Integration and Synthesis Summary for Plants

Plants in habitats expected to result in lower exposures to atrazine

This Integration and Synthesis Summary includes our jeopardy analysis for plant species that we or EPA determined would "likely be adversely affected" by the proposed action. Our jeopardy analysis of the proposed action's impacts to listed species is split into three major factors: vulnerability, exposure, and toxicity. The tables below contain summaries of vulnerability, exposure, and toxicity. Data and information used for each species include environmental baselines, cumulative effects, exposure information, and expected toxic effects for all species, and a template worksheet to show how species were assessed are in Appendix E. Status of the Species for each species can be found in Appendix B.

The species in this I&S appendix were grouped together as they occur in habitats that, as compared to other listed plants, were expected to have lower exposures to atrazine (i.e., desert, xeric habitats, cliffs, montane) and were predicted by EPA to be exposed to similar concentrations of atrazine from registered uses. Most of these species have low exposure to atrazine due to the factors described in the tables or individual rationales below, in combination with reductions in atrazine spray drift and runoff resulting from implementation of conservation measures added to the product label (including those developed during this consultation through the Herbicide Strategy[1]; see Conservation Measures section below). We anticipate exposures in the habitats where these species occur are at low enough levels where the label measures (including the 15- and 170-feet spray drift buffers and three runoff points) adequately reduce atrazine concentrations to levels where effects are expected to be low.

Vulnerability

For the plant species that we or EPA determined are "likely to be adversely affected" by the proposed action, we considered several factors for each listed plant to determine the current vulnerability of that species to additional stressors. This effort allows us to consider whether a species' current condition is stable, moving toward recovery, or moving toward further decline. In general, we expect the species' vulnerability to additional stressors to be higher if they are near extinction, far from recovery, or moving toward further decline than if their condition is stable or improving. We also identify which species are most (and least) susceptible to additional stressors in general based on information from species listing and recovery documents, or other sources as cited and considered in the Status of the Species and Critical Habitat section of this Opinion (Appendix B).

Our assessment of vulnerability focuses on six factors (as currently understood and available): (1) the species listing status and recent 5-year status review recommendation (if available), (2)

[1] https://www.regulations.gov/docket/EPA-HQ-OPP-2023-0365

distribution, (3) number of populations[2], (4) species population trends, (5) if pesticides have been noted as a threat, and (6) current and projected future impacts from activities associated with environmental baseline and cumulative effects. We obtained the information to create the vulnerability summary from the Status of the Species accounts (Appendix B), overarching Environmental Baseline section of this Opinion, five-year species status reviews, species recovery plans, species status assessments, range and critical habitat information from our ECOS[3] repository, and other sources containing the best available scientific information for the species.

We scored each of the six vulnerability components with high, medium, or low scores. We assigned a high vulnerability ranking to a species if all vulnerability components were scored as high, a mixture of medium and high, or if a threatened species was recommended for uplisting to endangered status in the most recent 5-year status review or proposed rule. We assigned a medium vulnerability ranking if a species' scores were all medium, a mix of high, medium, and low, or a mix of high and low (unless the species has been recommended for uplisting or delisting). We assigned a low vulnerability ranking to species with only low scores, a mixture of low and medium scores, or if the species was recommended for delisting. Considerations regarding specific aspects of the species' vulnerability or beyond what was included in the vulnerability ranking were applicable in our jeopardy analyses for some species depending on unique aspects of their vulnerability factors, recovery needs, or life history. This information is reflected in the rationales for conclusion below.

Exposure

We anticipate listed plant species will be exposed to atrazine primarily through direct contact, either as a result of exposure to pesticide applications on-site or in off-site areas through off-field transport via spray drift or runoff. Atrazine is moderately mobile in water and is relatively persistent in the environment relative to other pesticides, indicating that off-site transport, particularly through runoff, may result in exposure to listed species in areas far from use sites.

Exposure to Agricultural Uses

Atrazine has several registered agricultural uses (see Appendix 1-4 of EPA's Biological Evaluation) in the coterminous United States. We characterize the expected level of exposure using overlaps between the species' ranges and agricultural areas where atrazine is registered for use (i.e., overlap data; including a 305-m off-site transport area adjacent to use sites), past

[2] The number will vary in value and importance by species and in some cases is unknown. In general, species with a greater number of populations have greater representation, will be more resilient, and when distributed geographically, will have greater redundancy. Conversely, species with fewer populations, in general, have less representation, are less resilient, and have less redundancy.

[3] https://ecos.fws.gov/ecp/

atrazine usage data (when available; the amount and location where atrazine has been used in the past), any species-specific considerations such as life history information (e.g., habitat preferences), and existing protections or conservation actions (e.g., existing label measures, conservation measures from the action agency). Species with greater than 10% overlap between their range and agricultural atrazine use sites are assigned a high overlap score, species with 5-10% overlap are assigned a medium overlap score, and species with less than 5% overlap are assigned a low overlap score. In addition to range overlaps with atrazine use sites, we considered past atrazine usage data within a species' range to determine how much of a species' range we expect to be treated with each year of the proposed action. Except where otherwise noted, usage data is provided by EPA applying data from their National and State Summary Use and Usage Matrix, as described in the Usage Analysis section of this Opinion. Species with usage data that indicate a large portion of their range (>10%) is treated with atrazine each year are assigned a high usage score. Species that have a medium portion of their range (5-10%) treated with atrazine each year are assigned a medium usage score, and species where data indicate a low portion of their range (<5%) is treated with atrazine each year are assigned a low usage score.

We determine the overall exposure ranking by qualitatively considering both the total overlap and total usage, as well as any additional exposure considerations that might modify the level of exposure likely to occur. When overlap and usage scores are the same, we assign the overall exposure ranking the same score (e.g., if both overlap and usage is high, the overall exposure ranking is high). In cases where overlap is high and usage is medium or when overlap is medium and usage is low, we use the overlap score as the overall exposure ranking to maintain conservative exposure assumptions. As usage is a subset of overlap, the overlap score will always be greater than the usage score. In cases where overlap is high, but usage is low, we anticipate a moderate portion of the range may be treated over the duration of the proposed action even if only a small portion of the range is treated in any given year (particularly if the areas treated occur in different locations each year), leading to an overall exposure ranking of medium. For species where there are additional exposure considerations, we adjust the overall exposure ranking to reflect this additional information, as appropriate.

Agricultural uses of atrazine include labeled uses for corn, vegetables and ground fruit (i.e., sweet corn), sod, orchards (i.e., guava and macadamia nut), other grains (including sugarcane and sorghum), and fallow fields only within the coterminous United States.

Exposure to Non-Agricultural Uses

In addition to agricultural uses, atrazine is registered for use on non-agricultural turf, including residential lawns and golf course turf. UDLs for non-agricultural uses sites that represent turf tend to be less defined than those for agricultural UDLs and are less likely to accurately represent the actual footprint of these use sites on the landscape. As such, we assess exposure of species to all non-agricultural uses of atrazine in a qualitative manner, considering the life history of species, methods of application, atrazine usage, and any existing conservation measures to reduce drift and runoff or otherwise limit exposure to species. To facilitate this analysis, for every species in this Appendix, we reviewed species' documents (e.g., Status of the Species (Appendix B), 5-year reviews, Species Status Assessments, recovery plans, listing rules) to determine if the species could occur on or near non-agricultural atrazine use sites (i.e., residential areas where lawns or golf courses are likely present) and the manner in which they may rely on these sites.

Depending on region, cool-season, warm-season, or a combination of turf grass species are managed on golf courses and lawns. Cool-season grasses grow best in cooler conditions, and warm-season grasses thrive in hot, dry weather (USDA, 2004); there is a transition zone across the U.S. where either category of turf grasses may be planted based on microclimate conditions. Exposure to triazines will kill cool-season grasses, but warm-season grasses can tolerate exposure to atrazine. As such, EPA estimated where in the U.S. only cool-season grasses are exclusively used in turf based on the U.S. Department of Agriculture's plant hardiness zone map as atrazine use is not expected in these areas (USDA, 2023). Because hardiness zones will change over time with environmental conditions, EPA created a static map based on the hardiness zones where they expect warm- and cool-season grasses are grown based on the most recent data mapped (i.e., 1991-2020). EPA determined zones 1a-6a represent cool-season grasses (i.e., white areas) and zones 6b-13b may include warm-season grasses (i.e., black areas) (Figure 1). We expect the cool- and warm-season grass assessment to apply to all turf, including residential, commercial, and golf course turf. We refer to EPA's cool-season map in species assessments where relevant, particularly if a species occurs exclusively in the cool-season zone where we expect atrazine will not be used on turf and no exposure will occur from this use.

