Integration and Synthesis Summary for Bivalves (Mussels)

This Integration and Synthesis Summary includes our jeopardy analysis for bivalve (mussels) 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 atrazine due to the factors described in the tables or individual rationales below in combination with reductions in atrazine spray drift and runoff resulting from implementation of conservation measures added to the product label (including those developed during this consultation through the Herbicide Strategy[1]; see Conservation Measures section below). We anticipate 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

[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 listed mussel species will be exposed to atrazine primarily through direct contact in the water. Atrazine 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

Atrazine has several registered agricultural uses (see Appendix 1-4 of EPA's Biological Evaluation). We characterize the expected level of exposure using overlaps between the species' ranges and agricultural land uses where atrazine is registered for use (i.e., overlaps), past atrazine usage data (when available; the amount and location where atrazine has been used in the past), any species-specific considerations such as life history information (e.g., habitat 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 atrazine use sites are assigned a high overlap score, species with 5-10% overlap are assigned a medium overlap score, and species with less than 5% 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 atrazine each year

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

of the proposed action. Except where otherwise noted, usage data is provided by EPA applying data from their National and State Summary Use and Usage Matrix, as described in the Usage Analysis section of this Opinion. Species with usage data that indicate a large portion of their range (>10%) is treated with atrazine each year are assigned a high usage score. Species that have a medium portion of their range (5-10%) treated with atrazine each year are assigned a medium usage score, and species where data indicate a low portion of their range (<5%) is treated with atrazine each year are assigned a low usage score.

We determine the 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 overall exposure ranking to reflect this additional information, as appropriate.

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

Exposure to Non-Agricultural Uses

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

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

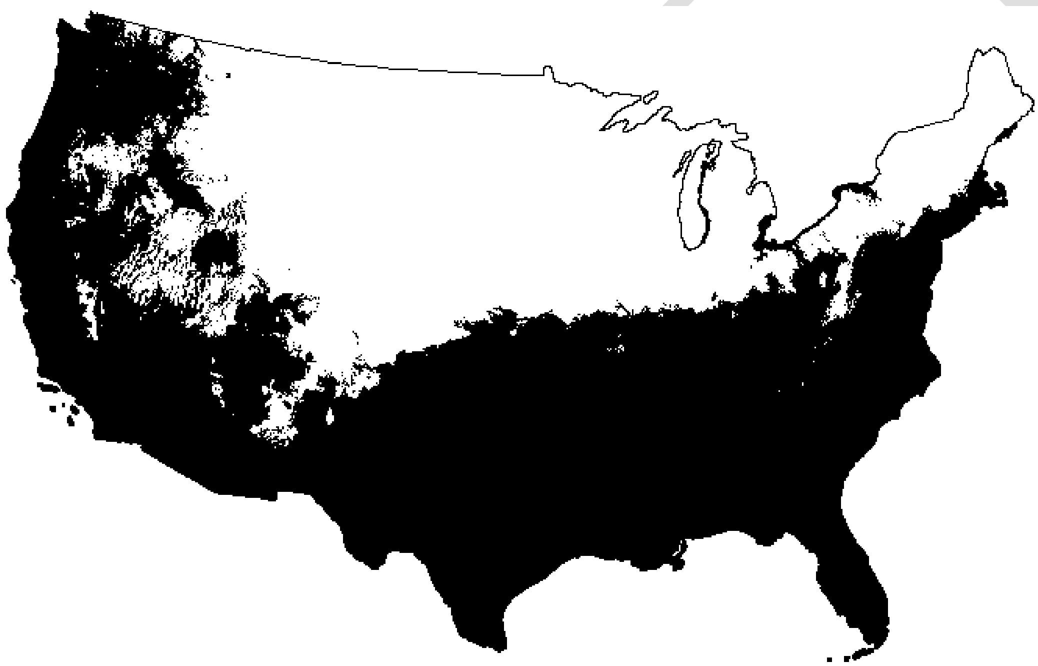

Figure 1. Map showing where cool-season grasses (white areas) and warm-season grasses (black areas) are used on turf across the continental U.S.

