Integration and Synthesis Summary for Crustaceans

This Integration and Synthesis Summary includes our jeopardy analysis for crustacean 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 occur in aquatic habitats and were predicted by EPA to experience similar levels of exposure to simazine from agricultural uses. Most of these species have low exposure to simazine due to the factors described in the tables or individual rationales below, in combination with reductions in simazine 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 that these measures will reduce exposure from agricultural uses to a level where no more than low level adverse effects are anticipated for many listed crustacean species.

Vulnerability

For the crustacean species that we or EPA determined are “likely to be adversely affected” by the proposed action, we considered several factors for each species 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 that could be surmised 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 biological 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) 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

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

[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.

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 that the main route of exposure for crustaceans is contact through the water. Simazine is moderately mobile in water and is relatively persistent in the environment relative to other pesticides on the market, indicating that off-site transport, particularly through runoff, may result in exposure to listed crustacean species in areas far from use sites.

Exposure to Agricultural Uses

Simazine has several registered agricultural uses (see Appendix 1-4 of EPA's Biological Evaluation) in the conterminous United States. We characterize the expected level of exposure using overlaps between the species' ranges and agricultural areas where simazine is registered for use (i.e., overlap data; including a 305-m off-site transport area adjacent to use sites), past simazine usage data (when available; the amount and location where simazine has been used in the past), any species-specific considerations such as life history information (e.g., habitat preferences, dietary needs, dispersal behavior), 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 simazine 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 simazine use sites, we considered past simazine usage data within a species' range to

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

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 simazine each year are assigned a high usage score. Species that have a medium portion of their range (5-10%) treated with simazine each year are assigned a medium usage score, and species where data indicate a low portion of their range (<5%) is treated with simazine each year are assigned a low usage score.

We determine the agricultural 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 agricultural exposure ranking the same score (e.g., if both overlap and usage is high, the agricultural 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 agricultural 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 agricultural exposure ranking of medium. For species where there are additional exposure considerations, we adjust the agricultural exposure ranking to reflect this additional information, as appropriate.

Agricultural uses of simazine include labeled uses for corn, vegetables and ground fruit, other crops, citrus, Christmas trees, grapes, and other orchards, only within the conterminous United States.

Exposure to Non-Agricultural Uses

Simazine has several registered non-agricultural uses, including nurseries (only ornamental conifers, deciduous trees and woody ornamental species), ornamental ponds (1,000 gallons or less), lawns, golf courses and other turf. In many cases, data provided by EPA indicate low to high levels of overlap between species' ranges and non-agricultural UDLs. Overall, nurseries (including ornamental plant uses) represent a very small footprint across the action area; across all species in this consultation, the Nurseries UDL overlaps between 0%-0.2% of species' ranges and 0%-5.6% of species' ranges plus a 305-m buffer. For species known to occur near nurseries, we assess nurseries specifically in our assessment. 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 simazine in a qualitative manner, considering the life history of species, methods of application, simazine 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 simazine use sites (i.e., residential areas where lawns are likely present, golf courses, and nurseries) 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 simazine. 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 simazine 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 simazine will not be used on turf and no exposure will occur from this use.