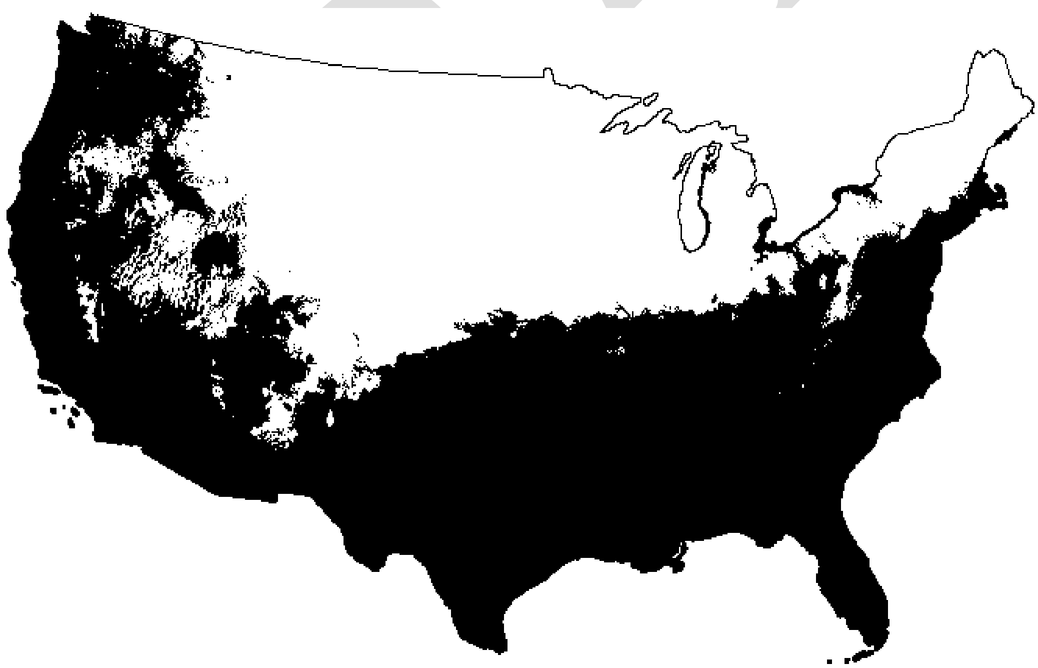

Figure 1. Map showing where cool-season grasses (white areas) and warm-season grasses (black areas) are used on turf across the continental U.S.

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Particularly for residential and commercial turf uses, qualitative usage information obtained by EPA from the National Association of Landscape Professionals (NALP) indicate that atrazine is no longer commonly used on residential or commercial turf due to preferential use of newer herbicides. If atrazine were used on residential or commercial turf, it would be applied during the fall and spring as a pre-emergent. In addition, commercial and residential applicators typically apply herbicides with hand-held equipment that release course droplets, limiting the potential for spray drift.

Particularly for golf course turf uses, we obtained qualitative usage information directly from the Golf Course Superintendents Association of America (GCSAA) and an academic turf scientist that indicate that atrazine is used to control winter annual broadleaf and annual bluegrass weeds on golf courses. They are applied as a pre-emergent in early fall and early winter to fairways and roughs, which make up approximately 30% of a golf course's acreage. Triazines are not applied to tee boxes or greens, which make up an additional 6% of golf course acreage. Most applications are made at rates lower than what is on the label (i.e., 1 lbs. AI./A spray). These applications are made only once or twice a year, 45-60 days apart. In general, golf courses typically apply herbicides using dedicated ground equipment with a low boom height (as per the label), and golf course superintendents make use of several tools to monitor soil moisture before any applications are made to help ensure turf and soil conditions do not lead to off-target movement of herbicides. In addition, riparian buffer zones are often used on golf courses between all water features to reduce off target movement (Golf Course Superintendents Association of America [GCSAA], pers. comm., 2025). The no-till methodology and continuous cover of a turf grass area inherent in managing golf course turf are equivalent to additional run-off mitigations (i.e., equivalent to six points on EPA's mitigation menu), and we considered them in our assessment.

For most species in this Appendix, we anticipate that non-agricultural uses will not meaningfully add to the overall level of anticipated exposure considered in our analysis of agricultural uses. Due to runoff and spray drift considerations described above, off-site exposure is not expected to result in effects to most species in this Appendix. In addition, we expect most listed species' habitat requirements preclude them from occupying non-agricultural use sites where atrazine may be used. For species whose habitat is known or presumed to occur in non-agricultural use sites of atrazine, we consider, individually and qualitatively, the extent and manner of non-agricultural atrazine usage within the species' range to generally determine whether a small, moderate, or large number of individuals are likely to be exposed and the expected level of adverse effects from non-agricultural exposure of atrazine.

References:

GCSAA (Golf Course Superintendents Association of America). 2025. Personal communication with USFWS HQ staff.

USDA. 2004. Comparing warm-season and cool-season grasses for erosion control, water quality, and wildlife habitat. Natural Resources Conservation Service, U.S. Department of Agriculture. 5 pp.

USDA. 2023. Plant Hardiness Zone Map. Agricultural Research Service, U.S. Department of Agriculture. Accessed from https://planthardiness.ars.usda.gov/ on August 20, 2025.

Toxicity

We characterize the expected toxic effect to species based on the anticipated level of direct and indirect[4] adverse effects to individuals. Our analysis of toxicity assumes individuals are exposed to atrazine at levels estimated by EPA's environmental exposure modeling and is focused on determining the level of adverse effect expected to occur once exposure has taken place. Direct effects are based on the anticipated level of mortality and sublethal effects (e.g., reduced growth) likely to occur in exposed individuals. Indirect effects are based on the impact a listed species is likely to experience when the organisms they rely on, such as those that act as pollinators or seed dispersers, are exposed to atrazine and experience adverse effects.

Given that herbicides like atrazine are designed to control plants, we assume listed plant species are sensitive to atrazine exposure. In general, we anticipate individuals exposed to atrazine are likely to experience direct adverse effects in the form of reduced biomass and growth, which, in severe cases, would result in mortality of individuals. Based on the available toxicity data in plants for atrazine, we use the HC_{05} (i.e., the exposure concentration where we expect more than 95% of plant species would not experience measurable impacts) for biomass at seedling emergence and compare that to the estimated environmental concentration (EEC) of atrazine for each listed species to determine the anticipated level of adverse effects atrazine. In contrast, available toxicity data indicate that animal species, including potential pollinators and seed dispersers of listed plant species, are not likely to experience mortality from atrazine exposure, suggesting that indirect adverse effects are not likely to occur to listed plant species.

Conservation Measures

The technical registrants have previously agreed to substantial conservation measures that were incorporated into EPA's 2021 BE. These conservation measures include the following:

- Prohibit use in Hawaii, Alaska, and the Territories,

[4] While our Opinion considers all consequences of the proposed action (per the definition of effects of the action at 50 CFR Part 402.02), the terms "direct" and "indirect" effects were used in EPA's BE, and are used in environmental risk assessment terminology in general, and do not have the same meaning as used in ESA regulations. As used in the effects analysis section, direct effects to species are those caused by the pesticide itself through dietary, dermal, or inhalation routes of exposure. Indirect effects occur when the pesticide acts on elements of the ecosystem that are required by the species, such as alterations to prey or shelter. Thus, in the effects analysis section, we may sometimes continue to use these terms to link back to the analysis in EPA's BE.