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

Particularly for golf course turf uses, we obtained qualitative usage information directly from the Golf Course Superintendents Association of America (GCSAA) and an academic turf scientist that indicate that atrazine is used to control winter annual broadleaf and annual bluegrass weeds on golf courses. They are applied as a pre-emergent in early fall and early winter to fairways and roughs, which make up approximately 30% of a golf course's acreage. Triazines are not applied to tee boxes or greens, which make up an additional 6% of golf course acreage. Most applications are made at rates lower than what is on the label (i.e., 1-1.5 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 run-off mitigations (i.e., equivalent to six points on EPA's mitigation menu), and we considered them in our assessment.

For most species in this Appendix, we anticipate that non-agricultural uses will not meaningfully add to the overall level of anticipated exposure considered in our analysis of agricultural uses. Due to runoff and spray drift considerations described above, off-site exposure is not expected to result in effects to most species in this Appendix. In addition, we expect most listed species' habitat requirements preclude them from occupying non-agricultural use sites where atrazine may be used.

References:

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

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

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

Toxicity

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

We consider estimated concentrations of atrazine 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 atrazine 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 host species 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 will not survive. Where sufficient numbers of suitable hosts 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 or reproduction to the host or reproduction to the mussel as atrazine data indicate reduced growth and reproduction can occur to fish/amphibians as hosts and reduced reproduction can occur to 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 sublethal endpoints for fish and aquatic mollusks but no EECS exceed the mortality threshold for fish or aquatic mollusks calculated by the EPA. We consider the NOAEC a conservative threshold for qualitatively estimating anticipated sublethal effects to listed fish.

Concentrations of atrazine can vary greatly among different regions and aquatic habitat types. Where atrazine enters smaller streams or static waters (e.g., low flow/low volume waterbodies)

[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.

from runoff or spray drift, we generally anticipate high levels of sublethal effects to individual 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 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. For mussel species that rely on few species of hosts (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 atrazine concentrations to be higher (i.e., low flow and/or low volume), and hosts 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 dietary items (e.g., algae, phytoplankton) in low flow or low volume waterbodies. We anticipate phytoplankton will be impacted by atrazine 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 atrazine exposure.

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

Experimental Populations, Nonessential

We considered nonessential experimental populations for the following mussel species in this section of the consultation: Alabama lampmussel, Appalachian monkeyface (pearlymussel), birdwing pearlymussel, clubshell, cracking pearlymussel, Cumberlandian combshell, Cumberland monkeyface (pearlymussel), Cumberland bean (pearlymussel), dromedary pearlymussel, fanshell, finerayed pigtoe, orangefoot pimpleback (pearlymussel), oyster mussel, purple cat's paw (pearlymussel), ring pink (mussel), rough pigtoe, shiny pigtoe, winged mapleleaf, and white wartyback (pearlymussel).

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

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

- Prohibit use in Hawaiʻi, Alaska, and the Territories,
- Prohibit use on roadsides, shelterbelts, Conservation Reserve Program (CRP) land, conifers (including Christmas tree plantings), timber and forestry, and miscanthus and other perennial bioenergy crops,
- Prohibit application via mechanically pressurized handguns to macadamia nuts, sweet corn, and guava,
- Restrict "fallow" uses on all labels to the following scenarios and geographies only:
    - Wheat-corn-fallow and wheat-fallow-wheat in CO, KS, ND, NE, SD, and WY,
    - Wheat-sorghum-fallow in AR, CO, GA, IL, KS, LA, MS, MO, NE, NM, NC, OK, SD, and TX
- Reduce the single maximum application rate of turf, granular formulations to 2.0 lbs. AI/A, and reduce the single maximum application rate of turf, sprays to 1.0 lb. AI/A,
- Restrict applications made by backpack-spray to landscape turf to spot treatments only,
- Restrict applicators from applying atrazine products to the same sorghum acre,
- Require all applications to use coarse or coarser droplet sizes,
- Require an in-field downwind buffer of 15-ft for all ground applications (from the edge of all streams and rivers as well as the high-tide line for all estuarine/marine

environments, and from threatened and endangered species critical habitat and/or species locations)

