetland EEC in units of lbs a.i./A (PWC and PAT)	25^{th} Percentile of SSD of IC_{25} or lowest IC_{25} for dicot or monocot plants
	1-in-10 year daily average wetland EEC in µg a.i./L (PWC, PAT) for applications to non-flooded fields Concentration in water released from rice paddy or cranberry bog after holding period for applications to intermittently flooded fields (PFAM)	All available vascular and nonvascular plant IC_{50} values and/or 25^{th} Percentile from SSDs of IC_{50} values

Species Group[1] (also includes CHs)	Magnitude of Difference (MoD) = Ratio of the Estimated Environmental Concentration (EEC) to the Toxicity Endpoint	
	EEC (Model[2])	Toxicity Endpoint[3]
	Spray drift onto the surface area of aquatic bins 2, 5, 8	
Listed **<u>animals</u>** that use medium volume/flow aquatic habitats and have a generalist relationship to plants in these habitats[5,6]	1-in-10 year daily average EEC in EPA Farm Pond in µg a.i./L (PWC) Concentration in water released from rice paddy or cranberry bog after holding period for applications to intermittently flooded fields (PFAM) Spray drift onto the surface area of aquatic bins 3, 4, 6, 7, 9, 10	All available vascular and nonvascular plant IC_{50} values and/or 25th Percentile from SSDs of IC_{50} values

CH=designated Critical Habitat; EEC = estimated environmental concentration; IC_{25} = concentration resulting in 25% inhibition in growth; IC_{50} = concentration resulting in 50% inhibition in growth; PAT = Plant Assessment Tool; PWC = Pesticide in Water Calculator; SSD = Species Sensitivity Distribution; PFAM = Pesticides in Flooded Applications Model; OCSPP=Office of Chemical Safety and Pollution Prevention

[1] The group assignment is determined based on the listed species taxon (plant or animal) and its habitat (terrestrial, wetland, small waterbodies, waterbodies equivalent to or larger than the farm pond). For listed plants, the plant group (monocot, dicot, non-flowering plant, lichen) is also considered. For listed animals, the relationship to plants (obligate or generalist) is considered. These group assignments link the species to the endpoint used to calculate the MoD, which is **bolded** and <u>underlined</u>. When discussing community level effects, this covers diet and habitat effects for listed animals with generalist relationship to plants and impacts on habitat quality and plant relevant physical and biological features for designated CH. As outlined in the **Case Study Summary and Process** document, when an SSD cannot be developed, the MoD for generalist and obligate animals are the same.

[2] The PWC version 2.001 is used to support exposure estimates in PAT and the EPA farm pond (USEPA, 2023b). PAT version 2.7.1 estimates exposure in the terrestrial and semi-aquatic plant exposure zones (USEPA, 2023c). PFAM is utilized to estimate exposure for pesticides applied to intermittently flooded crops such as cranberry bogs, rice, and watercress.

[3] Toxicity endpoints are selected from OCSPP guideline 850.4150 vegetative vigor 850.4150 (USEPA, 2012a), OCSPP Guideline 850.4100 seedling emergence (USEPA, 2012b), OCSPP Guideline 850.4400 aquatic vascular plants, and OCSPP Guideline 4500 (USEPA, 2012b) and 4550 (USEPA, 2012c) non-vascular aquatic plant studies. Data from the open literature and other toxicity data may also be considered when determined to be reliable, as recommended in the Revised Method (USEPA, 2020). When an SSD is available, endpoints from the SSD are used to calculate the MoD, but when a reliable SSD is not available/possible, generally the most sensitive toxicity endpoint is used to calculate the MoD.

[4] This is inclusive of animals that obligately depend on gymnosperms.

[5] Currently, all listed aquatic animals have a generalist relationship to plants. If an animal is listed in the future that obligately relies on plants, this species will need to be assessed separately.

[6] Also used to evaluate impacts on habitat quality and plant relevant physical and biological features (PBFs) for CH.

5.2 Interpreting Magnitude of Difference (MoD)

To address the potential for population-level impacts, the level of mitigation being proposed is based on the MoD for the particular species group considering species characteristics (*e.g.,* monocot, dicot, obligate animal, generalist animal, *etc*.) and habitat (*i.e.,* terrestrial, wetland, aquatic). The 10 species groups are outlined **Table 5-1** *(e.g.,* terrestrial dicot, terrestrial dicot, *etc*.). EPA identified proposed mitigations expected to reduce exposure to levels below the toxicity threshold when the MoD was greater than one. As described in the **Case Study Summary and Process**, there is variability in the toxicity data and exposure estimates. As such, EPA binned the MoDs by order of magnitude, because these are the levels where EPA is confident that there is a difference in the potential for population-level impacts. When the MoD is greater than 10 and the estimated environmental concentrations (EECs) exceed population-level toxicity thresholds, EPA has more confidence that there is a potential for population-level impacts and identified higher levels of mitigations. When MoDs are between 1 and 10 and the EECs and toxicity distributions overlap, there is a potential for some population-level impacts in some areas and populations but not in others. EPA identified less mitigation for these MoDs. As with the MoD calculations, there is also variability in the efficacy of the identified proposed mitigation measures. Thus, EPA binned both the MoD and mitigation categories according to the order of magnitude of the MoD.

EPA assigns a Magnitude of Effect (MoE) classification of low, medium, high, or very high to identify if there is a potential for population-level effects. EPA considers the supporting data used to calculate the MoD (environmental fate and toxicity data), incidents, and monitoring data as lines of evidence when making a determination on the potential for impacts to listed species as described in **Section 5.3**). EPA also identifies a mitigation category of low, medium, high, or very high based on the MoD as specified in **Table 5-2**. When the MoD is less than one and the lines of evidence confirm that population-impacts are not expected, EPA did not identify additional mitigation. When the MoD is between 1 and 10, EPA uses the lines of evidence to determine whether the MoD indicates low or medium MoE (e.g., a potential for population-level impacts or community-level impacts). For example, EPA would identify a low MoE for MoDs between 1 and 10 if there are orders of magnitude of difference between growth endpoints and limited effect on survival in the terrestrial plant toxicity studies (see Metolachlor Case Study Example); however, EPA proposes to assign an MoE of medium if the growth and survival endpoints are within an order of magnitude of each other. Other lines of evidence (*e.g*., incidents, monitoring data, and

Definition Box 5:

Magnitude of Effect (MoE): The MoE determines the potential for population level effects based on a low, medium, high, and very high classification. This is determined based on the MoD and lines of evidence (*e.g*., consideration of the empirical fate and toxicity data and reported incidents and monitoring data).

Mitigation Category: The mitigation category is assigned a low, medium, high, and very high based on the MoD.

factors influencing the exposure estimate), may provide additional information to influence the assignment of MoE for a pesticide.

Table 5-2. Magnitude of Difference using the Population-based Toxicity Endpoints and the Relationship to Magnitude of Effect, Potential Population Level Impacts, and Identified Mitigations.

Magnitude of Difference (MoD) using Population-based Toxicity Endpoint	Magnitude of Effect (MoE)	Population Level Impacts[1]	Mitigation Category (Identified Mitigations to Reduce Exposure Estimates[2])
<1	Low	Not Likely	None
1 to <10	Low or Medium	Not likely or likely	Low (1 to 10 times reduction)
10 to <100	Medium or High	Likely	Medium (10 to 100 times reduction)
100 to <1000	High or Very High		High (100 to 1000 times reduction)
1000 or higher			Very High (>1,000 times reduction)

[1] The MoD is only one consideration in identification of potential population-level impacts. The lines of evidence described in **Section 5.3** are also considered.

[2] This is the amount of reduction identified to reduce exposure to levels that are not expected to result in potential population-level impacts.

While the MoD reflects exposure estimates considering transport via spray drift and runoff/erosion, EPA is proposing to identify the level of mitigation for these transport pathways separately. EPA proposes to identify the amount of mitigation that would apply by the reduction in exposure to get below the population-level or community-level toxicity threshold for each species group. Therefore, the mitigation category is determined by the MoD. Where EPA determines a mitigation category of low and MoD between 1 and 10, mitigation measures will be identified that would achieve a one to 10x reduction in exposure; for the medium mitigation category and MoD between 10 and 100, mitigation measures will be identified for a 10 to 100x reduction in exposure; for a high mitigation category and MoD between 100 and 1000, mitigation measures will be identified for a 100 to 1000x reduction in exposure; and for a very high mitigation category (MoD >1000) mitigation measure will be identified for a >1000x reduction in exposure, with the potential for the highest level of protection and therefore, the most mitigation.

In the **Technical Support for Mitigation**, EPA evaluated the open literature associated with the runoff/erosion mitigation measures identified in **Section 6.2** to describe the effectiveness and reliability of the mitigation measures in reducing exposure. As described, uncertainty with effectiveness of an individual measure, as well as with the effectiveness of combinations of measures, make it difficult to provide an empirical estimate of reductions in EECs for any individual measure or combinations of measures. However, through evaluating these mitigations, it appears that there are likely to be functional limits to the effectiveness of runoff/erosion mitigation measures, used individually or in combination, as the measures are designed to reduce

exposure, not eliminate it. EPA is proposing that the MoDs developed considering transport in both drift and runoff/erosion would be utilized to determine runoff/erosion points; however, EPA would select the spray drift mitigation measures which would result in deposition below the relevant toxicity endpoint. Spray drift mitigation is expected to result in reduced exposure in the receiving terrestrial, wetland, and aquatic habitats. EPA does not revise model-based exposure estimates or recalculate the MoDs for runoff considering the loading reductions afforded by the identified spray drift mitigation. In general, EPA's MoD approach to identify different levels of mitigation considers the uncertainty in both the endpoint and exposure estimates, as well as the combination of spray drift and runoff/erosion mitigation measures. This approach allows flexibility so that the mitigation measures identified for an herbicide will reduce EECs to within an order of magnitude of the population-based endpoints. For plants in terrestrial and wetland habitats, MoDs from 1 to <1000 (*i.e.*, exposure estimates up to 3 orders of magnitude above the population-based endpoint) are expected to be mitigatable through the combination of spray drift mitigation and the runoff/erosion mitigation menu. Therefore, for listed plants and animals and CH, implementation of spray drift and/or runoff/erosion mitigation is sufficient to reduce exposures to the extent that population-level impacts are unlikely. In a future effects determination and/or through programmatic consultation, the mitigation identified for herbicides that follow the Strategy would be expected to result in a reduced likelihood of predicting J/AM and reducing the potential for take for all taxa as a result of effects to plants. For some herbicides, the MoDs may be >1000. In these cases, the mitigation menu (for spray drift and runoff/erosion) alone is unlikely to result in reductions sufficient to reduce the likelihood of a future prediction of J/AM for all species. Consideration of these cases will be made on a chemical/use specific basis to resolve these cases.

5.3 Lines of Evidence when Determining the Potential for Population-level Impacts

EPA uses 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, 1998a; USEPA, 2004; USEPA, 2020) when evaluating the potential for population-level impacts. For the Strategy, the level of confidence relates to the potential for plant population-level impacts or plant 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 (see **Case Study Summary and Process** for details).

Registrants submit environmental fate, exposure, and toxicity data, and EPA utilizes those data along with exposure models to develop MoDs. EPA considers the quality and reliability in these data sets when interpreting the reliability of the MoD. Additionally, registrants submit field studies, and EPA considers whether field data confirm the understanding of the potential for impacts or additional characterization is appropriate. Monitoring data and incidents may be collected after a pesticide is already in use that may inform future ecological analysis on the potential for impacts, in a similar manner to the way that EPA uses field study results. Where such data is available, EPA evaluates whether the model estimated results and laboratory data are consistent with what is being observed in the environment. One nuance to incident data and monitoring data, is that the absence of a detection in the environment or an incident does not

mean that exposure is not occurring or an impact is not occurring in the environment because monitoring data may not have been collected in areas where the pesticide is used, and not all incidents will necessarily be noticed or reported.[15] These lines of evidence are discussed in more detail in **Appendix B**.

When EPA does not have incident or monitoring data, EPA relies on the registrant submitted data to predict the potential for population-level impacts. This does not undermine our confidence in our MoD because the registrant submitted data and EPA's ecological analysis use the best available information to understand the potential for impacts to populations. Data submitted to support registration of pesticides provides a robust dataset to understand the potential for population-level effects from the use of pesticides.

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) and/or there are monitoring or incident data (which reinforce estimates of exposure and the likelihood of population-level impacts), then these increase EPA's confidence in predicting the potential for population-level impacts. EPA plans to consider these lines of evidence for all MoD categories. However, these lines of evidence may be especially important whenever the MoD is less 10. In this situation, the level of mitigation identified may differ if EPA does not consider the incident or monitoring data. EPA is proposing to use its best professional judgement when determining whether population impacts are likely for MoD between 1 and 10. Below are some examples of how EPA may consider the lines of evidence.

- The slope of the SSD is steep such that there is a small difference between the 5th and 25th percentile of the SSD and the MoD is between 1 and <10. EPA would select an MoE of medium indicating population-level effects may be likely because a small change in the EEC could result in exposure greater than the 25th percentile of the SSD. See the case study for dicamba and 2,4-D for an example of this line of evidence.
- Survival and growth were observed in the plant toxicity studies within 10x of each other and the MoD is between 1 and <10. EPA would select an MoE of medium indicating population-level impacts are likely because a small change in the EEC could result in reduced survival. See the case study for trifluralin for an example of this line of evidence.
- Incidents where effects to plants off the field were observed and there is confidence that the incidents resulted from the use of the herbicide of interest and the MoD was between 1 and

[15] Incident reports for non-target organisms typically provide information only on mortality events and plant damage. Sublethal effects in organisms such as abnormal behavior, reduced growth and/or impaired reproduction are rarely reported, except for phytotoxic effects in terrestrial plants. EPA's changes in the registrant reporting requirements for incidents in 1998 may account for a reduced number of reported incidents. Registrants are now only required to submit detailed information on 'major' fish, wildlife, and plant incidents. Minor fish, wildlife, and plant incidents, as well as all other non-target incidents, are generally reported aggregately and are not included in the incident database system. In addition, there have been changes in state monitoring efforts due to a lack of resources.

<10. EPA would select an MoE of medium indicating that population-level effects are likely because the incidents confirm that population-level impacts occurred in the field.

- Monitoring data were available showing that detections were occurring at EECs within an order of magnitude of population-level toxicity thresholds in environments similar to where species may occur and that reflected current use patterns of the herbicide. EPA would select and MoE of medium or high as there would be evidence indicating the exposure was occurring in the environment at levels that could result in population-level impacts.
- Effects were limited to reductions in growth and there was an order of magnitude or more difference in the IC_{25} endpoints and/or the 25^{th} percentile of the SSDs. There are no incident or monitoring data suggesting that population-level impacts are occuring in off-field environments. EPA would select an MoE of low for MoDs 1 to <10, as multiple lines of evidence indicate that population-level impacts are not likely. See the case study for metolachlor as an example of this line of evidence.

See the case studies for additional examples of how lines of evidence may be considered in determining the MoE or potential for population-level impacts.

6 Detailed Explanation of Step 2: Identify Mitigation Measures

This section describes the approaches for identifying spray drift and runoff/erosion mitigation measures under the proposed Strategy. This section also describes the types of areas that can be included in buffers when that mitigation is identified.

6.1 Spray Drift Mitigation Measures

Where EPA identified impacts from spray drift to at least one listed species at step 1 of the Strategy Analysis, the next step is to identify mitigations to address spray drift. EPA is proposing to use the use-specific application scenario (application rate, equipment, and DSD); chemical-specific toxicity endpoints [16] for aquatic, terrestrial, and wetland plants; and population-level MoD, to identify the level of spray drift mitigation that would apply (see **Figure 4-3**). EPA proposes to identify the level of spray drift mitigation that would apply by considering the relationship between the spray drift deposition and the relevant toxicity endpoint at the edge-of-the-field and at the maximum buffer distance. EPA is proposing that when the spray drift deposition is higher than the toxicity endpoint at the edge-of-the field, a downwind spray drift buffer would be established to reduce impacts from drift alone. For combinations of application rate, application release height, and droplet size where identified downwind spray drift buffer distances would result in deposition that would exceed the population-level MoD at the buffer distance, less drift prone application methods may be considered to address potential spray drift impacts. EPA uses AgDRIFT® to calculate the distance to get to concentrations below the toxicity endpoint (or below 10x the toxicity endpoint), and to establish the distance from the application

[16] EPA is proposing that the relevant toxicity endpoints are those utilized to calculate the corresponding MoD as described in **Table 4-1**

where EPA expects the potential for population-level impacts is unlikely. The EPA Offsite Transport Guidance describes how to use AgDRIFT® to calculate distances to a target concentration (USEPA, 2013). The **Technical Support for Mitigation** provides supporting information on the assumptions and development of the level of spray drift mitigation and **Case Study Summary and Process** provides chemical-specific demonstrations of this approach.

EPA's experience with identifying applicable drift buffers indicates that there is a need to identify buffers between the application and a habitat in increments that are feasible to implement and broadly applicable across agronomic and spray equipment differences. Buffers between the application and habitat are also most effective when they are downwind from application areas (see **Technical Support for Mitigation** for further details) and the downwind direction can be easily ascertained with use of simple equipment (*e.g.*, a windsock). EPA recognizes that the effectiveness of buffers is greatest near the site of application and diminishes as the distance away from the application increases. Therefore, EPA is proposing maximum drift buffers for typical spray application methods (aerial, ground, airblast)[17], and different spray droplet sizes (*e.g.*, fine to medium, coarse to very coarse; **Table 6-1**) to focus the use of spray drift buffers to circumstances where they are most effective. Generally, maximum buffers are the distance where the estimated exposure does not change substantially as the buffer distance increases incrementally (*i.e.*, less than 1% change in the fraction of applied over 100-feet).

Table 6-1. EPA's Proposed Maximum Drift Buffer Distances for Aerial, Ground, and Airblast Applications for Conventional Agricultural Herbicides.

Type of Application	Application Parameters Assumed in Modeling	Maximum Buffer Distance in Feet
Aerial Application	Very fine to fine DSD	500
	Fine to medium DSD	300
	Medium to coarse DSD	300
	Coarse to very coarse DSD	200
Ground Boom Application	Very fine to fine DSD; high boom	200
	Very fine to fine DSD; low boom	100
	Fine to medium-coarse; high boom	100
	Fine to medium-coarse; low boom	100
Airblast	Sparse	100

DSD=Droplet Size Distribution; Low boom height is the release height is less than 2 feet above the ground; high boom = release height is greater than 2 feet above the ground

Table 6-2 summarizes options EPA has identified to reduce spray drift buffers and the associated reduction in the buffer. See the **Technical Support for Mitigation** for additional information. These buffer reducing options that pesticide users may elect to use include wind breaks/hedgerows that are at least as tall as the spray release height to intercept drift; hooded sprayers[18]; and application rate reductions. Wind directional buffers could be reduced to half the

[17] Most herbicides are not applied via airblast; however, airblast applications may be needed for fruit thinners or plant growth regulators.

[18] Hooded sprayers are drift reducing technology that physically blocks driftable droplets at or near the spray nozzle.

distance otherwise required when windbreaks (*e.g*., trees or hedgerows) between the application site and habitat are present (*e.g.* a 100 ft buffer can be reduced to 50 ft when a windbreak is present). The windbreak would need to have a row of broad-leaved trees the full length of the treated crop with leaves visible over the entire length, with no noticeable gaps. Wind directional buffers could be reduced to half the distance otherwise required when a hooded sprayer is used. Additional site characteristics that can reduce a given buffer include a crop on field that is ≥1 ft tall (aerial)[19], application with a high relative humidity (>60% for ground and >70% for aerial)[20], or application at a low wind speed (3 to 7 mph for aerial)[21]. These site characteristics may result in reducing the spray drift buffer by 25 ft.

Definition Box 6.

Windbreaks are barriers, usually consisting of trees and shrubs, used to reduce and redirect wind. As wind blows against a windbreak, air moves up and over the top or around the ends of the windbreak. Windbreak structure (*i.e*., height, density, number of rows, plant composition) determines the effectiveness of a windbreak in reducing wind speed. Wind directional buffers may be maintained at half the distance when windbreaks (*e.g*., trees or riparian hedgerows) between the application site and listed species habitat are present. The windbreak must be downwind between the field and listed species habitat. Windbreaks must have a minimum of one row of broad-leaved trees and/or shrubs the full length of the treated crop with leaves visible over the entire length, with no noticeable gaps. The height of the trees or windbreak must be at a height higher than the release height of the application. The windbreak must be planted according to local/regional/federal conservation program standards; however, no state or federally listed noxious or invasive trees or shrubs should be planted. Windbreaks must be maintained such that their functionality is not compromised. While likely only feasible for small fields, a manmade structure (*e.g*., curtain that is raised prior to application, building) could serve as a wind break as long as the structure covered the entire distance of field adjacent to the listed species habitat and the structure is higher than the release height of the application.

Hooded sprayers are drift reducing technology that physically blocks driftable droplets at or near the spray nozzle.

