Integration and Synthesis Summary for Bivalves (Mussels)

This Integration and Synthesis Summary includes our jeopardy analysis for bivalve (mussel) 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.

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 mussel species.

Vulnerability

For the mussel species that we or EPA determined are "likely to be adversely affected" by the proposed action, we considered several factors for each listed mussel 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) 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

[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.

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 mussel species will be exposed to simazine primarily through direct contact in 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 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 agricultural exposure using overlaps between the species' ranges and agricultural land uses where simazine is registered for use (i.e., overlaps), 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 or soil 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 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% total overlap are assigned a low overlap score. In addition to range overlaps, we considered past usage data within a species' range to determine how much of a species' range we expect to be treated with simazine each year of the proposed action. Except where otherwise noted, usage data is provided by EPA applying data from their National and

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

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 coterminous 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. 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.

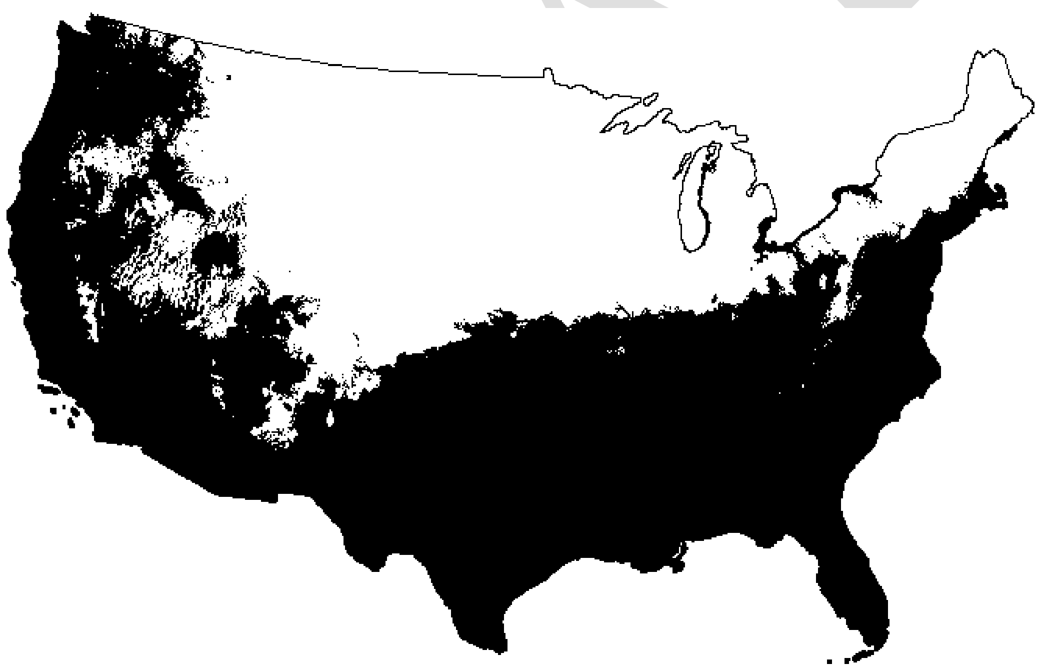

Figure 1. Map showing where cool-season grasses (white areas) and warm-season grasses (black areas) are used on turf across the continental U.S.

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.

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 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 likely to occur to mussels. Because mortality from simazine exposure at estimated environmental concentrations to mussels is not anticipated (see section *Effects to Aquatic Invertebrates* in the main body of the Opinion), we focus our assessment on sublethal effects to mussels, and indirect effects to the mussels from effects to fish hosts and plant related food resources. Mussels depend on host species to accomplish their reproductive lifecycle. Glochidia (larval stage) are released into the water and within a few days they must attach to an appropriate species of host, which they parasitize for a short time while they develop into juvenile mussels. Glochidia that do not attach to a host fish will not survive. Where sufficient numbers of suitable host fish are not available, we anticipate reproduction of mussels will be reduced.

We consider in our analysis if EECs exceed the threshold for sublethal effects on growth to the host or reproduction to the mussel as simazine data indicate reduced growth can occur to fish/amphibians as hosts and reduced fecundity can result for aquatic mollusks at EECs that may be observed in concentrations in lower flow or lower volume water bodies within the range of some mussels. For some mussels in this Opinion, EECs may occur at levels that exceed the fish sublethal NOAEC or the aquatic mollusk sublethal LOAEC but no EECS exceed the mortality threshold for fish or mollusks calculated by the EPA. We consider the NOAEC a conservative threshold for qualitatively estimating anticipated sublethal effects to listed fish.