- Prohibit all ground applications when wind speeds exceed 10 miles per hour at the application site,
- For ground boom applications, only apply with the release height recommended by the manufacturer, but no more than 4-ft above the ground or crop canopy,
- Require an in-field downwind buffer of 150-ft for all aerial applications (from the edge of all streams and rivers as well as the high-tide line for all estuarine/marine environments, and from threatened and endangered species critical habitat and/or species locations),
- If the windspeed is 10 miles per hour or less, applicators must use ½ swath displacement upwind at the downwind edge of the field. When the windspeed is between 11-15 miles per hour, applicators must use ¾ swath displacement upwind at the downwind edge of the field,
- If the windspeed is greater than 10 mph, the boom length must be 65% or less of the wingspan for fixed wing aircraft and 75% or less of the rotor diameter for helicopters. Otherwise, the boom length must be 75% or less of the wingspan for fixed-wing aircraft and 90% or less of the rotor diameter for helicopters,
- Prohibit all aerial applications when wind speeds exceed 15 miles per hour at the application site,
- Restrict aerial applications from releasing spray at a height greater than 10-ft above the ground or vegetative canopy unless a greater application height is necessary for pilot safety,
- Prohibit aerial applications of non-liquid formulations,
- Prohibit all applications during temperature inversions.

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

Herbicide Strategy Conservation Measures

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

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

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

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

The spray drift buffers will be placed on the general label and will apply to all uses of atrazine. EPA's Herbicide Strategy provides applicators with options to reduce the distance of this buffer by using other spray drift reduction strategies that we anticipate will result in an equivalent reduction in spray drift entering non-target habitats as stated buffers. These measures and the degree to which applicators can reduce buffers by employing them are described in EPA's Herbicide Strategy and EPA's Ecological Mitigation Support Document to Support Endangered Species Strategies. These documents are provided in Appendix A-1.

Based on EPA's analyses, the required spray drift conservation measures described above (from the current label, those from implementation of the Herbicide Strategy, and additional measures committed to through consultation for specific registered atrazine uses) will reduce spray drift from entering species' habitats by >95%. The Service anticipates that this reduction will

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

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

minimize off-site transport of atrazine from spray drift to a level where no more than low levels of effects are likely to occur to most species.

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

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

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

For all the species in this document, we expect that the runoff and conservation measures will reduce exposure concentrations to within one order of magnitude of the exposure level where individuals exposed to atrazine in areas off-site will not accumulate more than low levels of atrazine and are not likely to experience more than low levels of sublethal adverse effects to growth or reproduction (if any). Additionally, we anticipate these agricultural measures will reduce exposure to plant species, resulting in no more than low levels of adverse effects to plants that provide food or habitat features for listed species.

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 atrazine, 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 three mussels in this

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

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.

