Integration and Synthesis Summary for Amphibians

This Integration and Synthesis Summary includes our jeopardy analysis for amphibian 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 our rankings (high, medium, low) for vulnerability, exposure, and toxicity. Data and information used to determine individual species' rankings include environmental baselines, cumulative effects, exposure information, and expected toxic effects for all species, and a template worksheet to show how rankings were assessed and combined are in Appendix E. Status of the species for each species can be found in Appendix B.

Most of these amphibian 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 Herbicide Strategy[1] conservation measures added to the product label (including those developed during this consultation through the Herbicide Strategy; see Conservation Measures section below). We anticipate these measures will reduce exposures in the terrestrial and/or aquatic habitats where these species occur to a level where no more than low level direct and indirect adverse effects are anticipated for many listed amphibian species.

Vulnerability

For the amphibian species that we or EPA determined are "likely to be adversely affected" by the proposed action, we considered several factors for each listed amphibian 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 sections of this Opinion (Appendix B and Appendix D, respectively).

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 amphibian species will be exposed to atrazine primarily through direct contact with contaminated water in their habitats or via dietary exposure, depending on if they are a terrestrial species with an aquatic phase, or a fully aquatic species. However, many amphibians may be exposed to atrazine via multiple routes. We assume all atrazine that is transported off-site, whether through spray drift or runoff, is likely to end up in local waterbodies, which may distribute atrazine residues throughout the entire watershed. Atrazine is moderately mobile in water and is 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 amphibian species in areas far from both agricultural and non-agricultural 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 prey 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

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

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 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 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 the same score (e.g., if both overlap and usage is high, the agricultural exposure 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 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 atrazine include labeled uses for corn, vegetables and ground fruit, other crops that include rotations with fallow fields, sod, other orchards (macadamia nuts and guava), other grains (sorghum and sugar cane).

Exposure to Non-Agricultural Uses

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

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

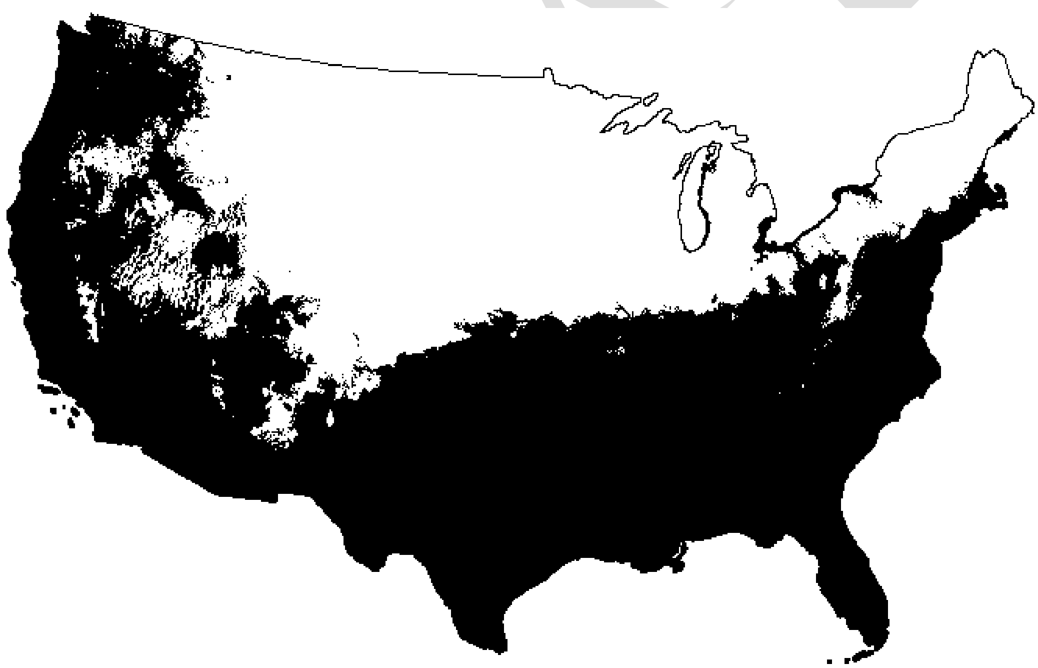

Figure 1. Map showing where cool-season grasses (white areas) and warm-season grasses (black areas) are used on turf across the continental U.S.

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. For species whose habitat is known or presumed to occur in non-agricultural use sites of atrazine, we consider, individually and qualitatively, the extent and manner of non-agricultural atrazine usage within the species' range to generally determine whether a small, moderate, or large number of individuals are likely to be exposed and the expected level of adverse effects from non-agricultural exposure of atrazine.

For most amphibian species, 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 listed species. In addition, we expect most listed species' habitat requirements precludes them from occupying non-agricultural use sites where atrazine may be used. For species whose habitat is known or presumed to occur in non-agricultural use sites of atrazine, we consider, individually and qualitatively, the extent and manner of non-agricultural atrazine usage within the species' range to generally determine whether a small, moderate, or large number of individuals are likely to be exposed and the expected level of adverse effects from non-agricultural exposure of atrazine.

References

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

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

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

Toxicity

We characterize the expected toxic effect to species based on the anticipated level of direct and indirect[4] adverse effects to individuals. Our analysis of toxicity assumes individuals are exposed to atrazine at levels estimated by EPA's environmental exposure modeling and is focused on determining the level of adverse effect expected to occur once exposure has taken place. Direct effects are based on the anticipated level of mortality and sublethal effects (e.g., reduced growth, reproduction, impaired motor activity or behavior) likely to occur in exposed individuals. Indirect effects are based on the impact a listed species is likely to experience when the organisms they rely on, such as those that act as food or habitat resources (e.g., aquatic and terrestrial invertebrate prey for amphibians), 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 to listed species or critical habitat. Concentrations of atrazine can vary greatly depending on where exposure takes place and/or what food item is consumed. For instance, exposures on or near use sites are at higher levels than exposures that occur in areas far away from use sites. Based on available toxicity data, we anticipate wholly aquatic or aquatic-phase amphibians are highly sensitive to atrazine at some estimated environmental concentrations and are likely to experience sublethal effects even in habitats that only accumulate low levels.

[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.

However, based on available toxicity data in birds (which we use as a surrogate for amphibians in the terrestrial phase as it applies to species that have a terrestrial phase), we expect that ingestion of vegetation or prey items contaminated with atrazine will only result in direct adverse effects to growth in amphibians consuming food items exclusively on atrazine use sites.

We anticipate species that rely on plant-based resources, such as algae and detritus for food or emergent aquatic vegetation as habitat, are likely to experience some indirect adverse effects, as available toxicity data in plants indicate reductions in plant survival or growth are likely to occur with atrazine exposure. However, these plant resource reductions will not significantly impact these species unless they are obligate to a plant resource dietary item. Most amphibians are omnivores and thus can rely on other dietary resources or they consume arthropod prey which are not likely to be impacted by atrazine exposure.

Concentrations of atrazine can vary greatly among different regions and aquatic habitat types. Atrazine is persistent in the environment and thus where atrazine 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 amphibians 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 amphibians.

We determine the overall toxicity ranking for amphibians by qualitatively assessing both the expected levels of direct adverse effects (i.e., mortality) and indirect effects (i.e., prey loss). As mentioned previously, available toxicity data indicate amphibians are sensitive to atrazine and may be exposed during the terrestrial phase via dietary exposure or during the aquatic phase via water as applicable to the species and are thus likely to experience sublethal effects even in habitats that only accumulate low levels.

