# Integration and Synthesis Summary for Crustaceans

The Integration and Synthesis Summary includes our jeopardy analysis for any species that we or EPA determined will "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, and a template worksheet to show how rankings were assessed and combined are in Appendix E. Ranges for all species in this assessment group are entirely within the conterminous United States.

**Vulnerability**

For the crustacean species that we or EPA determined are "likely to be adversely affected" by the proposed action, we considered several factors to summarize the current vulnerability of that species to additional stressors. This effort allows us to consider whether a species' current condition is moving toward recovery or further decline. In general, we expect the species' vulnerability to additional stressors to be higher if they are moving toward further decline than if they their condition is improving. We also identify which species are most (and least) susceptible to additional stressors in general based on information that could be surmised from species listing and recovery documents, or other sources as cited and considered in the *Status* section of this biological opinion.

Our assessment of vulnerability focuses on six factors: (1) the species listing status and recent 5-year status review recommendation (if available), (2) distribution, (3) number of populations, (4) species population trends, (5) if pesticides have been noted as a threat, and (6) impacts from activities associated with environmental baseline and cumulative effects. We obtained the information to create the vulnerability summary from the *Status of the Species* accounts (Appendix B), the overarching *Environmental Baseline* section of this Opinion, 5-year species status reviews, species recovery plans, species status assessments, 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 medium or high. We assigned a medium vulnerability ranking if a species' scores were a mix of high, medium, and low (though exceptions were allowed for species that have a low status score or have an uplisting recommendation). We assigned a low vulnerability ranking to species with only low scores. Considerations regarding specific aspects of the species' vulnerability or beyond what was included in the vulnerability ranking were applicable for some species depending on unique aspects of their life history. This information is reflected in the rationales for conclusion below.

**Exposure**

We anticipate crustaceans will primarily be exposed to methomyl through contact with contaminated water in their habitats. We assume all methomyl that is transported off-site, whether through spray drift or runoff, is likely to end up in local water bodies, which may distribute methomyl residues throughout the entire watershed. Methomyl degrades quickly (i.e., within a few days) in aerobic aquatic habitats and as such is not likely to persist in water bodies for long periods of time, be transported long distances in surface waters, or occur in groundwater sources.

We characterize the expected level of exposure using overlap data, past methomyl usage data, and any species-specific considerations such as life history information (e.g., habitat preferences, dispersal behavior) and existing protections or conservation actions. Species with greater than 10% overlap between their range and methomyl 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 with methomyl use sites, we considered past methomyl usage data within a species' range to determine how much of a species' range we expect to be treated with methomyl 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 biological opinion. Species that data indicate will have a large portion of their range (>10%) treated with methomyl each year are assigned a high usage score. Species that will have a medium portion of their range (5-10%) treated with methomyl each year are assigned a medium usage score, and species that data indicate will have a low portion of their range (<5%) treated with methomyl each year are assigned a low usage score.

We determine the overall exposure ranking by qualitatively considering both the total overlap and total usage, as well as any additional exposure considerations that might modify the level of exposure likely to occur. When overlap and usage scores are the same, we assign the overall exposure ranking the same score (e.g., if both overlap and usage is high, the overall exposure ranking is high). In cases where overlap is high and usage is medium or when overlap is medium and usage is low, we use the overlap score as the overall exposure ranking to maintain conservative exposure assumptions. (As usage is a subset of overlap, the overlap score will always be greater than the usage score.) In cases where overlap is high and usage is low, we anticipate a moderate portion of the range may be treated over the duration of the proposed action even if only a small portion of the range is treated in any given year (particularly if the areas treated occur in different locations each year), leading to an overall exposure ranking of medium. Past usage data for methomyl is not available for species located on Pacific or Caribbean islands including Hawai‘i and Puerto Rico, thus, in the absence of any additional exposure considerations for these species, our ranking is based on total overlap of methomyl use sites for species that occur in these areas. For all species, where there are additional exposure considerations, we adjust the overall exposure ranking to reflect this additional information, as appropriate.

**Toxicity**

We characterize the expected toxic effect to species based on the anticipated level of direct and indirect[1] adverse effects to individuals. Our analysis of toxicity assumes individuals are exposed to methomyl at levels estimated by EPA's environmental exposure modeling and is focused on determining the level of adverse effect expected to occur once exposure has taken place. Direct effects are based on the anticipated level of mortality and sublethal effects (e.g., reduced growth) likely to occur in exposed individuals. Indirect effects are based on the impact a listed species is likely to experience when the organisms they rely on, such as those that act as food or habitat resources, are exposed to methomyl and experience adverse effects.

We consider estimated concentrations of methomyl 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 methomyl can vary greatly among different regions and aquatic habitat types (e.g., low flow or low water volume habitats accumulate high levels of methomyl whereas fast flowing or large water volume habitats accumulate only low levels of methomyl). Based on available toxicity data, we anticipate crustaceans are highly sensitive to methomyl and are likely to experience high levels of mortality, even in habitats that only accumulate low levels. While sublethal effects, such as reduced growth or reproduction, are also possible with methomyl exposure, we do not anticipate sublethal effects are likely to occur before the onset of mortality for crustaceans.

We anticipate species that only rely on plant-based resources, such as algae and detritus for food or emergent aquatic vegetation as habitat, are not likely to experience any indirect adverse effects, as available toxicity data in plants indicate no reductions in plant survival or growth are likely to occur with methomyl exposure. In contrast, species that rely on other arthropods for food resources may experience high levels of indirect adverse effects as methomyl exposure will likely reduce the abundance and availability of prey.

We determine the overall toxicity ranking for crustaceans by qualitatively assessing both the expected levels of direct adverse effects (e.g., mortality) and indirect effects (e.g., prey loss). Given that mortality is the most adverse of direct effects to an individual of a species, we assign the most weight to direct adverse effects resulting in mortality when determining the toxicity ranking. As mentioned previously, available toxicity data indicate crustaceans are highly sensitive to methomyl and are likely to experience high levels of mortality, even in habitats that only accumulate low levels, thus all crustaceans will have a high toxicity ranking.

[1] 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 use these terms to link back to the analysis in EPA's BE.

C-A4. Crustaceans: Integration and Synthesis Summaries

**Summary of Crustacean Conclusions**

After reviewing the current status of the species, the environmental baseline for the action area, the effects of the proposed registration of methomyl, and the cumulative effects, it is our biological opinion that the registration of methomyl, as proposed with the inclusion of conservation measures, is not likely to appreciably reduce the survival and recovery of the 28 crustacean species in this Appendix and we provide additional information about these species below. Further, it is our biological opinion that the proposed action is not likely to jeopardize the continued existence of the 28 crustacean species within the Appendix.

In our analysis below, some species that had the same or very similar rationales for their conclusions were grouped together, to increase efficiency and avoid repetition. Relevant information and data unique to each individual species was considered when assigning species to groups and incorporated into the rationales as appropriate. Species-specific information (e.g., environmental baseline, cumulative effects, status of the species, exposure, and toxicity) was considered for all species, including those species in the grouped analyses, and are presented in full in Appendices B and E. Species with rationales that did not fit in a group, or warranted a separate rationale because of their life history, conservation status, or other information indicated that effects could be different, 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 process and analysis for each species remained the same, regardless of the format of the discussion presented below.

## Species with low concern of adverse effects

We group species together that have low concern of adverse effects due to low exposure and low toxicity with high vulnerability in Table 1. For crustaceans, only one species, the Nashville crayfish, meets the criteria for this group based on low exposure and low toxicity with high vulnerability. While we present some specific information about the species in Table 1 below, we provide additional information on vulnerability (including environmental baseline and cumulative effects), exposure, and toxicity in Appendix E. The status of the species accounts can be found in Appendix B.

**Table 1. Crustacean species with low exposure, low vulnerability, and high toxicity if exposed.**

| Scientific Name | Common Name | Vulnerability Ranking | Exposure Ranking | Toxicity Ranking | Determination |
|---|---|---|---|---|---|
| *Orconectes shoupi* | Nashville crayfish | Low | Low | High | No Jeopardy |

The Nashville crayfish is listed as endangered, and it only occurs in the Mill Creek watershed of Tennessee. Nashville crayfish have been found in stream reaches in metropolitan Nashville, and juveniles are found more commonly on stream margins in slower flowing water with aquatic vegetation cover. The Nashville crayfish was proposed for delisting due to recovery (85 FR 59732 59734). The species currently persists in high numbers and exhibits a high degree of resistance to disturbance, indicating that the species has a low susceptibility to threats and high degree of stability. Pesticides are a noted threat to the species, with herbicide and pesticide run-off included as contributing factors to habitat degradation. The Nashville crayfish has a high toxicity ranking for methomyl, indicating that mortality is likely when exposure occurs. However, we anticipate very few individuals are likely to experience adverse effects as the exposure ranking for the Nashville crayfish is low. Total overlap of the species range with use sites is 1.4% and methomyl usage is expected to occur in 0.1% of the species' range annually. The low level of methomyl usage within the Nashville crayfish range is corroborated by the USDA's Census of Agriculture (CoA) data that indicate that low usage of insecticides (of any type) occurred in the past in the counties where these species' ranges occur (0.97% of the species range treated). Thus, despite the high level of toxicity exposed individuals are likely to experience, we anticipate no more than a small number of individuals are likely to be adversely affected.

In summary, we expect a small number of individuals of the Nashville crayfish will likely experience exposure to methomyl in up to 0.97% of its range over the project duration. This low level of exposure is evidenced by the low annual methomyl usage and CoA data indicating any use of insecticides within the range of the Nashville crayfish is low. We expect a small number of individuals will likely die. However, we do not expect that this level of mortality will cause species-level effects due to the species' stable status and ability to withstand current levels of stressors in its environment. Therefore, we do not anticipate the proposed action will appreciably reduce the survival and recovery of the Nashville crayfish in the wild. It is our biological opinion that the proposed action is not likely to jeopardize the continued existence of the Nashville crayfish.

## Species with low exposure (informed by low overlap with agriculture), high vulnerability, and high toxicity

The species in Table 2 are grouped together as they all have low exposure informed by low overlap with agricultural sites where methomyl is registered for use. While we present some specific information about the species in Table 2 below, we provide additional information on vulnerability (including environmental baseline and cumulative effects), exposure, and toxicity in Appendix E. The status of the species accounts can be found in Appendix B.

**Table 2. Crustacean species with low exposure (informed by low overlap with agriculture), high vulnerability, and high toxicity.**

| Scientific Name | Common Name | Vulnerability Ranking | Exposure Ranking | Toxicity Ranking | Total Action Area Overlap | Determination |
|---|---|---|---|---|---|---|
| *Branchinecta sandiegonensis* | San Diego fairy shrimp | High | Low | High | <0.1 | No Jeopardy |
| *Cambarus aculabrum* | Benton County cave crayfish | High | Low | High | 0.5 | No Jeopardy |
| *Cambarus callainus* | Big Sandy crayfish | High | Low | High | 0.2 | No Jeopardy |
| *Cambarus veteranus* | Guyandotte River crayfish | High | Low | High | <0.1 | No Jeopardy |
| *Faxonius peruncus* | Big Creek crayfish | High | Low | High | 2.1 | No Jeopardy |
| *Faxonius quadruncus* | St. Francis River crayfish | High | Low | High | 2.1 | No Jeopardy |
| *Gammarus hyalleloides* | Diminutive amphipod | High | Low | High | 1.9 | No Jeopardy |
| *Gammarus pecos* | Pecos amphipod | High | Low | High | 0.2 | No Jeopardy |
| *Lirceus usdagalun* | Lee County cave isopod | High | Low | High | 0.9 | No Jeopardy |
| *Pacifastacus fortis* | Shasta crayfish | High | Low | High | 1.3 | No Jeopardy |
| *Streptocephalus woottoni* | Riverside fairy shrimp | High | Low | High | 0.9 | No Jeopardy |
| *Stygobromus hayi* | Hay's Spring amphipod | High | Low | High | 0.1 | No Jeopardy |

All species listed in Table 2 have high vulnerability rankings, indicating that they may not be able to withstand additional stressors in their environment, including mortality of individuals from methomyl exposure. Pesticides are a noted threat to the Lee County cave isopod, Benton County cave crayfish, Riverside fairy shrimp, San Diego fairy shrimp, and diminutive amphipod. The species in Table 2 have high toxicity rankings because they occur in low flow or smaller waterbodies where we expect methomyl to occur at higher concentrations. Available toxicity data indicate that aquatic invertebrates, including crustaceans, are highly sensitive to methomyl exposure and are likely to experience high levels of adverse effects (e.g., mortality) if exposed even at low concentrations.

Even though these species are highly vulnerable, individuals are likely to die if exposed, and pesticides are noted as a threat to some of the species in this group, we anticipate, at most, a very small number of individuals are likely to be exposed to methomyl. The species listed in Table 2 above have a low extent of overlap between the action area and their ranges (total overlaps range from <0.1%-2.1%). Furthermore, the total overlap metric we use is a conservative estimate of exposure as it does not fully account for redundancy between use site layers, assumes exposure is occurring in all possible overlapping areas, and does not consider information on past methomyl usage. As such, we expect that exposure of these species to methomyl will occur in an even smaller portion of the species' ranges.

Where available, data describing past methomyl usage generally supports this expectation. The Hays Spring amphipod does not have available CoA data, which broadly reports past total usage of all insecticides. For the Riverside fairy shrimp, the CoA data show 2.3% of the range was treated with any insecticide in the past; however, given that methomyl use sites (i.e., agricultural areas where methomyl is registered to be used) account for only 0.9% of the range, we know this is the highest extent of the range that could be treated with this pesticide. For all other species, the CoA indicated that the portion of the range treated with any insecticide, up to 0.1% of the species' ranges, was lower than the total overlap with methomyl use sites.

Given the conservative overlap assumptions, low level of overlap of the species' ranges with the action area, and low levels of past insecticide usage based on CoA data, we anticipate only low levels of exposure will occur for the species in this group. Thus, while these species' vulnerabilities and toxicity rankings are high, we have high confidence that no more than small numbers of individuals of these species are likely to be exposed to methomyl, and exposure will be limited to small portions of the species ranges that overlap with use sites. Therefore, we determine the overall risk of adverse effects to these species is low. While we anticipate low levels of mortality, the proposed action is not likely to appreciably reduce the survival and recovery of these crustacean species in the wild. It is our biological opinion that the proposed action is not likely to jeopardize the continued existence of the species listed in Table 2.

## Species with low exposure (confirmed by low past usage from USDA Census of Agriculture), high vulnerability, and high toxicity

The species in Table 3 are grouped together because we expect low exposure (% range treated) confirmed by low levels of past insecticide usage within their ranges, as informed by the USDA's Census of Agriculture (CoA) data. While we present some specific information about the species in Table 3 below, we provide additional information on vulnerability (including environmental baseline and cumulative effects), exposure, and toxicity in Appendix E. The status of the species accounts can be found in Appendix B.

**Table 3. Species with low exposure (confirmed by low past usage from USDA Census of Agriculture), high vulnerability, and high toxicity.**

| Scientific Name | Common Name | Vulnerability Ranking | Exposure Ranking | Toxicity Ranking | % Range Treated | Determination |
|---|---|---|---|---|---|---|
| *Antrolana lira* | Madison Cave isopod | High | Low | High | 3.3 | No Jeopardy |
| *Gammarus desperatus* | Noels amphipod | High | Low | High | 3.1 | No Jeopardy |
| *Stygobromus (=Stygonectes) pecki* | Peck's Cave amphipod | High | Low | High | 2.1 | No Jeopardy |
| *Thermosphaeroma thermophilus* | Socorro isopod | High | Low | High | 0.7 | No Jeopardy |

All species in Table 3 have high vulnerability rankings, indicating that they may not be able to withstand additional stressors in their environment, including mortality of individuals from methomyl exposure. Specifically, pesticides are a noted threat to all these species. The species in Table 3 also have high toxicity rankings because they occur in low flow or smaller waterbodies where we expect methomyl to occur at higher concentrations. Available toxicity data indicate that aquatic invertebrates, including crustaceans, are highly sensitive to methomyl exposure and are likely to experience high levels of adverse effects (e.g., mortality) if exposed even at low concentrations.

While species in Table 3 are highly vulnerable, individuals are likely to die if exposed, and pesticides are noted as a threat, we anticipate only a small number of individuals are likely to be exposed to methomyl given the low insecticide usage in the past across their ranges. Low CoA usage indicates that very little insecticide usage (of any type) occurred in the past in the counties where these species' ranges occur. Given that this reporting broadly includes all insecticide usage, we consider CoA data to be conservative estimates of methomyl usage that indicate very little of the species' ranges are likely to be treated. In addition, the Madison Cave isopod and Peck's Cave amphipod occur in cave systems, and we do not expect adverse effects to these species through groundwater penetration due to methomyl's low persistence in water. We expect recharge of karst cave systems, or the process of aboveground water reaching the groundwater supply, will often take weeks to months, at which point we expect methomyl to be degraded and no longer present in the water as it enters the cave. The Noels amphipod is extant in only isolated locations on Bitter Lake National Wildlife Refuge in New Mexico (USFWS 2020) where we expect methomyl usage is unlikely to occur. Its population numbers are unknown, although the species has remained stable at known occupied sites. The Socorro isopod is found in the wild in thermal springs and as a captive population near Socorro, New Mexico. Known or presumed occupied sites are near agriculture, but very little of its range and lands nearby (0.7% overlap with the action area) have been treated with any insecticide in the past.

We have high confidence that there is a low extent of exposure for these species and only a small number of individuals may be affected. While individuals are likely to die when exposed, and pesticides are noted as a threat to the species in this group, we determine the overall risk of adverse effects of methomyl to these species is low and losses of small numbers of individuals from the proposed action will not likely appreciably reduce the survival and recovery of these crustacean species in the wild. Therefore, it is our biological opinion that the proposed action is not likely to jeopardize the continued existence of the species listed in Table 3.

**References:**

U.S. Fish and Wildlife Service. 2020. Noel's amphipod (*Gammarus desperatus*), Koster's springsnail (*Juturnia kosteri*), Roswell springsnail (*Pyrgulopsis roswellensis*), and Pecos assiminea (*Assiminea pecos*) 5-Year Review: Summary and Evaluation. Albuquerque, New Mexico. 13 pp.

## Species with low exposure (informed by low past usage from the California Department of Pesticide Regulation, Pesticide Use Reporting Data), high vulnerability, and high toxicity

The species in Table 4 are grouped together because they all occur completely within California and have low exposure confirmed by low levels of past methomyl usage within their ranges (% range treated), as informed by the California Department of Pesticide Regulation Pesticide Use Reporting (CalPUR) data. While we present some specific information about the species in Table 4 below, we provide additional information on vulnerability (including environmental baseline and cumulative effects), exposure, and toxicity in Appendix E. The status of the species accounts can be found in Appendix B.

**Table 4. Crustacean species with low exposure (informed by low past usage from the California Department of Pesticide Regulation, Pesticide Use Reporting Data), high vulnerability, and high toxicity.**

| Scientific Name | Common Name | Vulnerability Ranking | Exposure Ranking | Toxicity Ranking | % Range Treated | Determination |
|---|---|---|---|---|---|---|
| *Branchinecta conservatio* | Conservancy fairy shrimp | High | Low | High | 1.1 | No Jeopardy |
| *Branchinecta longiantenna* | Longhorn fairy shrimp | High | Low | High | 1.5 | No Jeopardy |
| *Syncaris pacifica* | California freshwater shrimp | High | Low | High | <0.1 | No Jeopardy |

All the species in Table 4 have high vulnerability rankings, indicating that they may not be able to withstand additional stressors in their environment, including mortality of individuals from methomyl exposure. Pesticides are noted as a threat to the California freshwater shrimp and the Conservancy fairy shrimp. All the species listed in Table 4 also have high toxicity rankings because they occur in low flow or smaller waterbodies where we expect methomyl to occur at higher concentrations. Available toxicity data indicate that aquatic invertebrates, including crustaceans, are highly sensitive to methomyl exposure and are likely to experience high levels of adverse effects (e.g., mortality) if exposed even at low concentrations.