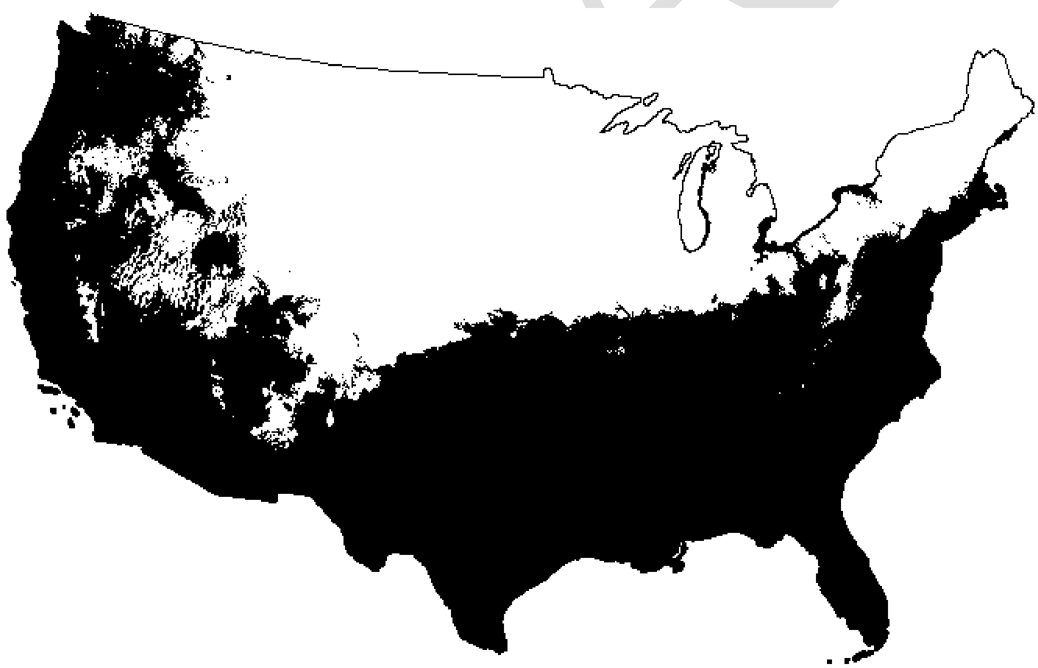

Figure 1. Map showing where cool-season grasses (white areas) and warm-season grasses (black areas) are used on turf across the continental U.S.

Particularly for residential and commercial turf uses, qualitative usage information obtained by EPA from the National Association of Landscape Professionals (NALP) indicate that simazine is no longer commonly used on residential or commercial turf as potential consequences to turf areas related to timing of application has led to preferential use of other herbicides that can be applied more broadly. If simazine 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 simazine 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., 1-1.5 lbs a.i./acre). 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 runoff 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 precludes them from occupying non-agricultural use sites where simazine may be used. For species whose habitat is known or presumed to occur near non-agricultural use sites of simazine, we consider, individually and qualitatively, the extent and manner of non-agricultural simazine 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 simazine.

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 simazine 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 dietary items like plankton, other crustaceans, or detritus are exposed to simazine and experience adverse effects.

We consider estimated concentrations of simazine on the landscape or within the environment and effects reported in available toxicity studies to determine the level of direct and indirect adverse effects to listed species or critical habitat. Concentrations of simazine can vary greatly depending on where exposure takes place. For instance, exposures on or near simazine use sites are at higher levels than exposures that occur in areas far away from simazine use sites. Based on available toxicity data, we anticipate crustaceans are not very sensitive to simazine at estimated environmental concentrations and are not likely to die, even in habitats that only accumulate low levels. However, sublethal effects, such as reduced growth or reproduction, are possible with simazine exposure for crustaceans at some estimated environmental concentrations (EECs).

We anticipate species that only rely on plant-based resources, such as aquatic vegetation for food or habitat, are likely to experience some indirect adverse effects. Available toxicity data in plants indicate a reduction in plant growth ultimately impacting survival of the plant is likely to occur with simazine exposure. However, we do not anticipate that it will eliminate all aquatic vegetation within a water body and will replenish over time in any dynamic aquatic system (flowing or non-flowing) based on several mesocosm and microcosm studies discussed in the main body of the Opinion. In contrast, species that rely on terrestrial arthropods for food resources may not experience high levels of indirect adverse effects as simazine exposure will

[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.

not likely reduce the abundance and availability of terrestrial arthropod prey. However, simazine may impact aquatic arthropod dietary resources, similarly as it would impact the species itself.