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

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

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

Common Name	Scientific Name	Vulnerability Ranking	Agricultural Exposure Ranking	Toxicity Ranking	Total Agricultural Action Area Overlap (% Range)	Determination
Alabama moccasinshell	*Medionidus acutissimus*	High	Low	Low	2.8	No Jeopardy
Alabama pearlshell	*Margaritifera marrianae*	High	Low	Low	1.3	No Jeopardy
Altamaha Spinymussel	*Elliptio spinosa*	High	Low	Low	4.9	No Jeopardy
Appalachian elktoe	*Alasmidonta raveneliana*	High	Low	Low	1.4	No Jeopardy
Appalachian monkeyface (pearlymussel)	*Theliderma sparsa*	High	Low	Low	0.3	No Jeopardy
Arkansas fatmucket	*Lampsilis powellii*	High	Low	Medium	0.3	No Jeopardy
Birdwing pearlymussel	*Lemiox rimosus*	High	Low	Low	2.9	No Jeopardy
Black clubshell	*Pleurobema curtum*	High	Low	Low	3.0	No Jeopardy
Canoe Creek Clubshell	*Pleurobema athearni*	High	Low	Low	1.3	No Jeopardy
Choctaw bean	*Obovaria choctawensis*	High	Low	Low	4.8	No Jeopardy
Coosa moccasinshell	*Medionidus parvulus*	High	Low	Low	2.0	No Jeopardy
Cumberland bean (pearlymussel)	*Villosa trabalis*	High	Low	Low	2.2	No Jeopardy
Cumberland elktoe	*Alasmidonta atropurpurea*	High	Low	Low	0.5	No Jeopardy
Cumberland moccasinshell	*Medionidus conradicus*	High	Low	Low	2.8	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
Cumberland monkeyface (pearlymussel)	*Theliderma intermedia*	High	Low	Low	3.0	No Jeopardy
Cumberlandian combshell	*Epioblasma brevidens*	High	Low	Low	2.2	No Jeopardy
Dark pigtoe	*Pleurobema furvum*	High	Low	Low	2.8	No Jeopardy
Dromedary pearlymussel	*Dromus dromas*	High	Low	Low	0.4	No Jeopardy
Finelined pocketbook	*Hamiota altilis*	High	Low	Low	1.8	No Jeopardy
Finerayed pigtoe	*Fusconaia cuneolus*	High	Low	Low	3.5	No Jeopardy
Fluted kidneyshell	*Ptychobranchus subtentus*	High	Low	Low	3.5	No Jeopardy
Fuzzy pigtoe	*Pleurobema strodeanum*	High	Low	Low	4.8	No Jeopardy
Georgia pigtoe	*Pleurobema hanleyianum*	High	Low	Low	2.2	No Jeopardy
Guadalupe Fatmucket	*Lampsilis bergmanni*	High	Low	Medium	4.5	No Jeopardy
Inflated heelsplitter	*Potamilus inflatus*	Medium	Low	Low	2.8	No Jeopardy
James spinymussel	*Parvaspina collina*	High	Low	Low	1.7	No Jeopardy
Louisiana Pigtoe	*Pleurobema riddellii*	High	Low	Low	1.8	No Jeopardy
Mexican fawnsfoot	*Truncilla cognata*	High	Low	Medium	1.0	No Jeopardy
Narrow pigtoe	*Fusconaia escambia*	High	Low	Low	2.7	No Jeopardy
Orangenacre mucket	*Hamiota perovalis*	High	Low	Low	2.6	No Jeopardy
Ouachita rock pocketbook	*Arcidens wheeleri*	High	Low	Medium	1.6	No Jeopardy
Ovate clubshell	*Pleurobema perovatum*	High	Low	Low	2.3	No Jeopardy
Oyster mussel	*Epioblasma capsaeformis*	High	Low	Low	2.6	No Jeopardy
Purple Cat's paw (=Purple Cat's paw pearlymussel)	*Epioblasma obliquata*	High	Low	Low	4.7	No Jeopardy