While species in Table 4 are highly vulnerable and individuals are likely to die if exposed, we anticipate only a small number of individuals are likely to be exposed to methomyl given that CalPUR data indicate low usage within their ranges. These species have high percent overlap between the action area and their ranges (approximately 6 to 31%). However, mandatory pesticide usage reporting data collected by the state of California indicates very little methomyl has been used in the agricultural areas where these species' ranges occur (i.e., conservancy fairy shrimp =1.1%, longhorn fairy shrimp =1.5%, California freshwater shrimp = <0.1%). Given that usage reporting is mandated by the state of California and that this data is provided regularly with relatively high spatial resolution, we have high confidence that only a small percent of the species' ranges is likely to be exposed to methomyl.

We have high confidence that there is a low extent of exposure for these species and only a small number of individuals may be affected. While individuals are likely to die when exposed, and pesticides are noted as a threat to two of the species in this group, we determine the overall risk of adverse effects of methomyl to these species is low and losses of small numbers of individuals from the proposed action will not likely appreciably reduce the survival and recovery of these crustacean species in the wild. It is our biological opinion that the proposed action is not likely to jeopardize the continued existence of the species listed in Table 4.

# Species with Individual Integration and Synthesis summaries

For species in Table 5, our preliminary exposure and toxicity rankings indicated that the proposed action may result in moderate to high adverse effects. As such, we discuss each species in more detail in individual Integration and Synthesis summaries below. In some cases, we modified initial exposure and toxicity rankings due to additional information regarding exposure and effects for individual species, as described below.

**Table 5. Crustaceans with moderate to high adverse effects anticipated from the proposed action. We addressed each species in individual Integration and Synthesis summaries.**

| Scientific Name | Common Name | Determination |
|---|---|---|
| *Palaemonias alabamae* | Alabama cave shrimp | No Jeopardy |
| *Palaemonias ganteri* | Kentucky cave shrimp | No Jeopardy |
| *Gammarus acherondytes* | Illinois cave amphipod | No Jeopardy |
| *Palaemonetes cummingi* | Squirrel Chimney Cave shrimp | No Jeopardy |
| *Branchinecta lynchi* | Vernal pool fairy shrimp | No Jeopardy |
| *Lepidurus packardi* | Vernal pool tadpole shrimp | No Jeopardy |
| *Cambarus williami* | Brawley Fork crayfish | No Jeopardy |
| *Cambarus cracens* | Slenderclaw crayfish | No Jeopardy |

# Integration and Synthesis Summary: Alabama cave shrimp

| Scientific Name: | Common Name: | Entity ID: |
|---|---|---|
| *Palaemonias alabamae* | Alabama cave shrimp | 480 |

## Species Overview

In reviewing the status of the species, the environmental baseline for the action area, cumulative effects, and the effects of the action, we determined that the species' vulnerability is high, anticipated exposure to methomyl is low, and toxicity is high within the action area across the species' range, as described in the following sections. After adding the effects of the action and cumulative effects to the environmental baseline, and in light of the status of the species, we determined the proposed action, with the incorporation of conservation measures, is not likely to appreciably reduce the survival and recovery of the Alabama cave shrimp in the wild. Thus, it is our biological opinion that the proposed action is not likely to jeopardize the continued existence of the Alabama cave shrimp. We discuss our rationale for the species in the sections below.

## Species range

Based on range map dated: 3/23/2023; Wherever found; *States within the range:* AL. Figure 1 depicts the species' range.

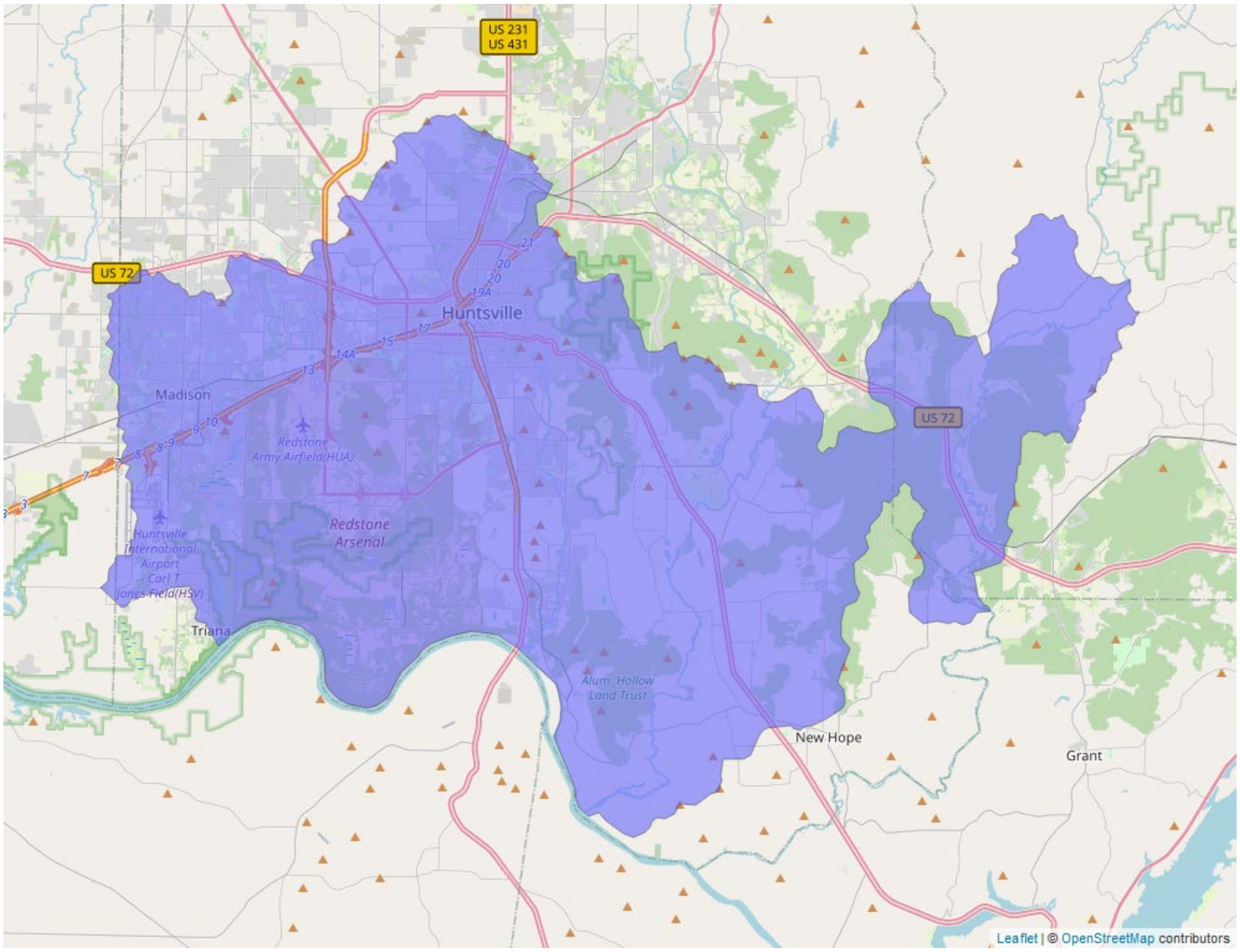


**Figure 1. Range map of Alabama cave shrimp (blue polygons). Range map accessed at https://ecos.fws.gov/ecp/species/5307.**

## Vulnerability

As mentioned above, vulnerability considers the present condition of the species to determine its vulnerability to additional stressors. Here, 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, as summarized below.

**Summary of status**

**Listing status:** Endangered

**Most recent 5-Year Review recommendation:** No change in Status

**Most recently completed 5-Year Review:** 5/24/2023

**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:** No

**Environmental Baseline/Cumulative Effects (EB/CE) Summary**

Alabama cave shrimp are cave-dwelling crustaceans found in caves in Madison and Jackson Counties, Alabama. As of 2023, they are known from five populations: Bobcat Cave, Hering/Glover/Brazelton Caves complex, Muddy Cave, Shelta Cave, and Fern Cave on the Wheeler National Wildlife Refuge. Populations are considered stable, but they fluctuate between years. The shrimp has not been documented in Shelta Cave since 1973 and it may be extirpated there; the two pit entrances to Shelta Cave are owned by the National Speleological Society and are gated to control activity in the cave. Bobcat Cave is located on Redstone Arsenal, under the control of the U.S. Army, and as with Muddy Cave and Fern Cave, access is restricted. Brazelton, Glover and Hering Caves are on private land. Surveys conducted between 2012-2019 confirmed extant populations from Fern Cave, Muddy Cave, Hering Cave, and Bobcat Cave (USFWS 2023). The species is believed to have a low reproductive capability from surveys and monitoring efforts done in the 1970s (USFWS 2016).

The primary threat to this species is groundwater contamination, which comes from nearby residential and industrial development. They are vulnerable to stochastic events like toxic spills, changes in flow regime, and changes to aquifer recharge due to pumping for public water supply or irrigation. Insecticides (e.g., chlordane and dichloro-diphenyl-trichloroethane (DDT), dichloro-diphenyl-dichloroethylene (DDE), and dichloro-diphenyldichloroethane (DDD), all of which are highly persistent in the environment) have been detected at concerning levels in sediment from Shelta Cave. Both Shelta and Bobcat caves are within the Huntsville Spring Branch and Indian Creek drainages, known areas of past DDT contamination. In any area where sinkholes occur, surface pollutants can easily and rapidly enter the sub-surface aquifer where shrimp live. The Alabama cave shrimp occurs with the southern cavefish (*Typhlichthys subterraneus*), cave salamander (*Gyrincthilus palleucus*), and cave crayfish (*Avitiacambarus jonesi*) in some areas, all three of which may prey upon young Alabama cave shrimp. Its small population levels and low reproductive capabilities are natural limitations to the ability of this species to recover from any adversity (USFWS 2016, 2023).

**Overall Vulnerability:** High

## Effects of the Action: Exposure

### Overlap

We do not expect listed crustacean species will occur on-field, and thus expect exposure will only result from off-field transport via spray drift or runoff. Given that the ranges for listed aquatic species are generally delineated using the relevant HUC 12 watersheds, we anticipate that all residues that leave use sites will be collected in the waterbodies 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. We use on-field overlaps with the species' range without a buffer as an estimate of the extent of exposure that's likely to occur. We expect up to 22.3% of the species' range will contain use sites (Table 6).

### Usage

Past usage data indicate that up to 1.2% of the species' range has been treated with methomyl annually (Table 6). Use layers with the highest usage include soybeans (0.9%) and cotton (0.2%).

**Table 6. Overlap and usage data for the Alabama cave shrimp.**

| Use Layer | Use Site Overlap (% range) | % Range Treated (On-field) |
|---|---|---|
| Alfalfa | <0.1 | <0.1 |
| Citrus | NA | NA |
| Corn | 12.1 | 0.6 |
| Cotton | 4.8 | 0.2 |
| Other Grains | 0.2 | <0.1 |
| Other Orchards | <0.1 | <0.1 |
| Other Row Crops | <0.1 | <0.1 |
| **Soybeans**[2] | 17.2 | 0.9 |
| Vegetables and Ground Fruit | <0.1 | 0.1 |
| Wheat | NA | NA |
| **Total** | **22.3** | **1.2** |

[2]We expect corn and soybean use sites are highly redundant with each other and only use the higher of the two layers in our calculation of total percent overlap and total percent treated range.

**Additional Exposure Considerations**

One occupied cave, Bobcat Cave, was returned to an unmanaged state and both cattle and agricultural practices were removed to protect the groundwater from contamination. Several other caves, including Muddy Cave, are locally influenced by agricultural fields, pasture, and ranches (USFWS 2016).

The karst habitats occupied by this species are susceptible to groundwater contamination from surface runoff because of the rapid penetration of karst rock and little natural filtration. However, we expect recharge of karst cave systems, or the process of aboveground water reaching the groundwater supply, will often take weeks to months, at which point we expect methomyl to be degraded and no longer present in the water as it enters the cave due to its low persistence in the environment.

**Exposure Summary**

While we anticipate a relatively high level of overlap between the action area and the species' range (22.3% overlap), we anticipate that only up to 1.2% of the species' range will likely be treated annually, which we consider a low level of usage. However, given its low persistence, we do not expect methomyl will reach groundwater at depths where this species is found. Thus, we determine the overall exposure ranking is low. As such, we anticipate a small number of individuals are likely to experience exposure.

**Overall Exposure**: Low

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Conservation Measures:

**Rain restriction:** The methomyl label has language designed to reduce the likelihood of pesticide runoff from use sites which is the following: "Do not apply during rain. Do not apply when soil in the area to be treated is saturated (if there is standing water on the field or if water can be squeezed from soil) or if NOAA/National Weather Service predicts a total rainfall of 1 inch or greater over the 48 hours following the day of application, only considering a 48-hour period when, at any point during the 48-hour period, the precipitation potential is 50% or greater. Detailed National Weather Service forecasts for local weather conditions should be obtained on-line at: www.weather.gov or by contacting your local National Weather Service Forecasting Office." This rain restriction language provides for a reduction in the concentration of methomyl in aquatic habitats by providing time for methomyl to degrade before runoff into aquatic habitats can occur, decreasing exposure and risk.

**Aquatic habitat buffers:** The methomyl label also has language to reduce the likelihood of pesticide spray drift from use sites specifically to nearby aquatic habitats. The label language states "Do not apply by ground equipment within 25 feet, or by air within 100 feet, of lakes, reservoirs, rivers, estuaries, commercial fish ponds and natural, permanent streams, marshes or natural, permanent ponds" for which vernal pools would be included.

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## Effects of the Action: Toxicity

**Direct Effects:**

Based on toxicity data for aquatic invertebrates, we expect that exposure to methomyl from runoff or spray drift deposition will result in mortality of any individuals exposed.

**Indirect Effects:**

We do not expect that methomyl exposure will result in adverse effects to aquatic plants, including the types of algae and plants that provide food and shelter for the species.

**Toxicity Summary**

Given the high sensitivity of aquatic invertebrates to methomyl at estimated environmental concentrations, we anticipate all individuals exposed to methomyl will die.

**Overall Toxicity:** High

## Effects of the Action Summary

The Alabama cave shrimp has a low exposure ranking. A high portion of the species' range overlaps with the action area (22.3%) and past usage data indicate very little of the range has been treated in the past (up to 1.2% annually) with methomyl. However, we do not expect methomyl to persist long enough in the environment to reach groundwater at depths where this species is found. We expect any individuals that are exposed to methomyl are likely to die as available toxicity data indicate that crustaceans are highly sensitive to methomyl at estimated environmental concentrations. As such, we anticipate a small number of individuals are likely to experience adverse effects from the proposed action.

## Conclusion

The Alabama cave shrimp is a narrow endemic cave-dwelling crustacean found in Madison and Jackson Counties, Alabama. There are five known populations, one of which may be extirpated. Population estimates are unknown, but they are believed to fluctuate annually, and some may be stable. They feed on plant material and are threatened by groundwater contamination and changes to flow regime. Insecticides have been detected at concerning levels in their habitat in the past, but those chemicals were so persistent in the environment that they were banned by the EPA. The species has a high vulnerability ranking.

Alabama cave shrimp have a high toxicity ranking because we expect any direct exposure to result in mortality. Even though a high percentage of the action area overlaps with the species' range (22.3%) and more of the range could receive treatment in the future, past annual methomyl usage occurred on a low percentage of the range (1.2%) and the label includes two conservation measures that would reduce the likelihood of methomyl exposure for this species (i.e., rain restrictions and aquatic habitat buffers). Some occupied caves occur on private lands where there are no protections in place, but many caves are protected, and access is restricted. However, while caves near agricultural fields are susceptible to groundwater contamination, we do not expect methomyl to be present in water as it enters the cave due to its short persistence in the environment. As such, we determined the species has a low exposure ranking and we anticipate that only a small number of individuals will experience exposure from the proposed action.

In summary, we expect low methomyl exposure to occur to a small number of individuals over the duration of the proposed action. Even though the species is highly vulnerable and the overlap with methomyl use sites is high, we do not expect methomyl to persist long enough in the environment to reach groundwater at depths where this species is found, only a small portion of the species' range has been treated with methomyl in the past, and two conservation measures (i.e., rain restrictions and aquatic habitat buffers) will reduce the likelihood of methomyl reaching aquatic habitats. We expect the small number of individuals exposed will not cause 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 likely to appreciably reduce the survival and recovery of the Alabama cave shrimp. Thus, it is our biological opinion that the proposed action is not likely to jeopardize the continued existence of the Alabama cave shrimp.

## References

U.S. Fish and Wildlife Service. 2023. Alabama Cave Shrimp (*Palaemonias alabamae*) 5-Year Review: Summary and Evaluation. Daphne, Alabama. 13 pp.

U. S. Fish and Wildlife Service. 2016. Alabama Cave Shrimp (*Palaemonias alabamae*) 5-Year Review: Summary and Evaluation. Daphne, Alabama. 22 pp.

## Integration and Synthesis Summary: Kentucky cave shrimp

| Scientific Name: | Common Name: | Entity ID: |
|---|---|---|
| *Palaemonias ganteri* | Kentucky cave shrimp | 482 |

### Species Overview

In reviewing the status of the species, the environmental baseline for the action area, cumulative effects, and the effects of the action, we determined that the species' vulnerability is high, anticipated exposure to methomyl is low, and toxicity is high within the action area across the species' range, as described in the following sections. After adding the effects of the action and cumulative effects to the environmental baseline, and in light of the status of the species, we determined the proposed action, with the inclusion of conservation measures, is not likely to appreciably reduce the survival and recovery of the Kentucky cave shrimp in the wild. Therefore, it is our biological opinion that the proposed action is not likely to jeopardize the continued existence of the Kentucky cave shrimp. We discuss our rationale for the species in the sections below.

### Species range

Based on range map dated: 4/28/2016; Wherever found; *States within the range:* KY. Figure 2 depicts the species' range.

