Appendix K-A10 - *The following integration and synthesis analyses were done in a step-wise approach that addresses vulnerability, risk, and usage, applicable conservation measures and our conclusion. Please see cover page of this appendix for additional information.*

**Summary of Changes to Risk Analysis for Snails**

Our analysis for snails incorporates an important change since the February 2021 draft biological opinion. For the toxicological analysis, we originally selected the most sensitive terrestrial invertebrate for which data were available (*Apis mellifera*, a honeybee) as a surrogate for terrestrial snails and the $HC_{05}$ from an aquatic invertebrate species sensitivity distribution to use as a reference for aquatic snails. We have since updated our methodology to use a more closely related surrogate species for this taxon for which data was available, the aquatic snail *Viviparus bengalensis*, which is less sensitive than honeybees and the aquatic invertebrate $HC_{05}$ but is a more appropriate surrogate for both terrestrial and aquatic snails (see the *Effects of the Action* section of the biological opinion for more details). While terrestrial species may not be exposed to malathion via the same exposure route as aquatic snails (i.e., in water), we consider aquatic snails to be a more suitable surrogate and assume terrestrial snails exhibit similar tolerance to malathion from contact exposure. Consequently, our original expected mortality rates reported in the draft biological opinion are likely overestimated and are not representative of this taxon. We use the updated risk information and assumptions in the rationale for each conclusion below.

Using a more appropriate surrogate species, we do not expect any mortality to occur, as even the highest estimated environmental concentrations are much lower than the $LC_{50}$ reported in available studies of aquatic snails. We expect terrestrial snails to be similarly tolerant. In addition, no effects to growth, behavior, and reproduction are expected at estimated environmental concentrations. Effects to the food base (e.g., algae, plants, detritus) are likely to be small and impacts to the food base will not have a discernable effect at the species level.

**Integration and Synthesis Summary: Snails (Terrestrial)**

| Scientific Name: | Common Name: | Entity ID: |
|---|---|---|
| *Helminthoglypta walkeriana* | Morro shoulderband (=Banded dune) snail | 387 |

***VULNERABILITY***
***(Summary of status, environmental baseline, and cumulative effects)***

**Status:** Endangered, Five-Year Review Recommendation (09/11/2006): Downlist to Threatened
**Distribution:** Small, endemic, constrained, and/or isolated population(s)
**Number of Populations:** Multiple populations (few)
**Species Trends:** Unknown population trends
**Pesticides noted** ☐

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

The Morro shoulderband snail is endemic to San Luis Obispo County, California, and is restricted to an area approximately 2 miles long (about 7,700 acres). It is a terrestrial snail that lives in coastal dune, coastal dune scrub, and maritime chaparral plant communities in back dunes and stabilized dune systems. It feeds on decaying vegetation and is usually found in moist areas under bushes or vegetative duff.

According to the 1998 Recovery Plan, the species is threatened by habitat destruction and degradation due to increasing development, invasion of non-native plant species (i.e., veldt grass), senescence of dune vegetation, recreational use, competition with the brown garden snail, molluscicides, parasitoids, and effects associated with small, isolated populations and stochastic events. The 2006 5-year status review states that some potential threats to the snail (e.g., competition and parasitism) have been eliminated or shown not to be occurring. Many threats to the Morro shoulderband snail have been reduced or eliminated to the point that it meets recovery criteria for downlisting to threatened status; however, some threats still exist, and it does not meet the recovery criteria for delisting. The two largest remaining threats to the snail are development and a lack of habitat management.

The Recovery Plan identifies four Conservation Planning Areas (CPAs) and states that downlisting from endangered to threatened can be considered when sufficient populations and suitable occupied habitats from all CPAs are secured and protected (Service 1998, p. 39). The 2019 Recovery Plan Amendment clarified delisting criteria. According to the 2020 proposed rule to downlist from endangered to threatened, all of CPA 1 (Morro Spit) and portions of CPAs 2, 3, and 4 (West Pecho, South Los Osos, and Northeast Los Osos) are largely secure under various ownerships and management (Service 2019, pp. 72–74). All have conservation easements, deed restrictions, or are managed by a conservation association for conservation purposes. Landowners and managers include the County, State Parks, California Department of Fish and Wildlife (CDFW), the Land Conservancy of San Luis Obispo County, Morro Coast Audubon Society, and the Small Wilderness Area Program. Approximately 202 ha (500 ac) have been

added to conserved lands since time of listing. This includes 56 ha (138 ac) of parcels purchased and transferred to the California Department of Parks and Recreation (CDPR) or CDFW that are managed for conservation purposes and 141 ha (348 ac) covered by a conservation easement or deed restriction and managed for conservation purposes. Overall, 85 percent (approximately (1,457 ha (3,600 ac)) of CPAs are now conserved. However, a lack of funding precludes adequate threats management on most of these lands (Service 2019, p. 53).