Common Name	Scientific Name	Vulnerability Ranking	Agricultural Exposure Ranking	Toxicity Ranking	Total Agricultural Action Area Overlap (% Range)	Determination
Purple bean	*Villosa perpurpurea*	High	Low	Low	1.1	No Jeopardy
Rough rabbitsfoot	*Quadrula cylindrica strigillata*	High	Low	Low	0.4	No Jeopardy
Round Ebonyshell	*Reginaia rotulata*	High	Low	Low	2.1	No Jeopardy
Shiny pigtoe	*Fusconaia cor*	High	Low	Low	4.1	No Jeopardy
Slabside Pearlymussel	*Pleuronaia dolabelloides*	High	Low	Low	4.2	No Jeopardy
Southern Sandshell	*Hamiota australis*	High	Low	Low	4.8	No Jeopardy
Southern clubshell	*Pleurobema decisum*	High	Low	Low	2.6	No Jeopardy
Southern combshell	*Epioblasma penita*	High	Low	Low	2.9	No Jeopardy
Southern pigtoe	*Pleurobema georgianum*	High	Low	Low	1.9	No Jeopardy
Speckled pocketbook	*Lampsilis streckeri*	High	Low	Medium	<0.1	No Jeopardy
Tan riffleshell	*Epioblasma florentina walkeri (=E. walkeri)*	High	Low	Low	0.2	No Jeopardy
Tennessee clubshell	*Pleurobema oviforme*	High	Low	Low	3.1	No Jeopardy
Tennessee pigtoe	*Pleuronaia barnesiana*	High	Low	Low	4.4	No Jeopardy
Texas Hornshell	*Popenaias popeii*	High	Low	Medium	3.3	No Jeopardy
Texas fatmucket	*Lampsilis bracteata*	High	Low	Medium	2.3	No Jeopardy
Texas heelsplitter	*Potamilus amphichaenus*	High	Low	Low	3.5	No Jeopardy
Triangular Kidneyshell	*Ptychobranchus greenii*	High	Low	Low	1.9	No Jeopardy
Winged Mapleleaf	*Quadrula fragosa*	High	Low	Medium	4.2	No Jeopardy

The species in Table 1 have high and medium vulnerabilities. These species have either medium or low toxicity rankings, reflecting differences in their expected sensitivity to atrazine-related sublethal effects, particularly those affecting fish host 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 atrazine is registered for agricultural use, including spray drift and runoff zones.

The species in Table 1 have low extents of overlap between their ranges and agricultural atrazine use sites (<0.1-4.8%), including associated off-site transport areas. The total overlap metric we use is a conservative estimate of exposure as it does not fully account for redundancy between registered use sites, assumes exposure is occurring in all possible overlapping areas, assumes spray drift will occur in all directions during treatment of fields, and does not consider information on past atrazine usage. As such, we expect that exposure of these species to atrazine from agricultural uses will occur in even smaller portions of the species' ranges than the overlaps shown in Table 1.

For species with low toxicity rankings, we do not anticipate direct or indirect adverse effects, as exposure is unlikely to occur at concentrations that exceed thresholds for direct adverse effects in mussels or fish and we do not anticipate atrazine will impact the detritus or phytoplankton that mussels rely on for food. For non-agricultural sources of atrazine, we expect little runoff from residential turf uses based on standard application methods and site characteristics (i.e., continuous cover, no till). 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 atrazine use areas and the conservation measures incorporated into this action, including those developed through the Herbicide Strategy—such as a standard 15-foot ground spray drift buffer, 170-foot aerial 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 atrazine 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 atrazine exposure. Therefore, we do not anticipate significant reductions in food availability for mussels or host fish.

In summary, we expect a small number of individuals of the species in Table 1 will experience exposure to atrazine over the project duration. Exposure will be limited to small portions of the species' ranges that overlap with agricultural or non-agricultural use sites and areas of off-site transport, and the few exposed individuals may experience adverse effects to reproduction through reductions in host fish (i.e., indirect effects). 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 general label conservation measures), we have determined the proposed action is not likely to appreciably reduce the survival and recovery of these species in the wild. Thus, it is our biological opinion that the registration of atrazine, as proposed, is not likely to jeopardize the continued existence of the species in Table 1.