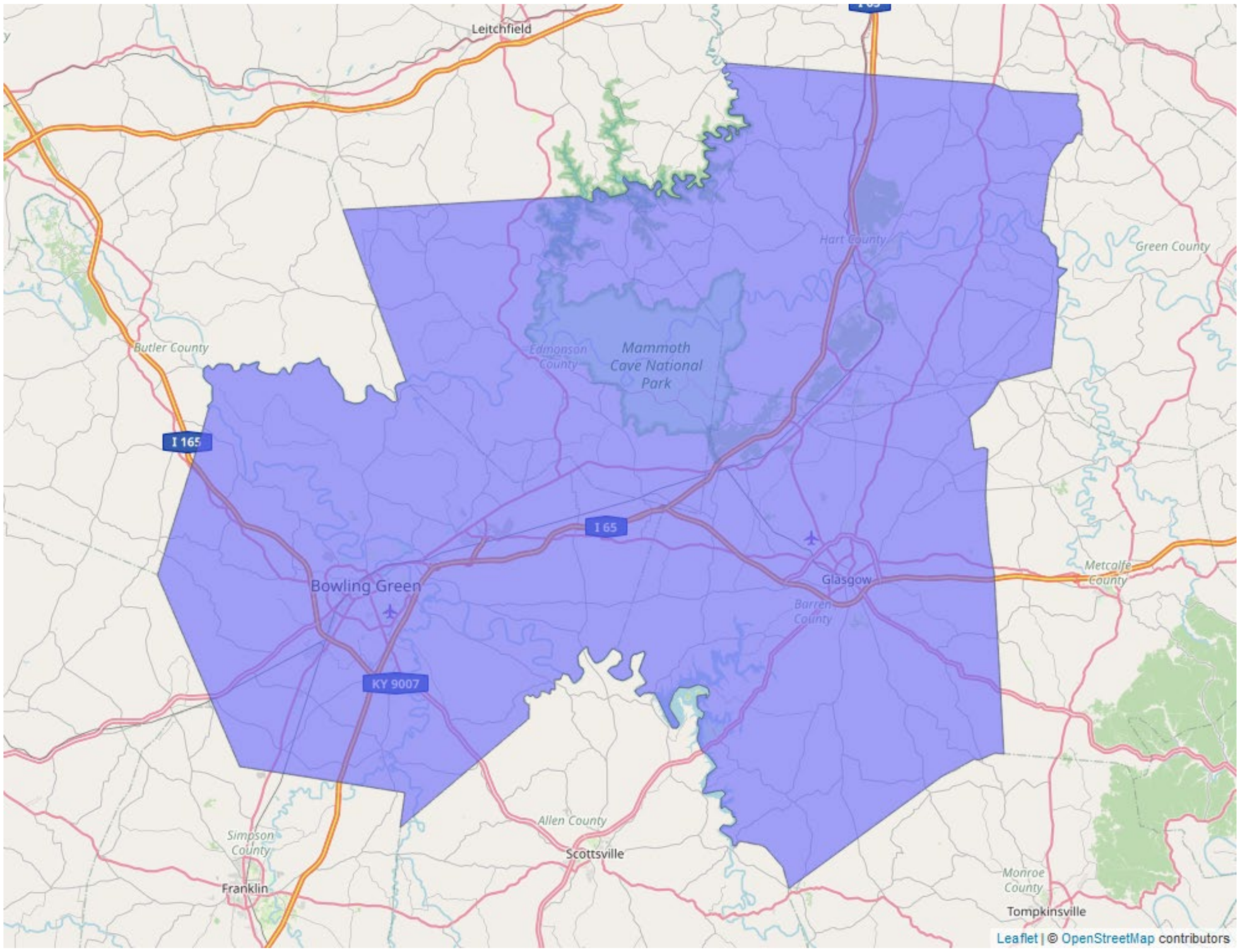


**Figure 2. Range map of Kentucky cave shrimp (blue polygons). Range map accessed at https://ecos.fws.gov/ecp/species/5008.**

## Vulnerability

As mentioned above, vulnerability considers the present condition of the species to determine its vulnerability to additional stressors. Here, 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, as summarized below.

**Summary of status**

**Listing status:** Endangered

**Most recent 5-Year Review recommendation:** No change in Status

**Most recently completed 5-Year Review:** 4/27/2022

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

**Number of populations:** Multiple populations (few)

**Species trends:** Unknown population trends

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

**Environmental Baseline/Cumulative Effects (EB/CE) Summary:**

Kentucky cave shrimp occur in large, base level passages of caves in Kentucky. They occupy 11 groundwater basins, nine of which occur wholly or partially within Mammoth Cave National Park. All occupied groundwater basins are connected to and influenced by the Green River. Reproduction appears to be continual and not seasonal, but it may be related to flooding events and the subsequent additional food supply (USFWS 2022). From surveys in the 1990s, estimates of shrimp density ranged from 0.0006 shrimp/$m^2$ to 0.262 shrimp/$m^2$. Last documented population estimates were in the 1988 recovery plan and ranged from 50 individuals in Mile 205.7 Spring to 5,000-10,000 in Pike Spring (USFWS 1988). As of 2022, we believe population abundances are low (USFWS 2022).

The greatest threat to Kentucky cave shrimp is groundwater contamination. Sources of this contamination include random traffic accidents (e.g., trucks carrying toxic chemicals) along Interstate 65 and other local highways; oil and gas activities; agriculture; permitted discharges from industry, wastewater treatment plants, and other sources; and general nonpoint-source pollution. Examples of contamination from toxic spills were presented in the recovery plan (USFWS 1988), including a cresol spill (an organic compound commonly used as a disinfectant or deodorizer), a spill of hazardous synthetic solvents, and a train derailment that threatened to send approximately 3,400 liters (900 gallons) each of an unidentified pesticide and methyl alcohol into the cave systems. Fortunately, in each of these cases, state and federal authorities were able to successfully contain the spill prior to leakage into groundwater systems. Traffic accidents continue to represent a threat to the species as truck traffic along I-65 and other local highways has increased over time. According to Kentucky Department of Wildlife, nonpoint-source impacts on groundwater in Kentucky are caused primarily by agriculturally related nutrients and pesticides. Pollutants of concern include nitrates (from fertilizer application, manure storage and application, and animal feeding operations), and pesticides (USFWS 2010). Because of the extensive karst systems in the Mammoth Cave region, pollutants associated with these contaminant sources can quickly enter groundwater basins through sinkholes, sinking streams, and other karst features and travel rapidly downstream to where they can adversely affect cave shrimp populations. They may also be negatively affected by climate change, particularly through changes in water temperature, dissolved oxygen, recharge rates, hydrological regime, groundwater levels, and groundwater quality (USFWS 2022).

In total, 18% of the occupied groundwater basin acreages occurs inside of the National Park, which provides some level of protection. Permanent protection has been achieved for three occupied groundwater basins – Echo River Spring, Ganter Spring and Running Branch Spring. The latter two basins lie entirely within Mammoth Cave National Park, and except for a small area along its southeastern border, most of the Echo River Spring groundwater basin also occurs within the park. Portions of three other basins (Mile 205.7 Spring, Pike Spring, and Turnhole Spring) are afforded some protection because they occur within the park (USFWS 2022).

**Overall Vulnerability:** High

## Effects of the Action: Exposure

### Overlap

We do not expect listed crustacean species will occur on-field, and thus expect exposure will only result from off-field transport via spray drift or runoff. Given that the ranges for listed aquatic species are generally delineated using the relevant HUC 12 watersheds, we anticipate that all residues that leave use sites will be collected in the waterbodies 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. We use on-field overlaps with the species' range without a buffer as an estimate of the extent of exposure that's likely to occur. We expect up to 16.9% of the species' range will contain use sites (Table 7).

### Usage

Past usage data indicate that up to 1.4 % of the species' range has been treated with methomyl annually (Table 7). Use Layers with the highest usage include soybeans (0.8%) and other row crops (0.5%).

**Table 7. Overlap and usage data for the Kentucky cave shrimp.**

| Use Layer | Use Site Overlap (% range) | % Range Treated (On-field) |
|---|---:|---:|
| Alfalfa | 0.5 | 0.1 |
| Citrus | NA | NA |
| Corn | 14 | 0.7 |
| Cotton | <0.1 | <0.1 |
| Other Grains | 0.3 | <0.1 |
| Other Orchards | <0.1 | <0.1 |
| Other Row Crops | 1.1 | 0.5 |

| Use Layer | Use Site Overlap (% range) | % Range Treated (On-field) |
|---|---|---|
| **Soybeans**[3] | 15 | 0.8 |
| Vegetables and Ground Fruit | <0.1 | <0.1 |
| Wheat | NA | NA |
| **Total** | **16.9** | **1.4** |

**Additional Exposure Considerations**

The species is afforded some protection from groundwater pollution and habitat disturbance because 4 of the 11 occupied groundwater basins occur entirely within Mammoth Cave National Park and an additional 5 basins occur partially within the park. While these basins, or portions of basins, are managed in a way to protect underground resources, they only comprise approximately 18% of the total acreage of occupied groundwater basins.

The karst habitats occupied by this species are susceptible to groundwater contamination from surface runoff because of the rapid penetration of karst rock and little natural filtration. However, we expect recharge of karst cave systems, or the process of aboveground water reaching the groundwater supply, will often take weeks to months, at which point we expect methomyl to be degraded and no longer present in the water as it enters the cave due to its low persistence in the environment.

**Exposure Summary**

While we anticipate a relatively high level of overlap between the action area and the species' range (16.9% overlap), we anticipate that only up to 1.4% of the species' range will likely be treated annually with methomyl, which we consider a low level of usage. However, given its low persistence, we do not expect methomyl will reach groundwater at depths where this species is found. Thus, we determine the overall exposure ranking is low. As such, we anticipate a small number of individuals are likely to experience exposure.

**Overall Exposure**: Low

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**Conservation Measures:**
**Rain restriction:**
The methomyl label has language designed to reduce the likelihood of pesticide runoff from use sites which is the following: "Do not apply during rain. Do not apply when soil in the area to be treated is saturated (if there is standing water on the field or if water can be squeezed from soil) or if NOAA/National Weather Service predicts a total rainfall of 1 inch or greater over the 48 hours following the day of application, only considering a 48-hour period when, at any point

[3] We expect corn and soybean use sites are highly redundant with each other and only use the higher of the two layers in our calculation of total percent overlap and total percent treated range.

during the 48-hour period, the precipitation potential is 50% or greater. Detailed National Weather Service forecasts for local weather conditions should be obtained on-line at: www.weather.gov or by contacting your local National Weather Service Forecasting Office." This rain restriction language provides for a reduction in the concentration of methomyl in aquatic habitats by providing time for methomyl to degrade before runoff into aquatic habitats can occur, decreasing exposure and risk.

**Aquatic habitat buffers:** The methomyl label also has language to reduce the likelihood of pesticide spray drift from use sites specifically to nearby aquatic habitats. The label language states "Do not apply by ground equipment within 25 feet, or by air within 100 feet, of lakes, reservoirs, rivers, estuaries, commercial fish ponds and natural, permanent streams, marshes or natural, permanent ponds" for which vernal pools would be included.

## Effects of the Action: Toxicity

**Direct Effects:**

Based on toxicity data for aquatic invertebrates, we expect that exposure to methomyl from runoff or spray drift deposition will result in mortality of any individuals exposed.

**Indirect Effects:**

We do not expect that methomyl exposure will result in adverse effects to algal cells, fungi, and protozoans that are washed in by floodwaters that provide food and shelter for the species.

**Toxicity Summary**

Given the high sensitivity of aquatic invertebrates to methomyl at estimated environmental concentrations, we anticipate all individuals exposed to methomyl will die.

**Overall Toxicity:** High

## Effects of the Action Summary

The Kentucky cave shrimp has a low exposure ranking. A high portion of the species' range overlaps with the action area (16.9%) and past usage data indicate very little of the range has been treated with methomyl in the past (up to 1.4% annually). However, we do not expect methomyl to persist long enough in the environment to reach groundwater at depths where this species is found. We expect any individuals that are exposed to methomyl are likely to die as available toxicity data indicate that crustaceans are highly sensitive to methomyl at estimated environmental concentrations. As such, we anticipate a small number of individuals are likely to experience adverse effects from the proposed action.

## Conclusion

The Kentucky cave shrimp is a narrow endemic cave-dwelling crustacean found in central Kentucky. There are eleven known occupied groundwater basins, all of which are believed to have low density and abundance. They feed on algae and microorganisms and are threatened by groundwater contamination and changes to flow regime. Past contamination primarily has been attributed to agricultural nutrients and pesticides. The species has a high vulnerability ranking.

Kentucky cave shrimp have a high toxicity ranking because we expect any direct exposure to result in mortality. Even though a high percentage of the action area overlaps with the species' range (16.9%) and more of the range could receive treatment in the future, past annual methomyl usage occurred on a low percentage of the range (1.4%) and the label includes two conservation measures that would reduce the likelihood of methomyl exposure for this species (i.e., rain restrictions and aquatic habitat buffers). Known contamination occurred from toxic spills and pesticide runoff, and the 82% of occupied groundwater basins that occurs outside of Mammoth Cave National Park is particularly threatened by contamination. However, while caves near agricultural fields are susceptible to groundwater contamination, we do not expect methomyl to be present in water as it enters the cave due to its short persistence in the environment. As such, we determined the species has a low exposure ranking and we anticipate that a small number of individuals will experience exposure from the Action.

In summary, we expect low methomyl exposure to occur to a small number of individuals over the duration of the proposed action. Even though the species is highly vulnerable and the overlap with methomyl use sites is high, we do not expect methomyl to persist long enough in the environment to reach groundwater at depths where this species is found, only a small portion of the species' range has been treated with methomyl in the past, and two conservation measures (i.e., rain restrictions and aquatic habitat buffers) will reduce the likelihood of methomyl reaching aquatic habitats. We expect the small number of individuals exposed will not cause 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 likely to appreciably reduce the survival and recovery of the Kentucky cave shrimp. Thus, it is our biological opinion that the proposed action is not likely to jeopardize the continued existence of the Kentucky cave shrimp.

## References

U. S. Fish and Wildlife Service. 2022. Kentucky Cave Shrimp (*Palaemonias ganteri*) 5-year review: Summary and Evaluation. Frankfort, Kentucky. 15 pp.

U. S. Fish and Wildlife Service. 2010. Kentucky Cave Shrimp (*Palaemonias ganteri*) 5-year review: Summary and Evaluation. Frankfort, Kentucky. 16 pp.

## C-A4. Crustaceans: Integration and Synthesis Summaries

U. S. Fish and Wildlife Service. 1988. Kentucky Cave Shrimp Recovery Plan. Atlanta, Georgia. 59 pp.

## Integration and Synthesis Summary: Illinois cave amphipod

| Scientific Name: | Common Name: | Entity ID: |
|---|---|---|
| *Gammarus acherondytes* | Illinois cave amphipod | 484 |

### Species Overview

In reviewing the status of the species, the environmental baseline for the action area, cumulative effects, and the effects of the action, we determined that the species' vulnerability is high, anticipated exposure to methomyl is low, and toxicity is high within the action area across the species' range, as described in the following sections. After adding the effects of the action and cumulative effects to the environmental baseline, and in light of the status of the species, we determined the proposed action, with the inclusion of conservation measures, is not likely to appreciably reduce the survival and recovery of the Illinois cave amphipod in the wild. Therefore, it is our biological opinion that the proposed action is not likely to jeopardize the continued existence of the Illinois cave amphipod. We discuss our rationale for the species in the sections below.

### Species range

Based on range map dated: 6/1/2022; Wherever found; *States within the range:* IL. Figure 3 depicts the species' range.

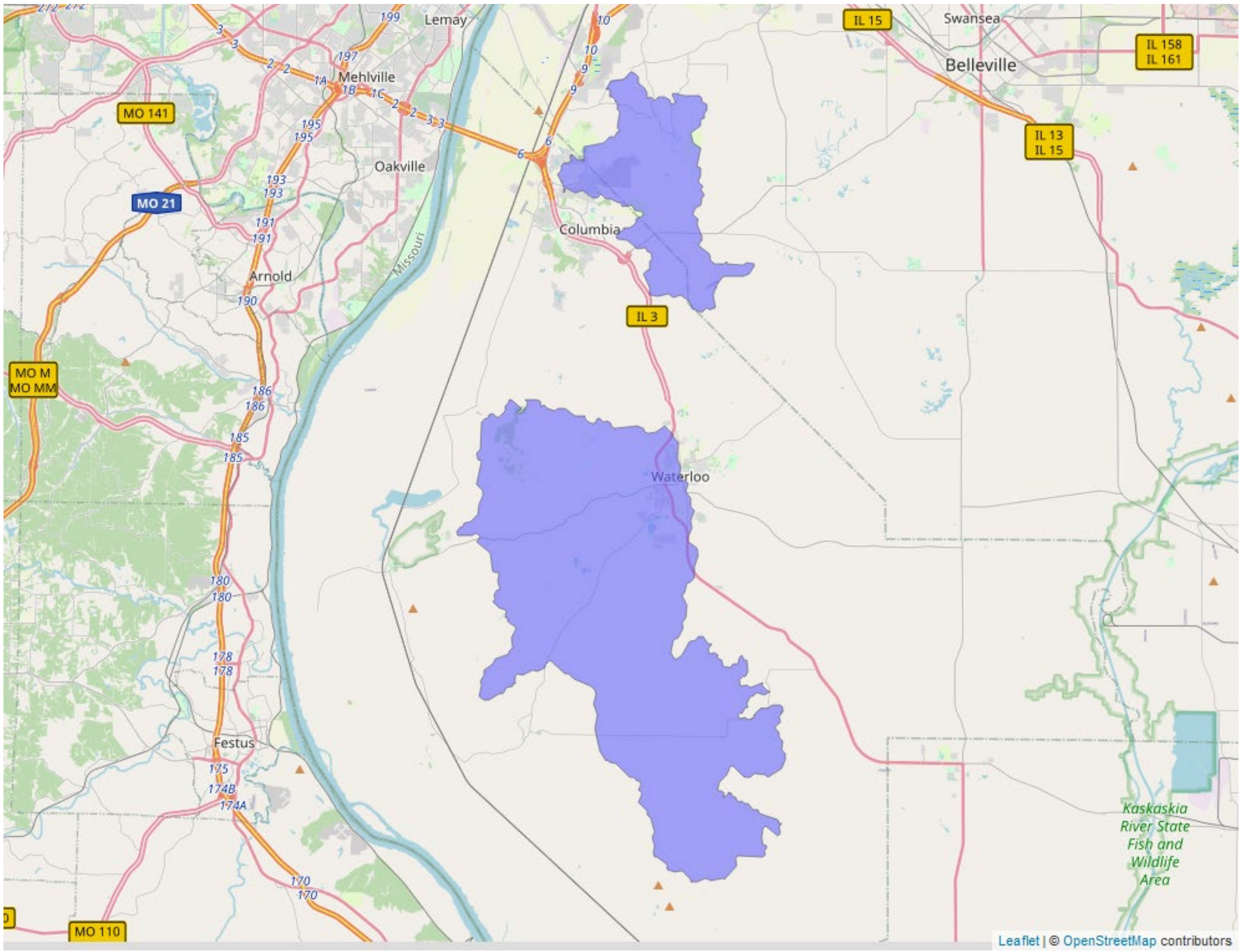


**Figure 3. Range map of Illinois cave amphipod (blue polygons). Range map accessed at https://ecos.fws.gov/ecp/species/8412.**

## Vulnerability

As mentioned above, vulnerability considers the present condition of the species to determine its vulnerability to additional stressors. Here, 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, as summarized below.

**Summary of status**

**Listing status:** Endangered

**Most recent 5-Year Review recommendation:** No change in Status

**Most recently completed 5-Year Review:** 4/14/2020

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

**Number of populations:** Multiple populations (few)

**Species trends:** Unknown population trends

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

**Environmental Baseline/Cumulative Effects (EB/CE) Summary**

Illinois cave amphipods have been collected in mainstream gravel riffles, smaller tributary streams, rimstone pools, and from streams with silt overlying bedrock. As a group, amphipods require cool water temperatures and are intolerant of wide ranges in temperature. Historically, the Illinois cave amphipod occurred in six cave systems in Monroe and St. Clair Counties, Illinois. Its presence has not been reconfirmed in Madonnaville Cave, Monroe County and it appears to be extirpated from Stemler Cave, St. Clair County. We now believe there are 16 occupied cave streams across the Salem Plateau karst region (USFWS 2011, 2020).