Concentrations of simazine can vary greatly among different regions and aquatic habitat types. Where simazine enters smaller streams or static waters (e.g., low flow/low volume waterbodies) from runoff or spray drift, we generally anticipate high levels of sublethal effects to individual

[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.

hosts or mussels where exposure occurs. In larger waterbodies (e.g., where concentrations may be lower due to dilution or other factors as described in the *Effects of the Action* Section of the Biological Opinion), we expect lower levels of sublethal effects to mussels or their host species.

We determine the agricultural toxicity ranking for mussels by qualitatively assessing the expected levels of adverse effects (e.g., sublethal effects to the host or the mussel) and the relationship to the host for the mussel. In terms of the mussel's relationship to the host, we characterize how specialized the mussel is to the hosts(s) it relies on for successful reproduction. For example, where listed mussel species are known to rely upon a variety of host fish species for glochidia attachment, we consider those species to be host generalists and assume a lower likelihood of adverse effects as these species are expected to be more tolerant of a decline in abundance of one or more host fish. For mussel species that rely on few species of host (1-2 species), we consider them to be host obligates or specialists and assume they are more susceptible to declines in abundance as there are fewer options for glochidia attachment. Where the host is unknown for a listed mussel species, we adopt the conservative assumption that they are host specialists in the absence of data to conclude otherwise. The following characteristics (i.e., toxicity modifiers) led us to increase toxicity rankings for mussel species when applicable: unknown host species, specialist host, hosts that occur in few aquatic habitat types where we expect simazine concentrations to be higher (i.e., low flow and/or low volume), and fish that are uncommon or occur in small populations.

We also consider effects to dietary resources in our toxicity ranking. Mussels generally consume plant-based and microbial resources (e.g., algae, detritus). We anticipate high levels of mortality to some mussel dietary items (e.g., phytoplankton) and impacts to mussel host fish dietary items (e.g., algae, phytoplankton) in low flow or low volume waterbodies. We anticipate phytoplankton will be impacted by simazine applications but we do not anticipate that it will eliminate all phytoplankton 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. We don't expect impacts to detritus from simazine exposure.

Therefore, we do not anticipate significant reductions in plant-base food availability for mussels or host fish. As such, impacts to growth to host fish and reproduction to mussels are the primary driver in determining the toxicity ranking for mussel species.

Experimental populations, nonessential

We considered the following nonessential experimental populations for mussel species in this section of the consultation:: Alabama lampmussel (Entity ID 1680), Appalachian monkeyface (pearlymussel) (Entity ID 9487), birdwing pearlymussel (Entity IDs 8356, 9488), clubshell (Entity ID 1897), cracking pearlymussel (Entity IDs 2308 and 9489), Cumberland bean (pearlymussel) (Entity IDs 7512 and 9490), Cumberlandian combshell (Entity ID 5715 and 9491), Cumberland monkeyface (pearlymussel) (Entity IDs 5718 and 9492), dromedary pearlymussel (Entity IDs 2192 and 9493), fanshell (Entity ID 9494), finerayed pigtoe (Entity ID 3226 and 9495), orangefoot pimpleback (pearlymussel) (Entity ID 9496), oyster mussel (Entity IDs 1905 and 9497), purple cat's paw (pearlymussel) (Entity ID 8349), ring pink (mussel) (Entity ID 9498), rough pigtoe (Entity ID 9499), shiny pigtoe (Entity ID 5833 and 9500), white wartyback (pearlymussel) (Entity ID 9401), and winged mapleleaf (Entity ID 7091). We do not provide separate analyses and jeopardy determinations for these populations. Rather, we treat all populations of the species (including populations designated as experimental) as a single listed entity when making jeopardy determinations or for other analyses in a section 7 consultation. An "essential experimental population" is a reintroduced population whose loss would be likely to appreciably reduce the likelihood of the survival of the species in the wild. However, there are no "essential experimental populations" in this consultation. A "nonessential experimental population" is a reintroduced population whose loss would not be likely to appreciably reduce the likelihood of survival of the species in the wild. By definition, a "nonessential experimental population" is not essential to the continued existence of the species. Therefore, no proposed action impacting a population so designated could lead to a jeopardy determination for the entire species. In cases where our assessment of the listed entity (i.e., the non-experimental population(s) of the species) leads to a "not likely to jeopardize" determination, we generally assume any added effects to the nonessential experimental population will not change these determinations. However, we consider the role of the experimental population in the survival and recovery of the species and consider this information in our jeopardy analyses as appropriate.