Conservation Measures

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

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

[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

from entering species' habitats by >95%. The Service anticipates that this reduction will minimize off-site transport of atrazine from spray drift to a level where no more than low levels of effects are likely to occur to most 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. We anticipate this level of mitigation will protect listed amphibian species by reducing the number of individuals exposed (by reducing the extent of off-site transport of atrazine residues) and reducing the level of direct and indirect adverse effects that will occur to exposed individuals (by reducing estimated exposure concentrations).

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

Summary of Conclusions for Amphibian Species

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 18 of the 19 amphibian entities in this Appendix. For the remaining amphibian species in this appendix, we plan to continue coordination with EPA and the technical registrants to further assess the 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
Austin blind salamander	*Eurycea waterlooensis*	High	Low	High	0.5	No Jeopardy
Barton Springs salamander	*Eurycea sosorum*	High	Low	High	0.5	No Jeopardy
Eastern hellbender	*Cryptobranchus alleganiensis alleganiensis*	Medium	Low	Medium	2.2	No Jeopardy
Georgetown salamander	*Eurycea naufragia*	High	Low	High	3.2	No Jeopardy
San Marcos salamander	*Eurycea nana*	High	Low	High	1.6	No Jeopardy
Sierra Nevada yellow-legged frog	*Rana sierrae*	High	Low	High	1.8	No Jeopardy
Texas blind salamander	*Eurycea rathbuni*	High	Low	High	3.3	No Jeopardy

The species in Table 1 have high and medium vulnerability. Specifically, pesticides are a noted threat to all of the species in Table 1.These species have a high or medium toxicity ranking as sublethal effects and some loss of prey abundance may occur if exposed to atrazine. However, the species in Table 1 have low extents of overlap between their ranges and agricultural atrazine use sites (0.5-3.3%), including associated off-site transport areas. Some species, like the Eastern hellbender, may occur in aquatic habitats adjacent to agricultural use sites where atrazine could be used, but we do not expect individuals will be exposed to levels of atrazine that will cause measurable effects to growth because the limitations on use including spray drift and runoff reduction measures reduce those exposures to levels below which we would observe these effects. Similarly, other species in this grouping (e.g., central Texas *Eurycea* spp.) may also experience offsite exposure from runoff from agricultural use sites, but we do not expect predicted concentrations of atrazine in runoff will cause any measurable direct toxic effects to individuals that would adversely affect their growth given both the low estimates of overlap with the species ranges and the volume and flow rates encountered by these species in their respective habitats.

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 non-agricultural uses of atrazine, we qualitatively evaluated the potential for atrazine exposure from non-agricultural use sites to individual species based on their preferred habitat and current known locations within the context of our expectation that overall, species will experience minimal exposure from non-agricultural atrazine use sites (described in the *Exposure* section, above). Based on individual reviews of available life history information for each of the 7 species in Table 1, we expect non-agricultural use sites do not provide the species' necessary habitat (e.g., large flowing rivers, karst cave aquifer systems, high elevation mountain ponds, etc.), therefore, these species are unlikely to be exposed to non-agricultural uses of this herbicide. 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. None of the species in Table 1 are likely to occur on non-agricultural use sites for which atrazine is registered as all but the Sierra Nevada yellow-legged frog are fully aquatic.

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 growth and some indirect effects through prey loss. 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.

References:

U.S. Fish and Wildlife Service. 2025. San Marcos Aquatic Resources Center personal communication with HQ staff.

U.S. Fish and Wildlife Service. 2024. Recovery Outline for the Georgetown Salamander, Jollyville Plateau Salamander, and Salado Salamander. Austin, Texas. 15 pp.

U.S. Fish and Wildlife Service. 2016. Barton Springs Salamander (*Eurycea sosorum*) Recovery Plan Amended to include Austin Blind Salamander (*Eurycea waterlooensis*). Albuquerque, New Mexico. 148 pp.

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

The species in Table 2 are grouped together because very little of their ranges have been treated with atrazine in the past according to data from USDA's Census of Agriculture. Our concern for adverse effects (direct or indirect) is low. While we present some specific information about the species below, we provide additional information on vulnerability (including environmental baseline and cumulative effects), exposure, and toxicity in Appendix E. The status of the species accounts can be found in Appendix B.

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

Common Name	Scientific Name	Vulnerability Ranking	Agricultural Exposure Ranking	Toxicity Ranking	% Range Treated (CoA)	Determination
Cheat Mountain salamander	*Plethodon nettingi*	Medium	Low	High	2.3	No Jeopardy
Chiricahua leopard frog	*Rana chiricahuensis*	Medium	Low	High	3.1	No Jeopardy
Oregon spotted frog	*Rana pretiosa*	Medium	Low	High	4.9	No Jeopardy
Sonoran tiger salamander	*Ambystoma mavortium stebbinsi*	Medium	Low	Low	1.8	No Jeopardy

The species in Table 2 have medium vulnerability rankings. Specifically, pesticides are a noted threat to Oregon spotted frog and the Chiricahua leopard frog. We anticipate these species may be more susceptible to impacts to individuals resulting from exposure to atrazine. The species in Table 2 have high and low toxicity rankings because we anticipate some indirect effects due to exposure from some dietary items and sublethal effects such as reduced growth and egg production in both the aquatic and terrestrial phases.

We anticipate a small number of individuals of each species are likely to experience exposure to agricultural uses of atrazine because the CoA indicates very little herbicide usage (potentially including atrazine) occurred on the agricultural crops in the counties where these species' ranges occur. Given that this reporting broadly includes all herbicide usage, we consider the CoA data a conservative estimate of atrazine usage. In addition, these data are presented at a relatively high spatial resolution. In addition, some of these species exist largely on federal lands (e.g., Cheat Mountain salamander in the Monongahela National Forest, Sierra Nevada yellow-legged frog in the El Dorado, Inyo, Lassen, Plumas, Sierra, Stanislaus, Tahoe, and Toiyabe National Forests) and are anticipated to have a very low likelihood of exposure given the limited use expected in the habitats associated with these areas. National Forests are not likely to contain significant areas, if any, for which atrazine is registered for use (e.g., agriculture, turf, golf courses) and as detailed in the main body of the BO, atrazine is not registered for forestry use. As such, we anticipate no more than a small number of individuals are likely to be exposed to atrazine through agricultural uses. Therefore, we have high confidence that only a small percentage of the species' ranges are likely to be exposed to agricultural uses of atrazine.

In addition to agricultural exposure, some of the species in Table 2 may be exposed to atrazine from non-agricultural (i.e., turf) uses. However, these non-agricultural use sites do not provide some of the species' necessary habitat (e.g., riverine sloughs and floodplains, red spruce and mixed deciduous forests above 2,980 feet). 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.

Similarly, we anticipate species that rely on plant-based resources, such as algae and detritus for food or emergent aquatic vegetation as habitat, are likely to experience some indirect adverse effects, as available toxicity data in plants indicate reductions in plant survival or growth are likely to occur with atrazine exposure. However, these plant resource reductions will not significantly impact these species unless they are obligate to a plant resource dietary item. The salamanders in this group (Cheat Mountain and Sonoran tiger) are not anticipated to consume plant material at any life stage. The two frog species (Chiricahua and Oregon spotted) may consume plants in the tadpole stage, but are not anticipated to be on-field in their aquatic stages. We also do not anticipate concentrations for aquatic stage amphibians to reach levels that would eliminate or severely limit plant materials available to these life stages for these species. Later life stage and terrestrial frogs and salamanders are insectivorous, omnivorous, or carnivorous and are not likely to experience indirect adverse effects to prey items.