[19] Based on changing AgDRIFT® Tier III aerial parameterization from bare ground surface roughness to an average crop surface roughness value. Not directly applicable to ground application because difference is only impactful at distances beyond maximum buffer distance.

[20] Based on changing relative humidity (RH) from 20% to 60% (ground) and 50% to 70% (aerial). 20% RH is representative of the atmospheric conditions relevant to ground boom spray drift modeling. Default aerial RH (50%) is not directly comparable to ground but relatively higher.

[21] Based on changing AgDRIFT® Tier III aerial parameterization from 10 mph to 7 mph.

Table 6-2. Summary of Spray Drift Mitigation Options That Could Result in Reducing the Spray Drift Buffer

Mitigation Consideration	Application Type		
	Aerial	Ground	Airblast
Downwind Windbreak/Hedgerow	Buffer reduced by 50%	Buffer reduced by 50%	Buffer reduced by 50%
Hooded Sprayer	N/C	Buffer reduced by 50%	N/C
App. Rate Reduction	Buffer calculated using app. rate and AgDRIFT®	Buffer calculated using app. rate and AgDRIFT®	Buffer calculated using app. rate and AgDRIFT®
Temperature	N/A	N/A	N/C
Relative Humidity	With RH >70%, 25 ft buffer reduction when recommended buffers is ≥250 ft*	With RH >60%, 25 ft buffer reduction when recommended buffer is ≥100 ft**	N/C
Change from Fine to Coarse DSD	Buffer derived from available deposition curves	25 ft buffer reduction when recommended buffer is ≥75 ft**	N/R
Crop on Field	25 ft buffer reduction for buffers ≥200 ft*	N/A	N/R
Windspeed: 3 to 7 mph	25 ft buffer reduction at 75-175 ft	N/A	N/A

Baseline for percent reduction is AgDRIFT® Tier I Aerial module
N/A – Not applicable currently because impact is not substantial enough to change spray drift buffer by ≥25 ft; N/C – Not considered in the current effort; N/R – Not relevant; App. – application; mph – miles per hour
*In order to use both the >70% relative humidity (RH) buffer reduction and the crop on the field buffer reduction together, the recommended buffer must be ≥275 ft.
** In order to use both the ground humidity reduction and coarse reduction together, the recommended buffer must be >125ft.

EPA is aware of other spray drift mitigation options that may have the potential to reduce the spray drift buffers but there are not enough data to support proposing the mitigations at this time. EPA has identified the following example mitigations that currently lack sufficient information for proposing at this time (including but not limited to): nozzle/formulation combinations that produce coarser droplets than currently labeled; and directed sprays/smart technology that reduce drift (*e.g.*, shutting off nozzles at specific times or reducing the spray boom width) and/or reduce the amount of pesticide applied at field edges. EPA welcomes information on their efficacy and plans to include additional options for uses given data that allows EPA reliably assess the potential for associated drift reduction.

6.1.1 Selection of the Level of Spray Drift Mitigation

Where EPA identified impacts from spray drift to at least one listed species at Step 1 of the Strategy Analysis, the next step is to identify mitigation measures to address spray drift. For efficiency, as described for the example case study herbicides, EPA is first comparing the calculated spray drift distances for a particular herbicide to the maximum drift distance as a screen. If spray drift distances for a particular herbicide are all greater than the maximum distance, then the spray drift buffer for that herbicide would default to the maximum distance, possibly with some additional mitigation measures (*e.g.*, windbreak). EPA identified mitigation

measures, including a spray drift buffer distance at which the deposition is predicted to result in exposure that would be below a toxicity threshold associated with a potential for population-level impacts (*i.e.*, MoD > 1). As explained in **Section 5.1**, EPA uses different toxicity endpoints to calculate MoDs for listed plants and listed animals that rely upon plants (**Table 5-1**). So, there may be different levels of mitigation identified for listed plants and for listed animals that depend on plants. EPA also calculates MoD and identifies the spray drift mitigation level for aquatic species and terrestrial habitat. The level of mitigation identified for terrestrial habitat is expected to reduce the potential for impacts via spray drift for aquatic habitat as definitions of terrestrial habitat for listed species include areas proximate to aquatic habitat for listed species and current herbicide case studies found spray drift mitigation measures for terrestrial plants are consistently higher than those for spray drift mitigation measures for aquatic plants (See **Case Study Summary and Process** for related support and other examples of spray drift mitigation measures).

For the proposed Strategy, as described in **Section 5.2** EPA evaluated levels of MoD and, based on that analysis, expects there could be potential population-level impacts when MoDs at the edge of the field are: 1) between 1 and 10; or 2) greater than 10. If lines of evidence as described in **Section 5.3** indicate an MoD between 1 and 10 could potentially result in population impacts at an MoD of 1, EPA sets the target concentration to the toxicity endpoint utilized to calculate the corresponding MoD. If the MoD of 10 results in a potential for population-level impacts (*e.g.*, an MoE of medium), then EPA sets the target concentration to 10x the toxicity endpoints used to calculate the corresponding MoD. EPA utilized AgDRIFT® to calculate the distance to get to concentrations below the toxicity endpoint (or below 10x the toxicity endpoint), and to establish the distance from the application where EPA expects the potential for population-level impacts is unlikely. The EPA Offsite Transport Guidance describes how to use AgDRIFT® to calculate distances to a target concentration (USEPA, 2013).

Table 6-3. Summary of MoD and Determinations of the Target Concentration for Drift

Magnitude of Difference (MoD)		Considerations for Mitigation
At the Edge of the Field	**At the Maximum Buffer Distance**	
<1	<1	No drift mitigation identified
>1	<1	The buffer distance to achieve the target deposition using AgDRIFT® and droplet size mitigation are identified and options to reduce the buffer are available. The target deposition is determined using the toxicity endpoint or the toxicity endpoint times 10 based on the lines of evidence described in **Section 5.3**.
>1	Between 1 and 10	If lines of evidence indicate population level impacts (as described in **Section 5.3**) may occur at an MoD of 1, the maximum buffer distance would apply. If the lines of evidence indicate that population level impacts may occur at an MoD of 10, a buffer distance to result in exposure that is 10x the relevant toxicity endpoint would apply. Options to reduce the buffer are available.
> 10	>10	EPA identified drift mitigations when the MoD is 10 or greater as EPA considers this level to indicate a potential for population-level impacts. The maximum spray drift buffer would apply and additional mitigation may also be applicable. Options to reduce the buffer would not be available.

The next step is to compare the distance to an MoE of medium[22] (which represents when population-level impacts may occur) to the maximum buffer distance. If the distance to no potential for population-level impacts is less than the maximum buffer distance in **Table 6-1**, then the buffer distance would apply and a user may use any of the options in **Table 6-2** to reduce the applicable buffer distance. If the distance to no potential of population-level impacts is greater than the maximum buffer, options to reduce the buffer would not apply without changing their application method (*e.g.*, lowering release height or increasing droplet size). Rather, additional restrictions would apply to reduce offsite exposure such as: 1) a windbreak, hooded sprayer, or coarser droplets; or 2) selecting a different application method.

The spray drift mitigation measures in **Table 6-4** and **Table 6-5** provide examples of the options that could be available to meet the same mitigation level for aerial and ground applications, respectively. Each table provides example mitigation measures where MoD >10 at the maximum buffer distance (a) and where MoD <10 at the maximum buffer distance (b). The example illustrates the mitigation measures to reduce spray drift exposure by 100x when compared to an application rate of 1.0 lb a.i./A (*e.g.,* for a population-level endpoint of 0.001 lb a.i./A and the MoD target identified is 10).

[22] As discussed, this may be a specific toxicity endpoint or 10x the toxicity endpoint based on lines of evidence.

Table 6-4. Example Proposed Spray Drift Mitigation as Related to Single Maximum Application Rate and Droplet Size with Target Deposition of 0.01 lb a.i./A for Aerial Application

(a) Application scenarios where windbreaks would apply without a reduction in buffer distance available.

Single Maximum Application Rate (lb ai/A)	Downwind Spray Drift Buffer Between the Application and Terrestrial or Aquatic Habitat (feet)		
	Fine-Medium DSD	Medium-Coarse DSD	Coarse-Very Coarse DSD
1.0	Not applicable	300 + windbreak would apply	200 + windbreak would apply
0.8	Not applicable	300' + windbreak would apply	Not applicable
0.6	300' + windbreak would apply	Not applicable	Not applicable

(b) Application scenarios where wind directional buffers can be maintained at half the distance when windbreaks (*e.g.*, trees or hedgerows) are present between the application site and habitat for listed species (*e.g.*, a 200 ft buffer would be reduced to 100 ft with a windbreak).

Single Maximum Application Rate (lb ai/A)	Downwind Spray Drift Buffer Between the Application and Terrestrial or Aquatic Habitat (feet)		
	Fine-Medium DSD	Medium-Coarse DSD	Coarse-Very Coarse DSD
1.0	Not applicable	Not applicable	Not applicable
0.8	Not applicable	Not applicable	200 [a,b]
0.6	Not applicable	275 [a,b,c]	200 [a,b]
Options to Reduce Buffer Distance	a. Windbreaks could be utilized to reduce the buffer distance by half. b. Buffers ≥175 ft can be reduced by 25 ft if on field vegetation height at application is ≥1 ft. c. Buffers ≥250 ft can be reduced by 25 ft if relative humidity at time of application is >70%.		

Table 6-5. Example Proposed Spray Drift Mitigation as Related to Single Maximum Application Rate and Droplet Size with Target Deposition of 0.01 lb a.i./A for Ground Boom Application

(a) Application scenarios where windbreaks or hooded sprayers would apply

Single Maximum Application Rate (lb ai/A)	Downwind Spray Drift Buffer Between the Application and Terrestrial and Aquatic Habitat (feet)			
	Very Fine-Fine High Boom	Very Fine-Fine Low Boom	Fine-Medium/Coarse High Boom	Fine-Medium/Coarse Low Boom
1.0	200 + windbreak or hooded sprayer would apply	Not applicable	Not applicable	Not applicable

(b) Application scenarios where windbreaks or hooded sprayers could be utilized to reduce the buffer distance by half (*e.g.*, a 100 ft buffer would be reduced to 50 ft with a hooded sprayer)

Single Maximum Application Rate (lb ai/A)	Downwind Spray Drift Buffer Between the Application and Terrestrial and Aquatic Habitat (feet)			
	Very Fine-Fine High Boom	Very Fine-Fine Low Boom	Fine-Medium/Coarse High Boom	Fine-Medium/Coarse Low Boom
1.0	Not applicable	100 [a, b, c]	75 [b, c]	50 [c]
0.8	200 [a, b, c]	75 [b, c]	50 [c]	25 [c]
0.6	150 [a, b, c]	75 [b, c]	50 [c]	20 [c]
Options to Reduce Buffer Distance	a. Buffers ≥100 ft can be reduced by 25 ft if relative humidity >60% at the time of application b. Buffers ≥75 ft can be reduced by 25 ft with coarse or coarser droplets c. Buffer can be reduced by half with Windbreak/Hedgerow or Hooded Sprayers. If original buffer is ≤25 ft, no buffer would be applicable			

6.2 Proposed Runoff and Erosion Mitigations

Exposure from transport of pesticides off-site in aqueous runoff and/or erosion could occur following herbicide applications. Whether runoff or erosion will occur from a particular field depends on the field characteristics such as soil type, slope, and weather (precipitation rate and amount) and pesticide properties. EPA is proposing mitigations where runoff/erosion could lead to population-level impacts. Whether a pesticide or transformation product is predominantly in dissolved phase transport (aqueous runoff) or sorbed phase transport (erosion) is largely dependent on the pesticide's physical-chemical properties such as the organic-carbon normalized soil-water distribution coefficient (K_{oc}).[23] Given that runoff and erosion mitigation measures vary in their effectiveness at reducing exposure in off-site environments, discussed in **Section 6.2.1**, EPA is proposing a point system, which recognizes that some mitigations are more effective than others and that some herbicide use(s) may need a higher level of mitigation than others. The

[23] For most pesticides, sorption coefficients are available 1) normalized to the fraction of organic material in soil (K_{OC}) and 2) without normalization (K_d). For pesticides where the K_d is the recommended sorption coefficient for the pesticide, the K_d can be converted to K_{OC} using standard equations and the K_{OC} and the corresponding efficacy applied. There is some uncertainty in this assumption as organic carbon is not always the driver of sorption for ionic pesticides. Freundlich sorption coefficients may also be utilized in this analysis.

number of points identified reflects the level of reduction in exposure needed to avoid the potential for population-level impacts (established in Step 2 and described in **Section 6.2.2**).

EPA categorized the runoff and erosion mitigation measures as follows:

- **Rain restrictions that generally would apply to all herbicides.**

- **Field Characteristics** are characteristics of the field that are likely to indicate the field will have less runoff and erosion than other fields and thus needs fewer mitigation measures to reduce offsite transport. For example, fields with a low slope or permeable soils likely have less runoff. These are similar to considerations used by conservation specialists to determine what measures are recommended for a particular field.

- **Pesticide Application Parameters** that users may employ to reduce runoff and erosion such as rate reductions, soil incorporation, and use of certain application technologies that may lead to less concentrated run-off. While changes to the application occur on the field, they are considered separately from the proposed in-field mitigation category below, which includes measures related to the field management. The pesticide application parameters consider the change in application related to a single application as it may be a single application that could result in an impact from a pesticide. While reducing the number of applications may also be beneficial considering the overall loading over time, a reduction may not be adequate to reduce population-level impacts.

- **In-field Management** measures that growers may employ to reduce runoff and erosion are those that involve the management of the field. For example, management of irrigation water, cover crops, or reduced tillage. Adjacent to the field mitigation measures are those that generally occur adjacent to the field such as a field border. Some measures may occur on the field and adjacent to the field, and they are included in both categories.

- **Adjacent to the Field** mitigation measures are those that occur adjacent to the field to which the pesticide application occurs and between an aquatic or terrestrial habitat for listed species.

- **Other mitigation measures** are those that may be considered but that do not fit into the categories above.

- **Exemptions** are those measures that EPA and/or the Services have determined are essentially equivalent to up to 9 points. Examples of these include when the application is more than 1000-feet away from a habitat for listed species, subsurface drainage is installed in the field, or the grower is following recommendations from an expert conservation specialist to reduce offsite transport from the field. When a field is more than 1000 feet away from the application site, overland flow will be substantially diminished (TXDOT, 2019; VADEQ, 1992; Wu and Lane, 2017). Therefore, EPA assumes that fields further than 1000-feet away would contribute limited runoff and erosion to

adjacent areas. When subsurface drainage is installed, the drainage would be released into saturation buffers or the drainage collected in a water retention system to minimize offsite runoff and erosion. Finally, EPA would like additional information on the which conservation specialists may be relied on to give recommendations to minimize offsite transport into adjacent areas or what characteristics of a conservation program could be relied on such that it may be utilized instead of the need to follow the mitigation menu in part or whole.

These are described in more detail in the **Technical Support for Mitigation** document and in **Section 7.2**.

6.2.1 Determining Level of Runoff/Erosion Mitigation

Where EPA's evaluation shows that there is a potential for population-level impacts for a species from runoff or erosion transport pathways, EPA determined the number of points to reduce these potential impacts based on the MoD for terrestrial, wetland, and aquatic plants available in the relevant pesticide specific risk assessment or from analysis conducted similar to Step 1 recommendations. **Table 6-6** provides a summary of the different points identified for different ranges of MoD. As explained further in **Case Study Summary and Process**, given the variability in exposure estimates and toxicity data, EPA assumed the precision in the MoD to be an order of magnitude (*i.e.*, a factor of 10). When there is an order of magnitude difference in the MoD, there is confidence that the potential for impacts is substantially different. EPA is proposing to identify the points based on the level of reduction in exposure to reduce the potential for population-level impacts. In other words, the higher the MoD for a particular herbicide, the higher the level of mitigation identified and therefore number of points needed.

EPA developed the proposed decision framework to show how runoff/erosion mitigation measures and points would be identified as described in **Figure 4-4**. Runoff/erosion mitigation measures would be identified when the MoD is greater than one. EPA is proposing that the number of points identified to reduce offsite transport would be determined based on 1) the MoD (as described in **Table 5-1** and **Table 6-6**, 2) the organic-carbon normalized soil-water distribution coefficient (K_{oc})[24] of the active ingredient and any residues of concern for plants, and 3) the aerobic soil metabolism half-life of the herbicide of parent and any residues of concern. EPA found that runoff/erosion mitigations are more effective for chemicals with K_{oc} greater than 1000 L/kg-organic carbon (Alix *et al.* 2017) or a solid-water distribution coefficient (K_d) of 50 L/kg-soil.[25] Pesticides that have an aerobic soil metabolism half-life less than 10-day tend to have reduced exposure estimates when the application does not occur within 48-hours of 1 inch of rain (USEPA, 2023a). Therefore, when all aerobic soil metabolism half-life values for the relevant

[24] The K_{OC} is a measure the propensity of an herbicide to be dissolved in water or sorbed to soil or sediment.
[25] EPA assumed the Kd value of 50 L/kg-soil was similar to 1000 L/kg-soil using the same criteria utilized in the CFR to identify when sediment toxicity data are required (40 CFR § 158.630 Subpart G Ecological Effects). The Agency's justification for selecting Kd ≥ 50 L/kg as a criterion for requiring the study was that this value would capture those chemicals with about 80% adsorption of a chemical to sediment organic carbon (2%).

residues are less than 10-days, one less runoff/erosion mitigation point would be identified, assuming the label includes the 48-hour rain restriction. However, this would not be applicable if the 48-hour rain restriction was not on the label. When the MoD is greater than 1000 or if the mitigation points identified are not achievable, other options to reducing the potential for population-level impacts to plants may be considered. For example, the use of offsets as discussed in **Section 8** may be considered.

Table 6-6. Potential Number of Points Identified to Reduce Exposure via Runoff and Erosion

Magnitude of Difference (MoD)[1]	Points Identified[2]	
	Runoff Prone (K_{OC} <1000 L/kg-oc or K_d <50 L/kg-soil)[4]	**Erosion prone (K_{OC} ≥1000 L/kg-oc or K_d ≥ 50 L/kg-oc)[4]**
<1	No mitigation	No mitigation
1 – <10	1 if lines of evidence indicate population level impacts[3] may occur at an MoD of 10 3 if lines of evidence indicate population level impacts[3] may occur at an MoD of 1	
10 – <100	6	5
100 -<1000	9	7
1,000 or higher	9 plus other mitigations	

[1] The MoD is the ratio of the exposure estimate to the relevant toxicity endpoint for population-level impacts, as described in **Section 5.1**.

[2] If the 48-hour rain restriction is on the label and the aerobic soil metabolism half-life for parent and residues of concern is less than 10-days, the number of mitigation points could be reduced by one point. The 48-hour rain restriction states, "Do not apply when soil in the area to be treated is saturated or if NOAA/National Weather Service (available at weather.gov) predicts a 50% chance or greater of 1 or more inches of rainfall to occur within 48 hours following application."

[3] **Section 5.3** describes the lines of evidence considered to determine whether population-level impacts may occur.

[4] The solid-water distribution coefficient (K_d) and organic-carbon normalized solid-water distribution coefficient (K_{OC}) are measures of the propensity of an herbicide to be dissolved in water or sorbed to soil or sediment. These are measured in OCSPP Guideline 835.1230 (USEPA, 2008).

EPA would identify fewer points for pesticides mainly transported in the sorbed phase as data demonstrates that the efficacy of mitigation measures for these pesticides is higher than the efficacy for pesticides mainly transported in the dissolved phase (Alix *et al.* 2017). EPA considers the sorption coefficients for parent and transformation products that are residues of concern for plants. For MoD between 1 and 10, the points EPA is proposing for the Strategy for both runoff and erosion prone herbicides are the same because the data for many of the measures did not show differences in efficacy. For MoD between 10 and 100, EPA is proposing to identify one less point for erosion prone pesticides than for runoff prone pesticides because efficacy of the mitigation is generally higher for erosion transport. For higher MoD herbicides, EPA increased this difference by 2 points because the Agency expects that multiple measures would apply, and all would likely have an increased efficacy for the erosion prone pesticides (Alix *et al.* 2017).

6.2.2 Runoff and Erosion Mitigation Measures Menu, Exemptions, and Efficacy Evaluation

As described in detail in the **Technical Support for Mitigation**, EPA collected information from various publications, conducted modeling, and developed runoff/erosion mitigation measures. As described in more detail below, the efficacy of reducing pesticide offsite transport in the studies for a particular measure varies considerably. For some measures, efficacy data is limited and for others, there are hundreds of efficacy studies.

EPA categorized mitigation measure efficacy at reducing exposure estimates and offsite transport into adjacent areas considering 1) the number of scientific studies available to support that the measure, on average, reduces runoff or erosion transport; 2) the range and average percent reductions across studies (when available in a review) and/or modeling results; and 3) best professional judgement.