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.

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

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,
- and ground application only.

Based on EPA's analyses, the Service anticipates that the 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 mussel species through this exposure route.

Additionally, 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. 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, 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 additional runoff mitigation points are needed and for what specific simazine uses through their Bulletins Live! Two online platform[6], 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 fish 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 Bivalves (Mussels)

After reviewing the current status of the species, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, it is our biological opinion that the registration of simazine, as proposed, is not likely to jeopardize the continued existence of at least 102 of the 105 mussel species in this Appendix. For the remaining 3 mussels 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 indicating that effects could be different, have an individual discussion to provide additional explanation. This approach allowed us to streamline our discussion in this Opinion by avoiding repeating our findings when species in the respective groupings would be expected to 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.

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

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

The species in Table 1 are grouped together as they all have low concern of adverse effects due to low exposure as informed by low agricultural overlap between the species' range and 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. Species with low exposure informed by low overlap with agriculture 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
Alabama moccasinshell	*Medionidus acutissimus*	High	Low	High	3.0	No Jeopardy
Alabama pearlshell	*Margaritifera marrianae*	High	Low	High	1.6	No Jeopardy
Appalachian elktoe	*Alasmidonta raveneliana*	High	Low	High	1.9	No Jeopardy
Appalachian monkeyface (pearlymussel)	*Theliderma sparsa*	High	Low	High	0.3	No Jeopardy
Arkansas fatmucket	*Lampsilis powellii*	High	Low	High	0.3	No Jeopardy
Birdwing pearlymussel	*Lemiox rimosus*	High	Low	High	2.9	No Jeopardy
Black clubshell	*Pleurobema curtum*	High	Low	High	2.7	No Jeopardy
Canoe Creek Clubshell	*Pleurobema athearni*	High	Low	High	1.4	No Jeopardy
Coosa moccasinshell	*Medionidus parvulus*	High	Low	High	2.1	No Jeopardy
Cumberland bean (pearlymussel)	*Villosa trabalis*	High	Low	High	2.2	No Jeopardy
Cumberland elktoe	*Alasmidonta atropurpurea*	High	Low	High	0.5	No Jeopardy
Cumberland moccasinshell	*Medionidus conradicus*	High	Low	Low	2.9	No Jeopardy
Cumberland monkeyface (pearlymussel)	*Theliderma intermedia*	High	Low	High	3.0	No Jeopardy
Cumberlandian combshell	*Epioblasma brevidens*	High	Low	High	2.2	No Jeopardy

Appendix C-A3. Bivalves (Mussels): Integration and Synthesis Summaries

Common Name	Scientific Name	Vulnerability Ranking	Agricultural Exposure Ranking	Toxicity Ranking	Total Agricultural Action Area Overlap (% Range)	Determination
Dark pigtoe	*Pleurobema furvum*	High	Low	High	2.9	No Jeopardy
Dromedary pearlymussel	*Dromus dromas*	High	Low	High	0.4	No Jeopardy
Finelined pocketbook	*Hamiota altilis*	High	Low	High	2.0	No Jeopardy
Finerayed pigtoe	*Fusconaia cuneolus*	High	Low	High	3.7	No Jeopardy
Fluted kidneyshell	*Ptychobranchus subtentus*	High	Low	High	3.6	No Jeopardy
Georgia pigtoe	*Pleurobema hanleyianum*	High	Low	High	2.2	No Jeopardy
Guadalupe Fatmucket	*Lampsilis bergmanni*	High	Low	High	2.6	No Jeopardy
Guadalupe Orb	*Cyclonaias necki*	High	Low	High	3.8	No Jeopardy
Inflated heelsplitter	*Potamilus inflatus*	Medium	Low	High	3.1	No Jeopardy
James spinymussel	*Parvaspina collina*	High	Low	High	2.0	No Jeopardy
Louisiana Pigtoe	*Pleurobema riddellii*	High	Low	High	1.4	No Jeopardy
Mexican fawnsfoot	*Truncilla cognata*	High	Low	High	0.6	No Jeopardy
Narrow pigtoe	*Fusconaia escambia*	High	Low	High	3.4	No Jeopardy
Orangenacre mucket	*Hamiota perovalis*	High	Low	High	2.9	No Jeopardy
Ouachita rock pocketbook	*Arcidens wheeleri*	High	Low	High	1.9	No Jeopardy
Ovate clubshell	*Pleurobema perovatum*	High	Low	High	2.6	No Jeopardy
Oyster mussel	*Epioblasma capsaeformis*	High	Low	High	2.7	No Jeopardy
Purple bean	*Villosa perpurpurea*	High	Low	High	1.1	No Jeopardy
Rough rabbitsfoot	*Quadrula cylindrica strigillata*	High	Low	High	0.4	No Jeopardy
Round Ebonyshell	*Reginaia rotulata*	High	Low	High	2.5	No Jeopardy
Shiny pigtoe	*Fusconaia cor*	High	Low	High	4.3	No Jeopardy
Slabside Pearlymussel	*Pleuronaia dolabelloides*	High	Low	High	4.3	No Jeopardy