In summary, we expect a small number of individuals of the species in Table 2 will experience exposure to atrazine over the project duration. Exposure will be limited to small portions of the species' ranges that overlap with agricultural herbicide usage according to CoA or non-agricultural usage on turf, where applicable, and the few exposed individuals may experience adverse effects to growth, and/or reproduction and may experience indirect effects through some prey loss. 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 2.

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

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

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

Common Name	Scientific Name	Vulnerability Ranking	Agricultural Exposure Ranking	Toxicity Ranking	Conservation Measures	Determination
Dusky gopher frog	*Rana sevosa*	High	Low	Low	General label measures + six points for all uses	No Jeopardy
Frosted flatwoods salamander	*Ambystoma cingulatum*	High	Low	Medium	General label measures + six points for all uses	No Jeopardy
Houston toad	*Bufo houstonensis*	High	Low	Low	General label measures + six points for all uses	No Jeopardy
Jollyville Plateau Salamander	*Eurycea tonkawae*	High	Low	High	General label measures	No Jeopardy
Reticulated flatwoods salamander	*Ambystoma bishopi*	High	Low	Low	General label measures + six pointts for all uses	No Jeopardy

The species in Table 3 have high vulnerability rankings. Specifically, pesticides are a noted threat to all of the species in Table 3.

The species in Table 3 have low to high toxicity rankings because we anticipate some indirect effects due to exposure from some dietary items and sublethal effects such as reduced growth and egg production in the aquatic and terrestrial phases (as applicable) to the species.

We anticipate the species in this group are not likely to occur in agricultural atrazine use sites. We expect the general label measures for agricultural uses described above (e.g., reduced application rates, a 15-foot spray drift buffer for ground application, a 170-foot spray drift buffer for aerial applications, and three runoff mitigation points) will reduce off-field exposures by an order of magnitude (i.e., a 90% reduction). All five species in this grouping require an additional three points for runoff mitigation, for a total of six points for all uses except the Jollyville Plateau salamander that only requires the general label measures. The six-point PULA will reduce off-field atrazine residues by two orders of magnitude (i.e., a 99% reduction), which will ensure no more than low levels of direct and indirect adverse effects to individuals of all species will occur.

In addition to agricultural exposure, two of the five species in Table 3 may occur near non-agricultural (i.e., turf) atrazine use sites. However, these non-agricultural use sites do not provide the species' necessary habitat (e.g., longleaf pine ecosystems, fossorial life history, karst aquifer caves). 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. In addition, there are other aspects of the life history or habitat locations for some of these species that also preclude them from most non-agricultural and agricultural exposures such as the dusky gopher frog where most individuals are located on the DeSoto National Forest in southern Mississippi, or the frosted flatwoods salamander which has a fossorial life history and remains underground in crayfish burrows for 1-2 years of their life and on federal lands where atrazine use sites are not expected to occur, such as Apalachicola National Forest in Florida and St. Marks National Wildlife Refuge in Florida.

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 level of adverse effects to growth, and/or reproduction and may experience indirect effects through some loss of vegetation in their habitat. After reviewing the current status of the species, environmental baseline for the action area, cumulative effects, and effects of the action (including conservation measures that are incorporated into the 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 atrazine, as proposed, is not likely to jeopardize the continued existence of the species in Table 3.

References

U.S. Fish and Wildlife Service. 2024. Recovery Outline for the Georgetown Salamander, Jollyville Plateau Salamander, and Salado Salamander. Austin, Texas. 15 pp.

U.S. Fish and Wildlife Service. 2021. Dusky Gopher Frog (*Rana sevosa*) 5-Year Review: Summary and Evaluation. Jackson, Mississippi, 16 pp.

Species with Individual Integration and Synthesis Summaries

The species in Table 4 have individual Integration and Synthesis summaries. We expect Herbicide Strategy conservation measures to reduce pesticide loading into aquatic habitats by 90-99% (i.e., one to two orders of magnitude) compared to unmitigated runoff and reduce spray drift from entering species' terrestrial habitats by >95%. We anticipate that this reduction will minimize off-site transport of atrazine to a level where no more than low levels of adverse effects are likely to occur to plants through this exposure route. While the conservation measures are expected to reduce the extent of off-field exposure and reduce exposure concentrations, we anticipate simazine residues on use sites or in aquatic habitats could remain at levels high enough to cause greater than low levels of adverse direct and/or indirect effects to these species. For each species, we provide additional information on vulnerability (including environmental baseline and cumulative effects), exposure, and toxicity in Appendix E. The status of the species accounts can be found in Appendix B.

Table 4. Species with Individual Integration and Synthesis summaries

Common Name	Scientific Name	Determination
Neuse River waterdog	*Necturus lewisi*	No Jeopardy
Western spadefoot	*Spea hammondii*	No Jeopardy

Integration and Synthesis Summary: Neuse River waterdog

Scientific Name:	Common Name:	Entity ID:
Necturus lewisi	Neuse River waterdog	2932

Conclusion: No Jeopardy

Species Range

Based on range map dated: 10-10-2018; Wherever found; *States within the range:* NC