The species' survival is threatened by factors affecting shallow karst groundwater, like loss and degradation of groundwater quality resulting from urbanization, agricultural activities, and an influx of human and animal waste. Potential contaminants include agricultural and residential pesticides and fertilizers; human and animal wastes from residential sewage disposal systems and livestock; sedimentation from agricultural and residential runoff; oil well production; surface runoff from roads, storm sewers, and increased surface paving due to urban development; sinkhole dumping of solid waste; and disruption of groundwater flow paths from quarry operations. Land use in the area is dominated by agriculture, with both livestock and row crops interspersed with forested tracts and rural housing. Crops grown in the region include milo, alfalfa, soybeans, wheat, corn, and barley. Excessive visitation to caves and over-collecting for scientific purposes may also threaten the species (USFWS 2011, 2020). Additional threats include predatory fish, non-native greenhouse millipedes (*Oxidus gracilis*), and non-native honeysuckles (*Lonicera* spp.) (USFWS 2020).

Insecticides used on alfalfa include carbaryl, carbofuran, malathion, permethrin, and phosmet and are typically applied in May and again in July or August. Herbicides are applied in April and May (timing is dependent on field conditions) and include alachlor, atrazine, bentazon, chlorimuron, cyanazine, glyphosate, imazaquin, imazethapyr, metolachlor, sethoxydim and trifluralin (M. Roegge, Cooperative Extension Service, University of Illinois, pers. Comm. 1993). Over half of the private sewage disposal systems used in the Sinkhole Plain do not meet State of Illinois minimum requirements for discharge of fecal coliform bacteria and at least 10% of the systems have no treatment at all (Panno et al. 1997). All three sources described above (croplands, livestock, and sewage disposal systems) contribute to relatively high concentrations of nitrates.

**Overall Vulnerability:** High

## Effects of the Action: Exposure

### Overlap

We do not expect listed crustacean species will occur on-field, and thus expect exposure will only result from off-field transport via spray drift or runoff. Given that the ranges for listed aquatic species are generally delineated using the relevant HUC 12 watersheds, we anticipate that all residues that leave use sites will be collected in the waterbodies 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. We use on-field overlaps with the species' range without a buffer as an estimate of the extent of exposure that's likely to occur. We expect up to 46.9% of the species' range will contain use sites (Table 8).

### Usage

Past usage data indicate that up to 2.6% of the species' range has been treated with methomyl annually (Table 8). Use layers with the highest usage include soybeans (2.3%) and vegetables and ground fruit (0.2%).

**Table 8. Overlap and usage data for the Illinois cave amphipod.**

| Use Layer | Use Site Overlap (% range) | % Range Treated (On-field) |
|---|---:|---:|
| Alfalfa | 0.8 | 0.1 |
| Citrus | NA | NA |
| Corn | 43.4 | 2.2 |
| Cotton | <0.1 | <0.1 |
| Other Grains | 0.6 | <0.1 |
| Other Orchards | <0.1 | <0.1 |
| Other Row Crops | <0.1 | <0.1 |
| **Soybeans**[4] | 45.3 | 2.3 |
| Vegetables and Ground Fruit | 0.2 | 0.2 |
| Wheat | NA | NA |
| **Total** | **46.9** | **2.6** |

[4] We expect corn and soybean use sites are highly redundant with each other and only use the higher of the two layers in our calculation of total percent overlap and total percent treated range.

**Additional Exposure Considerations**

The karst habitats occupied by this species are susceptible to groundwater contamination from surface runoff because of the rapid penetration of karst rock and little natural filtration. However, we expect recharge of karst cave systems, or the process of aboveground water reaching the groundwater supply, will often take weeks to months, at which point we expect methomyl to be degraded and no longer present in the water as it enters the cave due to its low persistence in the environment.

**Exposure Summary**

While we anticipate a high level of overlap between the action area and the species' range (46.9% overlap), we anticipate only up to 2.6% of the species' range will likely be treated annually with methomyl, which we consider a low level of usage. However, given its low persistence, we do not expect methomyl will reach groundwater at depths where this species is found. Thus, we determine the overall exposure ranking is low. As such, we anticipate a small number of individuals are likely to experience exposure.

**Overall Exposure**: Low

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**Conservation Measures**

**Rain restriction:** The methomyl label has language designed to reduce the likelihood of pesticide runoff from use sites which is the following: "Do not apply during rain. Do not apply when soil in the area to be treated is saturated (if there is standing water on the field or if water can be squeezed from soil) or if NOAA/National Weather Service predicts a total rainfall of 1 inch or greater over the 48 hours following the day of application, only considering a 48-hour period when, at any point during the 48-hour period, the precipitation potential is 50% or greater. Detailed National Weather Service forecasts for local weather conditions should be obtained on-line at: www.weather.gov or by contacting your local National Weather Service Forecasting Office." This rain restriction language provides for a reduction in the concentration of methomyl in aquatic habitats by providing time for methomyl to degrade before runoff into aquatic habitats can occur, decreasing exposure and risk.

**Aquatic habitat buffers:** The methomyl label also has language to reduce the likelihood of pesticide spray drift from use sites specifically to nearby aquatic habitats. The label language states "Do not apply by ground equipment within 25 feet, or by air within 100 feet, of lakes, reservoirs, rivers, estuaries, commercial fish ponds and natural, permanent streams, marshes or natural, permanent ponds" for which vernal pools would be included.

## Effects of the Action: Toxicity

**Direct Effects:**

Based on toxicity data for aquatic invertebrates, we expect that exposure to methomyl from runoff or spray drift deposition will result in mortality of any individuals exposed.

**Indirect Effects:**

We do not expect that methomyl exposure will result in adverse effects to algae and plankton that provide food for the species.

**Toxicity Summary**

Given the high sensitivity of aquatic invertebrates to methomyl at estimated environmental concentrations, we anticipate all individuals exposed to methomyl will die.

**Overall Toxicity:** High

## Effects of the Action Summary

The Illinois cave amphipod has a low exposure ranking. A high portion of the species' range overlaps with the action area (46.9%) and past usage data indicate little of the range has been treated with methomyl in the past (up to 2.6% annually). However, given its low persistence, we do not expect methomyl will reach groundwater at depths where this species is found.

We expect any individuals that are exposed to methomyl are likely to die as available toxicity data indicate that crustaceans are highly sensitive to methomyl at estimated environmental concentrations. As such, we anticipate a small number of individuals are likely to experience adverse effects from the proposed action.

## Conclusion

The Illinois cave amphipod is a narrow endemic cave-dwelling crustacean found in Monroe and St. Clair Counties, Illinois. There are 16 known occupied cave systems; one additional cave has historical presence and has not been reconfirmed and another is believed to be extirpated. All occupied populations are believed to have low density and abundance. They feed on algae and plankton and are threatened by groundwater contamination and changes to flow regime. Past contamination has been attributed to agricultural and residential pesticides and fertilizers, and the surrounding area is dominated by agricultural land uses (both livestock and row crops) where we expect high use of pesticides. The species has a high vulnerability ranking.

The Illinois cave amphipod has a high toxicity ranking because we expect any direct exposure to result in mortality. Even though a high percentage of the action area overlaps with the species' range (46.9%), past annual methomyl usage occurred on a low percentage of the range (2.6%) and the label includes two conservation measures that would reduce the likelihood of methomyl exposure for this species (i.e., rain restrictions and aquatic habitat buffers). Contamination could occur from the agricultural lands near the occupied caves, which has been described as a primary threat in species' 5-year reviews. However, while caves near agricultural fields are susceptible to groundwater contamination, we do not expect methomyl to be present in water as it enters the cave due to its short persistence in the environment. As such, we determined the species has a low exposure ranking and we anticipate that only a small number of individuals will experience exposure from the proposed action.

In summary, we expect low methomyl exposure to occur to a small number of individuals over the duration of the proposed action. Even though the species is highly vulnerable and the overlap with methomyl use sites is high, we do not expect methomyl to persist long enough in the environment to reach groundwater at depths where this species is found, only a small portion of the species' range has been treated with methomyl in the past, and two conservation measures (i.e., rain restrictions and aquatic habitat buffers) will reduce the likelihood of methomyl reaching aquatic habitats. We expect the small number of individuals exposed will not cause 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 likely to appreciably reduce the survival and recovery of the Illinois cave amphipod. Thus, it is our biological opinion that the proposed action is not likely to jeopardize the continued existence of the Illinois cave amphipod.

## References

U. S. Fish and Wildlife Service. 2011. Illinois Cave Amphipod (*Gammarus acherondytes*) 5-Year Review. Moline, Illinois. 20 pp.

U. S. Fish and Wildlife Service. 2020. Illinois Cave Amphipod (*Gammarus acherondytes*) 5 – Year Review. Moline, Illinois. 9 pp.

# Integration and Synthesis Summary: Kaua‘i cave amphipod

| Scientific Name: | Common Name: | Entity ID: |
|---|---|---|
| *Spelaeorchestia koloana* | Kaua‘i cave amphipod | 485 |

## Species Overview

In reviewing the status of the species, the environmental baseline for the action area, cumulative effects, and the effects of the action, we determined that the species’ vulnerability is high, anticipated exposure to methomyl is low, and toxicity is high within the action area across the species’ range, as described in the following sections. After adding the effects of the action and cumulative effects to the environmental baseline, and in light of the status of the species, we determined the proposed action, with the inclusion of conservation measures, is not likely to appreciably reduce the survival and recovery of the Kaua‘i cave amphipod in the wild. Therefore, it is our biological opinion that the proposed action is not likely to jeopardize the continued existence of the Kaua‘i cave amphipod. We discuss our rationale for the species in the sections below.

## Species range

Based on range map dated: 11/13/2023; Wherever found; *States within the range:* HI. Figure 4 depicts the species’ range.

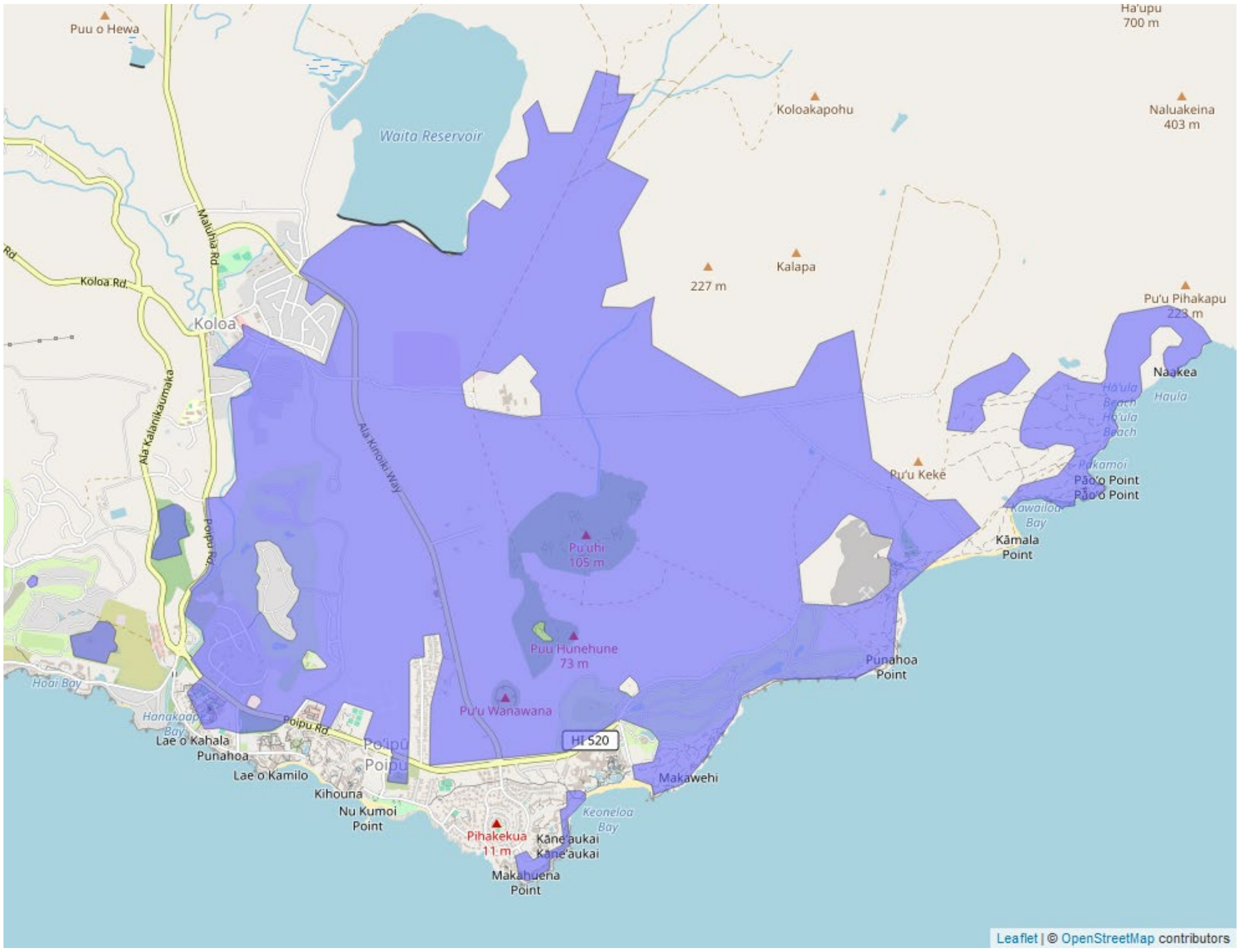


**Figure 4. Range map of Kaua'i cave amphipod (blue polygons). Range map accessed at https://ecos.fws.gov/ecp/species/5766.**

## Vulnerability

As mentioned above, vulnerability considers the present condition of the species to determine its vulnerability to additional stressors. Here, 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, as summarized below.

**Summary of status**

**Listing status:** Endangered

**Most recent 5-Year Review recommendation:** No change in Status

**Most recently completed 5-Year Review:** 7/27/2022

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

**Number of populations:** Multiple populations (few)

**Species trends:** All populations stable, with none known to be increasing or decreasing

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

**Environmental Baseline/Cumulative Effects (EB/CE) Summary**

The Kauaʻi cave amphipod is an obligate cave-dwelling arthropod restricted to the Hawaiian island of Kauaʻi. It has only been found in the Koloa Basin of the island of Kauaʻi where lava tubes and other cave bearing rock are present. Between 2006-2016, the Kauaʻi cave amphipod was frequently observed in six caves that were regularly monitored (USFWS 2017). The population size observed in each cave varied: typically, fewer than 20 individuals were in each of Cave 1927C, Cave 3179, Cave 3075C, and Quarry Cave; 9 to 182 individuals in Cave 1914 (Koloa Cave 2); and 18 to 82 individuals in Kiahuna Mauka Cave (USFWS 2017, 2020). In 2020, the population in Koloa Cave 2 was believed to only have 19 individuals (USFWS 2020). In another two caves where Kauaʻi cave amphipods are infrequently observed (Cave 3075A and Cave 3075B), there were typically fewer than five individuals (USFWS 2017, 2022). Two adults were observed at the Makauwahi Sinkhole on Grove Farm in 2019 (USFWS 2022).

The existence of amphipods in geographically separate areas may make them less vulnerable to catastrophic events that might impact a single cave. Cave ecosystems are affected by the following activities: urban and agricultural development; mining and quarrying; dumping and filling; contamination by surface sources of toxic chemicals from spills, pesticides, and waste disposal which enter caves via streams and/or ground-water seepage; non-native predators; drought; and human visitation and use. Urbanization typically results in large areas being covered by asphalt or other artificial surfaces that lack or have only limited permeability. Reduced local ground water recharge may greatly reduce humidity levels within caves, subterranean cracks, and mesocaverns, degrading or eliminating habitat for the amphipod. Runoff and recharge that contain urban and household pesticides may inadvertently deliver high concentrations of insecticides or other pesticides (e.g., herbicides, fungicides) into cave and mesocavern habitats, with potentially devastating effects on the Kauaʻi cave amphipod. Non-native predators are known to feed on mainland cave-dwelling species (USFWS 1994) and are assumed to compete with resident cave-dwelling animals for common food resources which are already in low supply. The non-native brown violin spider (*Loxosceles rufescens*) may prey upon the Kauaʻi cave amphipod. Web-building spiders, such as the brown violin, may pose a particularly serious threat because webs present a method of predation to which the Kauaʻi cave amphipod is likely not adapted. The introduced lesser brown scorpion (*Isometrus maculatus*) and centipedes (*Scolopendra* spp.) have both been observed in some caves inhabited by the endemic cave-dwelling species and the generalized diet of these predators will include Kauaʻi cave amphipods. All the caves may be threatened by prolonged drought, brought about either by global climatic changes or by local alteration of the vegetation that may reduce rainfall or otherwise result in reduced soil moisture content. Prolonged drought may desiccate the cave interior, making it less accommodating to cave-dwelling animals. Human visitation to and uses of caves are a serious threat (USFWS 2006). Additional threats include invasive plant species, bio-control agents, and flooding (USFWS 2022).

**Overall Vulnerability:** High

## Effects of the Action: Exposure

### Overlap

We do not expect listed crustacean species will occur on-field, and thus expect exposure will only result from off-field transport via spray drift or runoff. Given that the ranges for listed aquatic species are generally delineated using the relevant HUC 12 watersheds, we anticipate that all residues that leave use sites will be collected in the waterbodies 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. We use on-field overlaps with the species' range without a buffer as an estimate of the extent of exposure that's likely to occur. We expect up to 25.3% of the species' range will contain use sites (Table 9).

Table 9. Overlap for the Kaua‘i cave amphipod.

| Use Layer | On-field Overlap (% range) |
|---|---:|
| HI state agriculture layer | 25.3 |

### Usage

Past methomyl usage data in Hawai‘i is unavailable. However, prior reporting data indicate that 8-45% of agricultural crops in Hawai‘i have been treated with insecticides annually, with methomyl presumably being among these insecticides. As these data are island-wide and not spatially explicit, we cannot determine the percent of the species range treated. However, we can broadly use this data as confirmation that methomyl usage likely occurs on the island where this species resides.

### Additional Exposure Considerations

The lava tube habitats occupied by this species are susceptible to groundwater contamination from surface runoff because of the rapid penetration of lava tubes and little natural filtration. In Hawai‘i, rainwater percolates rapidly into porous basalt of which the lava tubes are made. Only where the water table is near the surface is significant water found in the cave. This occurs near the coast (Holthuis 1973, Maciolek & Brock 1974) but in other areas, the water table already lies deep beneath the lava formation (Kiernan and Middleton 2005). Pesticides have been identified as a contaminant of groundwater for this species and they may originate from surface use sites that reach groundwater on which the species depends. However, while the lava tubes occupied by this species are susceptible to groundwater contamination from surface runoff, methomyl is not likely to persist long enough in the environment after it has traveled from the surface to be present in the lava tube reaches where this species is found.

**Exposure Summary**

We anticipate a high level of overlap between the action area and the species' range (25.3% overlap). However, given its low persistence, we do not expect methomyl will be present in the lava tube reaches where this species is found. Thus, we determine the overall exposure ranking is low and we anticipate a small number of individuals are likely to experience exposure.

**Overall Exposure**: Low

**Conservation Measures**

**Rain restriction:** The methomyl label has language designed to reduce the likelihood of pesticide runoff from use sites which is the following: "Do not apply during rain. Do not apply when soil in the area to be treated is saturated (if there is standing water on the field or if water can be squeezed from soil) or if NOAA/National Weather Service predicts a total rainfall of 1 inch or greater over the 48 hours following the day of application, only considering a 48-hour period when, at any point during the 48-hour period, the precipitation potential is 50% or greater. Detailed National Weather Service forecasts for local weather conditions should be obtained on-line at: www.weather.gov or by contacting your local National Weather Service Forecasting Office." This rain restriction language provides for a reduction in the concentration of methomyl in aquatic habitats by providing time for methomyl to degrade before runoff into aquatic habitats can occur, decreasing exposure and risk.