Common Name	Scientific Name	Vulnerability Ranking	Agricultural Exposure Ranking	Toxicity Ranking	Total Agricultural Action Area Overlap (% Range)	Determination
Southern clubshell	*Pleurobema decisum*	High	Low	High	2.9	No Jeopardy
Southern combshell	*Epioblasma penita*	High	Low	High	2.9	No Jeopardy
Southern pigtoe	*Pleurobema georgianum*	High	Low	High	2.0	No Jeopardy
Speckled pocketbook	*Lampsilis streckeri*	High	Low	High	0.0	No Jeopardy
Tan riffleshell	*Epioblasma florentina walkeri (=E. walkeri)*	High	Low	High	0.3	No Jeopardy
Tennessee clubshell	*Pleurobema oviforme*	High	Low	Low	3.1	No Jeopardy
Tennessee pigtoe	*Pleuronaia barnesiana*	High	Low	Low	4.5	No Jeopardy
Texas Hornshell	*Popenaias popeii*	High	Low	High	1.9	No Jeopardy
Texas fatmucket	*Lampsilis bracteata*	High	Low	High	1.1	No Jeopardy
Texas heelsplitter	*Potamilus amphichaenus*	High	Low	Low	2.1	No Jeopardy
Triangular Kidneyshell	*Ptychobranchus greenii*	High	Low	High	2.0	No Jeopardy
Winged Mapleleaf	*Quadrula fragosa*	High	Low	High	4.4	No Jeopardy

The species in Table 1 have high vulnerability rankings based on biological and ecological traits such as restricted distributions, reliance on specific host fish for reproduction, and known sensitivity to environmental stressors. These species have either high or low toxicity rankings, reflecting differences in their expected sensitivity to simazine-related sublethal effects, particularly those affecting host fish reproduction or mussel food resources. While all species in this group may be vulnerable to adverse effects if exposed, they were grouped together based on a low exposure ranking, informed by a low level of total overlap (≤5%) between their ranges and areas where simazine is registered for agricultural use, including spray drift and runoff zones.

The overlap metric used assumes exposure in all potentially agricultural overlapping areas and does not account for redundancy across use site layers or incorporate past simazine usage data—factors which, if considered, would likely reduce the expected exposure even further. Given these conservative assumptions and the implementation of conservation measures (e.g., drift buffers and runoff controls), we expect that, at most, only a small number of individuals of each species may be exposed to agricultural uses of simazine over the duration of the proposed action.

For species with low toxicity rankings, we do not anticipate direct or indirect adverse effects, as exposure is unlikely to occur at biologically meaningful concentrations and we do not anticipate simazine will impact the detritus or phytoplankton that mussels rely on for food. For non-agricultural sources of simazine, we expect little runoff from residential turf uses based on standard application methods and site characteristics (i.e., continuous cover, no till). Therefore, these species are not expected to be affected by the levels of simazine from both agricultural and non-agricultural sources that may reach their aquatic habitats, especially with the implementation of conservation measures that reduce off-target transport for agricultural uses. For species with high toxicity rankings, adverse effects such as reduced glochidia-host attachment and reproductive impairment, may occur if exposure happens. However, due to the low spatial overlap with simazine use areas and the conservation measures developed through the Herbicide Strategy—such as a standard 15-foot spray drift buffer and at least three runoff mitigation points—we anticipate that pesticide transport to mussel habitats will be significantly reduced (up to 90% in most cases). As a result, the probability that individuals will be exposed at harmful concentrations is low, and any adverse effects to reproduction are expected to be limited to a small number of individuals.