Two major considerations in evaluating available literature on the effectiveness of a particular mitigation measure is the number of available studies and whether those studies show, on average, a percent reduction in offsite transport (Alix *et al.*, 2017; FOCUS, 2007; Reichenberger *et al.*, 2007; Yuan *et al.*, 2022). This is particularly important for many of the runoff/erosion mitigation measures as efficacy can vary considerably from site to site and within a site. For example, for some measures, the range of the efficacy from the studies is from 0% to 100%. EPA refers to the number of the available efficacy studies as the strength of evidence. This is a key factor because as the number of sites/studies increases, EPA can gain a better understanding of the efficacy of the measure in different environmental conditions. As multiple scientific studies confirm previous research, there is greater confidence in the efficacy of the measure across different environments and pesticides.

EPA employed the same strength of evidence approach as was used in a workshop where a group of experts reviewed efficacy data for runoff and erosion mitigation measures for pesticides titled: *Mitigating the Risks of Plant Protection Products in the Environment. Proceedings of the MAgPIE Workshop (referred to as MAgPIE; Alix et al, 2017)*. The measures were scored as follows: + few scientific publications existing; ++ many scientific publications existing; and +++ abundant scientific publications existing. For the evaluation described in this document, EPA's default for a specific measure was to use the MAgPIE Workshop score unless additional literature is now available that the workshop did not consider. When a score for a measure was not available from MAgPIE, EPA relied on other studies and reviews, as available, and scored the strength of evidence relying on the number of studies as described in **Table 6-7.** EPA acknowledges that one study may cover multiple sites and another only a few sites and that the quality of the studies also influences the reliability of the study results. These factors all need to be considered when evaluating the reliability of a measure at reducing offsite transport. EPA may update the efficacy analysis as additional information related to the efficacy becomes available.

Table 6-7. Strength of Evidence Categories for Runoff/erosion Mitigation Measure Efficacy Score

Strength of Evidence Category	Criteria	# of Studies
+	Few scientific publications existing	1 – 10
++	Many scientific publications existing	>10-20
+++	Abundant scientific publications existing	>20

The number of studies/sites evaluated is one consideration for evaluating the efficacy of mitigation measures. The second main consideration is the percent reduction in offsite transport or percent reduction in exposure observed in available studies or from modeling (either conducted by EPA or results reported in a scientific publication). For a particular measure, EPA scored the efficacy of a measure as high, medium, or low. To do so, EPA used a combination of: 1) the efficacy based on the totality of the available data; and 2) the strength of evidence score as shown in **Table 6-8** below.

Table 6-8. Summary of Efficacy Rating for Runoff and Erosion Mitigation Measures

Mitigation Measure Efficacy Rating	Lines of Evidence Score, Average Percent Reduction from Field or Modeling
Low	+, at least 10% on average reduction ++ or +++, ~25% reduction
Medium	++ or +++; > 25 – 50% on average reduction
High	++ or +++, ~50% or more average reduction

[1] For example, residues were measured downstream when rain did not occur and when irrigation management measures were not implemented.

In this effort, EPA considered targeted field data as well as model estimates when evaluating efficacy of mitigation measures and the percent reduction in exposure that could occur from a measure. EPA conducted modeling to evaluate the potential reduction in exposure for the 48-hour rain restriction, for defining areas less vulnerable to runoff and erosion, and to evaluate the vegetative filter strip efficacy. EPA also considered modeling assumptions for the field characteristics in the selection of efficacy category because the field characteristics are reflected in the exposure estimates. Due to the limitations of the model, sometimes modeling does not capture the reduction in offsite transport or exposure that may occur with a mitigation measure (see discussion in the **Technical Support for Mitigation**); however, the mitigation measure may still be effective in the field when considering targeted field study results. The target for incorporation of the mitigation measure on labels is whether the measure is likely to be effective at reducing offsite transport of pesticides, not whether the result would influence the ecological risk assessment results and exposure estimates.

As outlined in **Table 6-8**, EPA rated the efficacy of a measure as high when the strength of evidence score was +++ and 50% or greater reduction, on average, was observed or modeled. EPA rated the efficacy of measure as medium when the strength of evidence score was ++ and 25 to 50% reduction, on average, was observed or modeled. EPA rated the efficacy of a measure as low when the strength of evidence score was + and at least a 10% reduction, on average, was observed or when the strength of evidence was ++ or +++ and a 25% reduction, on average, was observed or modeled. In some cases, the data or information available did not fit into this

system, so EPA placed the measure in an efficacy category based on best professional judgement (see discussion in the **Technical Support for Mitigation**). When the literature indicated that a measure is efficacious, but this was not captured in modeling, EPA relied on the literature for the efficacy rating.

Although runoff and erosion often occur together, a distinction is necessary to understand how pesticide mitigation measures can be most effective. In the context of the discussion provided in this document, the term *runoff* will refer to water-only runoff, and the term *erosion* will refer to only the solid portion (*i.e.,* eroded solids, sediment, soil) that is picked up by the runoff and transported offsite. Pesticides with high sorption coefficients (*i.e*., high K_d[26] or K_{OC}[27]) will tend to attach to the eroded solids while those with lower sorption coefficients will tend to run off with water.

With the information on the efficacy of the various measures, EPA developed a runoff/erosion mitigation menu for the Strategy. EPA assigned points to the measure depending on the efficacy level for runoff prone pesticides:

- Low = 1 point
- Medium = 2 points
- High = 3 points

EPA acknowledges that as shown in the various literature studies, the actual percent reduction will be site and pesticide specific. In addition to the variability in the available efficacy data, EPA acknowledges that some of these mitigation measures (including saturation buffers and controlled drainage areas) may be overwhelmed by extreme weather events, lowering their efficacy. While the efficacy may be reduced in high rain events, these may not be frequent, depending on the site. Even when these large rainfall events occur, the frequency and duration of these higher runoff and erosion events will be reduced with these mitigation measures.

Table 6-9 lists the identified proposed mitigation measures for runoff and erosion pesticide transport for which EPA has efficacy data. Several of the proposed mitigation measures are similar in measure and efficacy, so EPA grouped them together. For example, since alley cropping, strip cropping, and inter-row vegetative filter strips (VFS) all have inter-row VFS, EPA included all of them in a measure titled in-field VFS. In other words, for this example, if the grower employed alley cropping, then they could not also claim credit for in-field VFS because they are all essentially the same measure, and EPA's current thinking is that a grower would only receive credit for in-field VFS once. This simplifies the mitigation menu terminology and provides a bridge to common terminology. EPA has brief descriptions of mitigation measures in the mitigation menu in the **Technical Support for Mitigation** with additional descriptions available in the November 2022 ESA Workplan Update (USEPA, 2022b). Updated descriptions and specifications are expected to be published in EPA decision documents for specific pesticides

[26] The K_d is the solid-water distribution coefficient where the solid is typically soil or sediment.
[27] The K_{OC} is the organic-carbon normalized solid-water distribution coefficent where the solid is typically soil or sediment.

starting in autumn of 2023. **Table 6-9** provides info on these groupings, the category of the mitigation, and points assigned. EPA recognizes that not all mitigations included on the menu will be able to be utilized by all growers due to differences in geography, crop production system, and whether they own or lease the land on which they farm. EPA has included all known run-off/erosion mitigations for which efficacy data is available in an effort to provide flexibility in the mitigation measures for the grower. EPA welcomes efficacy data on additional measures that they may be using that are not included here.

EPA acknowledges that the groupings of the mitigation measures can be confusing, particularly for VFS. Vegetative filter strips may occur in the field or adjacent to the field, and thus, they are listed under both the 'in-field' and 'adjacent to the field' categories. Additionally, in-field VFS can occur in contoured fields or in fields that are not planted with contours or sloped. The in-field VFS measure descriptions indicate that many of the measures may occur in flat fields or contoured fields and thus some measures occur in the contour field measure category and the in-field VFS without a contour field. EPAs intent is not to confuse growers and EPA welcomes ideas on ways to simplify this information.

Table 6-9. Potential Mitigation Measures and Efficacy Points

Mitigation Menu Item[1]	Measures that qualify[2]	Efficacy Points
Field Characteristics (one field may rely on multiple field characteristics if they are applicable)		
Application area is to the west of the Interstate-35 and east of U.S. Route 395[3]	Not applicable	1
Application area has predominantly sand, loamy sand, or sandy loam soil without a restrictive layer that impedes the movement of water through soil. See USDA's Web Soil Survey tool to determine soil texture: https://websoilsurvey.nrcs.usda.gov/app/.	Not applicable	1
The application area has a slope of less than 2%	Naturally low slope or flat fields/ Flat laser leveled	1
Application Parameters		
The maximum single application rate (lbs active ingredient/acre/application) allowed on the label for the specific crop is reduced or only a partial area in the acre is treated. Considered on a per application basis. The percent reduction is calculated as the applied lbs active ingredient applied per acre divided by the maximum single application rate in lbs active ingredient per acre allowed on the label for the crop and application equipment. If only a spot or portion of the field is treated, the reduction in the application over the entire field is considered in the calculation provided the field is draining to the same area. Follow all label requirements related to application rate including not making applications at a lower rate than the minimum required on the label to avoid resistance issues and to avoid no control of the weed/pest.	Reduced application rate, partial treatment of the field, banded application, spot treatment, precision agriculture or sprayers	Percent reduction = Applied application rate in lbs a.i./A divided by the maximum application rate allowed on the label for the crop in lbs a.i./A 90% reduction; 9 80% reduction; 8 70% reduction; 7 60% reduction; 6 50% reduction; 5 40% reduction; 4 30% reduction; 3 20% reduction; 2 10% reduction; 1

Mitigation Menu Item[1]	Measures that qualify[2]	Efficacy Points
Soil incorporation within a few hours of application. If soil incorporation is required on the label for the crop where the application is being utilized, these points are not applicable.	Watering-in or via discing before runoff producing rain event	2
In-field Management Mitigation Measures[4]		
Contour farming	Contour farming, contour tillage	2
	Contour buffer strips, contour strip cropping, prairie strip, alley cropping	3
Cover crop/continuous cropping	Cover crop, double cropping, relay cropping	1
Grassed waterway	Grassed waterway	1
In-field vegetative filter strip (not occuring on a contoured field)	Inter-row vegetated strips, strip cropping, alley cropping, strip	3
Irrigation water management	Not applicable	1
Mulch amendment with natural materials	Mulching	3
Residue tillage management	No till, reduced till	2
Terrace farming	Terrace farming, terracing, field terracing	2
Adjacent to the Field[4]		
Riparian area	Riparian forest buffer, riparian herbaceous cover	3
Vegetated ditch	Vegetated ditch	1
30-foot Vegetative filter strips – adjacent to the field	Vegetated filter strip, field border, vegetative barrier	2
Other Mitigation Measures[4]		
Water retention systems	Constructed wetland, irrigation and drainage tailwater recovery, retention pond, sediment basins	2
Mitigation measures from multiple categories (*i.e.*, in-field, adjacent to the field, or water retention systems) are utilized[5]	See options in categories above.	1

[1] Proposed mitigation measure descriptions specific to pesticides were published with the ESA Workplan update: *Nontarget Species Mitigation for Registration Review and Other FIFRA Actions* (USEPA, 2022b). These will be updated based on comments received on the workplan update. If the state law has a more restrictive requirement, that may be followed instead. Not all measures are applicable to all fields and crops. If a mitigation measure results in an increase in the amount of pesticides applied to the area, it is recommended that an alternative mitigation measure be selected.

[2] Only one of the 'measures that qualify' from a 'mitigation menu item' can be used for points at a time. For example, credit is given for contour farming or contour buffer strips but not both. Some of the measures that involve in-field VFS may occur in a contoured field or on a flat field without contours. The measure would only qualify for points once for the field.

[3] See **Section 6.3** and **Appendix C** in the **Technical Support for Mitigation** document for additional details.

[4] Voluntary programs implemented by the National Resource Conservation Service, and state programs help farmers with implementation of some of these mitigation measures. These programs are voluntary and not linked to label requirements. Participation in these programs may allow for exemptions from following the runoff/erosion mitigation menu or support the development of the mitigation measures. EPA is considering specifications for the programs such that if the program were followed, the reduction in runoff/erosion would be functionally equivalent to following the mitigation menu.

[5] For example, if a grassed waterway an in-field mitigation measure and an adjacent to the field VFS are both utilized, the efficacy of the mitigation measures in combination may be increased and a point is provided when both are being utilized in the same field.

Table 6-10 summarizes exemptions from run-off/erosion mitigation requirements (does not apply to 48-hour rain requirement).

Table 6-10. Potential Exemptions from Needing to Follow the Mitigation Menu

Exemption	Justification.
Follow recommendations from Conservation Specialist or Certified Expert to Reduce Runoff/erosion[1]	Growers may work with an expert to develop mitigation plans that are designed for their field and are efficacious in reducing offsite transport of pesticides substantially. While conservation programs are not specifically designed for reduction of offsite transport of pesticides, the same types of measures used for reducing offsite transport of nutrients and erosion of soil from the field also reduce offsite transport of pesticides. Evaluating a field for ways to reduce nutrient runoff and erosion are likely to result in similar recommended measures as those in the proposed runoff/erosion mitigation menu. EPA is currently developing criteria where this option would be considered functionally equivalent to relying on the mitigation menu. EPA requests feedback on the types of experts, conservation programs, and appropriate criteria that could be relied upon to ensure that this is an effective measure, including for pesticides that need a high level of reduction of offsite transport to be protective of listed species. EPA will develop specific definitions and criteria for programs and experts based on feedback received on this exemption. Preliminarily, if the expert/conservation program evaluated a field for potential areas where runoff/erosion could occur and supported the grower in the development of those conservation practices in the field to reduce that offsite transport, those mitigations may be more likely to be effective and well maintained.
Field is more than 1000 feet away from a terrestrial or aquatic habitat for listed species	Off-site transport adjacent to the field is highest when the field is adjacent to the habitat for listed species. Maximum overland flow distances are commonly assumed to be near 1000 to 1200 feet in engineering handbooks (TXDOT, 2019; USDA, 2010; VADEQ, 1992) and 1000 feet is on the high-end of the overland flow distances observed for wetlands in the prairie pothole region (Wu and Lane, 2017).
Field has subsurface drainage or tile drains installed	If the field has subsurface drainage installed, the mitigation measures are not applicable. The subsurface must release the effluent (water) into controlled drainage (such as release into a retention pond) or saturation buffer[1] zones 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 or saturation zone.[2]

[1] A saturated buffer is a conservation measure designed to remove nitrate from agricultural tile water by modifying the outlet so that water is diverted to a vegetated filter strip.

Field data support modeling observations that aqueous runoff is highest when rainfall occurs near the application event (see **Technical Support for Mitigation** for details). **Table 6-11** summarizes rain restrictions that EPA has identified for most pesticides. The rain restrictions in this table are consistent with those proposed for FIFRA IEMs (See November 2022 ESA Workplan

Update) and reflect updated language based on input from the public comments received.[28] The 48-hour rain restriction may not be required when the restriction would limit the efficacy of a pesticide.

Table 6-11. Summary of Potential Restrictions Included on All Herbicide Labels

Restriction	Language on the Label
Rain Restrictions	Do not apply during rain.
48-hour restriction[1]	Do not apply when soil in the area to be treated is saturated (if there is standing water on the field or if water can be squeezed from soil) or if NOAA/National Weather Service predicts 50% chance or greater of a 1 or more inches of rainfall to occur within 48 hours following application. Detailed National Weather Service forecasts for local weather conditions may be obtained on-line at: http://www.nws.noaa.gov, on NOAA weather radio, or by contacting your local National Weather Service Forecasting Office.

NOAA=National Oceanic and Atmospheric Administration

[1] The 48-hour rain restriction may not be required when the restriction would limit the efficacy of a pesticide.

EPA developed examples of combinations of runoff/erosion mitigation measures for different crops and different areas of the country that might be utilized. These are available in the document titled, "*Application of EPA's* Draft Herbicide Strategy Framework *Through Scenarios that Represent Crop Production Systems*". EPA acknowledges that some of these combinations of measures may be difficult for growers to implement and is open to recommendations to reduce the burden of implementing these mitigation measures while still adequately reducing exposure and the potential for population-level impacts to listed species. The consideration of possible offsets is discussed in **Section 9.4**.

6.3 Descriptions for Aquatic and Terrestrial Habitat for Listed Species that Can Be Included in Buffer Distances and Setbacks

Spray drift and runoff/erosion mitigation measures to reduce pesticide exposure to non-target species often include a buffer between the pesticide application and an adjacent area where listed species may occur (*i.e.*, habitat for listed species). Listed species occur in almost all types of terrestrial and aquatic habitats; however, they are less likely to occur in managed areas (*e.g.*, agricultural fields, buildings, roads, *etc.*). Therefore, for the purpose of identifying mitigations for listed species, EPA is including habitats as all areas within the species range or CH except managed areas. Managed areas may be included in the buffer because EPA has found that listed species are less likely to be in these areas. EPA will develop mitigation needs for the few listed plants (*e.g.,* Spring Creek bladderpod, *Lesquerella perforata*) that occur on the field in a separate effort, as on-field exposure was not part of the scope of the Strategy. EPA will work with the FWS to develop mitigations for species that commonly occur on agricultural fields when the programmatic consultation process is developed.

[28] The ESA Workplan Update, comments, are available at https://www.regulations.gov under docket ID: EPA-HQ-OPP-2022-0908.

Below are area descriptions and example label language that could be used when either spray drift or runoff/erosion buffers would apply. If the buffer identified for terrestrial habitat for listed species is greater than the buffer identified for aquatic habitat for listed species, the buffer applies to both aquatic and terrestrial areas because the terrestrial area around the aquatic area would need a buffer. If only a buffer is identified for the aquatic habitat for listed species, or the aquatic habitat has a greater buffer identified than the terrestrial habitat buffer, that buffer only applies to the aquatic habitat.

Definition Box 7.

A **buffer** is the area between a pesticide application and a habitat for listed species. It can be in-field, off-field, or both.

A **habitat for listed species** is an area with characteristics consistent with listed species' habitats or that may provide habitat to non-target organisms. For the purposes of agricultural pesticides, areas that are managed (*e.g.*, agricultural fields, roads, *etc*.) are not considered a habitat for listed species for general agricultural use patterns.

Labels may describe crops or sensitive plants that may be damaged by the herbicide and specific restrictions to protect those non-target plant species. Follow label restrictions to prevent damage to sensitive crops or vegetation in a buffer.

EPA defines a field for this purpose as the areas where the crop is grown (including fallow land). Identified buffers would begin where the application ends and therefore may be in-field, adjacent to the field, or a combination of both. The immediate area within 10 feet of the field is often a disturbed area that is managed and may be considered part of any buffer. **Figure 6-1** illustrates a terrestrial buffer, in-field buffer, and an aquatic buffer where part of the buffer is in the field and part is not. In summary for spray drift, the buffer represents areas that are not directly treated with the pesticide. Terrestrial buffers for runoff and erosion need to meet the standards for that type of mitigation measure which often includes specific vegetation and vegetation maintenance. While buffers and some areas associated with mitigation or conservation measures may be attractive to species (as described in **Definition Box 7**), they are not considered habitat for listed species for general agricultural use patterns for the purposes of the Strategy.

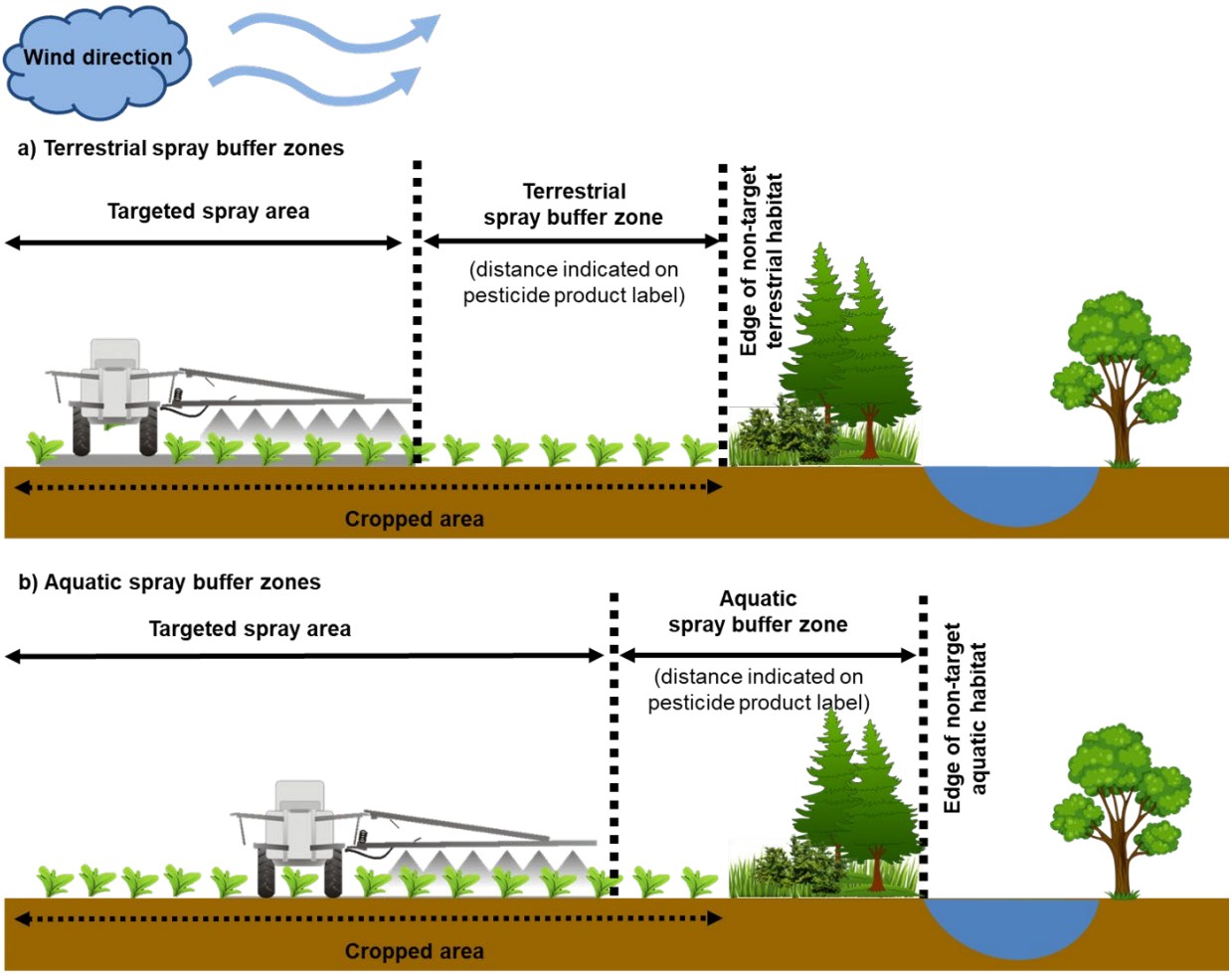


Figure 6-1. Diagram of the Field (Cropped Area) and Terrestrial and Aquatic Buffer Zones[29]
The buffer would begin where the application ends and therefore may be an in-field buffer, adjacent to the field, or a combination of both. The immediate area within 10 feet of the field is often a disturbed area that is managed and may be considered part of any buffer.