We determine the overall toxicity ranking for crustaceans by qualitatively assessing both the expected levels of direct adverse effects (e.g., reproduction) and indirect effects (e.g., prey or habitat loss). Given that mortality is the most adverse of direct effects to an individual of a species, we assign the most weight to direct adverse effects resulting in mortality when determining the toxicity ranking. As mentioned previously, available toxicity data indicate crustaceans are somewhat sensitive to simazine; they are likely to experience sublethal effects if exposed, even in habitats that only accumulate low levels, and mortality is unlikely even at the highest estimated concentrations.

Conservation Measures

Herbicide Strategy Conservation Measures

As part of the simazine 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 15-foot spray drift buffer and a minimum of three runoff mitigation points[5] necessary in all areas where simazine is used, as well as additional runoff mitigation points for certain simazine uses limited to specific geographic areas.

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

This buffer is in addition to spray drift mitigations that are already on the label, including:

- Restricting use to a maximum windspeed of 10 miles per hour,
- Prohibiting applications during temperature inversions,
- Applying with a release height of no more than 4 feet above the ground or crop canopy for ground applications,
- Selecting nozzles and pressures that deliver coarse or coarser droplets for all applications,

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

- and ground application only.

Based on EPA's analyses, the Service anticipates that the required spray drift conservation measures described above (from the current label and implemented through the Herbicide Strategy) will sufficiently reduce off-site transport of simazine from spray drift to a level where no more than low levels of effects are likely to occur to listed crustacean species through this exposure route.

Additionally, all agricultural labels will include a requirement for applicators to achieve 3 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[6]. The menu provides a suite of options, including relief points for certain field characteristics and likelihood for pesticide transport.

These runoff mitigation points are in addition to runoff mitigations that are already on the label, including:

- Product must not be mixed or loaded within 50 feet of intermittent streams and rivers, natural or impounded lakes and reservoirs.
- Product must not be applied within 66 feet of points where agricultural field (nurseries, Christmas tree plantings, and turf grasses for sod farms) surface water runoff enters perennial or intermittent streams and rivers or within 200 feet of natural or impounded lakes and reservoirs. If this product is applied to highly erodible land, the 66-foot buffer or setback from runoff entry points must be planted to crop or seeded with grass or other suitable crop.
- Do not apply within 66 feet of standpipes in tile-outletted terraced fields.
    - Apply this product to the entire tile-outletted terraced field under a no-till practice only when a high crop residue management practice is practiced. High crop residue management is described as a crop management practice where little, or no crop residue is removed from the field during and after crop harvest.

We expect implementation of the runoff and erosion reduction measures as required, to minimize off-site transport of simazine 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 simazine 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 three additional points, i.e., up to 99% reduction) will be required. EPA will communicate where

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

additional runoff mitigation points are needed and for what specific simazine uses through their Bulletins Live! Two online platform[7], 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 simazine will decrease by up to two orders of magnitude (i.e., reduce pesticide loading to one-one hundredth of pre runoff mitigation levels).

We anticipate this level of mitigation will protect listed crustacean species by reducing the number of individuals exposed (by reducing the extent of off-site transport of simazine residues) and reducing the level of direct and indirect adverse effects that will occur to exposed individuals (by reducing estimated exposure concentrations).

Summary of Conclusions for Crustacean Species

After reviewing the current status of the species, the environmental baseline for the action area, the effects of the proposed registration of simazine with conservation measures, and the cumulative effects, it is the Service's biological opinion that the registration of simazine, as proposed, is not likely to jeopardize the continued existence of at least 28 of the 29 crustacean species in this Appendix. For the remaining one crustacean in this appendix, we plan to continue coordination with EPA and the technical registrants to further assess this 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; we did not have any species that warranted individual discussions in this appendix. 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.