**Aquatic habitat buffers:** The methomyl label also has language to reduce the likelihood of pesticide spray drift from use sites specifically to nearby aquatic habitats. The label language states "Do not apply by ground equipment within 25 feet, or by air within 100 feet, of lakes, reservoirs, rivers, estuaries, commercial fish ponds and natural, permanent streams, marshes or natural, permanent ponds" for which vernal pools would be included.

## Effects of the Action: Toxicity

**Direct Effects:**

Based on toxicity data for aquatic invertebrates, we expect that exposure to methomyl from runoff or spray drift deposition will result in mortality of any individuals exposed.

**Indirect Effects:**

We do not expect that methomyl exposure will result in adverse effects to algae and plankton that provide food for the species.

**Toxicity Summary**

Given the high sensitivity of aquatic invertebrates to methomyl at estimated environmental concentrations, we anticipate all individuals exposed to methomyl will die.

**Overall Toxicity:** High

## Effects of the Action Summary

The Kauaʻi cave amphipod has a low exposure ranking. A high portion of the species' range overlaps with the action area (25.3%). While we cannot estimate prior methomyl usage within the range of this species, we infer from generic insecticide usage data that methomyl usage within the species' range is likely to occur. We expect any individuals that are exposed to methomyl are likely to die as available toxicity data indicate that crustaceans are highly sensitive to methomyl. However, while the lava tubes occupied by this species are susceptible to groundwater contamination from surface runoff, methomyl is not likely to persist long enough in the environment after it has traveled from the surface to be present in the lava tube reaches where this species is found. As such, we anticipate a small number of individuals are likely to experience adverse effects from the proposed action.

## Conclusion

The Kauaʻi cave amphipod is a narrow endemic cave-dwelling crustacean found in six caves across the Koloa Basin of Kauaʻi. The populations in each cave vary from fewer than five to more than one hundred; the largest population, found in Koloa Cave 2, was surveyed in 2020 and only 19 individuals were observed (maximum observed between 2006-2020 was 182 individuals). They feed on algae and plankton and are threatened by human visitation, pesticides and other contamination, drought, urban and agricultural development activities, and non-native predators. The species has a high vulnerability ranking.

Kauaʻi cave amphipods have a high toxicity ranking because we expect any direct exposure to result in mortality. A high percentage of the action area overlaps with the species' range (25.3%) and the label includes two conservation measures that would reduce the likelihood of methomyl exposure for this species (i.e., rain restrictions and aquatic habitat buffers). While lava tube habitats occupied by this species are susceptible to groundwater contamination from surface runoff, we do not expect methomyl will be present in the lava tube reaches where this species is found given its low persistence. We determined the species has a low exposure ranking and we anticipate that a low number of individuals will experience exposure from the proposed action.

In summary, we expect low methomyl exposure to occur to a small number of individuals over the duration of the proposed action. Even though the species is highly vulnerable and the overlap with methomyl use sites is high, we do not expect methomyl to persist long enough in the environment after it has traveled from the surface to be present in the lava tube reaches where this species is found, and two conservation measures (i.e., rain restrictions and aquatic habitat buffers) will reduce the likelihood of methomyl reaching aquatic habitats. We expect the small number of individuals exposed will not cause 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 determined the proposed action is not likely to appreciably reduce the survival and recovery of the Kaua‘i cave amphipod. Thus, it is our biological opinion that the proposed action is not likely to jeopardize the continued existence of the Kaua‘i cave amphipod.

## References

Holthuis, L. B~. 1973. Caridean shrimps found in land-locked saltwater pools at four Indo-west Pacific localities (Sinai Peninsula, Funafuti Atoll, Maui and Hawai‘i Islands), with the description of one new genus and four new species. Zoologische Verhandelingen 128: 48 pp. + 7 pl.

Kiernan, K. and Middleton, G. 2005. Groundwater movement and management in tube-fed lavas. Cave Management in Australasia (15): 41-45.

Maciolek, J. A., and R. E. Brock. 1974. Aquatic survey of the Kona Coast ponds, Hawai‘i Island. Sea Grant Advisory Report UNIHI-SEAGRANT-AR-74-04: 73 pp.

U.S. Fish and Wildlife Service. 2022. Kaua‘i Cave Amphipod (*Spelaeorchestia koloana*) 5- year review summary and evaluation. Honolulu, Hawai‘i. 7 pp.

U.S. Fish and Wildlife Service. 2017. Kaua‘i Cave Amphipod (*Spelaeorchestia koloana*) 5- year review summary and evaluation. Honolulu, Hawai‘i. 7pp.

U.S. Fish and Wildlife Service. 2006. Recovery Plan for the Kaua‘i Cave Arthropods. Portland, Oregon. 76 pp.

# Integration and Synthesis Summary: Squirrel Chimney Cave shrimp

| Scientific Name: | Common Name: | Entity ID: |
|---|---|---|
| *Palaemonetes cummingi* | Squirrel Chimney Cave shrimp | 487 |

## Species Overview

In reviewing the status of the species, the environmental baseline for the action area, cumulative effects, and the effects of the action, we determined that the species' vulnerability is high, anticipated exposure to methomyl is low, and toxicity is high within the action area across the species' range, as described in the following sections. 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, with the inclusion of conservation measures, is not likely to appreciably reduce the survival and recovery of the Squirrel Chimney Cave shrimp. Thus, it is our biological opinion that the proposed action is not likely to jeopardize the continued existence of the Squirrel Chimney Cave shrimp. We discuss our rationale for the species in the sections below.

## Species range

Based on range map dated: 2/18/2022; Wherever found; *States within the range:* FL. Figure 5 depicts the species' range.

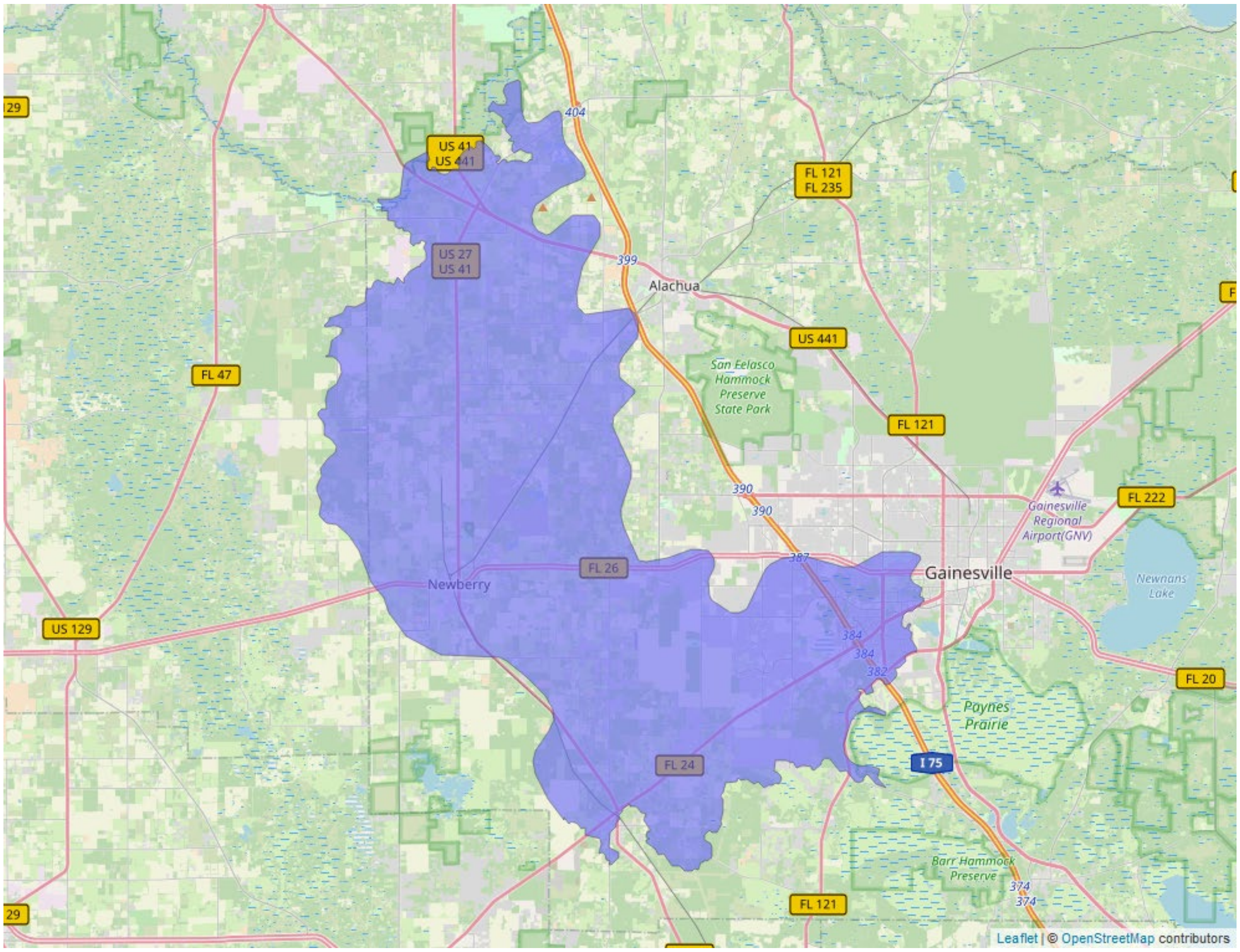


**Figure 5. Range map of Squirrel Chimney Cave shrimp (blue polygons). Range map accessed at https://ecos.fws.gov/ecp/species/1551.**

## Vulnerability

As mentioned above, vulnerability considers the present condition of the species to determine its vulnerability to additional stressors. Here, 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, as summarized below.

**Summary of status**

**Listing status:** Threatened

**Most recent 5-Year Review recommendation:** No change in Status

**Most recently completed 5-Year Review:** 10/5/2021

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

**Number of populations:** Single population

**Species trends:** Unknown population trends

**Pesticides noted in Service documents as a threat to the species:** no

**Environmental Baseline/Cumulative Effects (EB/CE) Summary**

The Squirrel Chimney Cave shrimp is the only cave shrimp found in Florida. It is only known from the Squirrel Chimney Cave, a sinkhole near Gainesville, that occurs on privately-owned land maintained as an oak hammock and pine plantation. The surrounding area is dominated by pasture, agriculture, and planted pines. The Squirrel Chimney Cave and others nearby were last surveyed between 1994-1996. Since the species' discovery in 1953, only a dozen has ever been collected and the last individual was seen in 1973. They may occur in other nearby sites, including Cherry Pits Cave, Herzog Cave, Hog Sink, Bat Cave, but surveys have been conducted and the species was not found. The population is believed to be small, but abundance and trends are unknown. In 1997, we found that a petition to delist the species did not present substantial information indicating that delisting due to extinction was warranted and no new information has been obtained since then about the species' status (USFWS 2021).

Threats to the Squirrel Chimney Cave shrimp include residential and industrial (mining) development, contaminant spills, changes in land use, vandalism, predation by redeye chub, natural droughts, and water withdrawals for human use. Changes in land use in the recharge area can accelerate pollutants delivery to the aquifer system associated with the Squirrel Chimney system. A single act of vandalism or contamination could cause the extinction of the species because it is only known from one location. Natural droughts and water withdrawals for human use can impact cave water levels (USFWS 2021).

**Overall Vulnerability:** High

## Effects of the Action: Exposure

### Overlap

We do not expect listed crustacean species will occur on-field, and thus expect exposure will only result from off-field transport via spray drift or runoff. Given that the ranges for listed aquatic species are generally delineated using the relevant HUC 12 watersheds, we anticipate that all residues that leave use sites will be collected in the waterbodies 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. We use on-field overlaps with the species' range without a buffer as an estimate of the extent of exposure that's likely to occur. We expect up to 10.9% of the species' range will contain use sites (Table 10).

### Usage

Past usage data indicate that up to 3.6% of the species' range has been treated with methomyl annually. Use layers with the highest usage include other row crops (2.2%) and vegetables and ground fruit (1.2%) (Table 10).

**Table 10. Overlap and usage data for the Squirrel Chimney Cave shrimp.**

| Use Layer | Use Site Overlap (% range) | % Range Treated (On-field) |
|---|---:|---:|
| Alfalfa | <0.1 | <0.1 |
| Citrus | NA | NA |
| **Corn**[5] | 1.7 | 0.1 |
| Cotton | 0.6 | <0.1 |
| Other Grains | 2.5 | 0.1 |
| Other Orchards | <0.1 | <0.1 |
| Other Row Crops | 4.9 | 2.2 |
| Soybeans | 0.3 | <0.1 |
| Vegetables and Ground Fruit | 1.2 | 1.2 |
| Wheat | NA | NA |
| **Total** | **10.9** | **3.6** |

### Additional Exposure Considerations

Areas surrounding the only occupied cave are predominantly oak hammock, pine plantations, pasture, and agriculture. Specifically, hay is found near the entrance to the occupied cave entrance and across the species range (Kern et al. 2024). The karst habitats occupied by this species are susceptible to groundwater contamination from surface runoff because of the rapid penetration of karst rock and little natural filtration. However, we expect recharge of karst cave systems, or the process of aboveground water reaching the groundwater supply, will often take weeks to months, at which point we expect methomyl to be degraded and no longer present in the water as it enters the cave due to its low persistence in the environment.

[5]We expect corn and soybean use sites are highly redundant with each other and only use the higher of the two layers in our calculation of total percent overlap and total percent treated range.

**Exposure Summary**

While we anticipate a high level of overlap between the action area and the species' range (10.9% overlap), we anticipate only up to 3.6% of the species' range will likely be treated annually, which we consider a low level of usage. Much of the area surrounding the occupied cave system is oak hammock, pine plantations, pasture, and agriculture. However, given its low persistence, we do not expect methomyl will reach groundwater at depths where this species is found. Therefore, we determine the overall exposure ranking is low and we anticipate a small number of individuals are likely to experience exposure.

**Overall Exposure:** Low

**Conservation Measures:**
**Rain restriction:** The methomyl label has language designed to reduce the likelihood of pesticide runoff from use sites which is the following: "Do not apply during rain. Do not apply when soil in the area to be treated is saturated (if there is standing water on the field or if water can be squeezed from soil) or if NOAA/National Weather Service predicts a total rainfall of 1 inch or greater over the 48 hours following the day of application, only considering a 48-hour period when, at any point during the 48-hour period, the precipitation potential is 50% or greater. Detailed National Weather Service forecasts for local weather conditions should be obtained on-line at: www.weather.gov or by contacting your local National Weather Service Forecasting Office." This rain restriction language provides for a reduction in the concentration of methomyl in aquatic habitats by providing time for methomyl to degrade before runoff into aquatic habitats can occur, decreasing exposure and risk.

**Aquatic habitat buffers:** The methomyl label also has language to reduce the likelihood of pesticide spray drift from use sites specifically to nearby aquatic habitats. The label language states "Do not apply by ground equipment within 25 feet, or by air within 100 feet, of lakes, reservoirs, rivers, estuaries, commercial fish ponds and natural, permanent streams, marshes or natural, permanent ponds" for which vernal pools would be included.

## Effects of the Action: Toxicity

**Direct Effects:**

Based on toxicity data for aquatic invertebrates, we expect that exposure to methomyl from runoff or spray drift deposition will result in mortality of any individuals exposed.

**Indirect Effects:**

We do not expect that methomyl exposure will result in adverse effects to detritus that provides food for the species.

**Toxicity Summary**

Given the high sensitivity of aquatic invertebrates to methomyl at estimated environmental concentrations, we anticipate all individuals exposed to methomyl will die.

**Overall Toxicity:** High

## Effects of the Action Summary

The Squirrel Chimney Cave shrimp has a low exposure ranking. A high portion of the species' range overlaps with the action area (10.9%), but past usage data indicate little of the range has been treated in the past with methomyl (up to 3.6% annually) and some of the surrounding area is land uses where methomyl may be used (pasture, which may include alfalfa, and agriculture). However, we do not expect methomyl to persist long enough in the environment to reach groundwater at depths where this species is found. We expect any individuals that are exposed to methomyl are likely to die as available toxicity data indicate that crustaceans are highly sensitive to methomyl. As such, we anticipate a small number of individuals are likely to experience adverse effects from the proposed action.

## Conclusion

The Squirrel Chimney Cave shrimp is a narrow endemic cave-dwelling crustacean found in Squirrel Chimney Cave, Florida. There is only one small population, and the species has not been observed since the 1973, despite surveys of Squirrel Chimney Cave and other nearby caves in the same system. They feed on detritus and are threatened by development, contaminant spills, and changes to water availability. While threats from pesticides are not specifically noted, contaminants are mentioned, and Squirrel Chimney Cave is surrounded by agriculture. The species has a high vulnerability ranking.

Squirrel Chimney Cave shrimp have a high toxicity ranking because we expect any direct exposure to result in mortality. A high percentage of the action area overlaps with the species' range (10.9%) and the area surrounding the occupied cave includes land uses where we expect methomyl usage to occur (pasture, which may include alfalfa, and agriculture), but past annual methomyl usage occurred on a low percentage of the range (3.6%) and the label includes two conservation measures that would reduce the likelihood of methomyl exposure for this species (i.e., rain restrictions and aquatic habitat buffers). However, while caves near agricultural fields are susceptible to groundwater contamination, we do not expect methomyl to be present in water as it enters the cave due to its short persistence in the environment. As such, we determined the species has a low exposure ranking and we anticipate that only a small number of individuals will experience exposure from the proposed action.

In summary, we expect low methomyl exposure to occur to a small number of individuals over the duration of the proposed action. Even though the species is highly vulnerable and the overlap with methomyl use sites is high, we do not expect methomyl to persist long enough in the environment to reach groundwater at depths where this species is found, only a small portion of the species' range has been treated with methomyl in the past, and two conservation measures (i.e., rain restrictions and aquatic habitat buffers) will reduce the likelihood of methomyl reaching aquatic habitats. We expect the small number of individuals exposed will not cause 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 likely to appreciably reduce the survival and recovery of the Squirrel Chimney Cave shrimp. Thus, it is our biological opinion that the proposed action is not likely to jeopardize the continued existence of the Squirrel Chimney Cave shrimp.

## References

Kern, M., S. Kay, D. Christian, and E. Tandy. 2024. Methomyl Effects Assessment of the Squirrel Chimney Cave Shrimp (*Palaemonetes cummingi*) for Risk Management of Methomyl Agricultural Uses. Tessenderlo Kerley, Inc. TKI-2024-EAM-060.

U.S. Fish and Wildlife Service. 2021. Squirrel Chimney Cave Shrimp (*Palaemonetes cummingi*) 5-Year Review: Summary and Evaluation. Jacksonville, Florida. 19 pp.

# Integration and Synthesis Summary: Vernal pool fairy shrimp

| Scientific Name: | Common Name: | Entity ID: |
|---|---|---|
| *Branchinecta lynchi* | Vernal pool fairy shrimp | 493 |

## Species Overview

In reviewing the status of the species, the environmental baseline for the action area, cumulative effects, and the effects of the action, we determined that the species' vulnerability is high. In our preliminary evaluation of the effects of the proposed action to the species (presented below), we determined there is high overlap of the action area with the species' range, and high past usage of methomyl within the species' range, indicating a high extent of exposure. Most exposed individuals are likely to die, and we do not expect indirect effects to their food resources (i.e., algae, bacteria, protozoa, rotifers, and detritus). Given that exposure is high and we expect exposed individuals will die, we determined the risk of adverse effects to the species is high. As such, we expected a large number of individuals were likely to die from the proposed action.