The **Definition Box 7** provides a general definition of habitat for listed species. More specific definitions for terrestrial and aquatic sensitive areas are provided below.

The reason EPA includes areas associated with some mitigation measures as part of identified buffers is to avoid disincentives for growers to provide such habitats, which may have considerable benefits to species. EPA is focused on mitigation exposure off of the treated field for the Strategy.[30]

[29] Terrestrial and aquatic spray drift buffer zones diagram reproduced with permission from the Pest Management Regulatory Agency of Health Canada (2020). 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.

[30] Other areas not covered by the Strategy will be considered in other strategies or during consultation with the Services on the pesticide.

Description of Terrestrial Habitat for Listed Species

For all herbicide products that have been identified to have direct impacts to terrestrial listed plants or diet and habitat impacts to listed animals due to impacts to plants due to exposure in runoff, erosion, or spray drift.

Terrestrial habitat for listed species includes any terrestrial area except the following managed areas, which can be included as a mitigation buffer when they are not treated with the pesticide:

a. Agricultural fields, including the treated field or adjacent fields;
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 for runoff or drift control, such as vegetative filter strips, field borders, hedgerows, and other areas on the mitigation menu; and
e. Conservation Reserve Program (CRP) and Agricultural Conservation Easement Program (ACEP) areas.[31] CRP and ACEP areas may provide habitat to listed species, so movement of pesticides into these areas should be minimized.

Terrestrial habitat for listed species includes but is not limited to naturalized areas, parks, wildlife refuges, or wilderness areas and cannot be included in the buffer composition.

All of the habitat exceptions described above may be counted as part of a buffer between the treated field and adjacent habitat for listed species. While these areas are not considered habitat for listed species, vegetation in the buffer may be damaged by the use of herbicides in adjacent areas.

Description of Aquatic (including Wetlands) Habitat for Listed Species

For all products that have been identified to have direct impacts to listed wetland or aquatic listed plant species or diet and habitat impacts to animals due to impacts to plants due to exposure in runoff, erosion, or spray drift.

Aquatic habitat for listed species includes all aquatic areas except:

a. On-farm contained irrigation water resources that are not connected to adjacent waters, including on-farm irrigation canals and managed irrigation/runoff retention basins;
b. Vegetated ditches, drainage ditches; and

[31] The Conservation Reserve Program (CRP) is a land conservation program administered by the Farm Service Agency (FSA). In exchange for a yearly rental payment, farmers enrolled in the program agree to remove environmentally sensitive land from agricultural production and plant species that will improve environmental health and quality. Agricultural Conservation Easement Program (ACEP) supports long-term viability of productive farmland from being converted into non-agricultural areas.

c. Managed wetlands including constructed wetlands on the farm. Wetlands may provide habitat to listed species and movement of pesticides into these areas should be minimized.

Aquatic habitat for listed species includes but is not limited to lakes, reservoirs, rivers, permanent streams, wetlands or ponds, and estuaries.

EPA acknowledges that some listed species may occupy areas that are not habitat for listed species in this Strategy. For example, the whorled sunflower (*Helianthus verticillatus)* is commonly found on agricultural fields (USFWS, 2023). EPA expects to address this situation with FWS when the agencies are in a consultation involving this listed species.

7 Detailed Explanation of Step 3: Identify Geographic Extent of Mitigation

For the Strategy, EPA may identify a combination of mitigation across the conterminous United States as well as identifying mitigation in specific geographic areas. This section describes how EPA identified when herbicide mitigations are identified throughout the lower 48 conterminous states versus when BLT would be used for geographic specific mitigation. This geographic framework is relevant to both runoff/erosion mitigation measures and spray drift mitigation measures; however, different geographic scales may be used for spray drift and runoff/erosion mitigations (for the same herbicide). Spray drift and runoff/erosion proposed mitigations are covered in further detail above in **Section 6.**

7.1 Identified Mitigation Measures proposed to be Implemented on General Labels

When EPA identifies mitigation that would cover the entire use area, EPA is proposing that such restrictions would be expected on the general label. In general, EPA expects mitigations would apply across the entire use site when diet and habitat population-level impacts are expected for listed animals that plants generally rely on.[32] **Figure 7-1** presents the distribution of listed animal species that 1) are found in terrestrial environments and have a generalist relationship to terrestrial plants (**Figure 7-1a**), 2) are found in wetland environments and have a generalist relationship to wetland plants (**Figure 7-1b**) or are found in aquatic environments and have a generalist relationship to aquatic plants (**Figure 7-1c**). Listed generalist animals in terrestrial, wetland, and aquatic habitats are distributed across the United States (**Figure 7-1d**). For the Strategy, mitigation would likely apply throughout the conterminous US when there are concerns for population-level impacts for plants that could impact the diet and/or habitat of listed animal generalists in all of these environments. EPA proposes that implementation would include mitigations for animals on the general labels because they are distributed throughout the majority of the conterminous US. Spatially limited mitigations would not apply.

[32] Generalist listed species do not have an obligate relationship to another species, whereas listed species that cannot survive and/or complete their life-cycle without the specific species are called obligates.

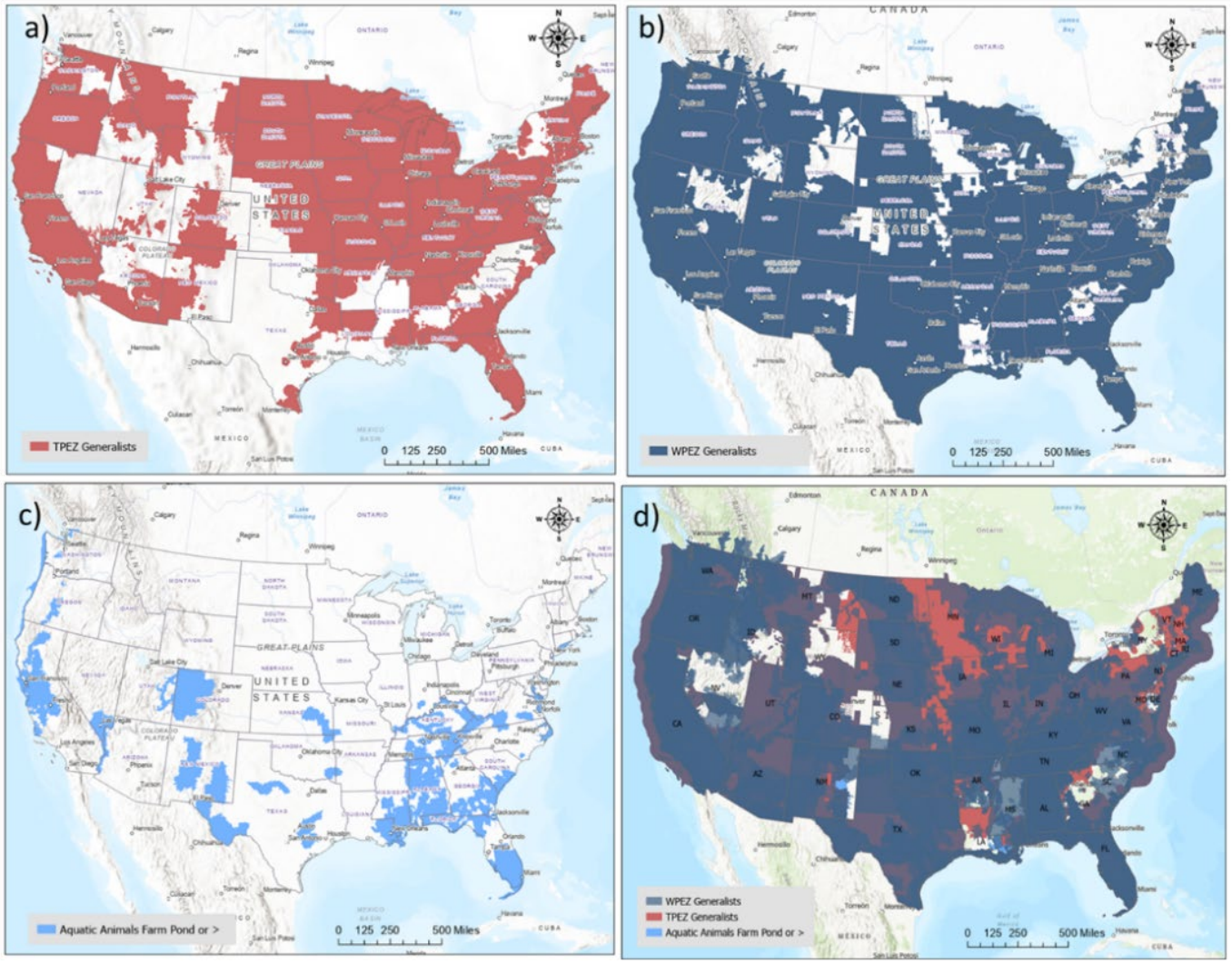


Figure 7-1. a) Terrestrial Generalists: Listed animals that generally rely on terrestrial plants (plus their CHs) and have ≥5% overlap with the Cultivated Use Data Layer (UDL) plus 300 m. This list does not include fully aquatic species that are captured in the wetland generalists and/or aquatic animals lists.

b) Wetland Generalists: Listed animals that generally rely on wetland plants (plus their CHs) and have ≥5% overlap with the Cultivated UDL plus 300 m. This list includes aquatic animals found in waterbodies smaller than the EPA farm pond.

c) Aquatic Generalists: Listed animals that rely on aquatic plants (plus their CHs), are found in waterbodies that are equivalent in size to the EPA farm pond or larger, and have ≥5% overlap with the Cultivated UDL plus 300 m.

d) All Listed Animal Generalists

7.2 Identified Mitigations proposed to be implemented using Bulletins

7.2.1 Bulletins Live! Two and PULAs

As described earlier in **Section 4.3**, EPA usually prefers to provide directions for pesticide use directly on the general label. However, when pesticide use directions related to listed species include geographically specific requirements, EPA typically creates a bulletin that is made available to the public on the Bulletins Live! Two (BLT) website [33] to communicate these requirements. EPA references on the pesticide product labeling the need to access and follow bulletins on BLT. Doing so allows EPA to minimize complexity on labels, increase flexibility for growers, and limit the geographically specific listed species protections to only where they would apply. Bulletins typically include: 1) the geographic extent (referred to as the "pesticide use limitation area" or PULA) of the area where the same set of mitigations apply, and 2) a description of additional mitigations that apply to that geographic extent (referred to as "pesticide use limitations"). Under the Strategy, when the mitigation measures apply only to a limited geographic area for an herbicide use, the specific PULA representing that area would be identified. The spray drift and/or runoff/erosion mitigations described in **Section 6** would be incorporated into the bulletin to represent the pesticide use limitations.

As described earlier, the Strategy is focused on listed species under the jurisdiction of FWS. For the proposed Strategy, EPA used species-specific location information (species range and CH, if applicable) provided by FWS to establish proposed PULAs. In establishing PULAs, EPA's default is to use the species' ranges and CHs to identify protection areas. For the proposed Strategy, EPA used spatial data representing the listed species range and designated CH locations provided by the FWS as of February 16, 2022 (USFWS, 2022). [34] FWS has embarked on an effort to refine its species range maps and now has refined range maps for about half of the listed species under its jurisdiction. Additionally, for the consultation with FWS on malathion (USFWS 202210), species experts at FWS provided alternative, even more refined areas where protections are needed for select species. Recognizing the efforts FWS has been undertaking to refine species ranges and areas where protections are most needed for certain species, EPA's current thinking is that it would update any PULAs developed for the final Strategy on a periodic and known basis (e.g., once per year in a given month), ensuring its geographic restrictions reflect the best available information not only today but into the future.

PULAs can represent the spatial extent of a single listed species range or designated CH, or can represent the combined ranges and designated CHs of multiple listed species. EPA develops PULAs with multiple species ranges/CHs when the locations all share the same pesticide use limitations (*i.e.,* mitigations). To efficiently and effectively implement mitigations for the Strategy, EPA is not proposing to develop single species PULAs and bulletins, but rather to

[33] Bulletins Live! Two can be accessed at: https://www.epa.gov/endangered-species/bulletins-live-two-view-bulletins

[34] For the final Strategy, EPA may use the most current information available in the FWS Environmental Conservation System (ECOS) range and CH available during that time.

produce bulletins that represent multiple species that have common taxonomy and habitats and thus need the same mitigations. EPA considered applying a more complex approach but chose a simpler approach in the interest of its available resources, achieving implementation more expeditiously, and having simpler and consistent mitigation instructions for all.

7.2.2 Grouped Species PULAs

Listed plants do not occur throughout the conterminous US (unlike listed animals discussed above). Therefore, when specific mitigations are identified for listed plants, bulletins are an effective approach to focus mitigations on areas where they are identified and limiting impacts on potential use sites where less or no mitigation is identified. For the Strategy, EPA is proposing to use an approach where listed plants are grouped by taxon (*e.g.*, dicots, monocots and obligates versus generalists) and habitat type (*e.g.*, terrestrial, wetland). This approach is proposed for calculating MoDs, identifying mitigations, and applying those mitigations for bulletins.

For the Strategy, EPA is proposing to use 4 grouped PULAs to represent the following categories of listed plants: monocots in wetlands and aquatic habitats; dicots in wetlands and aquatic habitats; monocots in terrestrial areas; and dicots in in terrestrial areas. Listed animals with obligate relationships to one of the above categories were also grouped into the PULAs (based on range and CH). EPA also grouped in the limited number of non-flowering plants with the monocot and dicot PULAs because EPA uses monocot and dicot toxicity data and associated MoDs as surrogates for the non-flowering plants. **Table 7-1** summarizes the four proposed PULAs. **Appendix C** includes additional information on these PULAs, including how they were derived and characterization of the extent of agricultural lands that overlap with the four PULAs. The document titled, "*List of Species in Each Grouped Species Pesticide Use Limitation Area* " includes the species ranges and CHs that were used to develop the 4 PULAs**. Figure 7-2** presents the spatial extents for the four proposed PULAs. EPA expects that the most up to date range and CH data would be utilized to develop these spatial extents when the Strategy would be implemented.

PULAs 1 and 2 include those listed plant species and listed animals with obligate relationships to plants that only occur in terrestrial habitats. PULAs 3 and 4 include listed plants that all occur in wetlands but may also occur in terrestrial or aquatic habitats. In Step 2, EPA identifies what mitigations are needed for terrestrial and wetland/aquatic habitats. For spray drift, mitigations are not expected to differ by the type of habitat. In cases where EPA identifies different mitigation for terrestrial and wetland/aquatic habitats, EPA would propose two sets of mitigations for PULAs 3 and 4—one set for terrestrial habitats and one for the wetland/aquatic habitats.

Table 7-1. Taxa and Habitat Associated Pesticide Use Limitation Areas (PULAs).

Group[1] (includes species and their CHs)		Applicable Grouped Species PULA (Corresponding Figure)	Magnitude of Difference (MoD)[2]
Listed Plants	**Listed Animals**		
Dicots in Terrestrial Habitats	Animals found in terrestrial environments that are obligately dependent on dicots	PULA 1 **(Figure 7-2a)**	TPEZ EEC/5th percentile of SSD of IC_{25} or lowest IC_{25} for dicots
Monocots in Terrestrial Habitats	Animals found in terrestrial environments that are obligately dependent on monocots	PULA 2 **(Figure 7-2b)**	TPEZ EEC/5th percentile of SSD of IC_{25} or lowest IC_{25} for monocots
Dicots in Wetland and Aquatic Habitats	Animals found in wetlands/aquatic habitats[3] that are obligately dependent on dicots	PULA 3 **(Figure 7-2c)**	WPEZ EEC/5th percentile of SSD of IC_{25} or lowest IC_{25} for dicots
Monocots in Wetland and Aquatic Habitats	Animals found in wetlands/aquatic habitats[3] that are obligately dependent on monocots	PULA 4 **(Figure 7-2d)**	WPEZ EEC/5th percentile of SSD of IC_{25} or lowest IC_{25} for monocots
Non-Flowering Plants in Terrestrial Habitats	Animals found in terrestrial environments that are obligately dependent on non-flowering plants[4]	PULAs 1 and 2 **(Figure 7-2a** and **Figure 7-2b)**	Highest MoD across monocots and dicots for direct effects in TPEZ
Lichens & Non-Flowering Plants in Wetland and Aquatic Habitats	Animals found in wetlands/small water bodies[3] that are obligately dependent on lichens or non-flowering plants	PULAs 3 and 4 **(Figure 7-2c** and **Figure 7-2d)**	Highest MoD across monocots and dicots for direct effects in WPEZ

EEC = estimated environmental concentration; SSD = Species Sensitivity Distribution; TPEZ = Terrestrial Plant Exposure Zone; WPEZ = Wetland Plant Exposure Zone; PULA = Pesticide Use Limitation Area; IC_{25} = concentration resulting in 25% inhibition in growth; IC_{50} = concentration resulting in 50% inhibition in growth

[1] The group assignment is determined based on the listed species taxon (plant or animal) and its habitat (terrestrial, wetland, small waterbodies, waterbodies equivalent to or larger than the farm pond). For listed plants, the plant group is also considered (monocot, dicot, non-flowering plant, lichen). For listed animals, the relationship to plants (obligate or generalist) is considered. These group assignments link the species to the endpoint used to calculate the MoD. The areas considered in the PULA reflect both the off-field range and designated critical habitat expanded to 300 m to account for offsite transport distances.

[2] The MoD determines whether a PULA is applicable for a specific herbicide. If the MoD indicates that there is potential for population-level impacts, then the PULA is applicable.

[3] All of the listed species in PULAs 3 and 4 occur in wetland habitats. Some of these species also occur in varying types of aquatic habitats. Runoff/erosion mitigations applied to PULA 3 and 4 would be applied to wetland and aquatic habitats (see **Section 6.3** for habitat description), regardless of whether listed plants occur in aquatic habitats in specific portions of the PULA.