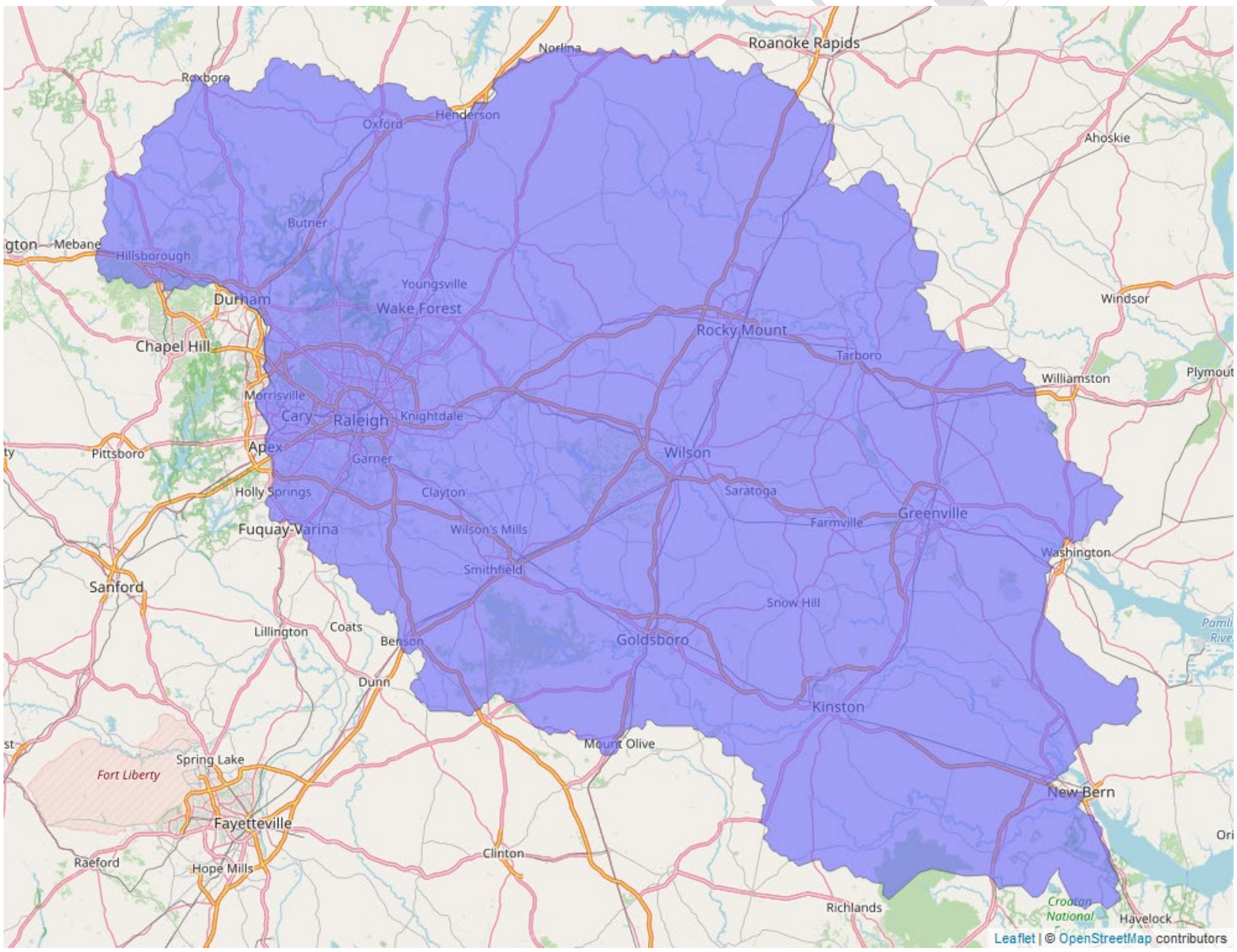

Figure 2. Range map of Neuse River waterdog (blue polygons). Range map accessed at https://ecos.fws.gov/ecp/species/6772.

Vulnerability

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

Summary of Status

Listing status: Threatened

Most recent 5-year review recommendation: N/A

Most recently completed 5-year review: None available for this species

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

Number of populations: Multiple populations (few)

Species trends: Declining population(s) - one or more populations declining

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

Environmental Baseline/Cumulative Effects (EB/CE) Summary

The Neuse River waterdog is a permanently aquatic salamander species endemic to the Tar-Pamlico and Neuse River drainages in North Carolina. The species occurs in riffles, runs, and pools in medium to large streams and rivers with moderate gradient in both the Piedmont and Coastal Plain physiographic regions. Waterdogs prefer clean water with permanent flow and are not tolerant of siltation and turbidity. Benthic critters such as the waterdog have disproportionate rates of imperilment and extirpation because stream bottoms are often the first habitats affected by pollution. The Neuse River waterdog has declined in abundance and distribution and many remaining populations are fragmented (USFWS 2021a). Since the 2018 SSA analyses (USFWS 2021a), survey and research efforts have led to documentation of Neuse River waterdogs in places they were believed to be extirpated. The species was found in 37 HUC-10s between 2011-2022; 338 of 430 were added since 2018. As of 2023, the Neuse River waterdog has 3 populations: Trent, Neuse (8 subpopulations), and Tar-Pamlico (5 subpopulations) (USFWS 2023). The one population predicted to remain extant (Tar) is expected to be characterized by low occupancy and abundance in the future (USFWS 2021a).

The Neuse River waterdog faces a variety of risks from declines in water quality, loss of stream flow, riparian and instream fragmentation, deterioration of instream habitats, invasive species (i.e., red swamp crayfish (*Procambarus clarkii*), flathead catfish (*Pylodictis olivaris*), and hydrilla (*Hydrilla verticillata*)). These risks, which are expected to be exacerbated by urbanization and climate change, were important factors in our assessment of the future viability of the Neuse River waterdog. Streams with urbanized or agriculturally dominated riparian corridors are subject to increased sediment-loading from unstable banks and/or impervious surface run-off, resulting in less suitable in-stream habitat for waterdogs as compared to habitat with forested corridors. Agricultural pesticide use can have detrimental effects, and studies have shown the species to have low to moderate levels of pesticide contamination from a variety of sources, including insect control. The human population in the southern portion of the U.S. has increased by nearly 1% annually since 2020 (twice the average nationally) and we expect additional growth in the future (U.S. Census, 2025). With human population growth, we also expect additional urban development that could result in mortality or habitat loss for the Neuse River waterdog. Climate change has already begun to affect the watersheds where Neuse River Waterdog occurs, resulting in higher air temperatures, increased evaporation, and altered precipitation patterns such that water levels range-wide have reached historic lows, which put the populations at elevated risk for habitat loss, especially in the headwater areas. We expect other threats to the waterdog, including water quality issues, loss of stream flow, fragmentation, and general habitat loss to be exacerbates by increased development and climate change (USFWS 2021a).

Overall Vulnerability: High

Effects of the Action: Exposure

Overlap with Agricultural Use Sites

Data indicate that 21.2% of the species' range overlaps with agricultural use sites and 17.8% of the species' range overlaps with areas adjacent to use sites that are likely exposed through off-site transport (e.g., through spray drift or runoff). In total, there is up to 21.2% overlap between the species' range and the agricultural footprint of atrazine use sites (Table 5).

Table 5. Estimated Overlap with Agricultural Use Sites.

Use Layer	Total Overlap (% watershed)	% Watershed Treated
Corn	11.0	11.0
Vegetables and Ground Fruit (Sweet Corn)	3.3	0.2
Other Grains (Sorghum & Sugarcane)	0.4	0.4
Other Orchards (Guava & Macadamia Nut)	0.0	0.0

Use Layer	Total Overlap (% watershed)	% Watershed Treated
Other Crops (Wheat-Corn-Fallow)	0.0	0.0
Other Crops (Wheat-Sorghum-Fallow)	4.1	3.8
Other Crops (Wheat-Fallow-Wheat)	0.0	0.0
Other Crops (Sod)	2.4	2.4
Total	**21.2**	**17.8**

Usage

Past usage data indicate that up to 17.8% of the species' range has been treated with atrazine annually from agricultural uses.

Additional Exposure Considerations

Neuse River waterdogs breed once per year, with mating in the fall/winter and spawning in the spring. During the spring (May-June), females will lay a clutch of ~25-90 eggs in a rudimentary nest, under large rocks in moderate currents. Nest sites are guarded by females and usually found under large bedrock outcrops or large boulders with sand and gravel beneath them, often placed there by the waterdogs (USFWS 2021a).

Exposure from Non-Agricultural Uses

The Neuse River waterdog may be exposed to atrazine run-off or spray drift through the non-agricultural uses for applications within developed areas such as residential lawns or open space developed areas such as golf courses and nurseries. While the nurseries footprint is small within the range of the Neuse River waterdog, there are ~ 80 golf courses within the range of the Neuse River waterdog. North Carolina is within the transition zone where warm season grasses for golf course turf may be treated with atrazine within the range of the Neuse River waterdog.