After incorporating general conservation measures as part of the action and considering past usage data according to the California Department of Pesticide Regulation (CalPUR), we now expect exposure for the vernal pool fairy shrimp to be low. We determined the proposed action is not likely to appreciably reduce the survival and recovery of the vernal pool fairy shrimp in the wild. Thus, it is our biological opinion that the proposed action, with the inclusion of conservation measures, is not likely to jeopardize the continued existence of the vernal pool fairy shrimp. We discuss our rationale for this conclusion for the species in the sections below.

## Species range

Based on range map dated: 12/17/2019; Wherever found; *States within the range:* CA, OR. Figure 6 depicts the species' range.

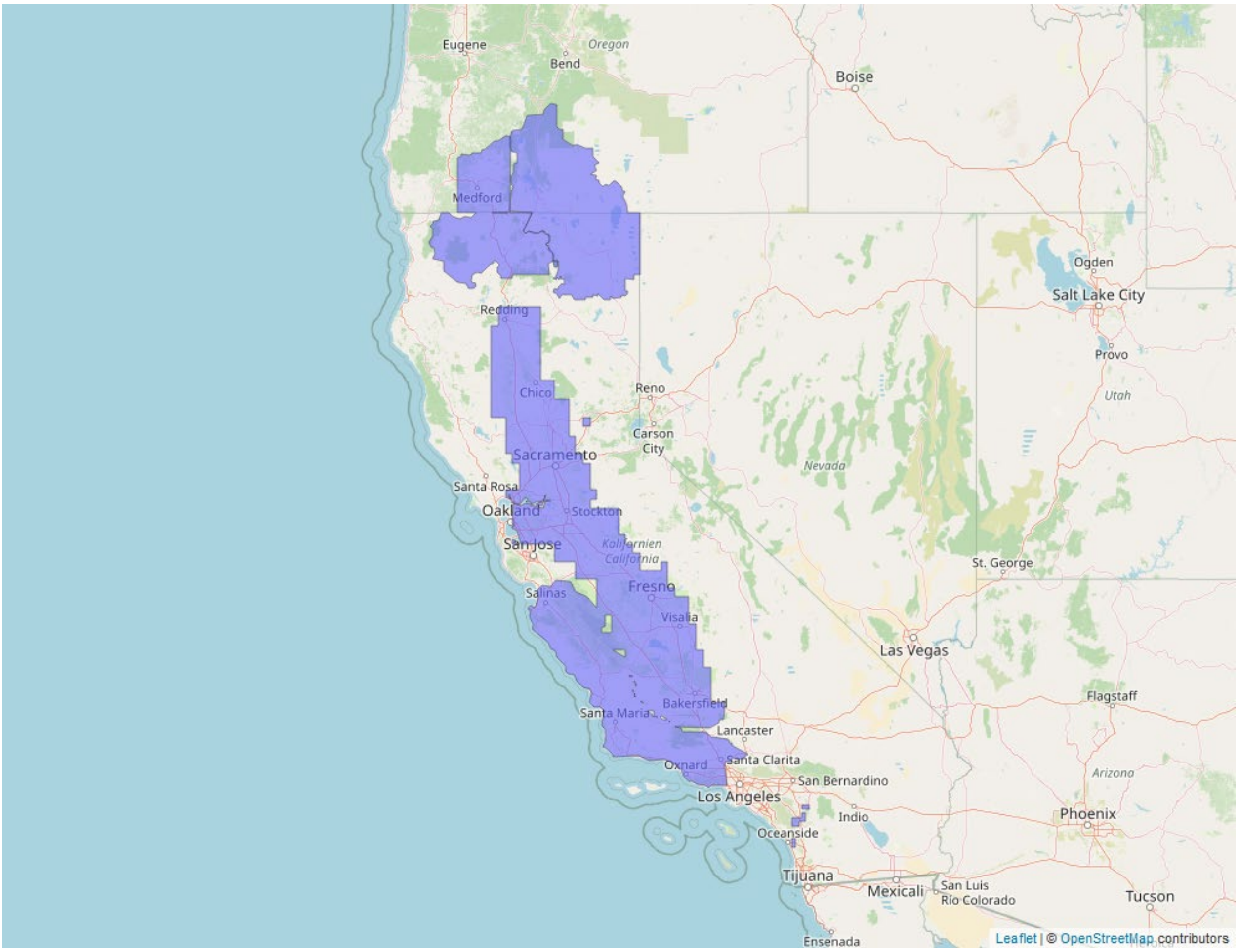


**Figure 6. Range map of vernal pool fairy shrimp (blue polygons). Range map accessed at https://ecos.fws.gov/ecp/species/498.**

## Vulnerability

As mentioned above, vulnerability considers the present condition of the species to determine its vulnerability to additional stressors. Here, 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, as summarized below.

**Summary of status**

**Listing status:** Threatened

**Most recent 5-Year Review recommendation:** No change in Status

**Most recently completed 5-Year Review:** 9/28/2007

**Distribution:** Species/Populations neither constrained nor widespread

**Number of populations:** Multiple populations (numerous)

**Species trends:** Unknown population trends

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

**Environmental Baseline/Cumulative Effects (EB/CE) Summary**

The vernal pool fairy shrimp is a small freshwater crustacean endemic to California and the Agate Desert of southern Oregon. It is seldom abundant where found and only exists in vernal pools or similar habitats with cool water; it is not found in permanent bodies of water. They have no predatory defenses and cannot survive where fish are present. As of 2007, 400 species records were present in the California Natural Diversity Database and approximately 53% were located on private lands and 15% were on federal lands: 13% on Department of Defense installations and 2% on public lands managed by the U.S. Forest Service, U.S. Bureau of Reclamation, U.S. Bureau of Land Management, and Western Area Power Administration (USFWS 2007).

Loss and modification of vernal pool habitat continues to be the primary threat to the vernal pool fairy shrimp and is expected to continue in the future. Even in areas where habitat is protected, urbanization of lands surrounding conserved areas fragments protected habitats, likely preventing dispersal of the shrimp within and between populations and causing increased edge effects to pool complexes. Some vernal pool habitats are protected through conservation easements, but vernal pool habitat loss has continued. Remaining habitat fragments often exhibit different hydrological conditions, invasion by non-native plants and other species, increased vegetation growth, and other conditions (such as cessation of grazing or overgrazing) that reduce the suitability of the land as habitat for the shrimp. Water quality in vernal pools can be degraded by pesticide overspray and residues entering across the Central Valley, where agriculture is a common land use. Eight counties where vernal pool fairy shrimp are found are among the ten counties in California with the highest pesticide usage: Fresno, Tulare, San Joaquin, Madera, Monterey, Merced, Ventura, and Kings Counties. In the 2007 5-Year Review, we mentioned various levels of chemical toxicity to other crustaceans, including malathion, herbicides surfactants used in Round-up, diazinon, and DDT, that could affect the vernal pool fairy shrimp also (USFWS 2007).

**Overall Vulnerability:** High

## Effects of the Action: Exposure

### Overlap

We do not expect listed crustacean species will occur on-field, and thus expect exposure will only result from off-field transport via spray drift or runoff. Given that the ranges for listed aquatic species are generally delineated using the relevant HUC 12 watersheds, we anticipate that all residues that leave use sites will be collected in the waterbodies 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. We use on-field overlaps with the species' range without a buffer as an estimate of the extent of exposure that's likely to occur. We expect up to 28% of the species' range will contain use sites (Table 11).

**Table 11. Overlap and usage data for the vernal pool fairy shrimp.**

| Use Layer | Use Site Overlap (% range) | % Range Treated (On-field) |
|---|---:|---:|
| Alfalfa | 4 | 0.6 |
| Citrus | NA | NA |
| **Corn**[6] | 2.7 | 0.1 |
| Cotton | 1.7 | 0.1 |
| Other Grains | 3.4 | 0.2 |
| Other Orchards | 12.1 | 12.1 |
| Other Row Crops | 0.5 | 0.2 |
| Soybeans | <0.1 | <0.1 |
| Vegetables and Ground Fruit | 3.5 | 3.5 |
| Wheat | NA | NA |
| **Total** | **28** | **16.8** |

### Usage

Past statewide usage data indicate that up to 16.8% of the species' range has been treated with methomyl for agriculture annually. However, because the majority of the species' range is in California (Table 12), we consider CalPUR data for this species, which indicates that 0.39% of the range was treated with methomyl between 2012-2022. Given that usage reporting is mandated by the state of California and that this data is provided regularly at a fine spatial

[6] We expect corn and soybean use sites are highly redundant with each other and only use the higher of the two layers in our calculation of total percent overlap and total percent treated range.

resolution (i.e., at the section level, which is per square mile), we have high confidence that only a small percentage of the species' range in California has been (and is likely to be in the future) exposed to methomyl. As we have no indication that methomyl usage would differ in the small part of the range extending into Oregon, and because most occurrences of this species are in California, we consider CalPUR usage data to be the best measures of usage within the entire range of the vernal pool fairy shrimp.

**Table 12. Annual percent of the vernal pool fairy shrimp's range treated with pesticides, insecticides or methomyl from 2012-2022. Pesticide usage data collected by the California Department of Pesticide Regulations.**

| % range treated with all pesticides | % range treated with all insecticides | % range treated with methomyl | average # of growers reporting within the species' range |
|---|---|---|---|
| 21.1 | 16.7 | 0.78 | 57,047 |

**Exposure Summary**

There is a high extent of overlap between the action area and the species' range (28% overlap). Based on CalPUR data, we anticipate a low level of usage within the range, as <1% has been treated annually for agricultural uses. Thus, based on our confidence in the CalPUR data, we determine the overall exposure ranking is low. As such, we anticipate a small number of individuals are likely to experience exposure.

**Overall Exposure**: Low

**Conservation Measures**

**Rain restriction:** The methomyl label has language designed to reduce the likelihood of pesticide runoff from use sites which is the following: "Do not apply during rain. Do not apply when soil in the area to be treated is saturated (if there is standing water on the field or if water can be squeezed from soil) or if NOAA/National Weather Service predicts a total rainfall of 1 inch or greater over the 48 hours following the day of application, only considering a 48-hour period when, at any point during the 48-hour period, the precipitation potential is 50% or greater. Detailed National Weather Service forecasts for local weather conditions should be obtained on-line at: www.weather.gov or by contacting your local National Weather Service Forecasting Office." This rain restriction language provides for a reduction in the concentration of methomyl in aquatic habitats by providing time for methomyl to degrade before runoff into aquatic habitats can occur, decreasing exposure and risk.

**Aquatic habitat buffers:** The methomyl label also has language to reduce the likelihood of pesticide spray drift from use sites specifically to nearby aquatic habitats. The label language states "Do not apply by ground equipment within 25 feet, or by air within 100 feet, of lakes, reservoirs, rivers, estuaries, commercial fish ponds and natural, permanent streams, marshes or natural, permanent ponds" for which vernal pools would be included.

## Effects of the Action: Toxicity

**Direct Effects:**

Based on toxicity data for aquatic invertebrates, we expect that exposure to methomyl from runoff or spray drift deposition will result in mortality of any individuals exposed.

**Indirect Effects:**

Vernal pool fairy shrimp are opportunistic filter feeders. We do not expect that methomyl exposure will result in adverse effects to algae, bacteria, protozoa, rotifers, and bits of waste from other plants and animals present in their environments that provide food for the species.

**Toxicity Summary**

Given the high sensitivity of aquatic invertebrates to methomyl at estimated environmental concentrations, we anticipate all individuals exposed to methomyl will die.

**Overall Toxicity:** High

## Effects of the Action Summary

There is a high level of overlap between the species' range and agricultural use sites and associated off-field areas (28% total overlap) and a low level of past usage (<0.78 % range treated annually with methomyl). Based on our confidence in the CalPUR data, we expect a small number of individuals are likely to be exposed to methomyl over the duration of the proposed action. We expect crustacean species are highly sensitive to methomyl, indicating a small number of individuals will die. As such, the overall risk of adverse effects to the vernal pool fairy shrimp is low.

## Conclusion

The vernal pool fairy shrimp is a narrow endemic vernal pool species found in California and southern Oregon. There are several populations, all of which occur in small numbers in temporary water bodies. Most occurrences of the species were found on private lands (85%). They are opportunistic filter feeders. Their threats include habitat loss and fragmentation (mostly from development) and changes to water quality, including use and runoff of pesticides. Herbicides and other pesticides are specifically mentioned as threats to the species, from runoff and atmospheric deposition from nearby agricultural land uses. The species has a high vulnerability ranking.

Vernal pool fairy shrimp have a high toxicity ranking because we expect any direct exposure to result in mortality. Past annual methomyl usage occurred on a high percentage of the range (16.8%) and a high percentage of the action area overlaps with the species' range (28%), indicating that even more of the range could receive treatment in the future. We determined the species has a high exposure ranking and we anticipate that a large number of individuals will experience exposure from the action.

However, because the majority of the species' range is in California (Figure 6), we consider CalPUR data for this species, which indicates that <1% of the range was treated with methomyl between 2012-2022. Given that usage reporting is mandated by the state of California and that this data is provided regularly at a fine spatial resolution (i.e., at the section level, which is per square mile), we have high confidence that only a small percentage of the species' range in California has been (and is likely to be in the future) exposed to methomyl. As we have no indication that methomyl usage would differ in the small part of the range extending into Oregon, and because most occurrences of this species are in California, we consider CalPUR usage data to be the best measures of usage within the entire range of the vernal pool fairy shrimp.

Because of the effects described in our preliminary conclusion above, we also include the two conservation measures on the label that would reduce the likelihood of methomyl exposure for this species (i.e., rain restriction and aquatic habitat buffers). We anticipate exposure to methomyl runoff would result in mortality, but after incorporating these conservation measures, we expect exposure to be unlikely to occur and, as most, very low numbers of individuals over the course of the action will be exposed. After reviewing the current status of the listed species, environmental baseline for the action area, effects of the proposed action, cumulative effects, and general conservation measures, we have determined the proposed action, with the inclusion of conservation measures, is not likely to appreciably reduce the survival and recovery of the vernal pool fairy shrimp. Thus, it is our biological opinion that the proposed action is not likely to jeopardize the continued existence of the vernal pool fairy shrimp.

## References

U.S. Fish and Wildlife Service. 2007. Vernal Pool Fairy Shrimp (*Branchinecta lynchi*) 5-Year Review: Summary and Evaluation. Sacramento, California. 76 pp.

# Integration and Synthesis Summary: Vernal pool tadpole shrimp

| Scientific Name: | Common Name: | Entity ID: |
|---|---|---|
| *Lepidurus packardi* | Vernal pool tadpole shrimp | 494 |

## Species Overview

In reviewing the status of the species, the environmental baseline for the action area, cumulative effects, and the effects of the action, we determined that the species' vulnerability is high. In our preliminary evaluation of the effects of the proposed action to the species (presented below), we determined there is high overlap of the action area with the species' range, and high past usage of methomyl within the species' range, indicating a high extent of exposure. Most exposed individuals are likely to die, and we do not expect indirect effects to their food resources (i.e., algae, bacteria, protozoa, rotifers, and detritus). Given that exposure is high and we expect exposed individuals will die, we determined the risk of adverse effects to the species is high. As such, we expected a large number of individuals were likely to die from the proposed action.

After incorporating general conservation measures as part of the action and considering past usage data according to the California Department of Pesticide Regulation (CalPUR), we now expect exposure for the vernal pool tadpole shrimp to be low. We determined the proposed action is not likely to appreciably reduce the survival and recovery of the vernal pool tadpole shrimp in the wild. Thus, it is our biological opinion that the proposed action, with the inclusion of conservation measures, is not likely to jeopardize the continued existence of the vernal pool tadpole shrimp. We discuss our rationale for this conclusion for the species in the sections below.

## Species range

Based on range map dated: 3/19/2018; Wherever found; *States within the range:* CA, OR. Figure 7 depicts the species' range.

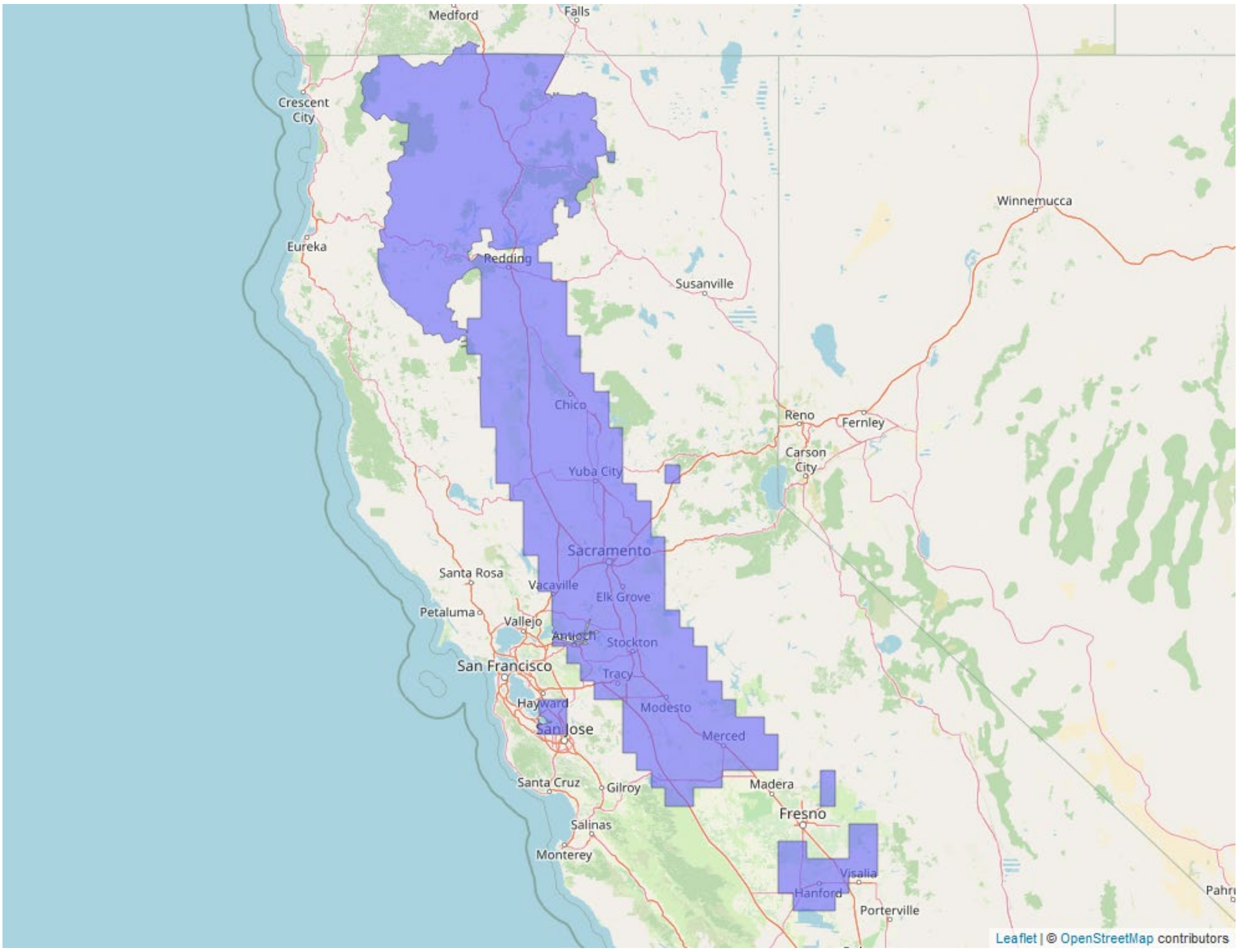


**Figure 7. Range map of vernal pool tadpole shrimp (blue polygons). Range map accessed at https://ecos.fws.gov/ecp/species/2246.**

## Vulnerability

As mentioned above, vulnerability considers the present condition of the species to determine its vulnerability to additional stressors. Here, 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, as summarized below.