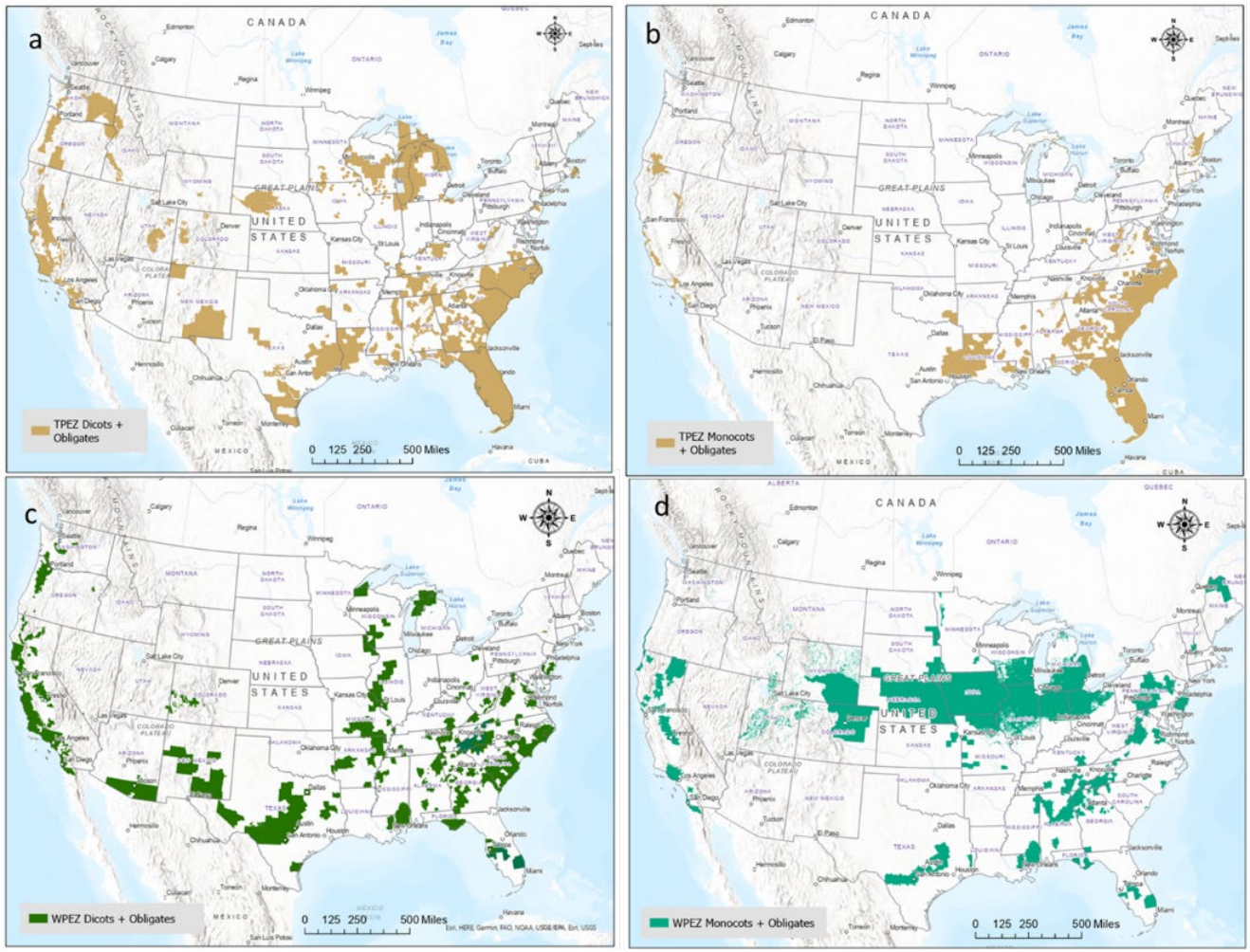
[4] This is inclusive of animals that obligately depend on gymnosperms.

Figure 7-2. a) PULA 1: Listed dicots, non-flowering plants, and animals with an obligate relationship to these plants located in terrestrial habitats. All species and CHs have ≥5% overlap at 300 m using the Cultivated Use Data Layer (UDL);

b) PULA 2: Listed monocots, non-flowering plants, and animals with an obligate relationship to these plants located in terrestrial habitats. All species and CHs have ≥5% overlap at 300 m using the Cultivated UDL;

c) PULA 3: Listed dicots, non-flowering plants, lichens, and animals with an obligate relationship to these plants located in wetland and aquatic habitats. All species and CHs have with ≥5% overlap at 300 m using the Cultivated UDL; and

d) PULA 4: Listed monocots, non-flowering plants, lichens, and animals with an obligate relationship to these plants located in wetland and aquatic habitats. All species and CHs have with ≥5% overlap at 300 m using the Cultivated UDL.



8 Case Studies

8.1 Development of Case Studies

EPA conducted case studies of representative herbicides to evaluate and calibrate the proposed three step framework of the Strategy. EPA developed these case studies concurrently with the framework. EPA used an iterative process to develop the proposed framework by considering the different toxicity data and use patterns for the selected herbicides. EPA drafted an initial framework and set of mitigations and then applied and revised them based on the case studies. For the case studies, EPA selected conventional agricultural herbicides that differ by 1) modes of action (MOAs; e.g., photosystem inhibition, growth regulators, lipid peroxidation), 2) use patterns, 3) physical-chemical properties and 4) toxicities to plants. EPA conducted case studies for the following example herbicides:

1. 2,4-D and its salts and esters (referred to collectively as '2,4-D'),
2. dicamba and its salts (referred to collectively as 'dicamba'),
3. diuron,
4. MCPA (2-methyl-4-chlorophenoxyacetic acid) and its salts and esters (referred to collectively as 'MCPA'),
5. metolachlor and its isomer *S*-metolachlor (referred to collectively as 'metolachlor'),
6. metribuzin,
7. oxyfluorfen,
8. paraquat dichloride,
9. pendimethalin,
10. propanil,
11. thiobencarb, and
12. trifluralin.

The 12 chemical example case studies reflect the draft proposed framework that is presented in this document (**Sections 4-7**). Each case study includes two components. The first component is an application of the three-step process proposed for the Strategy. The second component is an analysis identifying specific listed species and CHs with potential population-level impacts.

The purpose of the first component of the case studies is to demonstrate how the draft framework would be applied to different herbicides and illustrate how herbicide specific information may influence the mitigations that are identified. In these analyses, EPA presents the three steps of the Strategy, including estimates of exposure, a summary of the toxicity endpoints used to calculate MoDs and identify the MoE, discussion of the level of mitigation needed for terrestrial and wetland/aquatic habitats, and identification of which spray drift and runoff/erosion mitigations would be proposed for the general label and for the four PULAs. For this analysis, EPA applied the framework that is described in **Sections 4-7** above. In some cases, EPA simplified the pesticide-specific information, including labeled use information, to concisely demonstrate the framework. The case studies are not intended to support a regulatory action for the specific herbicide active ingredients. **Section 8.2** below summarizes the mitigations that

are identified for each of the 12 herbicides when EPA applied the proposed herbicide framework.

In the second component of these example case studies, EPA identified potential listed species and CHs of listed plants and animals located in the 48 conterminous United States where there may be population-level impacts. The purpose of this analysis was to support future streamlined consultation with FWS. EPA's proposed Strategy relies upon a streamlined, taxon-based assessment to identify mitigations; however, EPA is providing species specific examples to connect the dots between the species groups and specific species that would receive similar proposed mitigations. To identify those species and CHs with potential population-level impacts, EPA adapted some elements of FWS's method used in the malathion biological opinion (USFWS, 2022); however, EPA did not fully address several aspects of the method that would be necessary to predict the likelihood of potential J/AM. For example, EPA considered the magnitude of effect and degree of overlap to identify these species and CHs, but EPA did not consider species vulnerability nor life history modifiers. The **Case Study Summary and Process** includes details on the method EPA used in these example case studies to identify specific species and CHs with potential population-level impacts prior to mitigation. Although EPA conducted this analysis to establish a starting point for consultation discussions with FWS, EPA anticipates it may revisit the analyses to incorporate other considerations important to FWS in future consultations.

8.2 Application of Proposed Three Step Framework to Identify Mitigations

8.2.1 Spray drift

For all 12 herbicides in the example case studies, EPA identified that spray drift mitigations for liquid spray applications to registered uses. EPA identified a variety of mitigation options for the general label to minimize exposure to plant communities upon which listed animals are dependent (generalists). These mitigations differ by single application rate, application method, and DSD. In some cases, EPA identified that the maximum buffer distances would apply for the general label (*e.g.*, for some application rates and methods) for some of the herbicides. For the majority of herbicides, EPA identified different spray drift mitigations for the general label and the PULAs. In those cases, EPA identified more restrictive spray drift mitigations (*i.e.*, larger buffers) for implementation through the PULAs to protect listed plants. This is because when EPA is able to generate an SSD, EPA uses a lower toxicity endpoint for listed plants and animals obligately relying on plants (5^{th} percentile of the SSD) compared to the endpoint for generalist animals (25^{th} percentile of the SSD).

For illustration purposes, **Table 8-1** and **Table 8-2** include the spray drift mitigations identified for metolachlor to be implemented on the general label or PULAs, respectively. For the general label (**Table 8-1**), spray drift buffers of 25 ft or less are proposed for aerial applications. A 20 ft buffer is identified for the highest rates when applied as a ground spray of very fine-fine droplets and a high boom. No mitigations are proposed for other ground spray applications.

Because exposure needs to be minimized further for listed plants and animals with obligate relationships to plants, larger spray drift buffers are identified for implementation through the four PULAs (**Table 8-2**). EPA is not identifying separate spray drift mitigations based on habitat type because the same toxicity endpoints and exposures are used to determine necessary mitigations for terrestrial and wetland habitats when evaluating deposition in lbs a.i./A and utilizing the terrestrial plant toxicity endpoints for monocots and dicots. For the case studies, drift buffers for terrestrial and wetland plants were larger than those needed to reduce impacts on listed aquatic animal habitats and diet. Therefore, the mitigations identified in **Table 8-2** would be implemented on all four PULAs.

Table 8-1. General label spray drift mitigations identified for metolachlor. Mitigations Related to Single Maximum Application Rate, Application Method and Droplet Size.[1]

Single Maximum Application Rate (lb ai/A)[2]	Identified Downwind Spray Drift Buffer Distances (ft)						
	Aerial Application			Ground Application			
	Fine-Medium	Medium-Coarse	Coarse-Very Coarse	Very Fine-Fine, High Boom	Very Fine-Fine, Low Boom	Fine-Medium/ Coarse, High Boom	Fine-Medium/ Coarse, Low Boom
2.67	25[a]	20[a]	20[a]	20[b]	None[3]	None[3]	None[3]
1.9 – 2.0	10[a]	None[3]	None[3]	None[3]	None[3]	None[3]	None[3]
1.0 – 1.2	None[3]	None[3]	None[3]	None[3]	None[3]	None[3]	None[3]
Mitigation Measures the Pesticide Applicator can Elect to Reduce Buffer Distances[4]	[a] The applicator would achieve sufficient mitigation with a windbreak (release height below the top of the windbreak) alone without a buffer.			[b] The applicator would achieve sufficient mitigation with a windbreak or hedgerow (release height below the top of the windbreak/hedgerow) or hooded sprayers alone without a buffer.			

[1] Very fine to fine droplets are not included for aerial applications because this droplet size is not typically used when applying herbicides aerially.

[2] Single maximum label rates reflect the range of uses for metolachlor.

[3] EPA did not identify a spray drift buffer as a mitigation measure because the magnitude of difference is <10 at 10 ft off the treated field.

[4] See **Section 6.1** for discussion of these mitigation measures.

Table 8-2. PULAs 1-4 spray drift mitigations identified for metolachlor. Mitigations Related to Single Maximum Application Rate, Application Method, and Droplet Size.[1]

Single Maximum Application Rate (lb ai/A)[2]	Identified Downwind Spray Drift Buffer Distances (ft)						
	Aerial Application			Ground Application			
	Fine-Medium	Medium-Coarse	Coarse-Very Coarse	Very Fine-Fine, High Boom	Very Fine-Fine, Low Boom	Fine-Medium/ Coarse, High Boom	Fine-Medium/ Coarse, Low Boom
2.67	300 ft + windbreak [3]	300 ft + windbreak [3]	200 ft + windbreak[3]	175 [e,g,h]	75 [g,h]	50 [g,h]	25 [i]
1.9 – 2.0	300 ft + windbreak [3]	250 [a,b,c]	175 [a,b,d]	125 [e,g,h]	50 [g,h]	25 [i]	20 [i]
1.0 – 1.2	300 [a,b, c]	175 [a,b,d]	125 [b,d]	75 [g,h]	50 [g,h]	20 [i]	10 [i]
Mitigation Measures the Pesticide Applicator can Elect to Reduce Buffer Distances[4]	[a] Buffers ≥175 ft could be reduced by 25 ft if crop height at application is ≥1 ft. [b] Windbreak (release height below top of windbreak) reduces buffer distance by half. [c] Buffers ≥250 ft could be reduced by 25 ft if relative humidity at application is >70% [d] Buffers 75-175 ft could be reduced by 25 ft if windspeed at application is 3-7 miles per hour			[e] Buffers ≥100 ft could be reduced by 25 ft if relative humidity at application is >60% [f] Fine-Medium/Coarse-Low Boom buffers ≥75 ft could be reduced by 25 ft with coarse or coarser droplets [g] Windbreak/Hedgerow (release height below top of windbreak) reduces buffer distance by half [h] Hooded Sprayers reduce buffer distance by half [i] The applicator would achieve sufficient mitigation with a windbreak or hedgerow (release height below the top of the windbreak/hedgerow) or hooded sprayers alone without a buffer.			

[1] Very fine to fine droplets are not included for aerial applications because this droplet size is not typically used when applying herbicides aerially.
[2] Single maximum label rates reflect the range of uses for metolachlor.
[3] Additional mitigation measures (*e.g.,* windbreak, hedgerow) would apply for aerial applications at this rate using this droplet size because the magnitude of difference exceeds 10 at the maximum buffer distance. Use of these additional mitigation measures do not result in reduced buffer distances.
[4] See **Section 6.1** for discussion of these mitigation measures.

In other case studies (e.g., 2,4-D), EPA identified buffers for the general label that are protective for generalists and some of the listed species (*e.g.,* listed monocots; and animals with an obligate relationship to monocots). **Table 8-3** includes the spray drift mitigations identified for 2,4-D for the general label. At higher application rates, EPA determined that the maximum buffer distances would apply. 2,4-D is more toxic to dicots compared to monocots, so the general label mitigations would also apply to monocots (as explained further in the 2,4-D case study) and PULAs 2 and 4 would not be needed. To further reduce exposures to listed dicots and animals with obligate relationships with dicots, greater spray drift mitigations would be implemented using PULAs 1 and 3 (**Table 8-4**). Spray drift mitigations identified for the other 10 herbicides are included in the chemical-specific case studies.

Table 8-3. General label spray drift mitigations identified for 2,4-D. Mitigations Related to Single Maximum Application Rate, Application Method, and Droplet Size.[1,2]

Single Maximum Application Rate (lb ai/A)[3]	Identified Downwind Spray Drift Buffer Distances (ft)						
	Aerial Application			Ground Application			
	Fine-Medium	Medium-Coarse	Coarse-Very Coarse	Very Fine-Fine, High Boom	Very Fine-Fine, Low Boom	Fine-Medium/ Coarse, High Boom	Fine-Medium/ Coarse, Low Boom
2.0	300 [a,b,c]	300 [a,b,c]	200 [a,b]	200 [f,g,h]	100 [f,g,h]	100 [f,g,h]	50 [g,h]
1.5	300 [a,b,c]	300 [a,b,c]	200 [a,b]	200 [f,g,h]	100 [f,g,h]	75 [g,h]	50 [g,h]
0.50	300 [a,b,c]	175 [a,b,d]	125 [b,d]	100 [f,g,h]	50 [g,h]	20 [i]	10 [i]
0.07	50 [b]	20 [e]	20 [e]	20 [i]	10 [i]	None[4]	None[4]
Mitigation Measures the Pesticide Applicator can Elect to Reduce Buffer Distances[5]	[a] Buffers ≥175 ft could be reduced by 25 ft if crop height at application is ≥1 ft. [b] Windbreak with a release height below top of windbreak reduces buffer distance by half. [c] Buffers ≥250 ft could be reduced by 25 ft if relative humidity at application is >70% [d] Buffers 75-175 ft could be reduced by 25 ft if windspeed at application is 3-7 miles per hour [e] The applicator would achieve sufficient mitigation with a windbreak (release height below the top of the windbreak) alone without a buffer.			[f] Buffers ≥100 ft could be reduced by 25 ft if relative humidity at application is >60% [g] Windbreak/Hedgerow (release height below top of windbreak) reduces buffer distance by half [h] Hooded Sprayers reduce buffer distance by half [i] The applicator would achieve sufficient mitigation with a windbreak or hedgerow (release height below the top of the windbreak/hedgerow) or hooded sprayers alone without a buffer.			

[1] Very fine to fine droplets are not included for aerial applications because this droplet size is not typically used when applying herbicides aerially.

[2] EPA proposes to use the spray drift buffer distances in this table (based on the 25th percentile of the SSD) for listed monocots, animals obligately relying on monocots, and generalist animals.

[3] Single maximum label rates reflect the range of uses for 2,4-D**.**

[4] EPA did not identify a spray drift buffer as a mitigation measure because the magnitude of difference is ≤0.5 at 10 ft off the treated field.

[5] See **Section 6.1** for discussion of these mitigation measures.

Table 8-4. PULAs 1 and 3 spray drift mitigations identified for 2,4-D. Mitigations Related to Single Maximum Application Rate, Application Method, and Droplet Size.[1]

Single Maximum Application Rate (lb ae/A)[2]	Identified Downwind Spray Drift Buffer Distances (ft)						
	Aerial Application			Ground Application			
	Fine-Medium	Medium-Coarse	Coarse-Very Coarse	Very Fine-Fine, High Boom	Very Fine-Fine, Low Boom	Fine-Medium/ Coarse, High Boom	Fine-Medium/ Coarse, Low Boom
2.0	300 + windbreak[3]	300 [a,b,c]	200 [a,b]	200 [e,g,h]	100 [e,g,h]	100 [e,g,h]	100 [e,f,g,h]
1.5	300 + windbreak[3]	300 [a,b,c]	200 [a,b]	200 [e,g,h]	100 [e,g,h]	100 [e,g,h]	100 [e,f,g,h]
0.50	300 [a,b,c]	300 [a,b,c]	200 [a,b]	200 [e,g,h]	100 [e,g,h]	100 [e,g,h]	50 [g,h]
0.07	175 [a,b,d]	125 [b,d]	75 [b,d]	50 [g,h]	20 [i]	10 [i]	10 [i]
Mitigation Measures the Pesticide Applicator can Elect to Reduce Buffer Distances[4]	[a] Buffers ≥175 ft could be reduced by 25 ft if crop height at application is ≥1 ft. [b] Windbreak (release height below top of windbreak) reduces buffer distance by half. [c] Buffers ≥250 ft could be reduced by 25 ft if relative humidity at application is >70% [d] Buffers 75-175 ft could be reduced by 25 ft if windspeed at application is 3-7 miles per hour.			[e] Buffers ≥100 ft can be reduced by 25 ft if relative humidity at application is >60% [f] Fine-Medium/Coarse-Low Boom buffers ≥75 ft can be reduced by 25 ft with coarse or coarser droplets [g] Windbreak/Hedgerow (release height below top of windbreak) reduces buffer distance by half [h] Hooded Sprayers reduce buffer distance by half [i] The applicator would achieve sufficient mitigation with a windbreak or hedgerow (release height below the top of the windbreak/hedgerow) or hooded sprayers alone without a buffer.			

[1] Very fine to fine droplets are not included for aerial applications because this droplet size is not typically used when applying herbicides aerially.
[2] Single maximum label rates reflect the range of uses for 2,4-D.
[3] Additional mitigation measures (*e.g.,* windbreak, hedgerow) would apply for aerial applications of fine-medium droplets at application rates of 1.5 and 2.0 lb a.e./A because the magnitude of difference exceeds 10 at the maximum buffer distance. Use of additional mitigation measures do not result in reduced buffer distances.
[4] See **Section 6.1** for discussion of these mitigation measures.

8.2.2 Runoff/Erosion

Mitigations identified to minimize runoff/erosion exposure varied by herbicide. Mitigations vary in two ways: first, whether and how mitigations are implemented using the general label and the four PULAs; second, the number of points assigned.

Table 8-5 summarizes how mitigations may be applied using the general label and PULAs (Step 3 of the framework). For four chemicals (diuron, metolachlor, oxyfluorofen and pendimethalin), different mitigations would apply for the general label and the PULAs. Also, mitigations differ by type of land (*i.e.*, terrestrial and wetland/aquatic), but not by dicot/monocot taxonomy of plants. Therefore, four different sets of mitigation points would apply:

1. general label for terrestrial habitats,
2. general label for wetland/aquatic habitats,
3. PULAs 1 and 2 (terrestrial habitats) and
4. PULAs 3 and 4 (wetland/aquatic habitats).

Note that because PULAs 3 and 4 include terrestrial areas relevant to listed plants, the terrestrial habitat points for PULAs 1 and 2 would also be applied to PULAs 3 and 4. There are two example chemicals (MCPA and metribuzin) where separate mitigations are identified for generalists and listed plants; however, mitigations do not differ by habitat type. Therefore, only one set of runoff points would apply for the general label for all habitat types and a separate set of higher runoff points is needed for the four PULAs to be applied to all habitat types. For 2,4-D and dicamba, mitigations are identified for the general label to address impacts on listed animals and listed monocot plants. Dicots are more sensitive, so, higher points are identified for PULAs 1 and 3 to minimize exposure to listed dicots and animals that are obligate to dicots. There are four chemicals where PULAs would not apply for mitigations. No mitigations would apply for paraquat based on its physical, chemical and fate properties. For propanil and thiobencarb, which are only registered for use on rice, mitigations would only apply for wetland/aquatic habitats when rice fields do not include levees or berms. This mitigation would be applied using the general label.

Table 8-5. Implementation of runoff/erosion mitigations for case study chemicals through general label and PULAs.