Conservation Measures

There are several conservation measures on the atrazine label that apply to all agricultural uses and are intended to reduce spray drift and runoff to off-site areas, including a 15-foot spray drift buffer for ground applications, a 170-foot spray drift buffer for aerial applications, and three runoff mitigation points for all agricultural uses of atrazine. We expect these measures will reduce the environmental concentration of atrazine by up to an order of magnitude (i.e., up to a 90% reduction in atrazine residues in spray drift and runoff), reducing both the extent of areas exposed to spray drift and runoff as well as decreasing the exposure concentration in these off-site areas.

Effects of the Action: Toxicity

Direct Effects

Estimated environmental concentrations of atrazine in the Neuse River waterdog's habitat will vary depending on the application rate corresponding to different registered uses, the habitat features (e.g., flow rate and size of waterbody), and the region. EPA's fate modeling indicate that maximum estimated environmental concentrations will range between 0.87 µg/L to 206.4 µg/L (Table 6).

Table 6. EPA's aquatic modeling estimates of maximum estimated environmental concentrations (all concentrations in µg/L).

HUC2	Habitat	Corn	Developed	OSD[8]	Other Crops (Fallow)	Other Crops (sod)	Other Grains	Other Orchards	VGF[9]
3	Low flow or low volume	59.7	1.58	4.69	85.8	152.5	174.0	206.4	64.7
3	High flow	14.37	0.87	1.03	40.8	39.6	85.1	36.6	16.5

These EECs encompass exposure expected from all uses, including both agricultural and non-agricultural. Mortality is not expected in any of the aquatic habitats where the Neuse River waterdog is found. The Neuse River waterdog prefers riffles, runs, and pools in medium to large streams and rivers with moderate gradient such as streams wider than 15m, although some have been observed in smaller creeks deeper than 100 cm, and with a main channel flow rate greater than 10cm/sec (USFWS 2021b), so it may be found in both high flow waterbodies and low flow /low volume waterbodies. We anticipate a reduction in growth for the Neuse river waterdog in some low flow/low volume waterbodies within its range. However, breeding and nesting most likely occur in water bodies with moderate current protected under large boulders or bedrock outcrops below the water surface where EECs are likely to be lower than what would impact reproduction.

For residential uses of atrazine, we do not anticipate much exposure from applications of this type as atrazine is no longer commonly used on residential or commercial turf due to preferential use newer herbicides.

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[8] OSD = open space developed.

[9] VGF = vegetables and ground fruit.

While there are a large number of golf courses within the range of the Neuse River waterdog, and atrazine is used on warm season grasses, golf courses typically apply herbicides using dedicated ground equipment with a low boom height (as per the label), and 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. These general practices help ensure turf and soil conditions do not lead to off-target movement of atrazine. In addition, riparian buffer zones are often used on golf courses between all water features to reduce off target movement as well. We also anticipate non-agricultural uses will not meaningfully add to the overall level of anticipated exposure considered within the range of the Neuse River waterdog due to runoff and spray drift considerations described above and off-site exposure is not expected to result in effects to listed species as the EECs are well below concentrations where we would anticipate any direct adverse effects to the Neuse River waterdog. In addition, the Neuse River waterdog habitat requirements preclude them from occupying non-agricultural use sites where atrazine may be used.

Indirect Effects

Atrazine is likely to impact any aquatic vegetation the Neuse River waterdog relies on for breeding and sheltering however, atrazine is not likely to eliminate all aquatic vegetation within a water body and aquatic plant based sources 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. The Neuse River waterdog can consume invertebrate species as a food resource. Available toxicity data indicate that invertebrate species, particularly aquatic arthropods, are sensitive to atrazine and are likely to die and exhibit reduced fecundity with exposure to atrazine at some predicted environmental concentrations. However, we do not expect all invertebrate species will be equally sensitive to atrazine exposure. Abundance of some invertebrate species may be reduced while other species may not exhibit as large of a reduction in abundance. As such, we anticipate a temporary loss of certain invertebrate prey species will result in no more than low levels of indirect adverse effects to the Neuse River waterdog.

Effects of the Action Summary

The Neuse River waterdog has high exposure. There is a large presence of agricultural atrazine use sites within the species' range (21.2% total overlap) and a high level of anticipated agricultural usage rate within the range (up to 17.8% of the range treated annually). As such, we expect a large number of individuals are likely to experience exposure.

Individuals may occur near non-agricultural use sites, including Developed and Open Space Developed areas. However, as described above, there are a number of general practices for golf course turf use and residential turf grass applications that minimize the likelihood of off-site movement into non-target areas and the low likelihood of atrazine use for residential areas also minimizes the exposure we anticipate for the Neuse river waterdog.

The Neuse River waterdog has high toxicity. Based on predicted environmental concentrations of atrazine from agricultural uses within the species' habitat of low flow/low volume habitats, we expect there will be a high likelihood of direct effects (e.g., reduced growth) and a low level of indirect effects through the loss of prey resources and vegetation for sheltering and breeding. We anticipate this level of direct and indirect effects will result in a medium level of adverse effects to a large number of individuals. Therefore, we determine the overall risk of adverse effects to the species is medium from agricultural uses of atrazine.

Species Conclusion

The Neuse River waterdog is a fully aquatic salamander that sometimes utilizes low to moderate-gradient streams with low current velocities but prefers riffles, runs, and pools in medium to large streams and rivers with moderate gradient. The species requires uncontaminated sites and is intolerant of degraded water quality as from siltation or turbidity so that, in general, stream channels with forested and stable banks where erosion is limited are more likely to support the species than sites where vegetation and stream banks have been altered (i.e., where agriculture or development activities exist). The Neuse River waterdog has a high vulnerability based on its status, distribution, and trends. Because the species is aquatic, we expect exposure to occur through spray drift and runoff.

In general, the Neuse River waterdog is under a variety of threats, including habitat loss/degradation related to water quality impairment and in-stream and riparian deterioration from development. Invasive species also represent a risk to the species. While these threats appear to represent the most significant risks to the species, the Neuse River waterdog also occurs in aquatic habitats adjacent to agricultural and non-agricultural use sites where atrazine could be used, including medium to large streams and rivers with moderate gradients. While atrazine exposure is anticipated at low levels due to low levels of residual runoff in streams and rivers adjacent to non-agricultural sources (e.g., golf courses) we expect a low number of individuals will be exposed to low levels of atrazine that will cause measurable effects to growth. Effects to reproduction or survival are not anticipated because the limitations on use spray drift and runoff reduction measures reduce those exposures to levels below which we would observe these effects. For agricultural uses, the anticipated levels of exposure from off-site transport are anticipated to result in low levels of adverse effects, if any, from indirect effects to aquatic invertebrate prey.

Thus, we anticipate a low number of individuals of this species and their food resources will experience exposure over the duration of the action. We do not expect mortality of individual Neuse River waterdogs, but do anticipate low levels of direct adverse effects to growth from agricultural exposure and even fewer indirect adverse effects from reductions of prey resources (i.e., aquatic invertebrates). We anticipate the reduction of growth and loss of dietary items in a small number of individuals will not result in species-level effects. After adding the effects of the action and cumulative effects to the environmental baseline, and in light of the status of the species, we have determined the proposed action is not expected to appreciably reduce the survival and recovery of the species in the wild. Thus, it is our biological opinion that the proposed action is not likely to jeopardize the continued existence of the Neuse River waterdog.

References

U.S. Census. 2025. United States Population Growth by Region. https://www.census.gov/popclock/data_tables.php?component=growth (accessed: 9/25/2025).