**Summary of status**

**Listing status:** Endangered

**Most recent 5-Year Review recommendation:** No change in Status

**Most recently completed 5-Year Review:** 9/28/2007

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

**Number of populations:** Multiple populations (numerous)

**Species trends:** Unknown population trends

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

**Environmental Baseline/Cumulative Effects (EB/CE) Summary**

Vernal pool tadpole shrimp is found in ephemeral freshwater habitats, including alkaline pools, clay flats, vernal lakes, vernal pools, vernal swales, and other seasonal wetlands, in California. They are found across a wide geographic range, but their habitat is highly fragmented, and they are uncommon where they are found. As of 2007, the California Natural Diversity Database reported 226 species occurrences in the following 19 counties: Alameda, Butte, Colusa, Contra Costa, Fresno, Glenn, Kings, Merced, Placer, Sacramento, San Joaquin, Shasta, Solano, Stanislaus, Sutter, Tehama, Tulare, Yolo, and Yuba. The greatest number of occurrences (28%) was found in Sacramento County (USFWS 2007).

Modification, fragmentation, and destruction of habitat caused largely by urban development and conversion of natural lands to agriculture continue to cause the greatest threat to the species. Additionally, altered site hydrology, inappropriate levels of grazing, contaminant runoff into vernal pools, stochastic extirpation, invasive plants, mosquito fish (*Gambusia affinis*) predation, climate change, and prolonged drought are also major threats. Petroleum products, pesticides, herbicides, and other chemicals can be conveyed into the vernal pool habitats by overland runoff during the rainy season, thereby adversely affecting water quality and chemistry of vernal pools and reducing the suitability for tadpole shrimp. Many of these chemical compounds are thought to have adverse effects on listed vernal pool crustaceans and/or their cysts, with individuals being killed directly or suffering reduced fitness through physiological stress or a reduction in their food base. Fertilizer contamination can lead to vernal pool eutrophication, which can reduce dissolved oxygen and kill vernal pool crustaceans. Vernal pools are hydrated by winter precipitation, which often includes pesticides (e.g., herbicides, insecticides, fungicides) that have volatized and are atmospherically transported. Concentrations of the pesticide diazinon, found in vernal pools on National Wildlife Refuge complexes in the Sacramento and San Joaquin Valleys, have been measured at levels that could have adverse effects on the vernal pool tadpole shrimp. Endosulfane, hexazinone, trifluralin, and simazine were also present in sampled pools at levels that could be toxic to the shrimp. The Central Valley, where this shrimp lives, is dominated by agricultural land uses and we expect pesticide use to be high. Biocides, which are pesticides or disinfectants used against microorganisms, may cause a threat, but the magnitude of this threat is unknown (USFWS 2007).

**Overall Vulnerability:** High

## Effects of the Action: Exposure

### Overlap

We do not expect listed crustacean species will occur on-field, and thus expect exposure will only result from off-field transport via spray drift or runoff. Given that the ranges for listed aquatic species are generally delineated using the relevant HUC 12 watersheds, we anticipate that all residues that leave use sites will be collected in the waterbodies 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. We use on-field overlaps with the species' range without a buffer as an estimate of the extent of exposure that's likely to occur. We expect up to 32% of the species' range will contain use sites (Table 13).

**Table 13. Overlap and usage data for the vernal pool tadpole shrimp.**

| Use Layer | Use Site Overlap (% range) | % Range Treated (On-field) |
|---|---:|---:|
| Alfalfa | 5.3 | 0.8 |
| Citrus | NA | NA |
| **Corn**[7] | 3.8 | 0.2 |
| Cotton | 1.5 | 0.1 |
| Other Grains | 3.7 | 0.2 |
| Other Orchards | 13.4 | 13.4 |
| Other Row Crops | 1 | 0.4 |
| Soybeans | <0.1 | <0.1 |
| Vegetables and Ground Fruit | 3.3 | 3.3 |
| Wheat | NA | NA |
| **Total** | **32** | **18.4** |

### Usage

Past statewide usage data indicate that up to 18.4% of the species' range has been treated with methomyl for agriculture annually. However, because the majority of the species' range is in California (Table 14), we consider CalPUR data for this species, which indicates that 0.48% of the range was treated with methomyl between 2012-2022. Given that usage reporting is mandated by the state of California and that this data is provided regularly at a fine spatial

[7] We expect corn and soybean use sites are highly redundant with each other and only use the higher of the two layers in our calculation of total percent overlap and total percent treated range.

resolution (i.e., at the section level, which is per square mile), we have high confidence that only a small percentage of the species' range in California has been (and is likely to be in the future) exposed to methomyl. As we have no indication that methomyl usage would differ in the small part of the range extending into Oregon, and because most occurrences of this species are in California, we consider CalPUR usage data to be the best measures of usage within the entire range of the vernal pool tadpole shrimp.

**Table 14. Annual percent of the vernal pool tadpole shrimp's range treated with pesticides, insecticides or methomyl from 2012-2022. Pesticide usage data collected by the California Department of Pesticide Regulations.**

| % range treated with all pesticides | % range treated with all insecticides | % range treated with methomyl | average # of growers reporting within the species' range |
|---|---|---|---|
| 21 | 15.6 | 0.48 | 36,628 |

**Exposure Summary**

There is a high extent of overlap between the action area and the species' range (32% overlap). Based on CalPUR data, we anticipate a low level of usage within the range, as <1% has been treated annually for agricultural uses. Thus, based on our confidence in the CalPUR data, we determine the overall exposure ranking is low. As such, we anticipate a small number of individuals are likely to experience exposure.

**Overall Exposure**: Low

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**Conservation Measures:**

**Rain restriction:**
The methomyl label has language designed to reduce the likelihood of pesticide runoff from use sites which is the following: "Do not apply during rain. Do not apply when soil in the area to be treated is saturated (if there is standing water on the field or if water can be squeezed from soil) or if NOAA/National Weather Service predicts a total rainfall of 1 inch or greater over the 48 hours following the day of application, only considering a 48-hour period when, at any point during the 48-hour period, the precipitation potential is 50% or greater. Detailed National Weather Service forecasts for local weather conditions should be obtained on-line at: www.weather.gov or by contacting your local National Weather Service Forecasting Office." This rain restriction language provides for a reduction in the concentration of methomyl in aquatic habitats by providing time for methomyl to degrade before runoff into aquatic habitats can occur, decreasing exposure and risk.

**Aquatic habitat buffers:** The methomyl label also has language to reduce the likelihood of pesticide spray drift from use sites specifically to nearby aquatic habitats. The label language states "Do not apply by ground equipment within 25 feet, or by air within 100 feet, of lakes, reservoirs, rivers, estuaries, commercial fish ponds and natural, permanent streams, marshes or natural, permanent ponds" for which vernal pools would be included.

## Effects of the Action: Toxicity

**Direct Effects:**

Based on toxicity data for aquatic invertebrates, we expect that exposure to methomyl from runoff or spray drift deposition will result in mortality of any individuals exposed.

**Indirect Effects:**

The vernal pool tadpole shrimp is a very aggressive omnivore. We expect that methomyl exposure will result in adverse effects to insects, other fairy shrimp including the conservancy fairy shrimp, and tadpoles, but not the algae, bacteria, protozoa, rotifers, or aquatic earthworms that provide food for the species.

**Toxicity Summary**

Given the high sensitivity of aquatic invertebrates to methomyl at estimated environmental concentrations, we anticipate all individuals exposed to methomyl will die, including the other aquatic invertebrate species it may rely on for food.

**Overall Toxicity:** High

## Effects of the Action Summary

There is a high level of overlap between the species' range and agricultural use sites and associated off-field areas (28% total overlap) and a low level of past usage (<1.0 % range treated annually with methomyl). Based on our confidence in the CalPUR data, we expect a small number of individuals are likely to be exposed to methomyl over the duration of the proposed action. We expect crustacean species are highly sensitive to methomyl, indicating a small number of individuals will die. As such, the overall risk of adverse effects to the vernal pool tadpole shrimp is low.

## Conclusion

The vernal pool tadpole shrimp is a narrow endemic vernal pool species found in the Central Valley of California. There are several populations, all of which occur in small numbers in temporary water bodies. Many occurrences of the species were found on private lands. They are omnivores that feed on other aquatic invertebrates, algae, and microorganisms. Their threats include habitat loss and fragmentation (mostly from development and conversion to agriculture) and changes to water quality, including use, runoff, and atmospheric deposition of pesticides from nearby agricultural lands. The species has a high vulnerability ranking.

Vernal pool tadpole shrimp have a high toxicity ranking because we expect any direct exposure to result in mortality. Past annual methomyl usage occurred on a high percentage of the range (18.4%) and a high percentage of the action area overlaps with the species' range (32%), indicating that even more of the range could receive treatment in the future. In the 2007 5-Year Status Review, we mentioned concern about pesticides volatized from winter precipitation, but we do not expect methomyl to volatize into the atmosphere from water because it has a low Henry's law constant, or low vapor pressure. We determined the species has a high exposure ranking and we anticipated that a large number of individuals will experience exposure from the action.

However, because the majority of the species' range is in California (Figure 7), we consider CalPUR data for this species, which indicates that <1% of the range was treated with methomyl between 2012-2022. Given that usage reporting is mandated by the state of California and that this data is provided regularly at a fine spatial resolution (i.e., at the section level, which is per square mile), we have high confidence that only a small percentage of the species' range in California has been (and is likely to be in the future) exposed to methomyl. As we have no indication that methomyl usage would differ in the small part of the range extending into Oregon, and because most occurrences of this species are in California, we consider CalPUR usage data to be the best measures of usage within the entire range of the vernal pool fairy shrimp.

Because of the effects described in our preliminary conclusion above, we also include the two conservation measures on the label that would reduce the likelihood of methomyl exposure for this species (i.e., rain restriction and aquatic habitat buffers). We anticipate exposure to methomyl runoff would result in mortality, but after incorporating these conservation measures, we expect exposure to be unlikely to occur and, as most, very low numbers of individuals over the course of the action will be exposed. After reviewing the current status of the listed species, environmental baseline for the action area, effects of the proposed action, cumulative effects, and general conservation measures, we have determined the proposed, with the inclusion of conservation measures, action is not likely to appreciably reduce the survival and recovery of the vernal pool tadpole shrimp. Thus, it is our biological opinion that the proposed action is not likely to jeopardize the continued existence of the vernal pool tadpole shrimp.

## References

U. S. Fish and Wildlife Service. 2007. Vernal Pool Tadpole Shrimp (*Lepidurus packardi*) 5-Year Review: Summary and Evaluation. Sacramento, California. 50 pp.

# Integration and Synthesis Summary: Brawleys Fork crayfish

| Scientific Name: | Common Name: | Entity ID: |
|---|---|---|
| *Cambarus williami* | Brawleys Fork crayfish | 10771 |

## Species Overview

In reviewing the status of the species, the environmental baseline, and cumulative effects for the action area, we determined that the species' vulnerability is high. In our evaluation of the effects of the proposed action to the species, we determine there is high overlap of the action area with the species' range, and low past usage of methomyl within the species' range, indicating a medium extent of exposure within the action area across the species' range (Figure 8). Exposed individuals are likely to die and experience a high level of macroinvertebrate prey loss; plant food items are not expected to be negatively affected by methomyl exposure. Given that exposure is medium and the level of indirect effects is high, we determined the risk of adverse effects to the species is high. As such, we expected a moderate number of individuals were likely to die or experience indirect effects (i.e., loss of prey) from the proposed action.

Because of the effects described in our preliminary evaluation and conclusion, EPA and the applicant agreed to incorporate the species-specific conservation measures as part of the action. We now expect exposure for the Brawley's Fork crayfish to be low. We determined the proposed action is not likely to appreciably reduce the survival and recovery of the Brawleys Fork crayfish in the wild. Thus, it is our biological opinion that the proposed action is not likely to jeopardize the continued existence of the Brawleys Fork crayfish. We discuss our rationale for this conclusion for the species in the sections below.

## Species range

Based on range map dated: 8/20/2015; Wherever found; *States within the range:* TN. Figure 8 depicts the species' range.

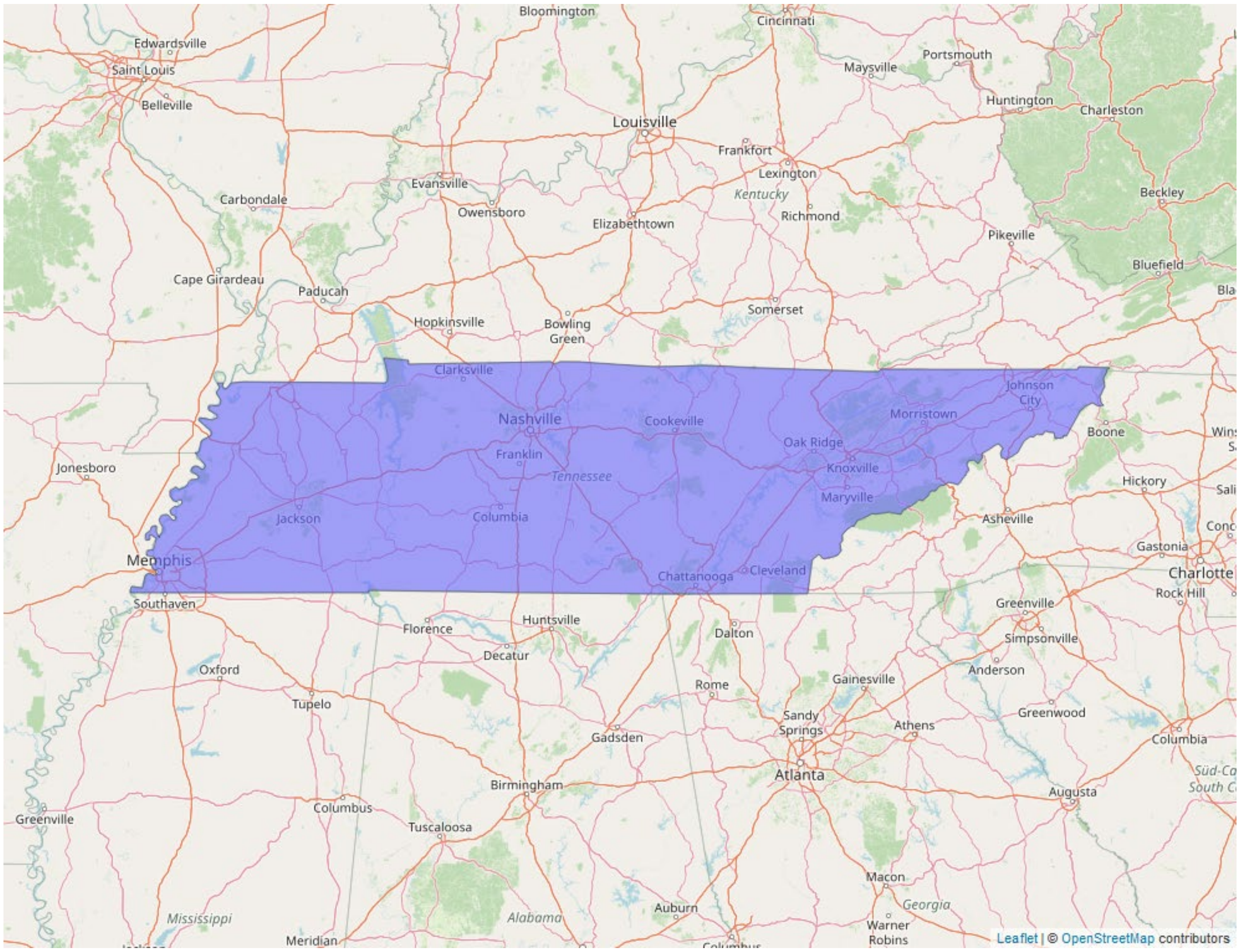


**Figure 8. Range map of Brawleys Fork crayfish (blue polygons). Range map accessed at https://ecos.fws.gov/ecp/species/9806.**

## Vulnerability

As mentioned above, 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 Status Review recommendation:** N/A

**Most recently completed 5-Year Status Review:** N/A

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

**Number of populations:** Multiple populations (few)

**Species trends:** Unknown population trends

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

**Environmental Baseline/Cumulative Effects (EB/CE) Summary**

Brawleys Fork crayfish is a small, freshwater crayfish endemic to the Nashville Basin and Eastern Highland Rim ecoregions of central Tennessee. They primarily occur in small- to medium-sized streams of the Stones and Collins River systems and one medium-sized river and are found across 20 streams in five Hydrologic Unit Code (HUC) watersheds. They occupy runs and riffles with moderate to fast flow and layered cherty gravel substrate and cobble with ample interstitial space. Habitat condition for all occupied areas is low. Out of 15 streams with abundance data, eight of them had low or very low abundance. Available information indicates no loss of populations or analysis units over time and the current known range of the species is wider than the historical range (USFWS 2023).

The primary threat to Brawleys Fork crayfish is sedimentation (e.g., agricultural and horticultural practices, gravel dredging, stream impoundment, and urban growth). Sediment fills interstitial spaces that the crayfish needs for feeding, breeding, and sheltering. Other threats include water quality degradation, channel modifications, and effects of climate change.

**Overall Vulnerability:** High

## Effects of the Action: Exposure

### Overlap

We do not expect listed crustacean species will occur on-field, and thus expect exposure will only result from off-field transport via spray drift or runoff. Given that the ranges for listed aquatic species are generally delineated using the relevant HUC 12 watersheds, we anticipate that all residues that leave use sites will be collected in the waterbodies 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. We use on-field overlaps with the species' range without a buffer as an estimate of the extent of exposure that's likely to occur. We expect up to 14.9% of the species range will contain use sites Table 15.

**Usage**

Past usage data indicate that up to 1.5 % of the species' range has been treated with methomyl annually. Uses with the highest annual usage include soybeans/corn, cotton, and other row crops.

**Table 155**. **Overlap and usage data for the Brawleys Fork crayfish.**

| Use Layer | Use Site Overlap (% range) | % Range Treated (On-field) |
|---|---|---|
| Alfalfa | <0.1 | <0.1 |
| Citrus | NA | NA |
| Corn | 9.1 | 0.7 |
| Cotton | 2.3 | 0.2 |
| Other Grains | 0.1 | <0.1 |
| Other Orchards | <0.1 | <0.1 |
| Other Row Crops | 0.2 | 0.2 |
| Soybeans | 12.3 | 1.1 |
| Vegetables and Ground Fruit | <0.1 | <0.1 |
| Wheat | NA | NA |
| **Total** | **14.9** | **1.5** |

**Exposure Summary**

There is a high extent of overlap between the action area and the species' range (14.9% total overlap). Based on past usage data, we expect a low level of usage within the species' range (up to 1.5% range treated annually). Given that the extent of overlap is high but the expected usage is low, we expect a moderate number of individuals are likely to experience exposure from the proposed Action.

**Overall Exposure Ranking:** Medium

**Conservation Measures:**

**Rain restriction:** The methomyl label has language designed to reduce the likelihood of pesticide runoff from use sites which is the following: "Do not apply during rain. Do not apply when soil in the area to be treated is saturated (if there is standing water on the field or if water can be squeezed from soil) or if NOAA/National Weather Service predicts a total rainfall of 1 inch or greater over the 48 hours following the day of application, only considering a 48-hour period when, at any point during the 48-hour period, the precipitation potential is 50% or greater. Detailed National Weather Service forecasts for local weather conditions should be obtained on-line at: www.weather.gov or by contacting your local National Weather Service Forecasting Office." This rain restriction language provides for a reduction in the concentration of methomyl in aquatic habitats by providing time for methomyl to degrade before runoff into aquatic habitats can occur, decreasing exposure and risk.