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- Prohibit use on roadsides, shelterbelts, Conservation Reserve Program (CRP) land, conifers (including Christmas tree plantings), timber and forestry, and miscanthus and other perennial bioenergy crops,
- Prohibit application via mechanically pressurized handguns to macadamia nuts, sweet corn, and guava,
- Restrict "fallow" uses on all labels to the following scenarios and geographies only:
    - Wheat-corn-fallow and wheat-fallow-wheat in CO, KS, ND, NE, SD, and WY,
    - Wheat-sorghum-fallow in AR, CO, GA, IL, KS, LA, MS, MO, NE, NM, NC, OK, SD, and TX
- Reduce the single maximum application rate of turf, granular formulations to 2.0 lbs. AI/A, and reduce the single maximum application rate of turf, sprays to 1.0 lb. AI/A,
- Restrict applications made by backpack-spray to landscape turf to spot treatments only,
- Restrict applicators from applying atrazine products to the same sorghum acre,
- Require all applications to use coarse or coarser droplet sizes,
- Require an in-field downwind buffer of 15-ft for all ground applications (from the edge of all streams and rivers as well as the high-tide line for all estuarine/marine environments, and from threatened and endangered species critical habitat and/or species locations)
- Prohibit all ground applications when wind speeds exceed 10 miles per hour at the application site,
- For ground boom applications, only apply with the release height recommended by the manufacturer, but no more than 4-ft above the ground or crop canopy,
- Require an in-field downwind buffer of 150-ft for all aerial applications (from the edge of all streams and rivers as well as the high-tide line for all estuarine/marine environments, and from threatened and endangered species critical habitat and/or species locations),
- If the windspeed is 10 miles per hour or less, applicators must use ½ swath displacement upwind at the downwind edge of the field. When the windspeed is between 11-15 miles per hour, applicators must use ¾ swath displacement upwind at the downwind edge of the field,
- If the windspeed is greater than 10 mph, the boom length must be 65% or less of the wingspan for fixed wing aircraft and 75% or less of the rotor diameter for helicopters. Otherwise, the boom length must be 75% or less of the wingspan for fixed-wing aircraft and 90% or less of the rotor diameter for helicopters,
- Prohibit all aerial applications when wind speeds exceed 15 miles per hour at the application site,
- Restrict aerial applications from releasing spray at a height greater than 10-ft above the ground or vegetative canopy unless a greater application height is necessary for pilot safety,
- Prohibit aerial applications of non-liquid formulations,
- Prohibit all applications during temperature inversions.

While these conservation measures are impactful and contribute to reducing the level of exposure and adverse effects to listed species, EPA and the Service anticipate substantial risk of adverse effects to many listed species remain after incorporating these measures into the proposed action.

Herbicide Strategy Conservation Measures

As part of the atrazine ESA consultation with the Service, EPA is implementing the final Herbicide Strategy to inform and identify any necessary conservation measures where EPA's analysis indicated there was a risk of population level effects to listed species. The measures identified by EPA, and committed to by the technical registrants, include:

- a standard 170-foot wind-directional spray drift buffer for aerial applications[5] (not in addition to the buffers the technical registrants committed to previously), and
- a minimum of three runoff mitigation points[6] necessary in all areas where atrazine is used, as well as additional runoff mitigation points (i.e., six points total) for certain atrazine uses limited to certain geographic areas when required to protect specific listed species.

In addition to the conservation measures identified through EPA's Herbicide Strategy, in the course of this consultation the technical registrants have also committed to additional measures for specific registered uses of atrazine to reduce exposure to listed species, including:

- Reduce the maximum annual application rate for field corn from 2.5 lbs. AI/A to 2.0 lbs. AI/A,
- For sweet corn uses, adopt one of the following:
    - Do not apply atrazine to sweet corn from August 15th to November 1st; when applied during other times of the year, use as a pre-emergent up to 2.0 lbs ai/acre.
    - With no timing restrictions for use, use as pre-emergent up to 1.25 lbs ai/acre followed by post-emergent 0.75 lbs ai/acre.
- Restrict "corn" in wheat-corn-fallow rotations to "field corn" meaning "wheat-field corn-fallow rotations",
- Off-label all uses in California except for Imperial County, and
- Add the restriction "Do not apply atrazine products during rain or when soils are saturated or above field capacity" to all formulations.

The spray drift buffers will be placed on the general label and will apply to all uses of atrazine. EPA's Herbicide Strategy provides applicators with options to reduce the distance of this buffer

[5] Note: The 170-foot aerial buffer replaces the 150-foot aerial buffer agreed to before implementation of the Herbicide Strategy.

[6] Ecological Mitigation Support Document to Support Endangered Species Strategies

by using other spray drift reduction strategies that we anticipate will result in an equivalent reduction in spray drift entering non-target habitats as stated buffers. These measures and the degree to which applicators can reduce buffers by employing them are described in EPA's Herbicide Strategy and EPA's Ecological Mitigation Support Document to Support Endangered Species Strategies. These documents are provided in Appendix A-1.

Based on EPA's analyses, the required spray drift conservation measures described above (from the current label, those from implementation of the Herbicide Strategy, and additional measures committed to through consultation for specific registered atrazine uses) will reduce spray drift from entering species' habitats by >95%. The Service anticipates that this reduction will minimize off-site transport of atrazine from spray drift to a level where no more than low levels of effects are likely to occur to most listed plants.

As stated above, all agricultural labels will include a requirement for applicators to achieve three points of runoff mitigation, as described in the Herbicide Strategy, for all agricultural uses. EPA's Herbicide Strategy provides applicators with various options to reduce runoff and erosion and assigns points to each option based on its effectiveness. Applicators must implement sufficient mitigation points to meet the label requirement. Applicators can achieve the required points using the conservation measures identified on EPA's Mitigation Menu website[7]. The menu provides a suite of options, including relief points for certain field characteristics and likelihood for pesticide transport.

We expect implementation of the required runoff and erosion reduction measures to minimize off-site transport of atrazine to habitats of listed species. EPA's analyses indicated that the general label requirement of three runoff mitigation points will reduce estimated environmental concentrations of atrazine in runoff by up to an order of magnitude (i.e., up to 90% reduction, in other words reduce pesticide loading to one-tenth of pre-runoff mitigation levels).

In cases where EPA has identified additional runoff measures are needed, additional points (up to six points total) will be required. EPA will communicate where additional runoff mitigation points are needed and for what specific atrazine uses through their Bulletins Live! Two online platform, which all applicators are required to check before making pesticide applications. In areas requiring up to six runoff mitigation points total, EPA expects estimated environmental concentrations of atrazine will decrease by up to two orders of magnitude (i.e., reduce pesticide loading to one-one hundredth of pre runoff mitigation levels; 99% reduction).

[7] Mitigation Menu website: https://www.epa.gov/pesticides/mitigation-menu

For all the species in this document, we expect that the runoff and mitigation measures will reduce exposure concentrations to within one order of magnitude of the exposure level where 95% of plant species are not likely to experience measurable adverse effects. We anticipate this level of mitigation will protect listed plant species by reducing the number of individuals exposed (by reducing the extent of off-site transport of atrazine residues) and reducing the level of adverse effects that will occur to exposed individuals (by reducing estimated exposure concentrations).

Summary of Conclusions for plants in habitats expected to result in lower exposures to atrazine

After reviewing the current status of the species, the environmental baseline for the action area, the effects of the proposed registration of atrazine with conservation measures, and the cumulative effects, it is the Service's biological opinion that the registration of atrazine, as proposed, is not likely to jeopardize the continued existence of at least 107 of the 111 plant species in this Appendix. For the remaining 4 plants in this appendix, we plan to continue coordination with EPA and the technical registrants to further assess these species.

In our analysis below, some species that had the same or very similar rationales for their conclusions were grouped together, to increase efficiency and avoid repetition. Relevant information and data unique to each individual species was considered when assigning species to groups and incorporated into the rationales as appropriate. Species-specific information (e.g., environmental baseline, cumulative effects, status of the species, exposure, and toxicity) was considered for all species, including those species in the grouped analyses, and are presented in full in Appendices B and E. Species with rationales that did not fit in a group, or warranted a separate rationale because of their life history, conservation status, or other information indicated that effects could be different, would have had an individual discussion to provide additional explanation. This approach allowed us to streamline our discussion in this Opinion by avoiding repeating our findings when we expected species in the respective groupings would be affected similarly. The use of these groupings, therefore, does not mean that our evaluation failed to evaluate each individual species. On the contrary, our detailed process for each species-specific analysis remained the same, including for species for which we summarized our findings in tables below.

Species with low exposure informed by low overlap with agriculture and low likelihood of non-agricultural exposure

For the species in Table 1, we expect low exposure as informed by low overlap between the species' range and agricultural lands where atrazine is registered for use. Therefore, our concern for adverse effects is low. While we present some specific information about the species in Table 1 below, we provide additional information on vulnerability (including environmental baseline and cumulative effects), exposure, and toxicity in Appendix E. The status of the species accounts can be found in Appendix B.

Table 1. Species with low exposure informed by low overlap with agricultural areas and low likelihood of non-agricultural exposure.