Species with low agricultural exposure achieved through 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 (e.g., measures already on the label, three runoff points and ground and aerial buffers determined through implementation of the Herbicide Strategy, and rate reductions and other restrictions to particular registered uses). 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 atrazine 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 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 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	Low	General label measures	No Jeopardy
Atlantic pigtoe	*Fusconaia masoni*	High	Low	Low	General label measures	No Jeopardy
Carolina heelsplitter	*Lasmigona decorata*	High	Low	Low	General label measures	No Jeopardy
Clubshell	*Pleurobema clava*	High	Low	Low	General label measures	No Jeopardy
Cracking pearlymussel	*Hemistena lata*	High	Low	Low	General label measures	No Jeopardy
Curtis pearlymussel	*Epioblasma florentina curtisii*	High	Low	Medium	General label measures	No Jeopardy
Dwarf wedgemussel	*Alasmidonta heterodon*	High	Low	Low	General label measures	No Jeopardy
Fanshell	*Cyprogenia stegaria*	High	Low	Low	General label measures	No Jeopardy
Fat threeridge (mussel)	*Amblema neislerii*	High	Low	Low	General label measures	No Jeopardy
Green floater	*Lasmigona subviridis*	High	Low	Low	General label measures	No Jeopardy
Guadalupe Orb	*Cyclonaias necki*	High	Low	Medium	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
Gulf moccasinshell	*Medionidus penicillatus*	High	Low	Low	General label measures	No Jeopardy
Higgins eye (pearlymussel)	*Lampsilis higginsii*	High	Low	Low	General label measures	No Jeopardy
Littlewing pearlymussel	*Pegias fabula*	High	Low	Low	General label measures	No Jeopardy
Longsolid	*Fusconaia subrotunda*	High	Low	Low	General label measures	No Jeopardy
Louisiana pearlshell	*Margaritifera hembeli*	High	Low	Medium	General label measures	No Jeopardy
Neosho Mucket	*Lampsilis rafinesqueana*	High	Low	Medium	General label measures	No Jeopardy
Northern riffleshell	*Epioblasma rangiana*	High	Low	Low	General label measures	No Jeopardy
Ochlockonee moccasinshell	*Medionidus simpsonianus*	High	Low	Low	General label measures	No Jeopardy
Orangefoot pimpleback (pearlymussel)	*Plethobasus cooperianus*	High	Low	Low	General label measures	No Jeopardy
Oval pigtoe	*Pleurobema pyriforme*	High	Low	Low	General label measures	No Jeopardy
Pale lilliput (pearlymussel)	*Toxolasma cylindrellus*	High	Low	Low	General label measures	No Jeopardy
Pink mucket (pearlymussel)	*Lampsilis abrupta*	High	Low	Medium	General label measures	No Jeopardy
Purple bankclimber (mussel)	*Elliptoideus sloatianus*	High	Low	Low	General label measures	No Jeopardy
Rabbitsfoot	*Quadrula cylindrica cylindrica*	High	Low	Medium	General label measures	No Jeopardy
Rayed Bean	*Villosa fabalis*	High	Low	Low	General label measures	No Jeopardy
Ring pink (mussel)	*Obovaria retusa*	High	Low	Low	General label measures	No Jeopardy
Rough pigtoe	*Pleurobema plenum*	High	Low	Low	General label measures	No Jeopardy
Round hickorynut	*Obovaria subrotunda*	High	Low	Low	General label measures	No Jeopardy
Sheepnose Mussel	*Plethobasus cyphyus*	High	Low	Medium	General label measures	No Jeopardy
Shinyrayed pocketbook	*Hamiota subangulata*	High	Low	Low	General label measures	No Jeopardy
Snuffbox mussel	*Epioblasma triquetra*	High	Low	Medium	General label measures	No Jeopardy

Common Name	Scientific Name	Vulnerability Ranking	Agricultural Exposure Ranking	Toxicity Ranking	Conservation Measures	Determination
Southern elktoe	*Alasmidonta triangulata*	High	Low	Low	General label measures	No Jeopardy
Southern kidneyshell	*Ptychobranchus jonesi*	High	Low	Low	General label measures	No Jeopardy
Texas pimpleback	*Cyclonaias petrina*	High	Low	Medium	General label measures	No Jeopardy
Western fanshell	*Cyprogenia aberti*	High	Low	Low	General label measures	No Jeopardy
White catspaw (pearlymussel)	*Epioblasma perobliqua*	High	Low	Low	General label measures	No Jeopardy

The species in Table 2 have high vulnerabilities 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 atrazine 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 atrazine into their habitats. While all species in this group may be vulnerable to adverse effects if exposed, they were grouped together based most of them having a reliance on several species of common fish hosts, which reduces their susceptibility to reproductive failure from localized impacts to any single host fish species.