Herbicide	PULAs Applicable?	Comments[1]
2,4-D	Yes	PULAs 1 and 3 because more mitigations identified for listed dicots
Dicamba	Yes	PULAs 1 and 3 because more mitigations identified for listed dicots
Diuron	Yes	PULAs 1 and 2 same mitigations would be applied for terrestrial habitats. PULAs 3 and 4 same mitigations would be applied for wetland/aquatic habitats.
MCPA	Yes	Same mitigations for all 4 PULAs because there is no difference between runoff/erosion mitigations based on habitat type.
Metolachlor	Yes	PULAs 1 and 2 same mitigations would be applied for terrestrial habitats. PULAs 3 and 4 same mitigations would be applied for wetland/aquatic habitats.
Metribuzin	Yes	PULAs 1 and 2 same mitigations would be applied for terrestrial habitats. PULAs 3 and 4 same mitigations would be applied for wetland/aquatic habitats.
Oxyfluorfen	Yes	PULAs 1 and 2 same mitigations would be applied for terrestrial habitats. PULAs 3 and 4 same mitigations would be applied for wetland/aquatic habitats.
Paraquat	No	No runoff/erosion mitigations identified
Pendimethalin	Yes	PULAs 1 and 2 same mitigations would be applied for terrestrial habitats. PULAs 3 and 4 same mitigations would be applied for wetland/aquatic habitats.
Propanil	No	Runoff/erosion mitigations only identified for wetland/aquatic habitats
Thiobencarb	No	Runoff/erosion mitigations only identified for wetland/aquatic habitats
Trifluralin	No	All mitigations indicated on general label

[1] When "same mitigations" are identified for PULAs, this is either due to similar potential for population-level impact to monocots and dicots.

For the same chemical, mitigation points sometimes varied by use. In general, when considering similar use patterns across chemicals, different numbers of points were identified by chemical, meaning that not all herbicides would need the same levels of mitigation. **Tables 8-6** through **8-11** include the runoff/erosion points identified for the case study herbicides. In this table, uses are grouped by the 13 Use Data Layers (UDLs) for convenience to allow for easy comparisons across chemicals and uses; however, on labels the uses would be specific to the use pattern. Of the 12 herbicides, diuron has the highest number of points identified, with 9 points needed for most uses on the general label and 9 or 9+ [35] points needed for the four PULAs. Oxyfluorfen also tends to have higher points, ranging 5-7 (Oxyfluorfen has a Koc >1000, so fewer maximum points are needed). Other herbicides have fewer points identified for a similar use pattern and general label or PULAs. 2,4-D, dicamba, metolachlor and metribuzin most often need 6 points for uses implemented on the label, but sometimes need more points on the PULAs. MCPA, pendimethalin and trifluralin generally need fewer points, ranging 3-6 across uses, habitat type and general label versus. Both propanil and thiobencarb are registered for use on rice; however, propanil was identified as needing more points compared to thiobencarb. As indicated above, no runoff mitigation is needed for paraquat.

When conducting the analysis for the 12 case studies, EPA followed the three-step framework described above. EPA calculated MoDs for species and habitats according to **Table 5-1**. Because the wetland and aquatic lands are lumped into one category, EPA selected the MoDs and corresponding numbers of points for the most conservative combination of species and habitat. Often, EPA found that the number of points needed to minimize exposures to wetlands would be more than for aquatic habitats. For MCPA, trifluralin and dicamba, EPA found that mitigations would not apply for aquatic habitats, but would apply for wetland habitats. EPA recognizes that this may result in requiring mitigations in some areas where less mitigations may be needed. Therefore, in the future, EPA is considering creating separate sets of mitigations and habitat descriptions for aquatic and wetland habitats.

[35] Nine runoff/erosion mitigation points plus other mitigation measures are identified when the MoD is 1,000 or greater (**Table 4-3**).

Table 8-6. General Label: Runoff/erosion Points for Terrestrial Areas

UDL	2,4-D	Dicamba	Diuron	MCPA	Metolachlor	Metribuzin	Oxyfluorfen	Paraquat	Pendimethalin	Propanil	Thiobencarb	Trifluralin
Alfalfa	NA	NA	9	3	NA	6	NA	0	3	NA	NA	5
Citrus	3	NA	9	NA	NA	NA	5	0	3	NA	NA	5
Corn	6	6	6	NA	6	6	7	0	3	NA	NA	5
Cotton	NA	6	6	NA	6	NA	5	0	3	NA	NA	5
Grapes	3	NA	9	NA	NA	NA	7	0	5	NA	NA	5
Other Crops	NA	NA	NA	3	NA	6	NA	0	3	NA	NA	NA
Other Grains	6	3	6	3	1	6	NA	0	3	NA	NA	5
Other Orchards	6	NA	9	NA	NA	NA	5	0	3	NA	NA	5
Other Row Crops	6	NA	NA	NA	NA	NA	NA	0	3	NA	NA	5
Rice	NA	NA	NA	NA	NA	NA	NA	0	NA	0	0	NA
Soybeans	6	6	NA	NA	6	6	5	0	NA	NA	NA	5
VGF	6	6	6	3	6	6	5	0	3	NA	NA	5
Wheat	6	6	6	3	NA	6	NA	0	NA	NA	NA	5

UDL = use data layer

VGF = vegetables and ground fruit

NA = not applicable because herbicide is not registered for uses within this UDL.

Table 8-7. General Label: Runoff/erosion Points for Wetland and Aquatic Areas

UDL	2,4-D	Dicamba	Diuron	MCPA	Metolachlor	Metribuzin	Oxyfluorfen	Paraquat	Pendimethalin	Propanil	Thiobencarb	Trifluralin
Alfalfa	NA	NA	9	3	NA	6	NA	0	5	NA	NA	3
Citrus	3	NA	9	NA	NA	NA	7	0	3	NA	NA	3
Corn	6	6	6	NA	6	6	7	0	3	NA	NA	3
Cotton	NA	6	9	NA	6	NA	7	0	3	NA	NA	5
Grapes	3	NA	9	NA	NA	NA	7	0	5	NA	NA	3
Other Crops	NA	NA	NA	3	NA	6	NA	0	3	NA	NA	NA
Other Grains	6	3	9	3	6	6	NA	0	3	NA	NA	3
Other Orchards	6	NA	9	NA	NA	NA	7	0	3	NA	NA	3
Other Row Crops	6	NA	NA	NA	NA	NA	NA	0	3	NA	NA	3
Rice	NA	NA	NA	NA	NA	NA	NA	0	NA	9	5	NA
Soybeans	6	6	NA	NA	6	6	5	0	NA	NA	NA	3
VGF	6	6	9	3	6	6	5	0	3	NA	NA	3
Wheat	6	6	9	3	NA	6	NA	0	NA	NA	NA	3

PULA = Pesticide Use Limitation Area
UDL = use data layer
VGF = vegetables and ground fruit
NA = not applicable because herbicide is not registered for uses within this UDL.

Table 8-8. PULA 1: Runoff/erosion Points for Terrestrial Areas and Dicots

UDL	2,4-D	Dicamba	Diuron	MCPA	Metolachlor	Metribuzin	Oxyfluorfen	Paraquat	Pendimethalin	Propanil	Thiobencarb	Trifluralin
Alfalfa	NA	NA	9	3	NA	6	NA	General	5	NA	NA	General
Citrus	6	NA	9+	NA	NA	NA	7	General	5	NA	NA	General
Corn	6	9	9	NA	9	6	7	General	5	NA	NA	General
Cotton	NA	9	9	NA	9	NA	7	General	5	NA	NA	General
Grapes	6	NA	9+	NA	NA	NA	7	General	7	NA	NA	General
Other Crops	NA	NA	NA	3	NA	6	NA	General	5	NA	NA	NA
Other Grains	6	6	9	6	6	6	NA	General	5	NA	NA	General
Other Orchards	6	NA	9	NA	NA	NA	7	General	5	NA	NA	General
Other Row Crops	6	NA	NA	NA	NA	NA	NA	General	5	NA	NA	General
Rice	NA	NA	NA	NA	NA	NA	NA	General	NA	General	General	NA
Soybeans	6	9	NA	NA	9	6	7	General	NA	NA	NA	General
VGF	6	9	9	3	9	6	5	General	5	NA	NA	General
Wheat	6	6	9	6	NA	6	NA	General	NA	NA	NA	General

PULA = Pesticide Use Limitation Area
UDL = use data layer
VGF = vegetables and ground fruit
NA = not applicable because herbicide is not registered for uses within this UDL.
General = no PULA needed, mitigations only needed on general label

Table 8-9. PULA 2: Runoff/erosion Points for Terrestrial Areas and Monocots

UDL	2,4-D	Dicamba	Diuron	MCPA	Metolachlor	Metribuzin	Oxyfluorfen	Paraquat	Pendimethalin	Propanil	Thiobencarb	Trifluralin
Alfalfa	NA	NA	9	3	NA	6	NA	General	5	NA	NA	General
Citrus	General	NA	9+	NA	NA	NA	7	General	5	NA	NA	General
Corn	General	General	9	NA	9	6	7	General	5	NA	NA	General
Cotton	NA	General	9	NA	9	NA	7	General	5	NA	NA	General
Grapes	General	NA	9+	NA	NA	NA	7	General	7	NA	NA	General
Other Crops	NA	NA	NA	3	NA	6	NA	General	5	NA	NA	NA
Other Grains	General	General	9	6	6	6	NA	General	5	NA	NA	General
Other Orchards	General	NA	9	NA	NA	NA	7	General	5	NA	NA	General
Other Row Crops	General	NA	NA	NA	NA	NA	NA	General	5	NA	NA	General
Rice	NA	NA	NA	NA	NA	NA	NA	General	NA	General	General	NA
Soybeans	General	General	NA	NA	9	6	7	General	NA	NA	NA	General
VGF	General	General	9	3	9	6	5	General	5	NA	NA	General
Wheat	General	General	9	6	NA	6	NA	General	NA	NA	NA	General

PULA = Pesticide Use Limitation Area
UDL = use data layer
VGF = vegetables and ground fruit
NA = not applicable because herbicide is not registered for uses within this UDL.
General = no PULA needed, mitigations only needed on general label

Table 8-10. PULA 3: Runoff/erosion Points for Wetland/aquatic Areas and Dicots

UDL	2,4-D	Dicamba	Diuron	MCPA	Metolachlor	Metribuzin	Oxyfluorfen	Paraquat	Pendimethalin	Propanil	Thiobencarb	Trifluralin
Alfalfa	NA	NA	9	3	NA	6	NA	General	5	NA	NA	General
Citrus	6	NA	9	NA	NA	NA	7	General	5	NA	NA	General
Corn	9	9	9	NA	9	6	7	General	5	NA	NA	General
Cotton	NA	9	9	NA	9	NA	7	General	5	NA	NA	General
Grapes	6	NA	9	NA	NA	NA	7	General	5	NA	NA	General
Other Crops	NA	NA	NA	3	NA	6	NA	General	5	NA	NA	NA
Other Grains	6	6	9	6	9	6	NA	General	5	NA	NA	General
Other Orchards	6	NA	9	NA	NA	NA	7	General	5	NA	NA	General
Other Row Crops	6	NA	NA	NA	NA	NA	NA	General	5	NA	NA	General
Rice	NA	NA	NA	NA	NA	NA	NA	General	NA	General	General	NA
Soybeans	6	9	NA	NA	9	6	7	General	NA	NA	NA	General
VGF	6	9	9	3	9	6	5	General	5	NA	NA	General
Wheat	6	6	9	6	NA	6	NA	General	NA	NA	NA	General

PULA = Pesticide Use Limitation Area
UDL = use data layer
VGF = vegetables and ground fruit
NA = not applicable because herbicide is not registered for uses within this UDL.
General = no PULA needed, mitigations only needed on general label

Table 8-11. PULA 4: Runoff/erosion Points for Wetland/aquatic Areas and Monocots

UDL	2,4-D	Dicamba	Diuron	MCPA	Metolachlor	Metribuzin	Oxyfluorfen	Paraquat	Pendimethalin	Propanil	Thiobencarb	Trifluralin
Alfalfa	NA	NA	9	3	NA	6	NA	General	5	NA	NA	General
Citrus	General	NA	9	NA	NA	NA	7	General	5	NA	NA	General
Corn	General	General	9	NA	9	6	7	General	5	NA	NA	General
Cotton	NA	General	9	NA	9	NA	7	General	5	NA	NA	General
Grapes	General	NA	9	NA	NA	NA	7	General	5	NA	NA	General
Other Crops	NA	NA	NA	3	NA	6	NA	General	5	NA	NA	NA
Other Grains	General	General	9	6	9	6	NA	General	5	NA	NA	General
Other Orchards	General	NA	9	NA	NA	NA	7	General	5	NA	NA	General
Other Row Crops	General	NA	NA	NA	NA	NA	NA	General	5	NA	NA	General
Rice	NA	NA	NA	NA	NA	NA	NA	General	NA	General	General	NA
Soybeans	General	General	NA	NA	9	6	7	General	NA	NA	NA	General
VGF	General	General	9	3	9	6	5	General	5	NA	NA	General
Wheat	General	General	9	6	NA	6	NA	General	NA	NA	NA	General

PULA = Pesticide Use Limitation Area
UDL = use data layer
VGF = vegetables and ground fruit
NA = not applicable because herbicide is not registered for uses within this UDL.
General = no PULA needed, mitigations only needed on general label

9 Implementation Plan

This section describes EPA's current thinking as to how it may implement the Strategy through registration and registration review decisions. Additionally, EPA is considering ways to ensure that the mitigations can be employed effectively and expeditiously, as well as adding mitigation options as they become available. This could lead to providing more feasible options for growers and users. One option the Agency is considering is whether use of an EPA website to host the applicable mitigation measures would provide more flexibility and efficiencies to growers and users. EPA is considering whether including a website reference on labeling could avoid the need to amend hundreds to thousands of product labels, perhaps multiple times, if additional mitigation options become available over time. The resources EPA would need to amend such a large number of labels to include additional mitigation would not allow the Agency to complete this work in a timely fashion, leading to delays in expanding options to users and growers and differing mitigation requirements across herbicides until all herbicide labels have been reviewed for this purpose. EPA's thinking on web labels is in the early stages, as EPA is investigating the utility of this approach to ensure that, as more data become available on existing measures and emerging technologies, EPA could efficiently add options for pesticide product users to meet any necessary mitigations. EPA expects that further public input could be necessary before employing a website as described below. This section also describes EPA's current thinking as to how the Strategy interplays with FIFRA IEM and other ESA strategies (*e.g.*, the Vulnerable Species Project). Finally, this section describes how the Strategy may inform a future programmatic consultation with FWS.

9.1 Proposed Approach to incorporating Mitigation measures into Registration and Registration Review Decisions

EPA intends to begin implementing this Strategy once finalized. EPA is currently planning on finalizing the Strategy in early 2024. In addition to its standard FIFRA evaluations, when the EPA evaluates applications for new conventional herbicides or in its registration review processes for conventional herbicides that have agricultural uses, EPA will apply the final Strategy. Using the Strategy decision framework, EPA would apply needed mitigations to reduce herbicide exposures to the 900+ listed species covered by this Strategy.

In addition to the Strategy, EPA has also released in its ESA Workplan Update proposed FIFRA IEM that may be determined to be necessary in registration review decisions and registration actions. The proposed IEM was published 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 is in the process of reviewing the comments received and updating the proposed mitigation measures. EPA considered the need to be consistent across the FIFRA IEM and Strategy mitigations to the extent appropriate, given that IEM must consider benefits as required under FIFRA and the Strategy cannot because it proposes measures to address ESA requirements. To that end, EPA expects to use the same runoff/erosion "mitigation menu" for

IEMs and the Strategy (and other ESA strategies) and is considering how the "mitigation menu" approach could work for other types of mitigation across strategies. There are differences between the IEMs and the Strategy related to the factors considered in determining the need, level, and extent of mitigations. For example, when considering whether mitigations are identified for conventional agricultural uses on herbicides, EPA expects that the level of mitigation in the final Strategy would supersede the IEM for those uses. Refining the example further, both the Strategy and IEM include mitigations for spray drift and runoff/erosion. For herbicides, EPA's current thinking is that it would apply any spray drift and/or runoff/erosion requirements based on the Strategy instead of the IEM because the mitigations for the Strategy to protect listed species would be at least as stringent as mitigation identified under the IEMs for all non-target species. It is possible that other parts of IEM may be appropriate for herbicides. EPA plans to make clear in its regulatory decision documents which measures EPA considered appropriate for the herbicide and why, given the context of different yet overlapping efforts of IEM, the Herbicide Strategy, and other ESA strategies. For example, EPA expects to propose the other IEM label language not covered by the Strategy (*e.g.*, pollinator stewardship language, incident reporting language). As discussed in the November 2022 ESA Workplan Update (USEPA, 2022b) and in the Vulnerable Species Pilot (USEPA, 2023d), EPA has and continues to propose language on pesticide product labels that directs pesticide applicators to check the Bulletins Live Two! Website when mitigations may be implemented using bulletins (**Section 7**).

EPA acknowledges that it is not feasible to implement mitigations proposed in the Strategy on all herbicide products at the same time. As to registration review actions, the current workload includes hundreds of pesticide active ingredients, representing thousands of individual products. Taking into consideration the upcoming ESA strategies, EPA updated its registration review schedule on April 10, 2023[36] to align it with the strategies discussed in the ESA Workplan Update.[37] Several conventional herbicides in registration review are now scheduled for a proposed interim decision in calendar year 2024. The updated schedule is designed to align timing of review of herbicides with the timing of the final Strategy. This should result in better regulatory certainty as it relates to early mitigations for the protection of listed species and improve the efficiency and consistency in EPA's registration review work. As ESA strategies are developed and finalized, EPA may determine that additional revisions are necessary to its current registration review schedule.

EPA also acknowledges that many growers use multiple herbicides on the same field at the same time. In this case, once EPA finalizes the Strategy, if a grower applies more than one herbicide that is subject to the Strategy at the same time to a field, then the grower would need to meet the most restrictive set of mitigations from the Strategy among the herbicides they plan to apply.

[36] https://www.epa.gov/pesticides/epa-publishes-updated-registration-review-schedule
[37] https://www.epa.gov/pesticide-reevaluation/upcoming-registration-review-actions

After the Strategy is finalized, as conventional herbicides with agricultural uses undergo Registration Review, EPA expects to propose applicable Strategy mitigation measures in its registration review process, including Proposed Interim Decisions (PID) and Proposed Final Decisions (PFD), depending on where an herbicide is in the Registration Review process. Through the public comment process established for these decisions, stakeholders will have this additional opportunity to comment on the incorporation of the Strategy measures in the registration review process for each herbicide. After comments are considered on the PID or PFD, EPA will determine what is appropriate for any Interim Decisions (ID) or Final Decisions (FD). As described in **Section 7**, EPA expects that once finalized with an ID or FD, the mitigations would be implemented through labeling statements as well as the use of bulletins, as appropriate. The use of a "menu" of mitigations should provide applicators the needed flexibility, while also providing protections for listed species.

For registration decisions outside of the registration review program, as indicated in the ESA Workplan, EPA plans to prioritize ESA analyses for new active ingredients proposed for registration. Once the Strategy is finalized and EPA has formalized the Strategy with FWS, then the Strategy would serve as the basis for initial registration applications for new herbicide active ingredients with agricultural use sites. EPA expects that this would greatly increase the efficiency of EPA's ESA analyses and facilitate consultation. Until then, the proposed Strategy may serve as a tool to guide registrants and the EPA towards identifying mitigations that could be put into place on labels for currently registered herbicides prior to our BE and prior to entering formal consultation with the Services. EPA expects the Strategy to evolve from its draft form as we gain experience and get feedback from stakeholders. As EPA gains experience through implementation of the Strategy, EPA expects to consider how the Strategy may be applied to other registration actions.

9.2 Considerations for Future Additions and Updates on Mitigation Measures

EPA acknowledges that stakeholders may provide additional information on the proposed mitigations (*e.g.*, efficacy information for mitigation measures not yet on the menu) as well as information on other measures that the Agency may want to consider when determining whether revisions to the Strategy are necessary. EPA may become aware of information after the Strategy is finalized. To ensure that mitigation measures continue to be identified and updated as necessary, EPA realizes the need to provide ways to incorporate current and future emerging technologies in the mitigation menu as efficacy data become available. As such, EPA is considering ways to expand the proposed mitigation menus (once finalized) over time. Due to the limitations of EPA's current labeling review process, the Agency would like to investigate ways to provide information on labeling that would allow for future updates, without the need to repeatedly request label amendments. One way to do this would be for applicants/registrants to include on pesticide product labeling the mitigation identified (as discussed with EPA during registration or registration review) along with a direction to access and follow additional information contained on an EPA website. EPA envisions the website could include the list of mitigation measures that could be used along with descriptions of how to implement those measures. The product label could include the extent of mitigation

measures necessary (*e.g.*, mitigation points) along with the current list of mitigation measures and a reference to the EPA website that could be updated with additional mitigation measures that would be allowed to meet the amount of mitigation needed. In this way, users would have the same options in terms of mitigation measures regardless of when any individual herbicide undergoes registration or re-evaluation in registration review. Keeping mitigations up to date on a website rather than including the mitigations on labels would provide growers and pesticide applicators with the certainty that their investment in one mitigation measure would receive credit for any herbicide they need to apply (even if their mitigation measures are added to the menu later in time). This also creates more consistency across the pesticide marketplace, which is a common concern among pesticide registrants. EPA looks forward to input on this idea as well as other options to provide certainty and flexibility to use future technologies.