Common Name	Scientific Name	Vulnerability Ranking	Agricultural Exposure Ranking	Toxicity Ranking	Total Agricultural Action Area Overlap (% Range)	Determination
Amargosa niterwort	*Nitrophila mohavensis*	High	Low	High	1.6	No Jeopardy
Arizona cliffrose	*Purshia (=Cowania) subintegra*	High	Low	High	1.5	No Jeopardy
Ash Meadows blazingstar	*Mentzelia leucophylla*	High	Low	High	1.6	No Jeopardy
Ash Meadows gumplant	*Grindelia fraxinipratensis*	High	Low	High	1.6	No Jeopardy
Ash Meadows ivesia	*Ivesia kingii* var. *eremica*	High	Low	High	1.6	No Jeopardy
Ash Meadows sunray	*Enceliopsis nudicaulis* var. *corrugata*	Medium	Low	High	1.6	No Jeopardy
Ash meadows milk-vetch	*Astragalus phoenix*	Medium	Low	High	1.6	No Jeopardy
Barneby reed-mustard	*Schoenocrambe barnebyi*	High	Low	High	0.5	No Jeopardy
McDonald's rock-cress	*Arabis macdonaldiana*	Medium	Low	High	1.0	No Jeopardy
Nichol's Turk's head cactus	*Echinocactus horizonthalonius* var. *nicholii*	High	Low	High	0.8	No Jeopardy
Pima pineapple cactus	*Coryphantha scheeri var. robustispina*	High	Low	High	1.0	No Jeopardy
San Rafael cactus	*Pediocactus despainii*	Medium	Low	High	2.3	No Jeopardy
Showy stickseed	*Hackelia venusta*	High	Low	High	3.9	No Jeopardy
Shrubby reed-mustard	*Schoenocrambe suffrutescens*	High	Low	High	4.2	No Jeopardy

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Common Name	Scientific Name	Vulnerability Ranking	Agricultural Exposure Ranking	Toxicity Ranking	Total Agricultural Action Area Overlap (% Range)	Determination
Wright fishhook cactus	*Sclerocactus wrightiae*	Medium	Low	High	1.7	No Jeopardy

The species in Table 1 have medium to high vulnerabilities. Specifically, herbicides are a noted threat to Arizona cliffrose and showy stickweed. Most of these species occur in habitats where we do not expect agricultural or non-agricultural land uses to occur (e.g., cliffs, desert, mountains). These species are not known to occur on agricultural atrazine use sites but may be exposed via spray drift or runoff in small portions of their ranges.

The species in Table 1 have high toxicity because herbicides like atrazine are designed to control plants. Therefore, we assume all listed plant species are sensitive to atrazine exposure and no significant difference in the toxicity of atrazine among major plant taxa (e.g., dicots, monocots, non-flowering plants) is expected. In general, we anticipate individuals exposed to atrazine, from agricultural or non-agricultural use sites, are likely to experience direct adverse effects in the form of reduced biomass and growth, which, in severe cases, would result in death. We do not expect reductions in pollinators and seed dispersers of listed plant species from atrazine exposure, and therefore, indirect adverse effects are not likely to occur for these species.

However, the species in Table 1 have low extents of overlap between their ranges and agricultural atrazine use sites (0.5-4.2%), including associated off-site transport areas. The total overlap metric we use is a conservative estimate of exposure as it does not fully account for redundancy between registered use sites, assumes exposure is occurring in all possible overlapping areas, assumes spray drift will occur in all directions during treatment of fields, and does not consider information on past atrazine usage. As such, we expect that exposure of these species to atrazine from agricultural uses will occur in even smaller portions of the species' ranges than the overlaps shown in Table 1.

In addition to agricultural exposure, we expect the species in Table 1 will not be exposed to atrazine from non-agricultural (i.e., turf) uses. These non-agricultural use sites do not provide the species' necessary habitat (e.g., alkaline soils, desert washes). Given our understanding of atrazine usage on use sites such as golf courses and residential lawns (see *Exposure to Non-Agricultural Uses*, above), we expect atrazine usage within the ranges of these species to be limited. In addition, if applied, we anticipate off-site transport of atrazine will be minimal as characteristics of the non-agricultural use sites (i.e., continuous cover, no till) are expected to result in little runoff. Furthermore, commercial and residential applicators typically apply herbicides with hand-held equipment that release course droplets, limiting the potential for spray drift from these specific uses. Therefore, we expect atrazine exposure from non-agricultural uses to be low for these species.

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In summary, we expect a small number of individuals of the species in Table 1 will experience exposure to atrazine over the project duration. Exposure will be limited to small portions of the species' ranges that overlap with agricultural or non-agricultural use sites and areas of off-site transport. Therefore, we expect the proposed action will result in direct adverse effects (e.g., reduced biomass, growth, or survival) of, at most, a very small number of individuals of these species. We determine the overall risk of adverse effects to these species is low. We do not expect indirect adverse effects through reductions in pollinators or seed dispersers from atrazine exposure. After reviewing the current status of the species, environmental baseline for the action area, cumulative effects, and effects of the action (including general label conservation measures), we have determined the proposed action is not likely to appreciably reduce the survival and recovery of these species in the wild. Thus, it is our biological opinion that the registration of atrazine, as proposed, is not likely to jeopardize the continued existence of the species in Table 1.

Species with low agricultural exposure informed by low past usage of all herbicides from the USDA's Census of Agriculture and low likelihood of non-agricultural exposure

The species in Table 2 were grouped together as we anticipate they will experience low levels of exposure to atrazine based on available data from the USDA's Census of Agriculture (CoA). Therefore, our concern for adverse effects is low. While we present some specific information about the species below, we provide additional information on vulnerability (including environmental baseline and cumulative effects), exposure, and toxicity in Appendix E. The status of the species accounts can be found in Appendix B.

Table 2. Species with low agricultural exposure informed by low past usage of all herbicides from the USDA's Census of Agriculture (CoA) and low likelihood of non-agricultural exposure.

Common Name	Scientific Name	Vulnerability Ranking	Agricultural Exposure Ranking	Toxicity Ranking	% Range Treated (CoA)	Determination
Cochise pincushion cactus	*Coryphantha robbinsorum*	High	Low	High	3.61	No Jeopardy
Sacramento Mountains thistle	*Cirsium vinaceum*	High	Low	High	1.14	No Jeopardy
Sacramento prickly poppy	*Argemone pleiacantha* ssp. *pinnatisecta*	High	Low	High	1.14	No Jeopardy
Telephus spurge	*Euphorbia telephioides*	Medium	Low	High	3.81	No Jeopardy
Texas golden gladecress	*Leavenworthia texana*	High	Low	High	0.99	No Jeopardy
Texas trailing phlox	*Phlox nivalis* ssp. *texensis*	High	Low	High	2.50	No Jeopardy
Tobusch fishhook cactus	*Sclerocactus brevihamatus* ssp. *tobuschii*	Low	Low	High	2.69	No Jeopardy
Uinta Basin hookless cactus	*Sclerocactus wetlandicus*	High	Low	High	2.87	No Jeopardy
Western lily	*Lilium occidentale*	High	Low	High	1.16	No Jeopardy
White bladderpod	*Physaria pallida*	High	Low	High	1.40	No Jeopardy

The species in Table 2 have low to high vulnerabilities. Some of these species are found in mountains (e.g., Sacramento Mountains thistle) or on protected lands (e.g., Texas trailing phlox) where we expect atrazine use will be minimal. These species are not known to occur on agricultural atrazine use sites but may be exposed via spray drift or runoff in small portions of their ranges.

C-B1. Plants with Low Exposure Achieved Through Conservation Measures on the General Label: Integration and Synthesis Summaries

The species in Table 2 have high toxicity because herbicides like atrazine are designed to control plants. Therefore, we assume all listed plant species are sensitive to atrazine exposure and no significant difference in the toxicity of atrazine among major plant taxa (e.g., dicots, monocots, non-flowering plants) is expected. In general, we anticipate individuals exposed to atrazine, from agricultural or non-agricultural use sites, are likely to experience direct adverse effects in the form of reduced biomass and growth, which, in severe cases, would result in death. We do not expect reductions in pollinators and seed dispersers of listed plant species from atrazine exposure, and therefore, indirect adverse effects are not likely to occur for these species.