---

[7]Bulletins Live! Two website: https://www.epa.gov/endangered-species/bulletins-live-two-view-bulletins

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

The species in Table 1 are grouped together because we have low concern of adverse effects due to low exposure as informed by low overlap between the species' ranges and agricultural areas where simazine is registered for use. 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. Crustacean 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
Benton County cave crayfish	*Cambarus aculabrum*	High	Low	High	0.5	No Jeopardy
Big Creek crayfish	*Faxonius peruncus*	High	Low	High	1.5	No Jeopardy
Big Sandy crayfish	*Cambarus callainus*	High	Low	High	<0.1	No Jeopardy
Black Creek crayfish	*Procambarus pictus*	High	Low	High	2.5	No Jeopardy
Guyandotte River crayfish	*Cambarus veteranus*	High	Low	High	<0.1	No Jeopardy
Hay's Spring amphipod	*Stygobromus hayi*	High	Low	High	0.2	No Jeopardy
Hell Creek Cave crayfish	*Cambarus zophonastes*	High	Low	High	0.1	No Jeopardy
Lee County cave isopod	*Lirceus usdagalun*	High	Low	High	1.1	No Jeopardy
Nashville crayfish	*Orconectes shoupi*	Low	Low	High	1.1	No Jeopardy
Panama City crayfish	*Procambarus econfinae*	High	Low	High	0.3	No Jeopardy
Peck's cave amphipod	*Stygobromus (=Stygonectes) pecki*	High	Low	High	2.9	No Jeopardy
Riverside fairy shrimp	*Streptocephalus woottoni*	High	Low	High	1.5	No Jeopardy
San Diego fairy shrimp	*Branchinecta sandiegonensis*	High	Low	High	0.8	No Jeopardy
Shasta crayfish	*Pacifastacus fortis*	High	Low	High	0.6	No Jeopardy

Common Name	Scientific Name	Vulnerability Ranking	Agricultural Exposure Ranking	Toxicity Ranking	Total Agricultural Action Area Overlap (% Range)	Determination
St. Francis River crayfish	*Faxonius quadruncus*	High	Low	High	1.5	No Jeopardy

Most species in Table 1 have high vulnerability rankings. Specifically, pesticides are a noted threat to the Hell Creek cave crayfish, Nashville crayfish, Riverside fairy shrimp, and San Diego fairy shrimp. The Nashville crayfish has low vulnerability, and it occurs in the Mill Creek watershed of Tennessee. The species was proposed for delisting due to recovery in 2019 because it currently persists in high numbers and exhibits a high degree of resistance to disturbance (85 FR 59732 59734), indicating that the species has a high degree of stability.

The species in Table 1 have low extents of overlap between their ranges and agricultural simazine use sites (<0.1-2.9%), 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 use site layers, assumes exposure is occurring in all possible overlapping areas, and does not consider information on past simazine usage. As such, we expect that exposure of these species to simazine will occur in even smaller portions of the species' ranges than the overlaps shown in Table 1.

In addition to agricultural exposure, 7 of the 15 species in Table 1 may be exposed to simazine through non-agricultural use on lawns or golf courses. However, we expect little runoff from residential turf uses based on standard application methods (i.e., continuous cover, no till). In addition, given our knowledge of simazine application to turf and nursery areas (see *Exposure to Non-Agricultural Uses*, above), we expect simazine usage within the range of these species to be limited. One species, Nashville crayfish, occurs in Tennessee, but it does not occur in Warren County, where we expect potentially high overlaps with Nursery uses. Therefore, we expect simazine exposure from non-agricultural uses to be low for these species.

Most crayfish are omnivores and rely on a variety of dietary items including aquatic plants, fish, amphibians, fish eggs, algae, detritus, and dead plant and animal material. We expect simazine exposure will result in adverse effects to plant food sources, particularly a reduction in plant growth. However, we anticipate some aquatic vegetation will withstand simazine exposure and replenish over time in flowing or non-flowing dynamic aquatic systems based on several mesocosm and microcosm studies discussed in the main body of the Opinion. Simazine may also impact aquatic arthropod dietary resources. We do not expect simazine exposure will impact detritus, woody plant material, animal material, or dead plant food resources.