**Aquatic habitat buffers:** The methomyl label also has language to reduce the likelihood of pesticide spray drift from use sites specifically to nearby aquatic habitats. The label language states "Do not apply by ground equipment within 25 feet, or by air within 100 feet, of lakes, reservoirs, rivers, estuaries, commercial fish ponds and natural, permanent streams, marshes or natural, permanent ponds".

## Effects of the Action: Toxicity

**Direct Effects:**

Based on available toxicity data for crustaceans, we expect that crustaceans are highly sensitive to methomyl. As such, we expect exposure to methomyl at predicted environmental concentrations will result in a high level of mortality.

**Indirect Effects:**

The Brawleys Fork crayfish is very likely an omnivore. We expect that methomyl exposure will result in adverse effects to small invertebrates but not the algae or periphyton that provide food for the species.

**Toxicity Summary**

Given the high sensitivity of aquatic invertebrates to methomyl at estimated environmental concentrations, we anticipate all individuals exposed to methomyl will die, including the other aquatic invertebrate species it may rely on for food.

**Overall Toxicity:** High

## Effects of the Action Summary

The Brawleys Fork crayfish has a medium exposure ranking. A large portion of the species' range overlaps with the action area (14.9%) but past usage data indicate only a small portion of the range has been treated with methomyl in the past (up to 1.5% annually), suggesting a moderate number of individuals will be exposed over the duration of the proposed action. We expect any individuals that are exposed to methomyl are likely to die as available toxicity data indicate that crustaceans are highly sensitive to methomyl. We also expect potential impacts from methomyl to the aquatic invertebrate dietary items for the species. Therefore, we anticipate a moderate number of individuals are likely to experience adverse effects from the proposed action.

## Preliminary Conclusion (with General Conservation Measures)

The Brawleys Fork crayfish is a proposed threatened, narrow endemic crustacean found in five HUC watersheds in central Tennessee. They are found in small to medium flowing streams and a medium-sized river, particularly runs and riffles with moderate to fast flow and ample interstitial space in substrate. All populations have low abundance and low resiliency, and habitat conditions at all occupied sites are considered low. Threats to the species include sedimentation, primarily loss of interstitial space, effects of climate change, decreased water quality, and channel modifications.

Past annual methomyl usage occurred on a low percentage of the range (1.5%), while a high percentage of the action area overlaps with the species' range (14.9%), indicating that more of the range could receive treatment in the future. We determined the species has a moderate exposure ranking and we anticipate that a moderate number of individuals will experience exposure from the proposed action. Brawleys Fork crayfish have a high toxicity ranking because we expect any direct exposure to result in mortality.

## Final Conclusion (with Species-Specific Conservation Measures)

Because of the effects described in our preliminary conclusion above (Preliminary Conclusion), EPA and the applicant agreed to incorporate the following measures as part of the action. Within the Pesticide Use Limitation Area (PULA) for the Brawleys Fork crayfish:

(1) *Applicators need 3 points of mitigation as outlined in EPA's Draft Insecticide Strategy. This will reduce methomyl loads in the habitat of the Brawleys Fork crayfish by an order of magnitude (i.e., a 10-fold reduction).*

*The PULA for the Brawleys Fork crayfish will be developed as described in the Description of the Proposed Action section of the main Opinion and Appendix A-1. EPA is currently considering public comments received on the Draft Insecticide Strategy. If additional mitigation options become available during finalization of the Insecticide Strategy or in the future, this might warrant re-initiation to incorporate those measures into the action (i.e., additional options and mitigations for end users). In that case, EPA will provide documentation that these measures provide equivalent conservation for listed species, including reduction in off-site transport. Upon confirmation by the Service, those options will be added to the acceptable mitigations listed for end users of methomyl.*

We anticipate methomyl runoff will occur and result in mortality, but after incorporating these species-specific conservation measures (i.e. rain restrictions and aquatic habitat buffers), we expect these pathways of exposure will be greatly limited and result in exposure and mortality of very low numbers of individuals over the course of the action. 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 likely to appreciably reduce the survival and recovery of the species. Thus, it is our biological opinion that the proposed action is not likely to jeopardize the continued existence of the Brawleys Fork crayfish.

## References

U.S. Fish and Wildlife Service. 2023. Species Status Assessment Report for the Brawleys Fork Crayfish (*Cambarus williami*), Version 1.1. Atlanta, Georgia. 73 pp.

## Integration and Synthesis Summary: Slenderclaw crayfish

| Scientific Name: | Common Name: | Entity ID: |
|---|---|---|
| *Cambarus cracens* | Slenderclaw crayfish | 10757 |

### Species Overview

In reviewing the status of the species, the environmental baseline, and cumulative effects for the action area, we determined that the species' vulnerability is high. In our evaluation of the effects of the proposed action to the species, we determine there is moderate overlap of the action area with the species' range, and low past usage of methomyl within the species' range, indicating a medium extent of exposure within the action area across the species' range (Figure 9). Exposed individuals are likely to die and juveniles are likely to experience a high level of macroinvertebrate prey loss; adults forage on plants, which are not expected to be negatively affected by methomyl exposure. Given that exposure is medium and the levels of direct and indirect effects are high, we determined the risk of adverse effects to the species is high. As such, we expected a moderate number of individuals were likely to die or experience indirect effects (i.e., loss of prey) from the proposed action.

Because of the effects described in our preliminary evaluation and conclusion, EPA and the applicant agreed to incorporate the species-specific conservation measures as part of the action. We now expect exposure for the slenderclaw crayfish to be low. We determined the proposed action is not likely to appreciably reduce the survival and recovery of the slenderclaw crayfish in the wild. Thus, it is our biological opinion that the proposed action is not likely to jeopardize the continued existence of the slenderclaw crayfish. We discuss our rationale for this conclusion for the species in the sections below.

### Species range

Based on range map dated: 04-14-2021; Wherever found; *States within the range:* AL. Figure 9 depicts the species' range.

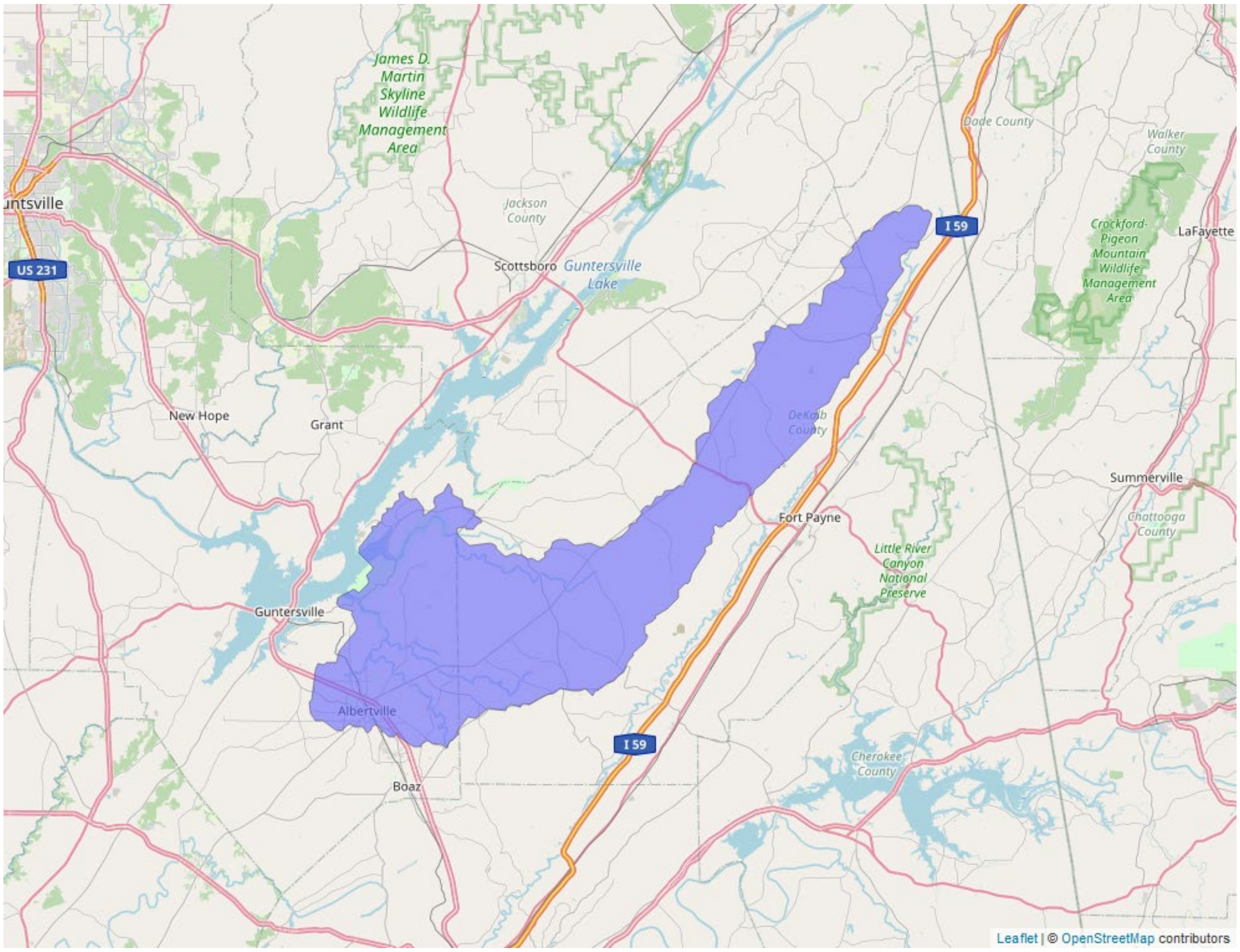


**Figure 9. Range map of slenderclaw crayfish (blue polygons). Range map accessed at https://ecos.fws.gov/ecp/species/9792.**

## Vulnerability

As mentioned above, 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:** Endangered

**Most recent 5-Year Status Review recommendation:** N/A

**Most recently completed 5-Year Status Review:** N/A

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

**Number of populations:** Multiple populations (few)

**Species trends:** Unknown population trends

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

**Environmental Baseline/Cumulative Effects (EB/CE) Summary**

The slenderclaw crayfish is a relatively small, freshwater crustacean with a comparatively elongate, slender front claw. It is cryptic, stream-dwelling, and endemic to Sand Mountain in DeKalb and Marshall counties, Alabama on the Cumberland Plateau in the Tennessee River Basin. They occur in small to medium flowing streams (usually 20 ft wide or smaller with depths of 2.3 ft or shallower). One population occurs where there are large boulders, fractured bedrock, and no turbidity and another occurs where there are small substrates (i.e., mix of sand, gravel, and cobble) and no turbidity. They need abundant interstitial space within each habitat type and adequate seasonal water flows to maintain benthic habitats and connectivity. They likely feed on aquatic macroinvertebrates as juveniles and shift toward omnivory as adults. As of 2019, there were two extant populations: Short Creek (three extant sites) and Town Creek (two extant sites) (USFWS 2019).

Hydrologic alteration (precipitation change), land-use change, and non-native virile crayfish were identified as factors affecting slenderclaw crayfish and coupled with low abundance and water quality concerns, the slenderclaw crayfish at risk of extinction within the next 10 to 20 years. The invasive virile crayfish is the biggest threat against the species; it has been documented in areas in the slenderclaw crayfish's range. The Short Creek population has low resiliency and the species' range within the Town Creek population may become highly restricted to the headwaters due to the expansion of virile crayfish and urban areas. In addition, the slenderclaw crayfish exhibits low natural redundancy given its narrow range. Pesticides, specifically those related to poultry farming, were mentioned as a threat to water quality and the species. Acreage of pastureland, poultry production, and row crop production in some of the species' range (i.e., Alabama) has decreased (USFWS 2019).

**Overall Vulnerability:** High

## Effects of the Action: Exposure

### Overlap

We do not expect listed crustacean species will occur on-field, and thus expect exposure will only result from off-field transport via spray drift or runoff. Given that the ranges for listed aquatic species are generally delineated using the relevant HUC 12 watersheds, we anticipate that all residues that leave use sites will be collected in the waterbodies 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. We use on-field overlaps with the species' range without a buffer as an estimate of the extent of exposure that's likely to occur. We expect up to 9.4% of the species range will contain use sites (Table 16).

**Usage**

Past usage data indicate that up to 4.8% of the species' range has been treated with carbaryl annually.

**Table 16. Overlap and usage data for the slenderclaw crayfish.**

| Use Layer | Use Site Overlap (% range) | % Range Treated |
|---|---|---|
| Alfalfa | <0.1 | <0.1 |
| Citrus | <0.1 | <0.1 |
| Corn | 6.8 | 3.9 |
| Cotton | 1.4 | <0.1 |
| Other Grains | 0.4 | 0.1 |
| **Other Orchards**[8] | <0.1 | <0.1 |
| Other Row Crops | 0.1 | 0.1 |
| **Soybeans**[9] | 7.4 | 3.5 |
| Vegetables and Ground Fruit | 0.1 | 0.1 |
| **Total** | **9.4** | **4.8** |

**Exposure Summary**

There is a moderate extent of overlap between agricultural use sites and the species' range (9.4% overlap). We anticipate up to 4.8% of the species' range will likely be treated annually from agricultural uses, which we consider a low level of usage. Thus, we determine the overall

[8] We expect 'other orchards' and 'citrus' use sites are highly redundant with each other and only use the higher of the two layers in our calculation of total percent overlap and total percent treated range.

[9] We expect corn and soybean use sites are highly redundant with each other and only use the higher of the two layers in our calculation of total percent overlap and total percent treated range.

exposure ranking is medium. As such, we anticipate a moderate number of individuals are likely to experience exposure.

**Overall Exposure**: Medium

**Conservation Measures**

**Rain restriction:** The methomyl label has language designed to reduce the likelihood of pesticide runoff from use sites which is the following: "Do not apply during rain. Do not apply when soil in the area to be treated is saturated (if there is standing water on the field or if water can be squeezed from soil) or if NOAA/National Weather Service predicts a total rainfall of 1 inch or greater over the 48 hours following the day of application, only considering a 48-hour period when, at any point during the 48-hour period, the precipitation potential is 50% or greater. Detailed National Weather Service forecasts for local weather conditions should be obtained on-line at: www.weather.gov or by contacting your local National Weather Service Forecasting Office." This rain restriction language provides for a reduction in the concentration of methomyl in aquatic habitats by providing time for methomyl to degrade before runoff into aquatic habitats can occur, decreasing exposure and risk.

**Aquatic habitat buffers:** The methomyl label also has language to reduce the likelihood of pesticide spray drift from use sites specifically to nearby aquatic habitats. The label language states "Do not apply by ground equipment within 25 feet, or by air within 100 feet, of lakes, reservoirs, rivers, estuaries, commercial fish ponds and natural, permanent streams, marshes or natural, permanent ponds".

## Effects of the Action: Toxicity

**Direct Effects:**

Based on available toxicity data for crustaceans, we expect that crustaceans are highly sensitive to methomyl. As such, we expect exposure to methomyl at predicted environmental concentrations will result in a high level of mortality.

**Indirect Effects:**

Based on the best available information from other crayfishes, slenderclaw crayfish likely eat aquatic macroinvertebrates in the juvenile stage and shift toward eating both plant and animals in the adult stage. We expect that methomyl exposure will result in adverse effects to macroinvertebrates that provide food for juveniles but will not adversely affect plant food sources that adults consume.

**Toxicity Summary**

Given the high sensitivity of aquatic invertebrates to methomyl at estimated environmental concentrations, we anticipate all individuals exposed to carbaryl will die. Additionally, we anticipate other aquatic invertebrate species it may rely on for food in its juvenile stage will also die with exposure to methomyl.

**Overall Toxicity:** High

## Effects of the Action Summary

There is a medium level of overlap between the species' range and agricultural use sites and associated off-field areas (9.4% total overlap) and a low level of past usage (up to 4.8% range treated annually), indicating a moderate number of individuals are likely to be exposed over the duration of the proposed action. We expect crustacean species are highly sensitive to carbaryl, indicating a moderate number of individuals are likely to die. As such, the overall risk of adverse effects to the slenderclaw crayfish is high.

## Preliminary Conclusion (with General Conservation Measures)

The slenderclaw crayfish is an endangered, narrow endemic crustacean found in two populations on Sand Mountains in DeKalb and Marshall counties of Alabama. They are found in small to medium flowing streams and likely feed on macroinvertebrates and vegetation. Both populations have low abundance, low resiliency, and are at risk of extinction from threats like habitat loss, non-native and invasive crustacean species (i.e., virile crayfish), and changes in precipitation.

Past annual carbaryl usage occurred on a low percentage of the range (4.8%) and a moderate percentage of agricultural use sites overlap with the species' range (8.6%), indicating that more of the range could receive treatment in the future. In the 2019 Species Status Assessment, we mentioned concern about pesticides, specifically from agriculture and poultry farming, and effects to water quality. Though the species occurs in areas near some non-agricultural use sites (i.e., pasturelands), we do not expect these routes of exposure to meaningful add to the overall level of anticipated exposure from agricultural uses or contribute to the overall risk of adverse effects from agricultural uses. We determined the species has a medium exposure ranking and we anticipate that a moderate number of individuals will experience exposure from the proposed action. Slenderclaw crayfish have a high toxicity ranking because we expect any direct exposure to result in mortality. In addition, juveniles will experience a loss of macroinvertebrate prey from methomyl exposure.

## Final Conclusion (with Species-Specific Conservation Measures)

Because of the effects described in our preliminary conclusion above (Preliminary Conclusion), EPA and the applicant agreed to incorporate the following measures as part of the action. Within the Pesticide Use Limitation Area (PULA) for the slenderclaw crayfish:

*(1) Methomyl must be applied using the following buffers: 50 feet for aerial applications, 10 feet for ground applications, and 25 feet for airblast applications. Based on AgDRIFT modeling, the buffers will reduce spray drift from entering aquatic habitat for the slenderclaw crayfish by between 74-99%. These buffer distances may be reduced using other measures identified as equivalent mitigations (i.e., reducing spray drift by similar magnitude) as specified in EPA's Draft Insecticide Strategy and as described in Appendix A-1 of this Opinion.*

*(2) Applicators need 6 points of mitigation as outlined in EPA's Draft Insecticide Strategy. This will reduce methomyl loads in the habitat of the slenderclaw crayfish by an order of magnitude (i.e., a 10-fold reduction).*

*The PULA for the slenderclaw crayfish will be developed as described in the Description of the Proposed Action section of the main Opinion and Appendix A-1. EPA is currently considering public comments received on the Draft Insecticide Strategy. If additional mitigation options become available during finalization of the Insecticide Strategy or in the future, this might warrant re-initiation to incorporate those measures into the action (i.e., additional options and mitigations for end users). In that case, EPA will provide documentation that these measures provide equivalent conservation for listed species, including reduction in off-site transport. Upon confirmation by the Service, those options will be added to the acceptable mitigations listed for end users of methomyl.*

We anticipate methomyl runoff will occur and result in mortality, but after incorporating these species-specific conservation measures (i.e., rainfall restrictions and aquatic habitat buffers), we expect these pathways of exposure will be greatly limited and result in exposure of very low numbers of individuals over the course of the action. 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 likely to appreciably reduce the survival and recovery of the species. Thus, it is our biological opinion that the proposed action is not likely to jeopardize the continued existence of the slenderclaw crayfish.

## References

U.S. Fish and Wildlife Service. 2019. Species Status Assessment Report for the Slenderclaw Crayfish (*Cambarus cracens*), Version 1.4. Atlanta, Georgia. 73 pp.