U.S. Fish and Wildlife Service. 2023. Draft Recovery Plan for the Neuse River Waterdog (*Necturus lewisi*). Raleigh, North Carolina. 17 pp.

U.S. Fish and Wildlife Service. 2021a. Species Status Assessment Report for the Neuse River Waterdog (*Necturus lewisi*). Version 1.2. February 2021. Atlanta, Georgia.

U.S. Fish and Wildlife Service. 2021b. Endangered and Threatened Wildlife and Plants; Threatened Species Status With Section 4(d) Rule for Neuse River Waterdog, Endangered Species Status for Carolina Madtom, and Designations of Critical Habitat. Final Rule. Federal Register 86(109): 30688-30751.

Integration and Synthesis Summary: Western spadefoot

Scientific Name:	Common Name:	Entity ID:
Spea hammondii	Western spadefoot (Southern DPS)	12394

Conclusion: No Jeopardy

Species Range

Based on range map dated: 08/19/2025; Southern Distinct Population Segment; *States within the range:* CA

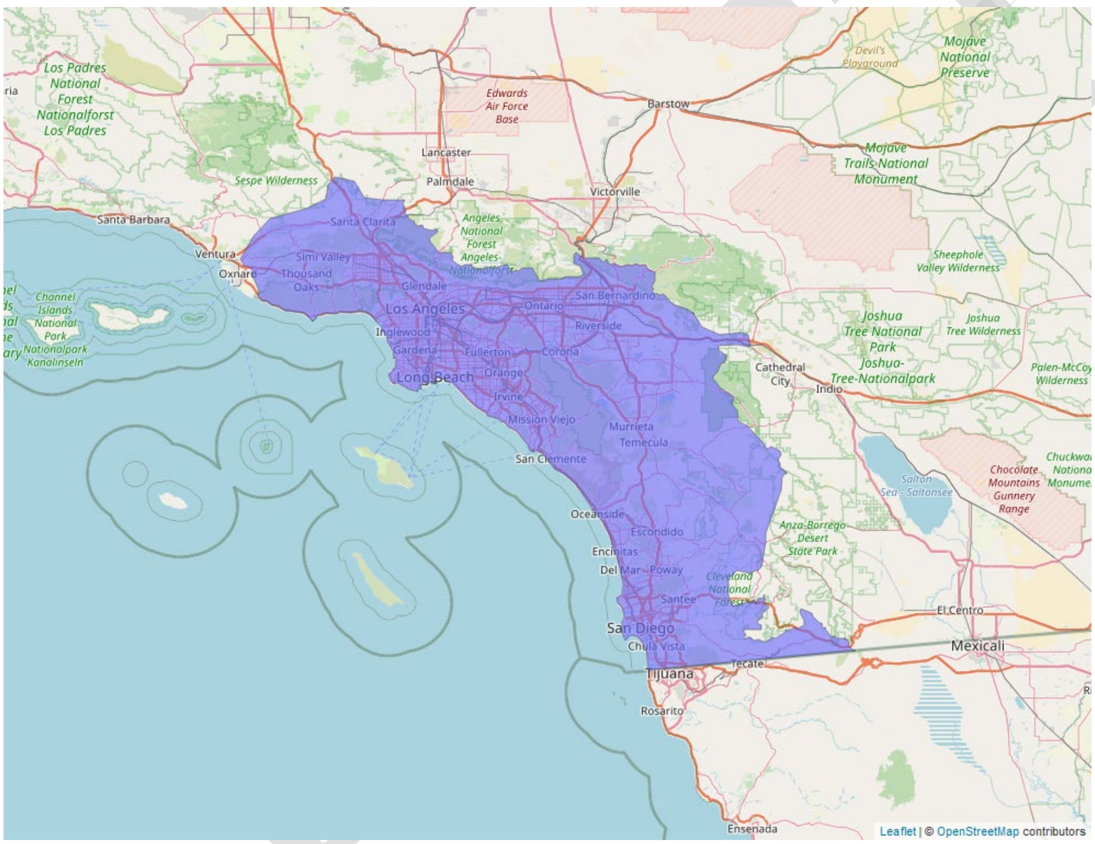

Figure 3. Southern DPS map of western spadefoot (blue polygons). Range map accessed at https://ecos.fws.gov/ecp/species/5425.

Vulnerability

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

Summary of Status

Listing status: Proposed Threatened

Most recent 5-year review recommendation: N/A

Most recently completed 5-year review: None available for this species

Distribution: Species/Populations neither constrained nor widespread

Number of populations: Multiple populations (numerous)

Species trends: Declining population(s) - one or more populations declining

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

Environmental Baseline/Cumulative Effects (EB/CE) Summary

Western spadefoots are primarily terrestrial and inhabit underground burrows. Radio-tagged individuals in southern California were found in underground burrows from 1 cm to 18 cm (0.4–7 in.) depth below the surface during the breeding season. It is estimated that western spadefoot individuals can burrow approximately 1 m (3 ft) below ground during the dry season to avoid temperature extremes and desiccation. During a majority of their life cycle, western spadefoot remains in a torpor state in underground burrows in upland areas surrounding their aquatic (breeding) habitat. Spadefoots emerge from their burrows to forage and breed in ephemeral pools following seasonal rains in winter and spring. Emergence is likely related to a sound or vibration cue from the rain. Most surface activity is nocturnal, presumably to reduce water loss. Depending on temperature and annual rains, western spadefoot breeding and oviposition generally occurs from October to May, most often in temporary pools and non-flowing drainage areas from winter or spring rains.

The historical range of western spadefoot is from the vicinity of Redding in Shasta County, California, southward to northwestern Baja California, Mexico. They have been found at sites from sea level up to 1,385 meters (m) (4,500 feet (ft)) in the Sierra Nevada foothills. In California, western spadefoot ranges throughout the Central Valley, and in the Coast Ranges and the coastal lowlands from San Francisco Bay southward to Mexico. Currently, the species is patchily distributed throughout its historical range. However, the western spadefoot is thought to be extirpated throughout most of the lowlands of southern California and from many historical locations within the Central Valley.

Western spadefoot habitat is primarily open treeless grasslands, scrub, or mixed woodland and grassland where aquatic breeding habitat is available. Western spadefoots require both aquatic and terrestrial habitat components in close proximity, within the dispersal distance of the species, to meet all life history requirements. Spadefoots are primarily terrestrial, and require upland habitats for feeding and for constructing burrows for long dry-season dormancy. Western spadefoots have been found to favor areas with grassland cover for burrow sites in both the northern and southern clade, and also shrub/scrub habitat in the southern clade. Aquatic habitat is used for breeding and developing larvae and typically includes temporary vernal pools, sand or gravel washes, and small streams that are often seasonal. However, eggs and larvae of western spadefoot have been observed in a variety of permanent and temporary wetlands, both natural and altered, including rivers, creeks, artificial ponds, livestock ponds, sedimentation and flood control ponds, irrigation and roadside ditches, roadside puddles, tire ruts, and borrow pits, indicating a degree of ecological plasticity.