The species in Table 1 have high toxicity rankings because available toxicity data indicate that if aquatic invertebrates, including crustaceans, are exposed to simazine, they will experience reduced reproductive effects and reduced growth. However, we anticipate a small number of individuals are likely to experience exposure at levels where these effects would occur because

EECs from agricultural and non-agricultural uses are generally below which we expect sublethal effects to aquatic invertebrates. We do not expect exposed crustaceans to die, even at the highest estimated concentrations of simazine.

In summary, we expect these species are likely to experience no more than low levels of agricultural exposure to simazine based on the low level of total overlap of the species' ranges and agricultural simazine use sites. We also expect non-agricultural exposure is low. Exposure will be limited to small portions of the species' ranges that overlap with use sites. The small numbers of exposed individuals may have fewer offspring, reduced growth, and temporary reduced food availability. We do not expect mortality or high levels of sublethal effects to these crustaceans. Therefore, 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 the conservation measures that are incorporated into the proposed action), we have determined the proposed action is not expected to appreciably reduce the likelihood of survival and recovery of these species in the wild. Thus, it is our biological opinion that the proposed action is not likely to jeopardize the continued existence of the crustaceans in Table 1.

Species with low exposure informed by low past usage from the California Department of Pesticide Regulation's Pesticide Use Reporting data and low likelihood of non-agricultural exposure

The species in Table 2 are grouped together because they occur completely or mostly within California and have low exposure confirmed by low levels of past simazine usage within their ranges (% range treated), as informed by the California Department of Pesticide Regulation Pesticide Use Report (CalPUR), and low likelihood of non-agricultural exposure. While we present some specific information about the species in Table 2 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. Crustacean species with low exposure informed by low past usage from California Department of Pesticide Regulation Pesticide Use Reporting (CalPUR) data and low likelihood of non-agricultural exposure.

Common Name	Scientific Name	Vulnerability Ranking	Exposure Ranking	Toxicity Ranking	% Range Treated (CalPUR)	Determination
California freshwater shrimp	*Syncaris pacifica*	High	Low	High	1.4	No Jeopardy
Conservancy fairy shrimp	*Branchinecta conservatio*	High	Low	High	0.5	No Jeopardy
Longhorn fairy shrimp	*Branchinecta longiantenna*	High	Low	High	<0.1	No Jeopardy
Vernal pool fairy shrimp	*Branchinecta lynchi*	High	Low	High	0.6	No Jeopardy
Vernal pool tadpole shrimp	*Lepidurus packardi*	High	Low	High	0.6	No Jeopardy

The species in Table 2 have high vulnerability rankings. Specifically, pesticides are noted as a threat to the California freshwater shrimp and the conservancy fairy shrimp. The species in Table 2 have high toxicity rankings because available toxicity data indicate that many aquatic invertebrates, including crustaceans, are sensitive to simazine exposure and are likely to experience sublethal effects such as reduced numbers of offspring and reduced growth if exposed even at low concentrations. We do not expect exposed crustaceans to die, even at the highest estimated concentrations of simazine.

The California freshwater shrimp, conservancy fairy shrimp, longhorn fairy shrimp, and vernal pool fairy shrimp are opportunistic filter feeders. The vernal pool tadpole shrimp is an aggressive omnivore. We expect that simazine exposure will result in indirect adverse effects to these species through loss of plant food and invertebrate prey (e.g., insects, fairy shrimp, and tadpoles), but the bacteria, protozoa, rotifers, or aquatic earthworms that provide food for these species will not be affected by simazine exposure. However, we anticipate that simazine exposure will not eliminate all aquatic vegetation within a waterbody and some will replenish over time in any dynamic aquatic system (flowing or non-flowing) based on several mesocosm and microcosm studies discussed in the main body of the Opinion. We also expect that simazine exposure will not impact detritus, woody plant material, animal material, or dead plant food resources. Because each of these crustaceans use a variety of food sources, we do not anticipate simazine will impact food availability for these species.