We also consider effects to dietary resources in our species analysis. Mussels generally consume plant-based, zooplankton, and microbial resources (e.g., algae, detritus). Fish can consume plant-based, microbial resources, and other aquatic vertebrates and invertebrates depending on the species of host fish. We anticipate algae and zooplankton will be impacted by simazine applications but we do not anticipate that it will eliminate all algae and zooplankton within a water body and both 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 don't expect impacts to detritus from simazine exposure. Therefore, we do not anticipate significant reductions in food availability for mussels or host fish.

In summary, exposure is expected to be low, we do not expect direct adverse effects from exposure, and any indirect adverse effects through loss of host fish would likely be limited to a small number of individuals. 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 in Table 1.

Species with low agricultural exposure achieved through spray drift and runoff conservation measures, low likelihood of non-agricultural exposure, and generalist fish host relationships

The species in Table 2 are grouped together as 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 measures (i.e., measures already on the label and three runoff points and ground buffers determined through implementation of the Herbicide Strategy), and are host fish generalists. Mussels with more than two host fish species that their glochidia can attach to are at less risk of the adverse effects of simazine in their environment due to an abundance and variety of host fish to rely on to complete their life cycle. 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. Species with low agricultural exposure due to spray drift and runoff conservation measures, low likelihood of non-agricultural exposure, and generalist fish host relationships.

Common Name	Scientific Name	Vulnerability Ranking	Agricultural Exposure Ranking	Toxicity Ranking	Conservation Measures	Determination
Alabama lampmussel	*Lampsilis virescens*	High	Low	High	General label measures	No Jeopardy
Atlantic pigtoe	*Fusconaia masoni*	High	Low	High	General label measures	No Jeopardy
Clubshell	*Pleurobema clava*	High	Low	High	General label measures	No Jeopardy
Curtis pearlymussel	*Epioblasma florentina curtisii*	High	Low	High	General label measures	No Jeopardy
Dwarf wedgemussel	*Alasmidonta heterodon*	High	Low	High	General label measures	No Jeopardy
Fanshell	*Cyprogenia stegaria*	High	Low	High	General label measures	No Jeopardy
Green floater	*Lasmigona subviridis*	High	Low	High	General label measures	No Jeopardy
Higgins eye (pearlymussel)	*Lampsilis higginsii*	High	Low	High	General label measures	No Jeopardy
Littlewing pearly mussel	*Pegias fabula*	High	Low	High	General label measures	No Jeopardy
Longsolid	*Fusconaia subrotunda*	High	Low	High	General label measures	No Jeopardy
Northern riffleshell	*Epioblasma rangiana*	High	Low	High	General label measures	No Jeopardy
Pale lilliput (pearlymussel)	*Toxolasma cylindrellus*	High	Low	High	General label measures	No Jeopardy

Appendix C-A3. Bivalves (Mussels): Integration and Synthesis Summaries

Common Name	Scientific Name	Vulnerability Ranking	Agricultural Exposure Ranking	Toxicity Ranking	Conservation Measures	Determination
Pink mucket (pearlymussel)	*Lampsilis abrupta*	High	Low	High	General label measures	No Jeopardy
Purple Cat's paw (=Purple Cat's paw pearlymussel)	*Epioblasma obliquata*	High	Low	High	General label measures	No Jeopardy
Rabbitsfoot	*Quadrula cylindrica cylindrica*	High	Low	High	General label measures	No Jeopardy
Rayed Bean	*Villosa fabalis*	High	Low	High	General label measures	No Jeopardy
Round hickorynut	*Obovaria subrotunda*	High	Low	High	General label measures	No Jeopardy
Sheepnose Mussel	*Plethobasus cyphyus*	High	Low	High	General label measures	No Jeopardy
Snuffbox mussel	*Epioblasma triquetra*	High	Low	High	General label measures	No Jeopardy
Spectaclecase (mussel)	*Cumberlandia monodonta*	High	Low	High	General label measures	No Jeopardy
Texas pimpleback	*Cyclonaias petrina*	High	Low	High	General label measures	No Jeopardy
Altamaha spinymussel	*Elliptio spinosa*	High	Medium	Low	General label measures	No Jeopardy
Carolina heelsplitter	*Lasmigona decorata*	High	Medium	Low	General label measures	No Jeopardy
Choctaw bean	*Obovaria choctawensis*	High	Medium	Low	General label measures	No Jeopardy
Fat threeridge (mussel)	*Amblema neislerii*	High	High	Low	General label measures	No Jeopardy
Gulf moccasinshell	*Medionidus penicillatus*	High	Medium	Low	General label measures	No Jeopardy
Louisiana pearlshell	*Margaritifera hembeli*	High	Medium	Low	General label measures	No Jeopardy
Neosho mucket	*Lampsilis rafinesqueana*	High	High	Low	General label measures	No Jeopardy
Orangefoot pimpleback (pearlymussel)	*Plethobasus cooperianus*	High	High	Low	General label measures	No Jeopardy
Oval pigtoe	*Pleurobema pyriforme*	High	Medium	Low	General label measures	No Jeopardy
Purple bankclimber	*Elliptoideus sloatianus*	High	Medium	Low	General label measures	No Jeopardy
Ring pink (mussel)	*Obovaria retusa*	High	High	Low	General label measures	No Jeopardy
Rough pigtoe	*Pleurobema plenum*	High	High	Low	General label measures	No Jeopardy