Overall Vulnerability: High

Effects of the Action: Exposure

Overlap with Agricultural Use Sites

We do not expect western spadefoots will occur on-field, and thus expect exposure will only result from off-field transport via spray drift or runoff. However, this species while not on-field, is known to breed and not disperse very far from their breeding pools that could functionally be agricultural ditches. Given that the ranges for listed aquatic species are generally delineated using the relevant HUC 12 watersheds, we anticipate that all residues that leave agricultural use sites will be collected in the waterbodies (including ephemeral agricultural ditches used as breeding pools) within the species range where individuals occur regardless of how residues leave treated sites or where in the range they are deposited. As such, we do not extend overlap metrics off-field as this will not functionally change the expected exposures that listed aquatic species are likely to experience. Data indicate that 14.1% of the species' watershed overlaps with agricultural use sites (Table 7). However, the overlap analysis took place prior to the registrants' commitment to limit atrazine use solely to Imperial County in California. Thus, we expect actual overlap to be much lower, and as such, we place a greater weight on the usage data gathered for Imperial County, as described below.

Table 7. Agricultural use overlap and annual usage data (% Range Treated) for the western spadefoot.

Use Layer	Total Overlap (% watershed)
Corn	2.5
Vegetables and Ground Fruit (Sweet Corn)	2.6

Use Layer	Total Overlap (% watershed)
Other Grains (Sorghum & Sugarcane)	1.8
Other Orchards (Guava & Macadamia Nut)	3.6
Other Crops (Wheat-Corn-Fallow)	0.0
Other Crops (Wheat-Sorghum-Fallow)	0.0
Other Crops (Wheat-Fallow-Wheat)	0.0
Other Crops (Sod)	3.5
Total	**14.1**

Usage

Mandatory reporting data from the state of California indicates that, between 2013-2022, no pesticides, including atrazine, were reported to have been using within the part of the species' range that overlaps with Imperial County, California where atrazine is the only county still labeled for use. Table 8.

Table 8. Past usage of all pesticides, herbicides, and specifically atrazine in Imperial County, California near the western spadefoot's range according to the California Department of Pesticide Regulation's Pesticide Use Reporting

Species	% overlap with all pesticide usage areas	% overlap with all herbicide usage areas	% overlap with atrazine usage
Western spadefoot	0.0	0.0	0.0

Additional Exposure Considerations

Western spadefoots are primarily terrestrial and inhabit underground burrows from 1 cm to 18 cm (0.4–7 inches) depth below the surface during the breeding season. It is estimated that western spadefoot individuals can burrow approximately 1 meter (3 feet) below ground during the dry season to avoid temperature extremes and desiccation. During a majority of their life cycle, western spadefoots remain in a torpor state in underground burrows in upland areas surrounding their aquatic (breeding) habitat. Spadefoots emerge from their burrows to forage and breed in ephemeral pools following seasonal rains in winter and spring. Most surface activity is nocturnal, presumably to reduce water loss. Depending on temperature and annual rains, western spadefoot breeding and oviposition generally occurs from October to May, most often in temporary pools and non-flowing drainage areas from winter or spring rains. Eggs and larvae of the western spadefoot have been observed in a variety of permanent and temporary wetlands, both natural and altered, including rivers, creeks, artificial ponds, livestock ponds, sedimentation and flood control ponds, irrigation and roadside ditches, roadside puddles, tire ruts, and borrow pits, indicating a degree of ecological plasticity (USFWS 2023a). Western spadefoots occur in ephemeral ponds, some of which occur on agricultural lands and ditches (USFWS 2023b).

Exposure from Non-Agricultural Uses

The western spadefoot occurs in ephemeral ponds, some of which may occur on non-agricultural use sites (USFWS 2023b).

Conservation Measures

There are several conservation measures on the atrazine label that apply to all agricultural uses and are intended to reduce spray drift and runoff to off-site areas, including a 15-foot spray drift buffer for ground applications, a 170-foot spray drift buffer for aerial applications, and three runoff mitigation points for all agricultural uses of atrazine. We expect these measures will reduce the environmental concentration of atrazine by up to an order of magnitude (i.e., up to a 90% reduction in atrazine residues in spray drift and runoff), reducing both the extent of areas exposed to spray drift and runoff as well as decreasing the exposure concentration in these off-site areas.

Effects of the Action: Toxicity

Direct Effects

The western spadefoot is primarily terrestrial. They have not been observed to disperse very far from their breeding pools (USFWS 2023a). If they are near agricultural areas when breeding in agricultural area ditches, terrestrial estimated environmental concentrations of atrazine from dietary exposure consumption of terrestrial arthropods will lead to reduced reproductive output (reduction in number of eggs laid, reduction in viable embryos, and reductions in hatchling survival). However, mortality is not expected from atrazine exposure in any of the terrestrial habitats where the western spadefoot is found and as, from the usage information (0%) we anticipate no exposure from agricultural uses.Aquatic habitat is used for breeding and developing larvae and typically includes temporary vernal pools, sand or gravel washes, and small streams that are often seasonal. In the aquatic habitat of the western spadefoot, estimated environmental concentrations of atrazine will vary depending on the application rate corresponding to different registered uses, the aquatic habitat features (e.g., flow rate and size of waterbody), and the region. EPA's fate modeling indicate that maximum estimated environmental concentrations will range between 0.3 µg/L to 175.9 µg/L (Table 9).

Table 9. Aquatic estimated environmental concentrations (EECs) for aquatic phase of the western spadefoot.

HUC2[10]	Habitat	Corn	Developed	OSD[11]	Other Crops (rotations)	Other Crops (sod)	Other Grains	Other Orchards	VGF[12] (sweet corn)
18a	Low flow or low volume	131	1.0	3.0	26.8	144.2	163.2	175.9	93.5
18a	High flow	5.7	0.6	0.9	1.8	23.7	9.4	10.5	18.2
18a	High volume	3.7	0.4	0.5	1.1	12.8	8.0	6.0	10.1
18b	Low flow or low volume	109.2	0.9	2.8	2.6	137.5	168.4	153.0	105.9
18b	High flow	6.7	0.4	0.6	1.1	13.4	9.6	7.1	11.7
18b	High volume	3.7	0.3	0.3	0.6	6.9	5.7	4.6	5.7

These EECs encompass exposure expected from all uses, including both agricultural and non-agricultural. Mortality is not expected in any of the aquatic habitats where the western spadefoot is found. The western spadefoot occurs in primarily open treeless grasslands, scrub, or mixed woodland and grassland where aquatic breeding habitat is available. When not burrowed underground, during the breeding season and during tadpole development, we anticipate a reduction in growth and reproduction for the western spadefoot in some low flow/low volume waterbodies within its range if they are in a low flow/low volume breeding pond/vernal pool.

For residential uses of atrazine, we do not anticipate much exposure from applications of this type as atrazine 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.

While there are many golf courses within the range of the western spadefoot, golf courses typically apply herbicides using dedicated ground equipment with a low boom height (as per the label), and 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 6 points on EPA's mitigation menu. These general practices help ensure turf and soil conditions do not lead to off-target movement of atrazine. In addition, riparian buffer zones are often used on golf courses between all water features to reduce off target movement as well. We also anticipate

[10] HUC = hydrologic unit code. In this case a HUC2, which is the broadest designation in a hierarchical nationwide system to delineate watersheds created by the U.S. Geological Survey. See https://nas.er.usgs.gov/hucs.aspx.

[11] OSD = open space developed. Generally, refers to lawns, turf areas, golf courses and similar land uses.