While species in Table 2 are highly vulnerable, we anticipate only a small number of individuals are likely to be exposed to agricultural and non-agricultural uses of simazine given that CalPUR data indicate low past usage within their species' ranges. Mandatory pesticide usage reporting data collected by the state of California indicates very little simazine has been used in the areas where these species' ranges occur. Up to 1.4% of the ranges (California freshwater shrimp) were treated with simazine annually between 2013-2022. CalPUR data indicates that no simazine was used within the range of the longhorn fairy shrimp between 2013-2022. Given that this usage reporting is mandated by the state of California and that these data are provided regularly at a relatively high spatial resolution (i.e., at the section level, which is per square mile), we have high confidence that only small percentages of the species' ranges are likely to be exposed to agricultural and most non-agricultural uses of simazine. Private residential pesticide use is not required for reporting to CalPUR.

In addition to agricultural exposure, 2 of the 5 species (i.e., California freshwater shrimp and longhorn fairy shrimp) in Table 2 may be exposed to simazine through non-agricultural use on lawns or golf courses. However, we expect little runoff from residential turf uses based on standard application methods and use site characteristics (i.e., continuous cover, no till). In addition, these species do not occur exclusively or disproportionately near these non-agricultural simazine use sites. Furthermore, given our knowledge of simazine application to turf and nursery areas (see *Exposure to Non-Agricultural Uses*, above), we expect simazine usage within the ranges of these species to be limited. As such, we anticipate no more than a small number of individuals of each species will be exposed to simazine from residential uses and experience reduced growth or offspring survival.

In summary, we expect these species are likely to experience no more than low levels of exposure to simazine based on the low level of usage reported through CalPUR and limited runoff expected from private residential uses. While pesticides are noted as a threat to some of the crustaceans in this group and some individuals may experience sublethal effects (e.g., reduced growth or offspring survival) and indirect effects (e.g., loss of prey items), we expect these adverse effects will be limited to a small number of individuals over the duration of the proposed action. After reviewing the current status of the species, environmental baseline for the action area, cumulative effects, and effects of the action (including the conservation measures that are incorporated into the proposed action), we have determined the proposed action is not expected to appreciably reduce the survival and recovery of these species in the wild. Thus, it is our biological opinion that the proposed action is not likely to jeopardize the continued existence of these crustacean species.

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

The species in Table 3 are grouped together because we anticipate all of these species are at low risk of adverse effects from the proposed action as a result of conservation measures included in the description of the action, including general label changes to reduce spray drift and runoff. While we present some specific information about the species in Table 3 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 spray drift and runoff conservation measures and low likelihood of non-agricultural exposure.

Common Name	Scientific Name	Vulnerability Ranking	Agricultural Exposure Ranking	Toxicity Ranking	Conservation Measures	Determination
Brawleys Fork crayfish	*Cambarus williami*	High	Low	High	General label measures	No Jeopardy
Noel's amphipod	*Gammarus desperatus*	High	Low	High	General label measures	No Jeopardy

The species in Table 3 have high vulnerability rankings. These species have low exposure rankings after incorporating conservation measures and subsequent reductions in off-target transport from agricultural use areas.

EPA's Herbicide Strategy requires a minimum of three runoff mitigation points and a 15-foot spray drift buffer on all agricultural simazine applications, which will reduce estimated environmental concentrations of simazine from agricultural uses by up to 90% (or an order of magnitude) for the species in this group. Applicators must select runoff and erosion control practices from EPA's mitigation menu, which is designed to be flexible while ensuring site-level risk is reduced. These general conservation measures will both reduce the number of individuals exposed (by reducing the extent of off-site transport of simazine residues) and reduce the level of adverse effects that will occur to exposed individuals (by reducing estimated exposure concentrations).