Similarly, EPA is currently developing two other ESA efforts that would apply to herbicides as well as other conventional pesticides. The first is EPA's Vulnerable Species Pilot (VSP) where EPA has drafted proposed mitigations for 27 highly vulnerable, limited-range listed species. In June 2023, EPA released its proposed mitigation measures for the VSP.[38] Once EPA finalizes the Strategy, if a grower is located in an area where mitigations identified in the pilot and the Strategy are necessary, EPA would apply the more restrictive set of mitigations (which would likely be the vulnerable species mitigations because they are intended to have the maximum set of spray drift and runoff/erosion mitigations that may be used for the Strategy, and thus offer the most progress toward full ESA compliance).

9.3 Decision support tools and training

EPA intends for the mitigation menus proposed in the Strategy to provide flexibility to applicators and growers so that they may choose mitigation measures that suit their circumstances. As a result, applicators and growers would have multiple options when deciding what mitigation measures to apply. Similarly, when growers have choices between different herbicides and/or may apply more than one herbicide, they may need to evaluate the different mitigation measures necessary across those herbicides. EPA welcomes feedback and engagement on decision support tools and training that stakeholders would find helpful when deciding among multiple mitigation options across a variety of crop uses and herbicide products.

9.4 Future Consideration of Offsets

To meet ESA obligations, federal agencies often use offsets (also known as compensatory mitigation) to address the effects of their actions that cannot be avoided or minimized. FWS defines offsets as measures to "*compensate for 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,*

[38] https://www.regulations.gov/docket/EPA-HQ-OPP-2023-0327

establishment, enhancement, or preservation of resources…." (USFWS, 2016). Offsets can include actions such as habitat preservation or restoration, 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.
As described in the April 2022 ESA Workplan (USEPA, 2022a) and the November 2022 ESA Workplan Update (USEPA, 2022b), EPA plans to identify opportunities for offsets to complement traditional FIFRA avoidance and minimization measures for ESA species. The Agency will do so through a multi-step process that includes working with the Services to develop general guidance on using offsets for pesticide consultations, working with registrants 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. EPA continues to welcome proposals to incorporate offsets into pesticide consultations. Any registration or registration review action that includes offsets will need to follow the Services' offset policies, particularly the mitigation hierarchy of first avoiding impacts, then minimizing, and finally offsetting.

9.5 Future consultation with the Services

One of the goals of the Strategy is to help increase the efficiency of the pesticide consultation process by creating an important component of a programmatic consultation, or other streamlining process, that is potentially larger in scope than just the Strategy. Programmatic consultation is defined in the Services' ESA regulations as "*consultation addressing an agency's multiple actions on a program, region, or other basis expected to be implemented in particular geographic areas* (50 CFR § 402.02). EPA is also considering other options such as using its overall EPA strategy as outlined in the Workplan (and Update) to develop a conservation plan that outlines EPA's overall strategy for working with FWS to protect listed species from pesticides and to streamline the consultation process on specific actions. The EPA's Strategy is an opportunity for EPA and FWS to consider the potentially significant contribution to consultation efficiency the Strategy could provide because there are over 400 listed plants in the lower 48 states that are under the authority of FWS. In addition, FWS has authority of over 500 listed animals and over 300 CHs located in the lower 48 states that may be impacted by effects to plants. By providing mitigation measures, through the Strategy, designed to address the main taxa affected by herbicides (plants), existing and future consultations on herbicides would be much more efficient.

The EPA and FWS have been collaborating on developing the Strategy. EPA and FWS plan to develop a programmatic consultation, or other streamlining process, for pesticides, of which the evaluation of herbicides using the Strategy will be a part. This includes the more efficient approach to determine the need for, the level of, and geographic extent of early mitigations for listed species from agricultural uses of conventional herbicides described in the proposed Strategy. As part of any consultation, EPA and FWS can also consider how the mitigation measures may help minimize potential for J/AM and take of listed animals. EPA envisions that any programmatic consultation or other streamlining process would consider as part of the

action the outcomes of the Strategy. In turn, as EPA develops future BEs, implementation of the Strategy should result in fewer resources for ESA compliance. By incorporating mitigation measures directly into EPA's actions prior to consultation, the mitigation needs for these species would already be partly or fully addressed prior to any future consultation for an agricultural herbicide. For future herbicide BEs and consultations, EPA and FWS could then focus on potential effects not addressed in this Strategy (*e.g.*, effects to animals on the treated field or newly listed species, and non-agricultural uses).

The National Marine Fisheries Service (NMFS) and EPA are currently working separately on developing a programmatic process for conventional pesticides. Therefore, species under the purview of NMFS were not included in the Strategy. The Strategy may inform programmatic consultation with NMFS.

10 Conclusions and Next Steps

EPA developed the proposed Herbicide Strategy to identify and implement early protections for listed species (before EPA has made effects determinations or completed consultation, if necessary) and to increase the efficiency of future effects determinations, and consultations with FWS for herbicides in the lower 48 states with agricultural uses. In turn, this should also create efficiencies in pesticide registration and registration review actions.

In particular, the Strategy is designed to reduce exposure to listed plants (and listed species that depend on plants) from spray draft and run-off/erosion. The Strategy reflects a more efficient analytical approach – one based on analyses EPA generally already performs to estimate exposure and assess impacts of a pesticide – to determine the need, level, and extent of mitigations for a particular herbicide to protect the listed species covered by the Strategy.

EPA is soliciting public comments on this proposed Strategy. After considering public comment, EPA plans to finalize it in early 2024.

11 Literature Cited

Alix, A., Brown, C., Capri, E., Goerlitz, G., Golla, B., Knauer, K., et al. 2017. *Society of Environmental Toxicology and Chemistry. Mitigating the Risks of Plant Protection Products in the Environment. Procedings of the MAgPIE Workshop*. Available at: https://www.spraydriftmitigation.info/mitigation-toolbox.

FOCUS. 2007. *Landscape and Mitigation Factors in Aquatic Risk Assessment. Volume 1: Extended Summary and Recommendations. Version 2*. EC Document Reference SANCO/10422/2005. September 2007. Report of the FOCUS Working Group on landscape and mitigation factors in ecological risk assessment. Available at: https://esdac.jrc.ec.europa.eu/projects/focus-landscape-mitigation.

Reichenberger, S., Bach, M., Skitschak, A., & Frede, H.-G. 2007. Mitigation strategies to reduce pesticide inputs into ground- and surface water and their effectiveness; A review. *Science of The Total Environment, 384*(1), 1-35.

TXDOT. 2019. *Section 11 Time of Concentration*, *Hydraulic Design Manual*: Texas Department of Transportation (TXDOT). Available at: http://onlinemanuals.txdot.gov/txdotmanuals/hyd/time_of_concentration.htm.

USDA. 2010. Chapter 15 Time of Concentration. In *Part 630 Hydrology National Engineering Handbook* U.S. Department of Agriculture. National Resource Conservation Service. Available at: https://directives.sc.egov.usda.gov/OpenNonWebContent.aspx?content=27002.wba.

USEPA. 1998a. *Guidelines for Ecological Risk Assessment*. EPA/630/R-95/002F. Risk Assessment Forum. Office of Research and Development. U.S. Environmental Protection Agency. Available at: http://www.epa.gov/raf/publications/guidelines-ecological-risk-assessment.htm.

USEPA. 1998b. *Guidelines for Ecological Risk Assessment*, *United States Environmental Protection Agency (USEPA)*. Washington, D.C.: Government Printing Office. Available at: http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=12460.

USEPA. 2004. *Overview of the Ecological Risk Assessment Process in the Office of Pesticide Programs*. U.S. Environmental Protection Agency. Office of Chemical Safety and Pollution Prevention. Office of Pesticide Programs.

USEPA. 2008. *Fate, Transport, and Transformation Guidelines. OPPTS 835.1230 Adsorption/Desorption (Batch Equilibrium)*. EPA 712-C-08-009. October 2008. U.S. Environmental Protection Agency. Office or Prevention, Pesticides, and Toxic Substances. Available at: http://www.epa.gov/ocspp/pubs/frs/publications/Test_Guidelines/series835.htm.

USEPA. 2012a. *Ecological Effects Test Guidelines. OCSPP 850.4150: Vegetative Vigor*. EPA 712-C-011. January 2012. U.S. Environmental Protection Agency. Office of Chemical Safety and Pollution Prevention. Available at: http://www.regulations.gov/#!documentDetail;D=EPA-HQ-OPPT-2009-0154-0024.

USEPA. 2012b. *Ecological Effects Test Guidelines. OCSPP 850.4500: Algal Toxicity*. EPA 712-C-006. January 2012. U.S. Environmental Protection Agency. Office of Chemical Safety and Pollution Prevention. Available at: http://www.regulations.gov/#!documentDetail;D=EPA-HQ-OPPT-2009-0154-0003.

USEPA. 2012c. *Ecological Effects Test Guidelines. OCSPP 850.4550 Cyanobacteria (Anabeana flos-aquae) Toxicity*. EPA 712-C-005. January 2012. U.S. Environmental Protection Agency. Office of Chemical Safety and Pollution Prevention. Available at: http://www.regulations.gov/#!documentDetail;D=EPA-HQ-OPPT-2009-0154-0004.

USEPA. 2013. *Guidance on Modeling Offsite Deposition of Pesticides Via Spray Drift for Ecological and Drinking Water Assessment*. U.S. Environmental Protection Agency. Office of Chemical Safety and Pollution Prevention. Office of Pesticide Programs. Environmental Fate and Effects Division.

USEPA. 2017. *Pesticide Industry Sales and Usage 2008 - 2012 Market Estimages*. U.S. Environmental Protection Agency. Office of Pesticide Programs. Biological and Economic Analysis Division. Available at: https://www.epa.gov/sites/default/files/2017-01/documents/pesticides-industry-sales-usage-2016_0.pdf.

USEPA. 2018. *Guidance for Using ECOSAR as a Line of Evidence for Identifying Residues of Toxicological Concern*. September 26, 2018. U.S. Environmental Protection Agency.

Office of Chemical Safety and Pollution Prevention. Office of Pesticide Programs. Environmental Fate and Effects Division. Available at: https://www.epa.gov/system/files/documents/2022-06/Procedure-for-using-ECOSAR-as-a-%20Line-of-Evidence.pdf.

USEPA. 2019. *Methods for Assessing Aquatic Exposure to Residue(s) of Concern*. June 20, 2019. U.S. Environmental Protection Agency. Office of Chemical Safety and Pollution Prevention. Office of Pesticide Programs. Environmental Fate and Effects Division.

USEPA. 2020. *Revised Method for National Level Listed Species Biological Evaluations of Conventional Pesticides*. March 12, 2020. Environmental Fate and Effects Division. Office of Pesticide Programs. U.S. Environmental Protection Agency. Available at: https://www.epa.gov/endangered-species/revised-method-national-level-listed-species-biological-evaluations-conventional.

USEPA. 2022a. *Balancing Wildlife Protection and Responsible Pesticide Use: How EPA's Pesticide Program Will Meet its Endangered Species Act Obligations*. April 2022. U.S. Environmental Protection Agency. Office of Chemical Safety and Pollution Prevention. Office of Pesticide Programs. . Available at: https://www.epa.gov/system/files/documents/2022-04/balancing-wildlife-protection-and-responsible-pesticide-use_final.pdf.

USEPA. 2022b. *ESA Workplan Update: Nontarget Species Mitigation for Registration Review and Other FIFRA Actions*. Docket ID EPA-HQ-OPP-2022-0908. November 2022. United States Environmental Protection Agency. Office of Chemical Safety and Pollution Prevention. Office of Pesticide Programs. Available at: https://www.epa.gov/system/files/documents/2022-11/esa-workplan-update.pdf.

USEPA. 2023a. *Draft Technical Support for Runoff, Erosion, and Spray Drift Mitigation to Protect Non-Target Plants and Wildlife*. Docket ID EPA-HQ-OPP-2023-0327-0003. June 22, 2023. U.S. Environmental Protection Agency. Office of Chemical Safety and Pollution Prevention. Office of Pesticide Programs. Available at: https://www.regulations.gov/document/EPA-HQ-OPP-2023-0327-0003.

USEPA. 2023b. *Pesticide in Water Calculator User Manual for Versions 2.001*. United States Environmental Protection Agency. Office of Pesticide Programs. Environmental Fate and Effects Division. Available at: https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/models-pesticide-risk-assessment.

USEPA. 2023c. *Plant Assessment Tool Version 2.7.1*. Washington, D.C. Available at: https://www.epa.gov/endangered-species/provisional-models-and-tools-used-epas-pesticide-endangered-species-biological.

USEPA. 2023d. *Vulnerable Listed (Endangered and Threatened) Species Pilot Project: Proposed Mitigations, Implementation Plan, and Possible Expansion: Draft Plan*. Docket ID EPA-HQ-OPP-2023-0327-0002. June 2023. U.S. Environmental Protection Agency. Office of Chemical Safety and Pollution Prevention. Office of Pesticide Programs. Available at: https://www.regulations.gov/document/EPA-HQ-OPP-2023-0327-0002.

USFWS.2016. Endangered and Threatened Wildlife and Plants: Endangered Species Act Compensatory Mitigaiton Policy. *Federal Register* Volume 81. Number 248.Pages 95316. December 27, 2016.

USFWS. 2021. *Draft Biological and Conference Opinion on the Registration of Malathion Pursuant to the Federal Insecticide, Fungicide, and Rodenticide Act*. February 2021. U.S. Fish and Wildlife Service Available at: https://www.epa.gov/endangered-species/biological-opinions-available-public-comment-and-links-final-opinions.

USFWS. 2022a. *Biological and Conference Opinion on the Registration of Malathion Pursuant to the Federal Insecticide, Fungicide, and Rodenticide Act*. February 28, 2022. U.S. Fish and Wildlife Service. Ecological Services Program. Available at: https://www.epa.gov/endangered-species/biological-opinions-available-public-comment-and-links-final-opinions.

USFWS. 2022b. *Final Biological and Conference Opinion on the Registration of Malathion Pursuant to the Federal Insecticide, Fungicide, and Rodenticide Act*. February 28, 2022. U.S. Fish and Wildlife Service. Ecological Services Program. Available at: https://fws.gov/media/biological-and-conference-opinion-registration-malathion.

USFWS. 2023. *Environmental Conservation Online System (ECOS)*. United States Fish and Wildlife Service. Available at: https://ecos.fws.gov/ecp/.

VADEQ. 1992. Chapter 5 Engineering Calculations. In *Virginia Erosion and Sediment Control Handbook. Third Edition*. Richmond, VA: Virginia Departement of Environmental Quality (VADEQ). Available at: https://www.deq.virginia.gov/water/stormwater/stormwater-construction/handbooks.

Wu, Q., & Lane, C. R. 2017. Delineating wetland catchments and modeling hydrologic connectivity using lidar data and aerial imagery. *Hydrol Earth Syst Sci, 21*(7), 3579-3595.

Yuan, Y., Book, R. S., Mankin, K. R., Koropeckyj-Cox, L., Christianson, L., Messer, T., et al. 2022. An overview of the effectiveness of agricultural conservation practices for water quality improvement. *Journal of American Society of Agricultural and Biological Engineers, 65*(2), 419-426.

12 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
J/AM	Jeopardy to the continued existence of a species or adverse modification to a designated critical habitat
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
^oF	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. Representation of Aquatic Bodies of Water Relevant to Listed Species

EPA and the Services worked together to develop "aquatic bins" to match estimated exposure concentrations (EECs) in surface water to the listed species assigned to these bins based on habitat requirements (USEPA, 2020). Each bin varies in depth, volume, and flow (**Table A1**).

Aquatic bin 1 is used to represent riparian habitats or other land-based habitats adjacent to waterbodies that may occasionally be inundated with surface water (such as wetlands) and provide habitat or influence the water quality for aquatic and semi-aquatic organisms.

Aquatic bins 2, 3, and 4 are used to simulate flowing waterbodies. Bin 2 represents low flow (*i.e.*, 0.001 m^3/sec), bin 3 represents moderate flow (*i.e.*, 1 m^3/sec), and bin represents 4 high flow (*i.e.*, 100 m^3/sec). Bins 5, 6, and 7 are used to simulate static waterbodies. Bin 5 represents low volume, bin 6 represents moderate volume, and bin 7 represents high volume.

EPA uses the Pesticide in Water Calculator (PWC) and the Plant Assessment Tool (PAT) models to estimate exposures in bodies of water that represent the aquatic bins discussed above. Within the PWC model, the standard farm pond is used to develop EECs for the medium and large static and flowing bins (*e.g.*, bins 3, 4, 6 and 7). For the smaller flowing and static bins (aquatic bins 1, 2 and 5) exposure estimates are generated with the PAT. More discussion of the models used here is provided in the sections below.

The tidal and marine environments are not modeled, however the PAT Wetland Plant Exposure Zone (WPEZ) model and PWC EPA Farm Pond are used as surrogate EECs. No differentiation of these estuarine marine environments from freshwater systems are made in the Strategy. Because of the different types of dynamic hydrologic and tidal influence in estuarine/marine environments, the approach of using the PAT WPEZ and EPA Farm Pond as surrogates is considered conservative and protective.

Table A1. Generic Aquatic Habitats (Bins)[1]

Generic Habitat (Bin #)	Depth (meters)	Width (meters)	Length (meters)	Flow (m^3/second)	Waterbody Used for Exposure Modeling
Aquatic-associated terrestrial habitats (1)	NA	NA	NA	NA	PAT-Wetland
Low-flow (2)	0.1	2	Length of treated area	0.001	PAT-Wetland
Moderate-flow (3)	1	8	Length of treated area	1	PWC - Standard Farm Pond
High-flow (4)	2	40	Length of treated area	100	PWC - Standard Farm Pond
Low-volume (5)	0.1	1	1	0	PAT-Wetland
Moderate-volume (6)	1	10	10	0	PWC - Standard Farm Pond

Generic Habitat (Bin #)	Depth (meters)	Width (meters)	Length (meters)	Flow (m^3/second)	Waterbody Used for Exposure Modeling
High-volume (7)	2	100	100	0	PWC - Standard Farm Pond
Intertidal nearshore (8)	0.5	50	Length of treated area	NA	PAT-Wetland
Subtidal nearshore (9)	5	200	Length of treated area	NA	PWC - Standard Farm Pond
Offshore marine (10)	200	300	Length of treated area	NA	PWC - Standard Farm Pond

PAT = Plant Assessment Tool; PWC = Pesticide in Water Calculator; NA = not applicable

[1] Length of treated area – The habitat being evaluated is the reach or segment that abuts or is immediately adjacent to the treated area. The habitat is assumed to run the entire length of the treated area.

Appendix B. Lines of Evidence Considered in Step 1 for Interpreting the Potential for Population-Level Impacts

EPA considered the following lines of evidence when evaluating the potential for impacts to plants that could result in population-level impacts to animals that depend on those plants. These are consistent with the lines of evidence recommended in the *Revised Method for National Level Listed Species Biological Evaluations of Conventional Pesticides* and other ecological impact analysis guidance documents (USEPA, 1998b; USEPA, 2004; USEPA, 2020). EPA summarizes most of these lines of evidence in the ecological risk analysis developed to support registration decisions under FIFRA. What may not have been available in that analysis is an SSD of the plant toxicity endpoints and the Plant Assessment Tool (PAT) modeling results. EPA considered these lines of evidence in Step 1. Identify Population-Level Impacts and for interpreting the MoD and identifying the appropriate mitigation that is appropriate in Step 2. Identify the Type and Level of Mitigation. These are especially important for consideration when the MoD is between 1 and 10, where the MoE could be either low or medium because the lines of evidence that would be needed to change the conclusion for MoDs less than one and greater than ten occur rarely (**Table 5-2**).

When multiple lines of evidence are complementary (*e.g.*, laboratory- and field-based data are consistent in terms of effect) and there are monitoring and incident data which reinforce estimates of exposure and the likelihood of effects at a landscape level, then these increase confidence in predicting the potential for population-level impacts. When field data and lines of evidence are not consistent, EPA considers why the inconsistency may have occurred, whether additional data are needed, or whether additional mitigation may be appropriate to reduce the potential for further incidents. While incident and monitoring data are not available for all pesticides, the MoD and ecological impact analysis is developed based on some of the most robust environmental fate and toxicity data available for most chemicals. Therefore, the MoD should be reliable without these additional results.