We anticipate a small number of individuals of each species are likely to experience exposure to agricultural uses of atrazine because the CoA indicates very little herbicide usage (potentially including atrazine) occurred on the agricultural crops in the counties where these species' ranges occur. Given that this reporting broadly includes all herbicide usage, we consider the CoA data a conservative estimate of atrazine usage. In addition, these data are presented at a relatively high spatial resolution. Therefore, we have high confidence that only a small percentage of the species' ranges are likely to be exposed to atrazine.

In addition to agricultural exposure, we expect the species in Table 2 will not be exposed to atrazine from non-agricultural (i.e., turf) uses. These non-agricultural use sites do not provide the species' necessary habitat (e.g., undisturbed soils, woodlands). Given our understanding of atrazine usage on use sites such as golf courses and residential lawns (see *Exposure to Non-Agricultural Uses*, above), we expect atrazine usage within the ranges of these species to be limited. In addition, if applied, we anticipate off-site transport of atrazine will be minimal as characteristics of the non-agricultural use sites (i.e., continuous cover, no till) are expected to result in little runoff. Furthermore, commercial and residential applicators typically apply herbicides with hand-held equipment that release course droplets, limiting the potential for spray drift from these specific uses. Therefore, we expect atrazine exposure from non-agricultural uses to be low for these species.

In summary, we expect a small number of individuals of the species in Table 2 will experience exposure to atrazine over the project duration. Exposure will be limited to small portions of the species' ranges that overlap with agricultural herbicide usage according to CoA or non-agricultural usage on turf, where applicable. Therefore, we expect the proposed action will result in direct adverse effects (e.g., reduced biomass, growth, or survival) of, at most, a very small number of individuals of these species. We do not expect indirect adverse effects through reductions in pollinators or seed dispersers from atrazine exposure. We determine the overall risk of adverse effects to these species is low. After reviewing the current status of the species, environmental baseline for the action area, cumulative effects, and effects of the action (including general label conservation measures), we have determined the proposed action is not likely to appreciably reduce the survival and recovery of these species in the wild. Thus, it is our biological opinion that the registration of atrazine, as proposed, is not likely to jeopardize the continued existence of the species in Table 2.

Species with low agricultural exposure achieved through conservation measures and low likelihood of non-agricultural exposure

For the species in Table 3, we expect they will have low exposure after incorporating general label measures (e.g., measures already on the label, three runoff points and ground and aerial buffers determined through implementation of the Herbicide Strategy, and rate reductions and other restrictions to particular registered uses). Therefore, we expect adverse effects to be low. While we present some specific information about the species below, we provide additional information on vulnerability (including environmental baseline and cumulative effects), exposure, and toxicity in Appendix E. The status of the species accounts can be found in Appendix B.

Table 3. Species with low agricultural exposure achieved through conservation measures and low likelihood of non-agricultural exposure.

Common Name	Scientific Name	Vulnerability Ranking	Agricultural Exposure Ranking	Toxicity Ranking	Conservation Measures	Determination
Alabama leather flower	*Clematis socialis*	High	Low	High	General label measures	No Jeopardy
American chaffseed	*Schwalbea americana*	Medium	Low	High	General label measures	No Jeopardy
Apalachicola rosemary	*Conradina glabra*	High	Low	High	General label measures	No Jeopardy
Applegate's milk-vetch	*Astragalus applegatei*	High	Low	High	General label measures	No Jeopardy
Avon Park harebells	*Crotalaria avonensis*	High	Low	High	General label measures	No Jeopardy
Beach jacquemontia	*Jacquemontia reclinata*	High	Low	High	General label measures	No Jeopardy
Beautiful pawpaw	*Deeringothamnus pulchellus*	High	Low	High	General label measures	No Jeopardy
Black lace cactus	*Echinocereus reichenbachii var. albertii*	High	Low	High	General label measures	No Jeopardy
Blowout penstemon	*Penstemon haydenii*	High	Low	High	General label measures	No Jeopardy
Bracted twistflower	*Streptanthus bracteatus*	Medium	Low	High	General label measures	No Jeopardy
Bushy whitlow-wort	*Paronychia congesta*	High	Low	High	General label measures	No Jeopardy
Carter's mustard	*Warea carteri*	High	Low	High	General label measures	No Jeopardy
Chapman rhododendron	*Rhododendron chapmanii*	High	Low	High	General label measures	No Jeopardy
Clay-loving wild buckwheat	*Eriogonum pelinophilum*	High	Low	High	General label measures	No Jeopardy

C-B1. Plants with Low Exposure Achieved Through Conservation Measures on the General Label: Integration and Synthesis Summaries

Common Name	Scientific Name	Vulnerability Ranking	Agricultural Exposure Ranking	Toxicity Ranking	Conservation Measures	Determination
Crenulate lead-plant	*Amorpha crenulata*	High	Low	High	General label measures	No Jeopardy
DeBeque phacelia	*Phacelia submutica*	Medium	Low	High	General label measures	No Jeopardy
Dwarf bear-poppy	*Arctomecon humilis*	High	Low	High	General label measures	No Jeopardy
Dwarf lake iris	*Iris lacustris*	Medium	Low	High	General label measures	No Jeopardy
Etonia rosemary	*Conradina etonia*	Medium	Low	High	General label measures	No Jeopardy
Florida ziziphus	*Ziziphus celata*	High	Low	High	General label measures	No Jeopardy
Four-petal pawpaw	*Asimina tetramera*	Medium	Low	High	General label measures	No Jeopardy
Garrett's mint	*Dicerandra christmanii*	High	Low	High	General label measures	No Jeopardy
Gentian pinkroot	*Spigelia gentianoides*	High	Low	High	General label measures	No Jeopardy
Georgia rockcress	*Arabis georgiana*	High	Low	High	General label measures	No Jeopardy
Guthrie's (=Pyne's) ground-plum	*Astragalus bibullatus*	High	Low	High	General label measures	No Jeopardy
Gypsum wild-buckwheat	*Eriogonum gypsophilum*	High	Low	High	General label measures	No Jeopardy
Hairy rattleweed	*Baptisia arachnifera*	Medium	Low	High	General label measures	No Jeopardy
Highlands scrub hypericum	*Hypericum cumulicola*	High	Low	High	General label measures	No Jeopardy
Jesup's milk-vetch	*Astragalus robbinsii var. jesupii*	High	Low	High	General label measures	No Jeopardy
Kincaid's lupine	*Lupinus sulphureus ssp. kincaidii*	Low	Low	High	General label measures	No Jeopardy
Lakela's mint	*Dicerandra immaculata*	High	Low	High	General label measures	No Jeopardy
Lakeside daisy	*Hymenoxys herbacea*	High	Low	High	General label measures	No Jeopardy
Large-fruited sand-verbena	*Abronia macrocarpa*	High	Low	High	General label measures	No Jeopardy
Leafy prairie-clover	*Dalea foliosa*	Medium	Low	High	General label measures	No Jeopardy
Lee pincushion cactus	*Coryphantha sneedii var. leei*	High	Low	High	General label measures	No Jeopardy

C-B1. Plants with Low Exposure Achieved Through Conservation Measures on the General Label: Integration and Synthesis Summaries

Common Name	**Scientific Name**	**Vulnerability Ranking**	**Agricultural Exposure Ranking**	**Toxicity Ranking**	**Conservation Measures**	**Determination**
Leedy's roseroot	*Rhodiola integrifolia ssp. leedyi*	High	Low	High	General label measures	No Jeopardy
Lewton's polygala	*Polygala lewtonii*	Medium	Low	High	General label measures	No Jeopardy
MacFarlane's four-o'clock	*Mirabilis macfarlanei*	High	Low	High	General label measures	No Jeopardy
Mead's milkweed	*Asclepias meadii*	Medium	Low	High	General label measures	No Jeopardy
Mesa Verde cactus	*Sclerocactus mesae-verdae*	Medium	Low	High	General label measures	No Jeopardy
Michaux's sumac	*Rhus michauxii*	Medium	Low	High	General label measures	No Jeopardy
Missouri bladderpod	*Physaria filiformis*	Low	Low	High	General label measures	No Jeopardy
Navasota false foxglove	*Agalinis navasotensis*	High	Low	High	General label measures	No Jeopardy
No common name	*Geocarpon minimum*	Low	Low	High	General label measures	No Jeopardy
Okeechobee gourd	*Cucurbita okeechobeensis ssp. okeechobeensis*	High	Low	High	General label measures	No Jeopardy
Pariette cactus	*Sclerocactus brevispinus*	High	Low	High	General label measures	No Jeopardy
Peter's mountain mallow	*Iliamna corei*	High	Low	High	General label measures	No Jeopardy
Pitcher's thistle	*Cirsium pitcheri*	Low	Low	High	General label measures	No Jeopardy
Prairie bush-clover	*Lespedeza leptostachya*	Low	Low	High	General label measures	No Jeopardy
Price’s potato-bean	*Apios priceana*	Low	Low	High	General label measures	No Jeopardy
Pygmy fringe-tree	*Chionanthus pygmaeus*	High	Low	High	General label measures	No Jeopardy
Rugel's pawpaw	*Deeringothamnus rugelii*	Medium	Low	High	General label measures	No Jeopardy
Ruth's golden aster	*Pityopsis ruthii*	High	Low	High	General label measures	No Jeopardy
Sand dune phacelia	*Phacelia argentea*	High	Low	High	General label measures	No Jeopardy
Sandlace	*Polygonella myriophylla*	High	Low	High	General label measures	No Jeopardy
Sandplain gerardia	*Agalinis acuta*	Low	Low	High	General label measures	No Jeopardy