[12] VGF = vegetables and ground fruit. Generally, refers to vegetables, sweet corn, and fruit grown on the ground.

non-agricultural uses will not meaningfully add to the overall level of anticipated exposure considered within the range of the western spadefoot due to runoff and spray drift considerations described above and off-site exposure is not expected to result in effects to listed species.

Indirect Effects

Atrazine is likely to impact any aquatic vegetation the western spadefoot relies on for breeding and sheltering however, atrazine is not likely to eliminate all aquatic vegetation within a water body and aquatic plant-based sources 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. Atrazine is also likely to impact any vegetation used during the terrestrial phase in dispersal habitats. Adult western spadefoot forage on a variety of small invertebrate prey including grasshoppers, true bugs, moths, ground beetles, predaceous diving beetles, ladybird beetles, click beetles, flies, ants, and earthworms (USFWS 2023a). Adult western spadefoot can consume 11 percent of their body mass during a single feeding and adults must be able to acquire sufficient energy for their long dormancy period of 8 to 10 months in only a few weeks so it is likely they will consume large quantities at or near breeding pools and dispersal areas (USFWS 2023a). The specific food items consumed by western spadefoot larvae are unknown, but they likely need some food to persist such as planktonic organisms, algae, and fairy shrimp (USFWS 2023a). Available toxicity data indicate that invertebrate species, particularly aquatic arthropods, are sensitive to atrazine and are likely to exhibit reduced fecundity and reduced growth with exposure to atrazine at the predicted environmental concentrations. However, we do not expect all invertebrate species will be equally sensitive to atrazine exposure. Abundance of some invertebrate species may be reduced while other species may not exhibit as large of a reduction in abundance. As such, we anticipate a temporary loss of certain aquatic invertebrate prey species, but this will result in no more than low levels of adverse indirect effect to the western spadefoot.

Effects of the Action Summary

Exposure for the western spadefoot is low. While there is a large presence of agricultural atrazine use sites within the species' range (14.1% total overlap), we expect this number to be lower given the commitment to restrict use to Imperial County. There is a low level of anticipated agricultural usage within the range (0% of the range treated annually) within Imperial County. As such, we expect a low number of individuals are likely to experience exposure.

Individuals may occur near non-agricultural use sites, including Developed and Open Space Developed areas. However, as described above, there are a number of general practices for golf course turf use and residential turf grass applications that minimize the likelihood of off-site movement into non-target areas and the low likelihood of atrazine use for residential areas also minimizes the exposure we anticipate for the western spadefoot.

The western spadefoot burrows for most of the year (8-10 months) however it is known to occur in agricultural ditches that can function as breeding pools. They are also known to disperse short distances from breeding pools, which makes them more susceptible to atrazine from agricultural uses, but as above, we don't anticipate usage per the CalPUR data. They are also known to consume a significant portion of their body weight during singular feedings and in doing so, if near agricultural areas, makes exposure to atrazine from agricultural uses through the dietary route in the terrestrial phase a risk, but one that we do not anticipate given the usage (0%). Based on predicted terrestrial environmental concentrations of atrazine from agricultural uses within the species' range, the western spadefoot is not likely to experience reduced reproductive output such as a reduction in number of eggs laid, reductions in viable embryos, and reductions in tadpole survival.

During the aquatic phase we expect there will be some direct effects (e.g., reduced growth) based on estimated environmental concentrations of atrazine in habitats of low flow/low volume habitats, and a low level of indirect effects through the loss of some prey resources and vegetation for sheltering and breeding. We anticipate this level of direct and indirect effects during both the terrestrial and aquatic phases for this species will result in a medium level of adverse effects to a small number of individuals. Therefore, we determine the overall risk of adverse effects to the species is low from agricultural uses of atrazine in the terrestrial and aquatic phases for this species.

Species Conclusion

The western spadefoot toad is a small, largely fossorial toad inhabiting dry grasslands and woodlands proximate to vernal pools, sand or gravel washes, and small streams, often only seasonally wetted. The species was once broadly distributed through California's Central Valley into northern Mexico but is currently patchily distributed in the foothills of the Sierra Nevada and Coast Ranges having been extirpated from many of the lowlands of southern California and from many former sites in lower elevations of the Central Valley. The western spadefoot toad has a high vulnerability based on its status, distribution, and trends. Because the species is largely terrestrial, but reproduces in aquatic sites, we expect exposure to primarily occur through spray drift and runoff in aquatic breeding sites.

The western spadefoot toad is under a variety of threats, including habitat loss/degradation related to urban development and agricultural conversion degrading or destroying natural habitats in the Central Valley and in southern California. While these threats appear to represent the most significant risks to the species, the Western spadefoot toad also occurs in aquatic habitats proximate to agricultural and non-agricultural use sites, including drainage and agricultural ditches adjacent to agricultural use sites where runoff from agricultural sites is a risk. However, given the usage (0%) on agricultural sites across the range we do not anticipate adverse effects from atrazine exposure through runoff in seasonal aquatic sites (e.g., vernal pools) near agricultural use sites and we do not anticipate the species on-field in adult terrestrial phases. Similarly, in or adjacent to non-agricultural sources (e.g., golf courses, open space developed sites), given the limited use of atrazine across the distribution of the species, we expect a small number of individuals will be exposed to biologically meaningful levels of atrazine from non-agricultural runoff that will cause measurable direct effects to growth and reproduction in affected individuals. While limitations on use (spray drift reduction measures cited above) and buffers already on the label reduce those exposures for many use types to levels below which we would observe such effects, for a limited number of use types we still anticipate exceedances of EECs such that effects to growth and reproduction from exposure and effects to prey availability are anticipated to a small number of individuals.

Thus, we anticipate a small number of individuals of this species and their food resources will experience exposure over the duration of the action. While we do not expect mortality of individual Western spadefoot toads, we do anticipate low levels of direct adverse effects to growth from indirect adverse effects from some reduction of food resources (i.e., aquatic invertebrates and algae). We anticipate the reduction of growth and loss of dietary items in a small number of individuals will not result in species-level effects. After adding the effects of the action and cumulative effects to the environmental baseline, and in light of the status of the species, we have determined the proposed action is not expected to appreciably reduce the survival and recovery of the species in the wild. Thus, it is our biological opinion that the proposed action is not likely to jeopardize the continued existence of the western spadefoot toad.

References

U.S. Fish and Wildlife Service. 2023a. Species Status Assessment Report for the Western Spadefoot (*Spea hammondii*), Version 1.1. Sacramento, California.

U.S. Fish and Wildlife Service, Sacramento Fish and Wildlife Office, Sacramento, California. 129 pp.

U.S. Fish and Wildlife Service. 2023b. Endangered and Threatened Wildlife and Plants: Threatened Status With Section 4(d) Rule for the Northern and Southern Distinct Population Segments of the Western Spadefoot. Proposed Rule. Federal Register 88(232):84252-84278.

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 10, 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. However, the species below is highly vulnerable, and while the conservation measures on the label are expected to reduce the extent of off-field exposure and reduce exposure concentrations, we anticipate atrazine residues on use sites or in aquatic habitats could remain at levels high enough to cause greater than low levels of adverse direct and/or indirect effects to this 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 the species to atrazine. As such, we have not yet made a determination for this species.

Table 10. Amphibian species requiring further analysis.

Common Name	Scientific Name	Vulnerability Ranking	Exposure Ranking	Toxicity Ranking
Salado salamander	*Eurycea chisholmensis*	High	High	High