Common Name	Scientific Name	Vulnerability Ranking	Agricultural Exposure Ranking	Toxicity Ranking	Conservation Measures	Determination
Shinyrayed pocketbook	*Hamiota subangulata*	High	Medium	Low	General label measures	No Jeopardy
Southern elktoe	*Alasmidonta triangulata*	High	Medium	Low	General label measures	No Jeopardy
Southern kidneyshell	*Ptychobranchus jonesi*	High	Medium	Low	General label measures	No Jeopardy
Southern sandshell	*Hamiota australis*	High	Medium	Low	General label measures	No Jeopardy
Western fanshell	*Cyprogenia aberti*	High	Medium	Low	General label measures	No Jeopardy

The species in Table 2 have high vulnerability rankings based on biological and ecological traits such as restricted distributions and known sensitivity to environmental stressors. These species have high toxicity rankings, reflecting sublethal effects of simazine on their host fish (e.g., reduced growth) and mussel food resources (e.g., detritus, phytoplankton) in the absence of conservation measures to reduce off-site transport of simazine into their habitats. While all species in this group may be vulnerable to adverse effects if exposed, they were grouped together based on their reliance on several species of common fish hosts, which reduces their susceptibility to reproductive failure from localized impacts to any single host fish species. The Altamaha spinymussel, Choctaw bean, orangefoot pimpleback (pearlymussel), ring pink (mussel), and the southern sandshell all have host fish that are unknown but based on closely related congeners and/or glochidia attachment studies in the laboratory, these species likely are host fish generalists that likely use various species of sunfishes (e.g, bluegill), shiners, sauger, darters, bullhead, perch, largemouth bass, and mosquito fish as their fish hosts.

For all species in this group, EPA's Herbicide Strategy requires a minimum of three runoff mitigation points and implementation of a 15-foot spray drift buffer on all agricultural simazine applications. 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 measures are anticipated to reduce pesticide loading into aquatic habitats by up to 90% (one order of magnitude) compared to unmitigated runoff.

Modeled overlap between species' ranges and agricultural simazine use sites is moderate to high for many species in this group, and while maximum estimated environmental concentrations of simazine may cause sublethal adverse effects (e.g., reduced growth) to some fish hosts for the mussel species in Table 2, we anticipate these high-level exposures will only occur on occasion and that typical exposure concentrations are likely to be lower than levels where toxicity studies have observed sublethal effects in fish as hosts for the mussel species in Table 2. Therefore, we expect low levels of sublethal adverse effects (i.e., reduced growth) to a small number of fish hosts to individuals of these species.

We also consider effects to dietary resources in our toxicity ranking. Mussels generally consume plant-based resources, zooplankton, and microbial resources (e.g., phytoplankton, detritus). Fish can consume plant-based, microbial resources, and other aquatic vertebrates and invertebrates depending on the species of host fish. We anticipate algae and zooplankton will be impacted by simazine applications but we do not anticipate that it will eliminate all algae and zooplankton within a water body and both 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 don’t expect impacts to detritus from simazine exposure. Therefore, we do not anticipate significant reductions in food availability for mussels or host fish.

In addition, all the species in this grouping are fish host generalists. We define host fish generalists as mussel species that utilize multiple, common fish hosts for glochidia attachment and successful reproduction. As such, we do not expect sublethal effects to individual fish (e.g., reduced size or condition) to meaningfully impact overall host fish availability or interfere with glochidia attachment. Even if some host fish are adversely affected, fish hosts will have differing sensitivities to simazine exposure and the availability of alternate suitable hosts is expected to sustain reproduction.