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 atrazine exposure and the availability of alternate suitable hosts is expected to sustain reproduction.

There are five mussels species in this group where the host fish species are unknown (white cat's paw, orangefoot pimpleback, ring pink (mussel), cracking pearlymussel, and the Ochlockonee moccasinshell). However, the host fish species for closely related congeners are known or based on glochidia attachment studies in the laboratory. We assume based on their close genetic relationship to those mussel species with known hosts that these mussels these species likely are host fish generalists that likely use various species of darters, sauger, logperch, and shiners as their fish hosts. All of these host species are common and abundant in the habitats where these mussels are found.

For all species in this group, EPA's Herbicide Strategy requires a minimum of three runoff mitigation points and implementation of a 15-foot ground spray drift buffer and 170-foot aerial spray drift buffer on all agricultural atrazine 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 which we expect will not cause more than low levels of adverse effects to exposed individuals and will not result in more than low levels of adverse effects to plant-based aquatic dietary items or habitat, or host species.

Modeled overlap between species' ranges and agricultural atrazine use sites is moderate to high for many species in this group, and while maximum estimated environmental concentrations of atrazine 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.

In addition to agricultural exposure species in Table 2 may be exposed to atrazine from non-agricultural (i.e., turf) uses. While some of these mussel species may occur in watersheds that include non-agricultural atrazine use sites (e.g., residential lawns, golf courses), 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 spray drift and runoff mitigation. Golf courses, for example, use no-till practices and maintain continuous vegetative cover, reducing runoff atrazine and achieving mitigation equivalent to two orders of magnitude (99%) reduction in atrazine 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. Furthermore, given our knowledge of atrazine application to turf (see *Exposure to Non-Agricultural Uses*, above), we expect atrazine usage within the range of these species to be limited. Therefore, we expect atrazine exposure from non-agricultural uses to be low for 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 atrazine 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 atrazine exposure. Therefore, we do not anticipate significant reductions in food availability for mussels or host fish.

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 atrazine will not reduce food availability for mussels or host fish. After reviewing the current status of the species, environmental baseline for the action area, cumulative effects, and effects of the action (including general label and specific conservation measures), we have determined the proposed action is not likely to appreciably reduce the survival and recovery of these species in the wild. Thus, it is our biological opinion that the registration of atrazine, as proposed, is not likely to jeopardize the continued existence of the species in Table 2.

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

The species in Table 3 were grouped together because they are fish host specialists, and we anticipate they will have low exposure after incorporating general label measures (e.g., measures already on the label, three runoff points and ground and aerial buffers determined through implementation of the Herbicide Strategy, and rate reductions and other restrictions to particular registered uses).). 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 atrazine in their environment is reduced because at least one host fish they rely on to complete their life cycle is abundant. While we present some specific information about the species below, we provide additional information on vulnerability (including environmental baseline and cumulative effects), exposure, and toxicity in Appendix E. The status of the species accounts can be found in Appendix B.

Table *3*. Species with low agricultural exposure achieved through 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 measures	No Jeopardy
Chipola slabshell	*Elliptio chipolaensis*	High	Low	Low	General label measures	No Jeopardy
False spike	*Fusconaia mitchelli*	High	Low	Medium	General label measures	No Jeopardy
Fat pocketbook	*Potamilus capax*	Low	Low	Medium	General label measures	No Jeopardy
Kentucky creekshell	*Villosa ortmanni*	Medium	Low	Low	General label measures	No Jeopardy
Salamander mussel	*Simpsonaias ambigua*	High	Low	Low	General label measures	No Jeopardy
Scaleshell mussel	*Leptodea leptodon*	High	Low	Medium	General label measures	No Jeopardy
Spectaclecase (mussel)	*Cumberlandia monodonta*	High	Low	Medium	General label measures	No Jeopardy
Suwannee moccasinshell	*Medionidus walkeri*	High	Low	Low	General label measures	No Jeopardy
Tapered pigtoe	*Fusconaia burkei*	High	Low	Low	General label measures	No Jeopardy
Tar River spinymussel	*Parvaspina steinstansana*	High	Low	Low	General label measures	No Jeopardy