C-B1. Plants with Low Exposure Achieved Through Conservation Measures on the General Label: Integration and Synthesis Summaries

Common Name	Scientific Name	Vulnerability Ranking	Agricultural Exposure Ranking	Toxicity Ranking	Conservation Measures	Determination
Schweinitz's sunflower	*Helianthus schweinitzii*	Medium	Low	High	General label measures	No Jeopardy
Scrub blazingstar	*Liatris ohlingerae*	High	Low	High	General label measures	No Jeopardy
Scrub mint	*Dicerandra frutescens*	High	Low	High	General label measures	No Jeopardy
Scrub plum	*Prunus geniculata*	Medium	Low	High	General label measures	No Jeopardy
Seabeach amaranth	*Amaranthus pumilus*	Medium	Low	High	General label measures	No Jeopardy
Shale barren rock cress	*Boechera serotina*	Medium	Low	High	General label measures	No Jeopardy
Shivwits milk-vetch	*Astragalus ampullarioides*	High	Low	High	General label measures	No Jeopardy
Short's goldenrod	*Solidago shortii*	High	Low	High	General label measures	No Jeopardy
Short-leaved rosemary	*Conradina brevifolia*	High	Low	High	General label measures	No Jeopardy
Slickspot peppergrass	*Lepidium papilliferum*	Medium	Low	High	General label measures	No Jeopardy
Smooth coneflower	*Echinacea laevigata*	Medium	Low	High	General label measures	No Jeopardy
Snakeroot	*Eryngium cuneifolium*	High	Low	High	General label measures	No Jeopardy
Sneed pincushion cactus	*Coryphantha sneedii var. sneedii*	High	Low	High	General label measures	No Jeopardy
Spalding's catchfly	*Silene spaldingii*	High	Low	High	General label measures	No Jeopardy
Star cactus	*Astrophytum asterias*	High	Low	High	General label measures	No Jeopardy
Steamboat buckwheat	*Eriogonum ovalifolium var. williamsiae*	High	Low	High	General label measures	No Jeopardy
Swale paintbrush	*Castilleja ornata*	High	Low	High	General label measures	No Jeopardy
Texas ayenia	*Ayenia limitaris*	High	Low	High	General label measures	No Jeopardy
Texas poppy-mallow	*Callirhoe scabriuscula*	High	Low	High	General label measures	No Jeopardy
Texas prairie dawn-flower	*Hymenoxys texana*	Medium	Low	High	General label measures	No Jeopardy
Tiehm's buckwheat	*Eriogonum tiehmii*	High	Low	High	General label measures	No Jeopardy
Umtanum desert buckwheat	*Eriogonum codium*	High	Low	High	General label measures	No Jeopardy

C-B1. Plants with Low Exposure Achieved Through Conservation Measures on the General Label: Integration and Synthesis Summaries

Common Name	Scientific Name	Vulnerability Ranking	Agricultural Exposure Ranking	Toxicity Ranking	Conservation Measures	Determination
White Bluffs bladderpod	*Physaria douglasii ssp. tuplashensis*	High	Low	High	General label measures	No Jeopardy
Wireweed	*Polygonella basiramia*	High	Low	High	General label measures	No Jeopardy
Zapata bladderpod	*Physaria thamnophila*	High	Low	High	General label measures	No Jeopardy

The species in Table 3 have low to high vulnerabilities. Specifically, pesticides are a noted threat to 17 of these species, including specifically herbicides for nine of them. Two of these plants have been recommended for delisting (i.e., dwarf lake iris) or proposed for delisting (i.e., gypsum wild-buckwheat) due to recovery. These species are not known to occur on agricultural atrazine use sites but may be exposed via spray drift or runoff. We expect the conservation measures incorporated into the label will sufficiently protect these species based on their habitat type (e.g., forests, sand dunes, grasslands).

The species in Table 3 have high toxicity because herbicides like atrazine are designed to control plants. Therefore, we assume all listed plant species are sensitive to atrazine exposure and no significant difference in the toxicity of atrazine among major plant taxa (e.g., dicots, monocots, non-flowering plants) is expected. In general, we anticipate individuals exposed to atrazine, from agricultural or non-agricultural use sites, are likely to experience direct adverse effects in the form of reduced biomass and growth, which, in severe cases, would result in death. We do not expect reductions in pollinators and seed dispersers of listed plant species from atrazine exposure, and therefore, indirect adverse effects are not likely to occur for these species.

We anticipate the species in this group are not likely to occur in agricultural atrazine use sites. We expect the general label measures for agricultural uses described above (e.g., reduced application rates, 15-foot spray drift buffer for ground application, 170-foot spray drift buffer for aerial applications, and three runoff mitigation points) will reduce off-field exposures by an order of magnitude (i.e., a 90% reduction), which we expect will not cause more than low levels of adverse effects to exposed individuals and will not result in more than low levels of adverse effects (e.g., death or reduced growth) to these plants.

In addition to agricultural exposure, 3 of the 81 species in Table 3 may be exposed to atrazine from non-agricultural (i.e., turf) uses. However, these non-agricultural use sites do not provide the species' necessary habitat (e.g., lakeshore, sand dunes, woodlands), and we expect any non-agricultural exposure would be from off-site transport. Sand dune phacelia occurs near a golf course, but we expect low exposure from this use to sand dune phacelia because the owners of the Bandon Dunes Golf Resort are aware of the phacelia's presence and intend to maintain phacelia on the property (Newport Ecological Services Field Office, pers. comm., 2025). Given our understanding of atrazine usage on use sites such as golf courses and residential lawns (see *Exposure to Non-Agricultural Uses*, above), we expect atrazine usage within the ranges of these species to be limited. In addition, if applied, we anticipate off-site transport of atrazine will be minimal as characteristics of the non-agricultural use sites (i.e., continuous cover, no till) are expected to result in little runoff. Furthermore, commercial and residential applicators typically apply herbicides with hand-held equipment that release course droplets, limiting the potential for spray drift from these specific uses. Therefore, we expect atrazine exposure from non-agricultural uses to be low for these species.

In summary, with implementation of conservation measures on product labels, we expect that few individuals will be exposed to atrazine via off-site transport from agricultural or non-agricultural areas. Therefore, we expect the proposed action will result in direct adverse effects (e.g., reduced biomass, growth, or survival) of, at most, a very small number of individuals of these species. We do not expect indirect adverse effects through reductions in pollinators or seed dispersers from atrazine exposure. We determine the overall risk of adverse effects to these species is low. After reviewing the current status of the species, environmental baseline for the action area, cumulative effects, and effects of the action (including general label and specific conservation measures), we have determined the proposed action is not likely to appreciably reduce the survival and recovery of these species in the wild. Thus, it is our biological opinion that the registration of atrazine, as proposed, is not likely to jeopardize the continued existence of the species in Table 3.

Species with Individual Integration and Synthesis Summaries

The species in Table 4 has an individual Integration and Synthesis summary. We expect the Herbicide Strategy conservation measures will reduce pesticide loading into habitats adjacent to agricultural use sites by up to 90% (i.e., by one order of magnitude) from runoff and by up to 95% from spray drift. We anticipate that this reduction will minimize off-site transport of atrazine and reduce the likelihood, magnitude, and frequency of exposure to a level where no more than low levels of adverse effects are likely to occur to listed plants through this exposure route. While the conservation measures on the label are expected to reduce the extent of off-field exposure and reduce exposure concentrations, we anticipate atrazine residues on use sites could remain at levels high enough to cause greater than low levels of adverse direct and/or indirect effects to this listed plant species. They may occur on atrazine use sites, either agricultural or non-agricultural. We provide additional information on vulnerability (including environmental baseline and cumulative effects), exposure, and toxicity in Appendix E. The status of the species account can be found in Appendix B.