Although modeled overlap between species' ranges and agricultural simazine use sites is high for species in this group, the required conservation measures are expected to reduce the likelihood, magnitude, and frequency of exposure to a level where we expect direct and indirect effects to be infrequent and of a low magnitude. The species may occur in smaller, low-flow waterbodies where pesticide concentrations could be higher, but the combined effect of drift buffers and runoff controls is expected to prevent exceedance of toxicity thresholds for agricultural uses.

In addition to agricultural exposure, these species may be exposed to simazine through non-agricultural use on lawns or golf courses. However, we expect little runoff from residential turf uses based on standard application methods and use site characteristics (i.e., continuous cover, no till). In addition, these species do not occur exclusively or disproportionately near these non-agricultural simazine use sites. Furthermore, given our knowledge of simazine application to turf and nursery areas (see *Exposure to Non-Agricultural Uses*, above), we expect simazine usage within the range of these species to be limited. Even though Noel's amphipod occurs near urban areas where simazine may be used on turf, most individuals are on National Wildlife Refuge lands where simazine use has not been reported in the past. In addition, Brawleys Fork crayfish occurs in areas subject to runoff from nearby nurseries, but we do not expect simazine EECs in runoff from these nurseries to rise to the level where Brawleys Fork crayfish that were exposed would experience sublethal effects.

Most crustaceans are omnivores and rely on a variety of dietary items including aquatic plants, fish, amphibians, fish eggs, algae, detritus, and dead plant and animal material. We expect simazine exposure will result in adverse effects to plant food sources, particularly a reduction in plant growth. However, we anticipate some aquatic vegetation will withstand simazine exposure and replenish over time in flowing or non-flowing dynamic aquatic systems based on several mesocosm and microcosm studies discussed in the main body of the Opinion. Simazine may also impact aquatic arthropod dietary resources. We do not expect simazine exposure will impact detritus, woody plant material, animal material, or dead plant food resources. We do not expect exposed crustaceans to die, even at the highest estimated concentrations of simazine.

In summary, we expect these species are likely to experience no more than low levels of exposure to simazine based on the low EECs of simazine we expect after implementation of the conservation measures for agricultural uses. We also expect non-agricultural exposure is low. The small numbers of exposed individuals may have fewer offspring, reduced growth, and temporary reduced food availability. We do not expect mortality or high levels of sublethal effects to these crustaceans. Therefore, 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 the conservation measures that are incorporated into the proposed action), we have determined the proposed action is not expected to appreciably reduce the likelihood of survival and recovery of these species in the wild. Thus, it is our biological opinion that the proposed action is not likely to jeopardize the continued existence of the species listed in Table 3.

Species that occur in caves with low agricultural exposure achieved through spray drift and runoff conservation measures and low likelihood of non-agricultural exposure

The species in Table 4 are grouped together because we anticipate all of these species are at low risk of adverse effects from the proposed action as a result of conservation measures included in the description of the action, including general label changes to reduce spray drift and runoff, and their primary habitat is in cave systems. While we present some specific information about the species in Table 4 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 4. Species that occur in caves with low agricultural exposure achieved through spray drift and runoff conservation measures and low likelihood of non-agricultural exposure.

Common Name	Scientific Name	Vulnerability Ranking	Agricultural Exposure Ranking	Toxicity Ranking	Conservation Measures	Determination
Alabama cave shrimp	*Palaemonias alabamae*	High	Low	High	General label measures	No Jeopardy
Illinois cave amphipod	*Gammarus acherondytes*	High	Low	High	General label measures	No Jeopardy
Kentucky cave shrimp	*Palaemonias ganteri*	High	Low	High	General label measures	No Jeopardy
Madison cave isopod	*Antrolana lira*	High	Low	High	General label measures	No Jeopardy
Miami cave crayfish	*Procambarus milleri*	High	Low	High	General label measures	No Jeopardy
Squirrel Chimney cave shrimp	*Palaemonetes cummingi*	High	Low	High	General label measures	No Jeopardy

The species in Table 4 have high vulnerability rankings. These species have low exposure rankings after incorporating conservation measures and subsequent reductions in off-target transport from agricultural use areas and accounting for the modeling of karst systems.