Considerations in Exposure Estimate

- EPA uses laboratory fate data along with modeling to develop exposure estimates. EPA considers whether the modeling and fate data inputs are likely to result in an over or underestimate of potential for exposure. For example, when EPA uses a total residue approach (USEPA, 2019) to calculate the EEC, the EEC is more likely to provide a high estimate of exposure because the exposure estimate reflects the potential for exposure to parent and transformation products of potential concern.
- EPA uses monitoring data to serve as a line of evidence in ground-truthing the environmental fate characterization in terms of the mobility and persistence of the chemical and to evaluate the estimated exposure. EPA considers whether the laboratory data and modeling results are consistent with targeted monitoring results.
- EPA evaluates whether monitoring data support the predicted exposures. For example, if monitoring data are available reflecting current use of a pesticide, EPA considers whether

the predicted concentrations are higher or lower than the monitoring data. Predicted EECs and monitoring may not be similar as they reflect very different timescales, environments, and pesticide use but EPA does expect that EECs should be on the high end of measured exposure in the environment, especially for targeted monitoring.

- EPA evaluates whether monitoring detections commonly occur in the environment at or close to EECs in the range or CH. If detections are occuring within the range or CH, there is likely a potential for exposure. In general, lack of detections is not used to support that exposure is not occuring because it may simply indicate that no one conducted monitoring in the area or near where an application occurred.

Considerations in The Toxicity Characterization

- Type of impact observed in studies. When higher percent reductions in growth are predicted at the EECs or the EECs exceed survival effects, there is more confidence in the prediction of potential population-level impacts occurring. When only a low level of percent reductions in growth were observed at the EECs, there is more confidence that population-level impacts will occur and if they did occur, full recovery is often possible.
- Percentage of the species sensitivity distribution that would be impacted at the predicted EECs. The slope of the SSD or of the dose/response curve is a relevant consideration because when the slope is steep a small change in the EEC would result in a big increase in the potential number of species impacted. When the slope is shallow, there would be small changes in the number of species impacted with larger changes in the EEC.
- For guidelines designed as a hypothesis-driven test designs, consider if the regression-based estimates are aligned with the empirical endpoints. Using a study designed to test a hypothesis does not always produce a reliable dose/response curve and considerations should be given as to whether the concentration (or dose) response relationship is sufficiently bracketed to provide reliable estimates (*e.g.*, do estimates fall within the domain of the data). Depending on data available across studies and the degree that the regression-based endpoint falls outside of the empirical data, if the regression-based toxicity endpoint is not aligned with the empirical endpoints, an alternative toxicity endpoint may be utilized for the MoD.
- Evaluate variables associated with different studies that generated toxicity data used for SSDs. For example, evaluate different environmental conditions, and different product formulations, and species represented in the SSD.

Incidents

- When reliable incidents exist and indicate that impacts to plants may have occurred, these are considered in determining the potential for population-level impacts for a species with similar characteristics to the species in the reported incident.
- If different species of plants are impacted in incidents for a particular herbicide, habitat and diet impacts may also be considered.
- To consider incidents, the incidents should have enough information to provide confidence that the incidents occurred due to the use of the pesticide (*e.g.*, measured residues, application information).

- The lack of incidents does not indicate that impacts to species is not occuring because incidents are not always reported.
- EPA also evaluates whether the incidents are consistent with the types of impacts observed in lab studies or found in the risk assessment. If incidents are not consistent with the results of the MoD analysis, EPA would evaluate why that might be occuring, whether additional analysis or data were needed to better understand the issue, or whether additional mitigation was appropriate for the case.

Regarding incidents, the certainty index (*e.g.*, probable, highly probable) assigned to an incident provides a means of identifying whether there are measured residues and/or use information which may link a pesticide more clearly with an incident and increase confidence that the incident occurred due to the use of the pesticide, thereby increasing the relevancy of incident data as a line of evidence. When EPA does not have incident or monitoring data, EPA relies on the registrant submitted data to predict the potential for population-level impacts. This does not undermine our confidence in our MoD because the registrant submitted data and EPA's ecological analysis use the best available information available to understand the potential for impacts to populations. Data submitted to support registration of pesticides provides a robust dataset to understand the potential for population-level effects from the use of pesticides.

Appendix C. Development, Characterization and Discussion of Four Pesticide Use Limitation Areas (PULAs)

Approach used to Derive Four Proposed PULAs

As discussed in **Section 7**, EPA is proposing to use four PULAs to represent areas where proposed runoff/erosion and spray drift mitigations would apply to reduce exposures to listed plants and those animals that have obligate relationships to plants. The four PULAs are divided by habitat type (i.e., either terrestrial or aquatic/wetland) and plant taxon (*i.e*., either dicots or monocots). Non-flowering plants were grouped with the monocot and dicot PULAs.

EPA used taxonomy information associated with all listed plants located in the lower 48 to identify different plant groupings: dicots, monocots and non-flowering plants. EPA used life history information available for listed animals to identify those species with obligate relationships to either dicots, monocots, or non-flowering plants. EPA also used life history information available for all listed plants and listed animals with obligate relationships to plants to identify the habitat type relevant to the listed species (to identify whether the species should be placed in the terrestrial or the wetland/aquatic PULA). In many cases, listed plants occur within two or more of the standard habitat types: terrestrial, wetland and aquatic habitats. EPA grouped the wetland and aquatic species into one PULA because the land definition for aquatic areas also includes wetlands (See **Section 6.3** for descriptions). In cases where species use terrestrial only habitats, species were placed in one of the terrestrial PULAs. In cases where species use both terrestrial and wetland/aquatic habitats, species were placed in the wetland/aquatic habitat PULA. In cases where EPA identifies proposed mitigations for both the terrestrial and wetland/aquatic habitats, both sets of mitigations would apply to PULAs 3 and 4. This is because those two PULAs include listed plants and obligate animals that may use terrestrial, wetland, and aquatic habitats.

The Strategy is focused on agricultural uses of conventional herbicides. Therefore, EPA used the cultivated landcover in the lower 48 states to represent potential exposure areas. EPA extended these potential use sites to account for offsite movement of spray drift and runoff (300 m; 1000 ft). EPA identified all listed plants in the conterminous US that have ranges and/or CHs ≥5% overlap with off-site exposure areas from cultivated lands.[39] EPA used the Use Data Layer Overlap Tool,[40] to post-process the percentage of overlap data with the exposure area (based on off-site transport areas discussed in previous section) for the cultivated landcover and each species range or CH. Those species ranges and CHs were used to define the grouped PULAs.[41] EPA used the overlap of 5% or more to be consistent with FWS's approach to identifying those

[39] The 2017 cultivated use data layer identifies cultivated land cover for the lower 48 states and is based on land cover information derived from USDA's Crop Data Layer from 2013 through 2017 (Boryan et al, 2011; USDA, 2017).
[40] The Use Data Layer Overlap Tool can be found at: https://www.epa.gov/endangered-species/provisional-models-and-tools-used-epas-pesticide-endangered-species-biological
[41] Ranges and CHs obtained from FWS on February 16, 2022

species and CHs where there may be a potential for future J/AM (USFWS, 2021; USFWS, 2022a). **Table C1** summarizes the number of species and CHs included in each of the 4 proposed PULAs. The docket includes the full list of species and CHs that are currently proposed for inclusion in the 4 PULAs.

Table C1. Summary of four proposed Pesticide Use Limitation Areas (PULAs).

PULA #	PULA Description	# of species	# of CHs	# Counties[1]	Millions of acres of cultivated land[2]
1	Dicots and non-flowering plants in Terrestrial Habitats	218 dicots 5 non-flowering plants[3] 21 obligate animals	48	1120	84
2	Monocots and non-flowering plants in Terrestrial Habitats	13 monocots 5 non-flowering plants[3] 2 obligates	3	346	10
3	Dicots and non-flowering plants in Wetland and Aquatic Habitats	86 dicots 6 non-flowering plants[4] 2 obligates	25	1033	71
4	Monocots and non-flowering plants in Wetland and Aquatic Habitats	29 monocots 6 non-flowering plants[4] 2 obligates	9	1311	170

[1]This represents the number of counties that partially or completely overlap with the PULA.
[2]Calculated using cultivated land Use Data Layer.
[3] The same non-flowering plant species were incorporated into the monocot and dicot PULAs for terrestrial habitats.
[4] The same non-flowering plant species were incorporated into the monocot and dicot PULAs for wetland and aquatic habitats.

The overlap analysis involves calculating the percent of a species range or CH that overlaps with the offsite pesticide exposure area. For the Strategy, EPA is focused on estimating the extent of overlap of areas where spray drift and runoff/erosion may be transported from herbicide uses on cultivated lands. All listed plants and animals with obligate relationships to plants with ≥5% overlap with their range and/or CH were included in one of the 4 PULAs. For terrestrial and wetland species, EPA extended the cultivated crop Use Data Layer out by 300 m (approximately 1000 feet) distance to approximate the area off the field that is relevant to population-level exposures from spray drift and runoff/erosion. For spray drift, this distance was based on the upper bound of the Tier 1 AgDRIFT® model. For runoff/erosion, maximum overland flow distances are commonly assumed to be approximately 300 to 370 m (1000 to 1200 feet) in engineering handbooks (TXDOT, 2019; USDA, 2010; VADEQ, 1992). Wu and Lane (2017) estimated flow path lengths for more than 32,000 wetlands in the prairie pothole region and 300 m was in the upper end of the distribution, with an average flow path length of 138 m and median of 83 m (Wu and Lane, 2017). Based on the potential spray drift and runoff/erosion transport distances, EPA set off site transport distance to 300 m (1000 ft). The area represented by the off-site exposure area was used to calculate the overlap with species ranges and CHs and

to develop the four PULAs proposed for the Strategy. PULAs represent areas where listed plants, obligate animals or their CHs occur and there is a potential population level impact of herbicides from applications to cultivated lands.

Discussion of proposed PULAs

The four proposed PULAs vary in size, extent and spatial locations. In some cases, the PULAs overlap with each other (See **Figure 7-2**). Individually, the PULAs overlap with 10-170 million acres of cultivated lands (**Table C1**). The largest proposed PULA #4 reflects ranges and CH of monocots in wetland and aquatic habitats and overlaps with 170 million acres of cultivated lands. Although PULA 4 includes only 37 species and 9 CHs, it includes species that have some of the largest ranges among the listed plants located in the conterminous US (*e.g*., prairie fringed orchids). Comparatively, the listed dicot PULA for wetland/aquatic areas (PULA 3) overlaps with 100 million fewer acres of cultivated lands but has many more species (N= 94) and CHs (N = 25). When these PULAs are implemented, only the areas representing potential registered use sites of the herbicides would receive the mitigations. **Figure C1** shows the extent of acres of specific crops (*e.g*., corn, cotton, wheat) or groups of crops (e.g., vegetables and ground fruit; **Table C2**) within each of the four PULAs.

EPA traditionally implements mitigations through changes to pesticide labels or through limited areas where specific species may occur using bulletins and BLT. EPA is not proposing to implement spatially limited mitigations for specific species because of the large number of listed plants and their extents throughout the conterminous US and because of the large amount of time and effort needed to generate and maintain individual PULAs. For the Strategy, EPA is proposing a new approach to bulletins where large numbers of species and CHs are grouped to identify areas where higher mitigations are needed compared to the general label (which is implemented throughout the lower 48 states). This approach is being proposed to limit impacts on growers and focus mitigations in areas where they are needed most. Although there are hundreds of millions of acres of cultivated lands that overlap with the PULAs, there are hundreds of millions of cultivated lands that are outside of the PULAs. **Figure C1** includes comparisons of the amount of total acres of cultivated land in the conterminous US compared to the amount of acres of cultivated land within the four PULAs. This figure also includes similar comparisons of all acres in the conterminous US and within the PULAs for specific or groups of crops. As shown in this figure, when EPA applies step 3 of the Strategy, mitigations applied using the PULAs will result in higher mitigations (compared to the rest of the conterminous US) on only a portion of the total acres of crops.

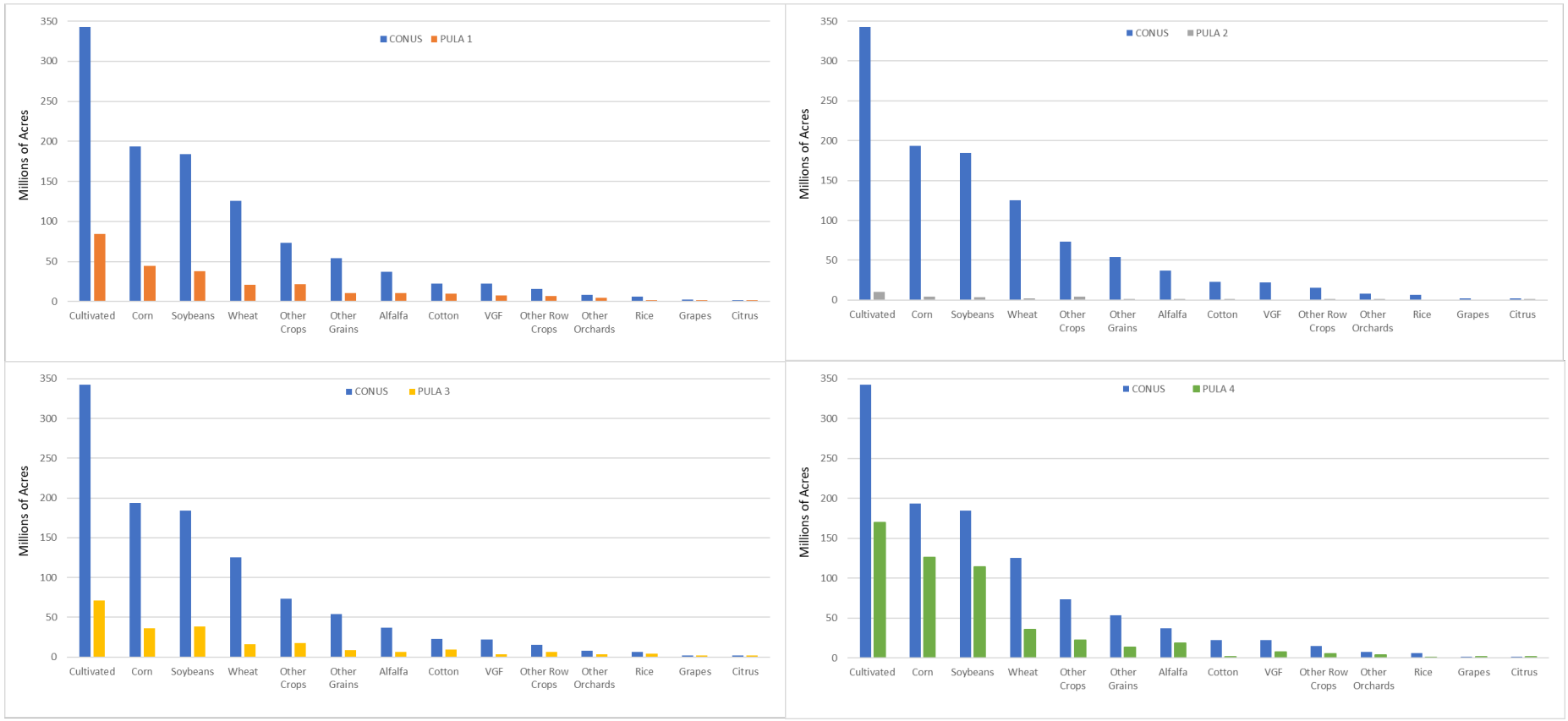


Figure C1. Extent of Acres of Cultivated Land and Specific Crops or Crop Groups in the Lower 48 states and in each of the Pesticide Use Limitation Areas (PULAs). Acres based on Use Data Layers (UDLs). Table C2 includes crops for each UDL. VGF = vegetables and ground fruit

Table C2. Relevant uses included in Use Data Layers.

Use Data Layer (UDL)	Uses included in UDL
Alfalfa	Alfalfa, Vetch, Switchgrass
Citrus	Citrus (other), Grapefruit, Kumquat, Lemon, Lime, Orange, Tangelo, Tangerine
Corn	Corn (grain), Corn (silage), Corn (traditional/Indian)
Cotton	Cotton
Grapes	Grapes
Other Crops	Field Crops (other), Fallow (other), Flaxseed, Grasses & Legumes (other, seed), Bahia Grass (seed), Bentgrass (seed), Bermuda Grass (seed), Kentucky Bluegrass (seed), Bromegrass (seed), Fescue (seed), Orchardgrass (seed), Ryegrass (seed), Sudangrass (seed), Timothy (seed), Wheatgrass (seed), Jojoba, Alfalfa (seed), Birdsfoot Trefoil (seed), Crimson Clover (seed), Red Clover (seed), White Clover (seed), Lespedeza (seed), Vetch (seed), Mustard (seed), Sesame
Other Grains	Barley, Buckwheat, Canola, Emmer & Spelt, Proso Millet, Oats, Rapeseed, Rye, Safflower, Sorghum (grain), Sorghum (silage), Sorghum (syrup), Sugarcane (seed), Sugarcane (sugar), Triticale
Other Orchards	Almond, Apricot, Avocado, Banana, Cherimoya, Sweet Cherry, Tart Cherry, Chestnut, Coffee, Date, Fig, Apple, Guava, Hazelnut, Macadamia, Mango, Nectarine, Other Non-Citrus (excluding berries), Olive, Papaya, Passion Fruit, Peach, Pear, Pear, Persimmon, Pistachio, Plum-Apricot Hybrids (including plumcots & pluots), Plum & Prune, Pomegranate, Other Tree Nuts, English Walnut
Other Row Crops	Hops, Peanut, Sugar Beet, Sunflower, Tobacco
Rice	Rice, Wild Rice
Soybeans	Soybean
Vegetables and Ground Fruit (VGF)	Aronia Berry, Artichoke, Asparagus, Dry Edible Bean (excluding chickpeas & lima), Dry Edible Lima Bean, Green Lima Bean, Snap Bean, Beet, Other Berries, Blackberry (including dewberry &marionberry), Tame Blueberry, Wild Blueberry, Boysenberry, Broccoli, Brussel Sprout, Chinese Cabbage, Head Cabbage, Mustard Cabbage, Camelina, Carrot, Cauliflower, Celery, Chickpea, Chicory, Cranberry, Cucumber, Currant, Daikon, Dill (oil), Eggplant, Elderberry, Escarole & Endive, Garlic, Ginger Root, Ginseng, Collard Greens, Kale, Mustard Greens, Turnip Greens, Guar, Dry Herbs, Fresh Cut Herbs, Horseradish, Kiwifruit, Lentil, Lettuce, Loganberry, Cantaloupe, Honeydew Melon, Watermelon, Mint (oil), Mint Tea Leaves, Okra, Dry Onions, Green Onions, Parsley, Austrian Winter Pea, Chinese Pea (sugar & snow), Dry Edible Pea, Dry Southern Pea (cowpea), Green Pea (excluding Southern), Green Southern Pea (cowpea), Bell Pepper, Chile Pepper, Pineapple, Shelled Popcorn, Potato, Pumpkin, Radish, Raspberry, Rhubarb, Spinach, Squash, Strawberry, Sweet Corn, Sweet Potato, Taro, Tomato, Turnip, Other Vegetables, Watercress
Wheat	Wheat

By establishing the PULAs using the entire cultivated land UDL and not individual UDLs for each herbicide, it is possible that EPA identified a need for mitigations in areas with low overlap (<5%) of the specific registered uses of a particular herbicide that has more limited labeled uses, particularly on crops that are grown on a small number of acres. By using the cultivated land UDL, EPA conservatively identifies a larger PULA; however, if there are limited use sites within the PULA, the impacts will also be limited. Because one of the main goals of the Strategy is to employ a simpler, much more efficient process to identify and implement mitigations, EPA's current thinking is that it would implement the mitigations by standardizing PULAs across

all herbicides based on the types of species potentially affected by the herbicide as described above. By applying this approach across all cultivated lands for herbicides, all herbicide uses would be mitigated with a consistent approach within the same area. Thus, all herbicides would have reduced exposures to the species where cultivated lands may lead to population level impacts. Moreover, the alternative of generating chemical, use and species specific PULAs is not feasible given the challenges EPA is facing as discussed in the introduction (**Section 1**).

For the PULAs described here, EPA used the current species ranges and CHs provided by the FWS as of February 16, 2022. When developing PULAs for the malathion BiOp, FWS, EPA, and the registrant reached out to species experts and sometimes refined the areas where mitigation was identified to reflect other information available on species location. It is possible in the future that EPA and FWS could work to refine some of the ranges that inform the PULAs proposed in this proposed Strategy; however, because they include hundreds of species, this is likely a longer-term effort. In addition, EPA did not consider several factors that FWS included in its' J/AM analyses, such as vulnerability and modifiers. These factors could result in changes to the list of species and CHs that are included in the 4 proposed PULAs (see the **List of Species in PULAs** in the docket). EPA expects to discuss these factors with FWS in the future. In addition, EPA expects to update the PULAs over time in order to incorporate new data (e.g., updated species ranges).

When considering the 4 PULAs, there are approximately 350 listed plant species that are used to represent the four PULAs (**Table C1**). As indicated previously, there are over 400 listed plants located within the lower 48 states. Some of those other listed plant species are included in the Vulnerable Species Pilot (N = 12). The other species are not included in the PULAs because they have <5% overlap with the exposure area of cultivated lands. Therefore, the listed plants species not included in the PULAs or in the vulnerable species pilot are not expected to have population-level impacts from herbicides. EPA plans to work with FWS in the future to evaluate whether a streamlined approach can be applied to consulting on these other species that have low overlap with cultivated lands.