Table 4. Species with an individual Integration and Synthesis Summary.

Common Name	Scientific Name	Determination
Kentucky glade cress	*Leavenworthia exigua laciniata*	No Jeopardy

Integration and Synthesis Summary: Kentucky glade cress

Scientific Name:	Common Name:	Entity ID:
Leavenworthia exigua laciniata	Kentucky glade cress	7167

Conclusion: No Jeopardy

Species Range

Based on range map dated: 12-28-2023; Wherever found; *States within the range:* KY

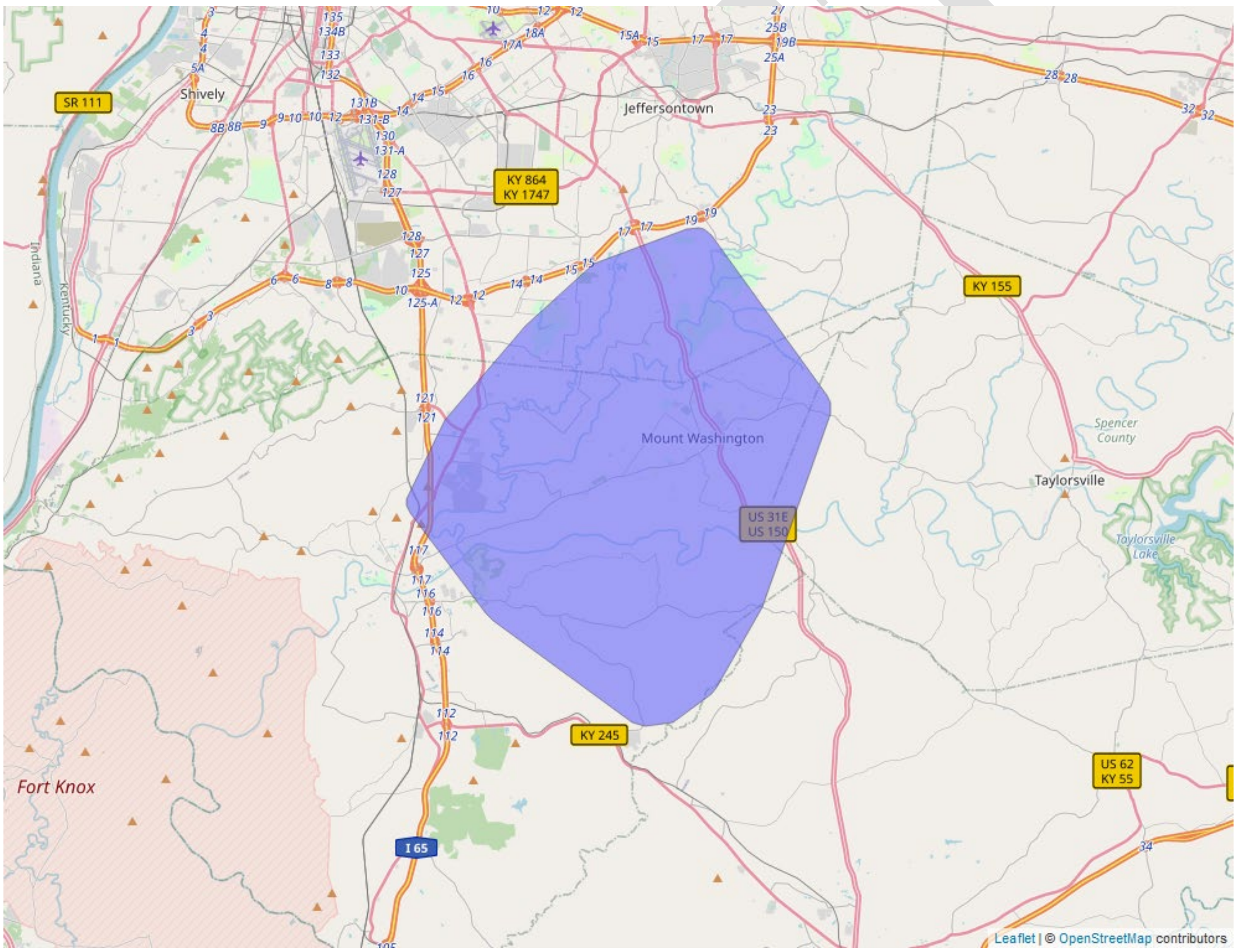

Figure 2. Range map of Kentucky glade cress (blue polygons). Range map accessed at https://ecos.fws.gov/ecp/species/698.

Vulnerability

As mentioned in the Introduction, vulnerability considers the present and likely future condition of the species to determine its vulnerability to additional stressors. In making our jeopardy determination, vulnerability of the species is a function not only of its status, but also the environmental baseline and cumulative effects. These are summarized below for this species.

Summary of status

Most recent 5-year review recommendation: No change in Status

Most recently completed 5-year review: 9/3/2020

Listing status: Threatened

Distribution: Small, endemic, constrained, and/or isolated population(s)

Number of populations: Multiple populations (numerous)

Species trends: Unknown population trends

Pesticides noted in Service documents as a threat to the species: Yes, herbicides

Environmental Baseline/Cumulative Effects (EB/CE) Summary

Kentucky glade cress is a federally threatened, small winter annual in the mustard family (Brassicaceae) endemic to mesic cedar glades in the Inner Bluegrass Region of Kentucky. It is restricted to Bullitt and Jefferson Counties and grows in thin, rocky soils over flat-bedded Ordovician limestone, completing its life cycle during the cool season — germinating in fall, overwintering as a rosette, and flowering in early spring (USFWS 2020, 2022).

As of 2020, there were 48 known extant occurrences of Kentucky glade cress, including 28 populations ranked as high- or moderate-quality and five considered highly resilient. The largest population, located on The Nature Conservancy's Eastview Preserve, has documented thousands of individuals during favorable years. Other significant populations occur on Fort Knox and the Jim Beam Brands Company property in Bullitt County. Approximately 34 percent of the species' known populations are protected or managed through conservation agreements (USFWS 2020).

Kentucky glade cress depends on open, seasonally wet glade habitats that are typically saturated in winter and spring, then dry and exposed in summer. The species is intolerant of heavy disturbance, shading, or changes in soil hydrology. It can continue to persist for some time in glades that have been converted from their natural conditions to pastures, lawns, and roadsides. Although it has a limited range, it can be locally abundant in high-quality habitat (USFWS 2020, 2022).

Primary threats include habitat loss, fragmentation, and degradation from residential and commercial development, especially in the fast-growing Louisville metropolitan region. This threat includes the application of herbicides, particularly in residential areas (lawns) or rights-of-way prior to seed set (USFWS 2014, 2020). Additional threats include hydrologic alteration (e.g., drainage or compaction), invasion by nonnative species, and cedar encroachment that reduces habitat openness. Because of its annual life cycle and short dispersal range, the species is particularly vulnerable to environmental and land-use changes. Conservation efforts focus on habitat management and maintaining glade hydrology through partnerships with private landowners and land trusts (USFWS 2022, 2020).

Overall Vulnerability: Medium

Effects of the Action: Exposure

Overlap with Agricultural Use Sites

Data indicate that 7.7% of the species' range overlaps with agricultural use sites and 90.3% of the species' range overlaps with areas adjacent to use sites that are likely exposed through off-site transport (e.g., through spray drift or runoff). In total, there is up to 98% overlap between the species' range and the agricultural footprint of atrazine use sites (Table 5).

Table 5. Agricultural use overlap and annual usage data (% Range Treated) for the Kentucky glade cress.