EPA's Herbicide Strategy requires a minimum of three runoff mitigation points and a 15-foot spray drift buffer on all agricultural simazine applications, which will reduce estimated environmental concentrations of simazine from agricultural uses by up to 90% (or an order of magnitude) for the species in this group. Applicators must select runoff and erosion control practices from EPA's mitigation menu, which is designed to be flexible while ensuring site-level risk is reduced. These general conservation measures will both reduce the number of individuals exposed (by reducing the extent of off-site transport of simazine residues) and reduce the level of adverse effects that will occur to exposed individuals (by reducing estimated exposure concentrations).

The crustaceans in Table 4 may be exposed to pesticides in water from over land flow or leaching from soil from land use practices over or near sinkholes, karst systems, or other porous features near the surface of cave habitats. The environmental fate, transport, and physicochemical properties of simazine are such that it is quite mobile in soil matrices and water. Simazine is persistent enough in the environment that it could run-off of agricultural fields and remain at levels toxic enough to impact cave species. Karst systems are known to have enhanced porosity and permeability and are therefore susceptible to pesticide contamination that could be present in run-off water. Karst cave systems recharge (i.e., the process of aboveground water reaching the groundwater supply) every several days to months, and simazine is not known to degrade in that time frame (see *Exposure* section in this Opinion) so simazine could be present in water that enters the cave. However, the karst system watersheds specific to where these different crustaceans occur (Alabama, Kentucky, Illinois, Virginia, and Florida) are such that the dilution of off-field run off of simazine will not reach concentrations that will impact these cave crustaceans or their dietary resources (aquatic arthropods, algae, detritus, etc.). In addition, we expect effects to growth and reproduction for these crustaceans and their dietary resources (e.g., aquatic arthropods, algae) willh be infrequent and of low magnitude due to the reduction in simazine exposure resulting from conservation measures for agriculture. Likewise, estimated environmental concentrations from non-agricultural exposure are not likely to reach levels where we would observe mortality or sub-lethal effects to these species.

In summary, we expect these crustaceans are likely to experience no more than low levels of exposure to simazine based on the low simazine EECs we expect after implementation of the conservation measures. We also expect non-agricultural exposure is low. A small number of exposed individuals may have fewer offspring, reduced growth, and temporary reduced food availability, but we do not expect mortality or high levels of sublethal effects to these crustaceans. Therefore, 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 the conservation measures that are incorporated into the proposed action), we have determined the proposed action is not expected to appreciably reduce the likelihood of survival and recovery of the species in the wild. Thus, it is our biological opinion that the proposed action is not likely to jeopardize the continued existence of the species listed in Table 4.

Species requiring further analysis

In our draft Biological Opinion, we focused our analyses on 1) species with low expected exposure to simazine (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 simazine (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. While the conservation measures are expected to reduce the extent of off-field exposure and reduce exposure concentrations, we anticipate simazine residues in aquatic habitats could remain at levels high enough to cause more than low levels of adverse direct and/or indirect effects to this crustacean species. We intend to continue coordinating with EPA and simazine registrants between the release of this draft Opinion and the transmission of the final Opinion to gain information regarding the exposure and effects of this species to simazine. As such, we have not yet a made determination for this species.

Table 5. Crustacean needing further analysis.

Common Name	Scientific Name	Vulnerability Ranking	Agricultural Exposure Ranking	Toxicity Ranking
Slenderclaw crayfish	*Cambarus cracens*	High	Medium	High