While some of these mussel species may occur in watersheds that include non-agricultural simazine use sites (e.g., residential lawns, golf courses, or nurseries), we do not expect more than a small number of individuals to be exposed through these pathways. For non-agricultural uses, application practices typically include built-in spray drift and runoff mitigation. Golf courses, for example, use no-till practices and maintain continuous vegetative cover, reducing runoff potential and achieving mitigation equivalent to two orders of magnitude (99%) reduction in simazine loading to aquatic habitats. In addition, residential and golf course applicators commonly use coarse spray droplet sizes and low boom heights, further limiting spray drift. All species in Table 3 have <0.1% range overlap with nursery uses, so we do not anticipate meaningful exposure from this use pattern. 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.

Given the implementation of conservation measures, the expectation that host fish availability will not be significantly affected, and the low likelihood of exposure from non-agricultural sources, we anticipate that adverse effects to mussel reproduction will be limited to a small number of individuals and will not occur at a scale that would affect populations, and that simazine will not reduce food availability for mussels or host fish. We anticipate that adverse effects, if they occur, will be limited to a small number of individuals of these species. 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 registration of simazine, as proposed, is not likely to jeopardize the continued existence of the mussel species listed in Table 2.

Species with low agricultural exposure achieved through spray drift and runoff conservation measures, low likelihood of non-agricultural exposure, and specialist fish host relationships

The species in Table 3 are grouped together because they are fish host specialists, and we anticipate they are at low risk of adverse effects from the proposed action as a result of general label measures (i.e., measures already on the label and three runoff points and ground buffers determined through implementation of the Herbicide Strategy). We define the mussels in this group as those species with two or fewer host fish species to which their glochidia can attach. For many species, they have one common fish host and one rare fish host, thus the risk of adverse effects of simazine in their environment is reduced because at least one host fish they rely on to complete their life cycle is common and abundant. 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 due to spray drift and runoff conservation measures, low likelihood of non-agricultural exposure, and specialist fish host relationships.

Common Name	Scientific Name	Vulnerability Ranking	Agricultural Exposure Ranking	Toxicity Ranking	Conservation Measures	Determination
Balcones spike	*Fusconaia iheringi*	High	Low	Medium	General label measure	No Jeopardy
Chipola slabshell	*Elliptio chipolaensis*	High	Medium	Low	General label measure	No Jeopardy
Cracking pearlymussel	*Hemistena lata*	High	Medium	Low	General label measure	No Jeopardy
False spike	*Fusconaia mitchelli*	High	Low	Medium	General label measure	No Jeopardy
Fat pocketbook	*Potamilus capax*	Low	Low	Medium	General label measure	No Jeopardy
Fuzzy pigtoe	*Pleurobema strodeanum*	High	Medium	Low	General label measure	No Jeopardy
Kentucky creekshell	*Villosa ortmanni*	High	Low	Medium	General label measure	No Jeopardy
Ochlockonee moccasinshell	*Medionidus simpsonianus*	High	Medium	Low	General label measure	No Jeopardy
Salamander mussel	*Simpsonaias ambigua*	High	Medium	Low	General label measure	No Jeopardy
Scaleshell mussel	*Leptodea leptodon*	High	Low	Medium	General label measure	No Jeopardy
Suwannee moccasinshell	*Medionidus walkeri*	High	Medium	Low	General label measure	No Jeopardy

Common Name	Scientific Name	Vulnerability Ranking	Agricultural Exposure Ranking	Toxicity Ranking	Conservation Measures	Determination
Tapered pigtoe	*Fusconaia burkei*	High	Medium	Low	General label measure	No Jeopardy
Tar River spinymussel	*Parvaspina steinstansana*	High	High	Low	General label measure	No Jeopardy
Texas fawnsfoot	*Truncilla macrodon*	High	Low	Medium	General label measure	No Jeopardy
White cats paw	*Epioblasma perobliqua*	High	Low	High	General label measure	No Jeopardy
White wartyback (pearlymussel)	*Plethobasus cicatricosus*	High	Medium	Low	General label measure	No Jeopardy

The species in Table 3 have high or low vulnerability rankings, reflecting a range of biological and ecological traits such as restricted distributions, small or declining populations, and known sensitivity to environmental stressors. These species have medium to high toxicity rankings, based on the sublethal effects of simazine on host fish reproduction and growth, as well as on mussel dietary resources (e.g., phytoplankton, algae) in the absence of conservation measures to reduce off-site transport of simazine into their habitats. While all species in this group may be vulnerable to adverse effects if exposed, they were grouped together based on their reliance on one or two host fish species, at least one of which is common and widespread, providing some level of reproductive resilience. The cracking pearlymussel, Ochlockonee moccasinshell, and the white wartyback all have host fish that are unknown. Based on closely related congeners and/or glochidia attachment studies in the laboratory, these species likely are host fish specialists that use common logperch, black banded darter, or sauger, respectively, as their fish hosts, which are all common and abundant throughout the range of these mussels.