Use Layer	Use Site Overlap (% range)	Off-Site Overlap (% range)	Total Overlap (% range)	% Range Treated On-Site	% Range Treated Off-Site	% Total Range Treated
Corn	7.4	68.6	76	7.4	68.6	76.0
Vegetables and Ground Fruit (Sweet Corn)	<0.1	0.6	0.7	<0.1	0.6	0.7
Other Grains (Sorghum & Sugarcane)	0	<0.1	<0.1	0	0.0	0.0
Other Orchards (Guava & Macadamia Nut)	0	0	0	0	0.0	0.0
Other Crops (Wheat-Corn-Fallow)	0	0	0	0	0.0	0.0

C-B1. Plants with Low Exposure Achieved Through Conservation Measures on the General Label: Integration and Synthesis Summaries

Use Layer	Use Site Overlap (% range)	Off-Site Overlap (% range)	Total Overlap (% range)	% Range Treated On-Site	% Range Treated Off-Site	% Total Range Treated
Other Crops (Wheat-Sorghum-Fallow)	0	0	0	0	0.0	0.0
Other Crops (Wheat-Fallow-Wheat)	0	0	0	0	0.0	0.0
Other Crops (Sod)	0.3	21	21.3	0.3	21.0	21.3
Total	**7.7**	**90.3**	**98**	**7.7**	**90.2**	**97.9**

Usage

Past usage data indicate that up to 97.9% of the species' range has been treated with or exposed to atrazine annually from agricultural uses with 7.7% occurring on agricultural fields and 90.2% resulting from off-site transport.

Additional Exposure Considerations

We do not have information to indicate that Kentucky glade cress will occur on agricultural atrazine use sites, and therefore, do not expect on-field exposure for this species.

Exposure from Non-Agricultural Uses

The Kentucky glade cress is a winter annual and herbicide application on lawns, rights of way, and roadsides is identified as at threat for this species. Currently, 22 of 61 extant occurrences are in lawns or other landscaped habitats. As such, non-agricultural use of atrazine could be a source of exposure for this species. However, given our knowledge of atrazine application to turf areas (see *Exposure to Non-Agricultural Uses* section in the introduction), we expect atrazine usage in residential areas within the range of the Kentucky glade cress to be limited. Furthermore, most areas converted to lawns that have extant or historic Kentucky glade cress records have been seeded with tall fescue (*Schedonorus arundinacea*) a common cool-season grass in Kentucky that will not survive an application of atrazine (USFWS 2020). Thus, atrazine application in these areas is unlikely.

Conservation Measures

There are several conservation measures on the atrazine label that apply to all agricultural uses and are intended to reduce spray drift to off-site areas, including a 15-foot spray drift buffer for ground applications and a 170-foot spray drift buffer for aerial applications. Additionally, product labels require three runoff mitigation points for all agricultural uses, which will reduce atrazine concentrations in runoff. We expect these measures will reduce the concentration of atrazine entering species' habitats by up to an order of magnitude (i.e., up to a 90% reduction in atrazine residues in spray drift and runoff).

Effects of the Action: Toxicity

Direct Effects

Based on toxicity data available for atrazine in plant species, we expect that exposure to atrazine (either on use sites or in off-site areas) will result in large impacts to growth, which, if severe enough, can result in mortality. While we anticipate atrazine use can impact the growth and survival of plant species off-field (exposure through spray drift or runoff), we expect implementation of conservation measures on agricultural product labels and existing pesticide practices in non-agricultural atrazine use sites to reduce the likelihood, magnitude, and frequency of exposure to a level such that we anticipate no more than low level effects to few individuals in these areas.

Indirect Effects

We do not expect that atrazine use will result in any indirect adverse effects to individual plants as we do not anticipate atrazine is likely to reduce the abundance and availability of the insect pollinator species necessary to support reproduction.

Effects of the Action Summary

There is a large extent of overlap between the species' range and the action area, and pesticide usage reporting indicates that a large percentage of the species' range will be treated with atrazine on agricultural fields annually. We do not expect Kentucky glade cress to occur on agricultural fields, but could be exposed to atrazine as a result of off-site transport. With implementation of conservation measures on product labels, we expect that few individuals will be exposed to atrazine via off-site transport and will experience no more than low level of adverse effects to growth and survival.

Kentucky glade cress is known to occur in residential areas, with 22 of 61 extant occurrences in lawns or other landscaped habitats. We expect that exposure from this use would lead to large impacts to growth, which, if severe enough, can result in mortality. Atrazine is generally used as a pre-emergent herbicide in spring or fall, so fall applications could coincide with Kentucky glade cress germination and spring applications with the species' flowering period However, we do not expect atrazine to be a commonly used herbicide on residential turf, and as such, we expect atrazine usage on lawns within the range of the Kentucky glade cress, if any, will be limited.

We conclude the overall risk of adverse effects to the species is low.

Species Conclusion

Kentucky glade cress is a winter annual found in only two counties in Kentucky. It historically occurred in mesic cedar glades, and while many populations now exist in degraded habitats, the species can continue to persist for some time in glades that have been converted to pastures, lawns, and roadsides. The species completes its life cycle during the cool season — germinating in fall, overwintering as a rosette, and flowering in early spring (USFWS 2020, 2022).

After accounting for spray drift and runoff conservation measures on the atrazine label, we expect the Kentucky glade cress has the potential to experience appreciable exposure to atrazine only if it occurs on a use site. As indicated above, we do not expect the species to occur on agricultural fields. While the Kentucky glade cress does occur on lawns in residential areas, atrazine is rarely used on residential turf. In addition, many of the lawns where the glade cress is found are reported to be populated with tall fescue, a cool-season grass to which atrazine cannot be applied. As such, we expect very limited exposure, if any, from atrazine use on lawns. In addition, we do not anticipate indirect effects from atrazine exposure to the insect pollinators this species relies on for reproduction.

Due to incorporation of the label modifications as described in the Conservation Measures section above, rare use of atrazine on lawns, and lack of indirect effects to pollinators, we expect exposure and resultant effects for the Kentucky glade cress to be low. After reviewing the current status of the species, environmental baseline for the action area, cumulative effects, and effects of the action (including the general and species-specific conservation measures that are incorporated into the proposed action), we have determined the proposed action is not likely to appreciably reduce the survival and recovery of the Kentucky glade cress. Thus, it is our biological opinion that the registration of atrazine, as proposed, is not likely to jeopardize the continued existence of the Kentucky glade cress.

References

U.S. Fish and Wildlife Service. 2022. Final Recovery Plan for the Kentucky Glade Cress (*Leavenworthis exigua* var. *lacinata*). Frankfort, Kentucky.

U.S. Fish and Wildlife Service. 2020. Species Status Assessment for the Kentucky Glade Cress (*Leavenworthis exigua* var. *laciniata*). Version 1.0. Atlanta, Georgia.

U.S. Fish and Wildlife Service. 2020. Kentucky glade cress (*Leavenworthia exigua* var. *lacinata*) 5-Year Review: Summary and Evaluation. Frankfort, Kentucky. 13 pp.

U.S. Fish and Wildlife Service. 2014. Endangered and Threatened Wildlife and Plants; Threatened Species Status for *Leavenworthia exigua* var. *laciniata* (Kentucky Glade Cress). Federal Register 79(87):25683–25694.

Species requiring further analysis

In our draft Biological Opinion, we focused our analyses on 1) species with low expected exposure to atrazine (due to low overlap, usage, or conservation measures adopted prior to consultation), and 2) species with more than low levels of exposure that benefited from conservation measures identified through the Herbicide Strategy that aimed to reduce off-site transport of atrazine (i.e., listed plants and listed animals that depend on plant resources). For the species in Table 5, we identified the need for further coordination. We expect Herbicide Strategy conservation measures to reduce pesticide loading into aquatic habitats by up to 90% (i.e., one order of magnitude) compared to unmitigated runoff, and reduce spray drift from entering species' terrestrial habitats by >95%. We anticipate that this reduction will minimize off-site transport of atrazine to a level where no more than low levels of adverse effects are likely to occur to plants through this exposure route. However, these species are highly vulnerable, and while the required conservation measures are expected to reduce the extent of off-field exposure and reduce exposure, we anticipate atrazine residues on use sites could remain at levels high enough to cause greater than low levels of adverse direct and/or indirect effects to these species. They may occur on atrazine use sites, either agricultural or non-agricultural. We intend to continue coordinating with EPA and atrazine registrants between the release of this draft Opinion and the transmission of the final Opinion to gain information regarding the exposure and effects of each species to atrazine. As such, we have not yet made determinations for these species.

Table 6. Species requiring further analysis

Common Name	Scientific Name	Vulnerability Ranking	Agricultural Exposure Ranking	Toxicity Ranking
Fleshy-fruit gladecress	*Leavenworthia crassa*	High	High	High
Lyrate bladderpod	*Lesquerella lyrata*	High	High	High
Spring Creek bladderpod	*Lesquerella perforata*	High	High	High
Whorled sunflower	*Helianthus verticillatus*	High	High	High