Common Name	Scientific Name	Vulnerability Ranking	Agricultural Exposure Ranking	Toxicity Ranking	Conservation Measures	Determination
Texas fawnsfoot	*Truncilla macrodon*	High	Low	Medium	General label measures	No Jeopardy
White wartyback (pearlymussel)	*Plethobasus cicatricosus*	High	Low	Low	General label measures	No Jeopardy

The species in Table 3 have high and one medium vulnerability 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 low to medium toxicity rankings, based on the anticipated sublethal effects of atrazine on host fish growth, as well as some effects on mussel dietary resources (e.g., phytoplankton, algae) in the absence of conservation measures to reduce off-site transport of atrazine 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. There is one mussel species in this group where the host fish species is unknown (white wartyback). However, the host fish species for closely related congeners are known and is likely the sauger, which is a common and abundant fish within the range of the white wartyback mussel. We assume this mussel will have the same or similar host fish species as the congener.

For all species in this group, conservation measures include a minimum of three runoff mitigation points and implementation of a 15-foot ground spray drift buffer and 170-foot aerial spray drift buffer on all agricultural atrazine 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 atrazine use sites is moderate to high for many species in this group. While maximum estimated environmental concentrations of atrazine may cause sublethal adverse effects (e.g., reduced growth) to some fish hosts for the mussel species in Table 3, 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 3.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 atrazine 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 atrazine exposure. Therefore, we do not anticipate significant reductions in food availability for mussels or host fish.

In addition to agricultural exposure species in Table 3 may be exposed to atrazine from non-agricultural (i.e., turf) uses. However, these non-agricultural use sites do not provide the species' necessary habitat (e.g., large flowing rivers or smaller flowing streams). In addition, given our understanding of atrazine usage on use sites such as golf courses and residential lawns (see *Exposure to Non-Agricultural Uses*, above), we expect atrazine usage within the ranges of these species to be limited. In addition, if applied, we anticipate off-site transport of atrazine will be minimal as characteristics of the use sites (i.e., continuous cover, no till) are expected to result in little runoff. Furthermore, commercial and residential applicators typically apply herbicides with hand-held equipment that release course droplets, limiting the potential for spray drift from these specific uses. Therefore, we expect atrazine exposure from non-agricultural uses to be low for these species.

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 atrazine will not reduce food availability for mussels or host fish.

In summary, with implementation of conservation measures on product labels, we expect that few individuals will be exposed to atrazine via off-site transport from agricultural or non-agricultural areas. Those few exposed individuals will experience no more than low levels of adverse effects to survival through reductions in growth to host fish. After reviewing the current status of the species, environmental baseline for the action area, cumulative effects, and effects of the action (including general label and specific conservation measures), we have determined the proposed action is not likely to appreciably reduce the survival and recovery of these species in the wild. Thus, it is our biological opinion that the registration of atrazine, as proposed, is not likely to jeopardize the continued existence of the species in Table 3.

Species requiring further analysis

In our draft Biological Opinion, we focused our analyses on 1) species with low expected exposure to atrazine (due to low overlap, usage, or conservation measures adopted prior to consultation), and 2) species with more than low levels of exposure that benefited from conservation measures identified through the Herbicide Strategy that aimed to reduce off-site transport of atrazine (i.e., listed plants and listed animals that depend on plant resources). For the species in Table 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 atrazine residues on use sites could remain at levels high enough to cause greater than low levels of adverse direct and/or indirect effects to the host fish for these mussel species. We intend to continue coordinating with EPA and atrazine registrants between the release of this draft Opinion and the transmission of the final Opinion to gain information regarding the exposure and effects of each species to atrazine. As such, we have not yet made determinations for these species.

Table 4. Species requiring further analysis

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