For all species in this group, EPA's Herbicide Strategy requires a minimum of three runoff mitigation points and implementation of a 15-foot spray drift buffer on all agricultural simazine applications. 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 measures are anticipated to reduce pesticide loading into aquatic habitats by up to 90% (one order of magnitude) compared to unmitigated

Modeled overlap between species' ranges and simazine use areas is moderate to high for many species in this group. While conservation measures are expected to substantially reduce simazine transport to aquatic systems, some exposure may still occur at levels that exceed sublethal thresholds for host fish—particularly in low-flow or static habitats. However, based on known habitat preferences and the distribution of agricultural simazine use, most species in this group occur in larger or higher-flow systems where concentrations are expected to be diluted. As such, we expect that only a small number of individuals may be exposed, and effects are likely to be limited in scale.

We also consider effects to dietary resources in our toxicity ranking. Mussels generally consume plant-based resources, zooplankton, and microbial resources (e.g., algae, detritus). Fish can consume plant-based resources, microbial resources, and other aquatic vertebrates and invertebrates depending on the species of host fish. We anticipate algae and zooplankton will be impacted by simazine applications, but we do not anticipate that it will eliminate all algae and zooplankton within a water body and both 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 don't expect impacts to detritus from simazine exposure. Therefore, we do not anticipate significant reductions in food availability for mussels or host fish.

All species in Table 3 are considered fish host specialists, defined as relying on two or fewer species of fish for reproduction. However, at least one host fish species for each mussel in this group is common, stable, and not of conservation concern (e.g., red drum, red shiner, banded sculpin). As such, even if some individual host fish experience sublethal effects, fish hosts will have differing sensitivities to simazine exposure and the availability of alternate suitable hosts is expected to sustain reproduction and we do not expect this to meaningfully reduce overall host fish availability or preclude glochidia attachment. We therefore do not anticipate significant disruption to the mussel reproductive cycle.

While we expect that some of these species may occur near non-agricultural use sites, we do not anticipate more than a small number of individuals of each species will be exposed to simazine through non-agricultural uses for the species in Table 4. Some species in Table 4 may co-occur within watersheds with developed, nurseries, and open-space developed areas, and they may be exposed to simazine runoff or spray drift through these uses. However, for non-agricultural uses, there are several practices in turf grass management for golf courses and residential lawn application practices that offer runoff and spray drift reduction inherent in the methods by which these applications are made. For example, for golf course management, a practice of no-tilling and continuous cover minimizes runoff such that mitigation points would be recognized for such and lead to a two-order of magnitude reduction in the concentrations of simazine in aquatic habitats where these mussels are found as compared to use sites without these practices. Additional practices for residential lawns and golf courses using a coarse droplet size further reduce spray drift from entering the aquatic habitats where these mussels are found. All of these species have <0.1% overlap with nurseries thus we do not have concern for simazine exposure from this use within the range of these mussel species. 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. Therefore, the mussel species in Table 4 are unlikely to be exposed to non-agricultural uses of this herbicide.

Given the implementation of conservation measures, the expectation that host fish availability will not be significantly affected, and the low likelihood of exposure from non-agricultural sources, we anticipate that adverse effects to mussel reproduction will be limited to a small number of individual mussel host fish and will not occur at a scale that would affect populations, and that simazine will not reduce food availability for mussels or host fish.

We anticipate that adverse effects, if they occur, will be limited to a small number of individuals of these species. 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 registration of simazine, as proposed, is not likely to jeopardize the continued existence of the mussel species listed in Table 3.

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 4, 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 greater than low levels of adverse direct and/or indirect effects to the host fish for these mussel 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 made determinations for these species.

Table 4. Bivalve species needing further analysis.

Common Name	Scientific Name	Vulnerability Ranking	Agricultural Exposure Ranking	Toxicity Ranking
Cumberland pigtoe	*Pleuronaia gibber*	High	Medium	Medium
Heavy pigtoe	*Pleurobema taitianum*	High	Medium	Medium
Yellow lance	*Elliptio lanceolata*	High	High	High