Based on the 1998 Recovery Plan and our 2018 Species Status Assessment (SSA) Report, we concluded that the status of the Morro shoulderband snail has improved throughout its range from the significant preservation or conservation of habitat once at risk of development, along with land use decisions and management activities undertaken by the County of San Luis Obispo (County) and landowners since the time of listing. The SSA Report contains an accounting of known conservation and management efforts. Overall, our analysis indicates that the down listing criteria for the Morro shoulderband snail has been met; however, delisting criteria have not yet been achieved.

**EB/CE Sources:** U.S. Fish and Wildlife Service. 1998. Recovery Plan for the Morro Shoulderband Snail and Four Plants from Western San Luis Obispo County, California. U.S. Fish and Wildlife Service, Portland, Oregon. 75 pp.

U.S. Fish and Wildlife Service. 2006. Banded Dune Snail (*Helminthoglypta walkeriana*) [=Morro shoulderband snail (*Helminthoglypta walkeriana*) and Chorro shoulderband snail (*Helminthoglypta morroensis*)], 5-Year Review: Summary and Evaluation. Ventura, CA. 26 pp.

U.S. Fish and Wildlife Service. 2018. Species status assessment report for the Morro Shoulderband Snail (*Helminthoglypta walkeriana*) and the Chorro Shoulderband Snail (*Helminthoglypta morroensis*). Ventura, California.

U.S. Fish and Wildlife Service. 2019. Recovery Plan for the Morro Shoulderband Snail and Four Plants from Western San Luis Obispo County, California – Recovery Criteria Clarification. 2 pp.

U.S. Fish and Wildlife Service. 2020. Reclassification of Morro Shoulderband Snail (*Helminthoglypta walkeriana*) from Endangered to Threatened with a 4(d) Rule; Proposed Rule. Federal Register Vol. 85, No. 143, July 24, 2020. pp 44821-44835.

**Overall Vulnerability:** ☐ **High** ☒ **Medium** ☐ **Low**

***RISK***
***(Risk is based on species exposure and response from labeled uses across the range)***

**Risk to individuals if exposed:** We do not anticipate effects to the for Morro shoulderband snail from exposure to malathion at labeled use rates.

**Risk to the species from labeled uses across the range:**

The table below summarizes the risk to the species from labeled uses across the range based on range overlaps with use sites and anticipated effects associated with the particular uses.

| ALL USES except mosquito control | |
|---|---|
| Mortality | No effects expected |
| MOSQUITO CONTROL | |
| Mortality | No effects expected |

**Risk modifiers:** The Morro shoulderband snail was first described as the banded dune snail (*Helix walkeriana*) by Hemphill in 1911 (USFWS SOS 2016). This species is found only in western San Luis Obispo County in the Los Osos/Morro Bay area. Its current known range is slightly expanded, to approximately 3.2 kilometers (2 miles) farther to the south and east than what was known at the time of listing; and it is also now known to occupy a narrow strip of dune vegetation north of Morro Bay (USFWS 2006). The range includes areas south of Morro Bay, west of Los Osos Creek, and north of Hazard Canyon (66 FR 9233). Its known range now comprises approximately 3,100 hectares (ha) (7,700 acres [ac.]) (USFWS 2006).

Though no studies or documented observations exist on the reproductive behaviors of the MSS, it is speculated that maturity may be reached, as in other *Helminthoglypta* that inhabit coastal scrub, sometime between 3 and 4 years of age, and that individuals may live as many as 6 to 10 years. Copulation and reproduction likely occur in the rainy season, as is the case with *H. arrosa* (65 FR 42962; NatureServe 2015).

The MSS is a detritivore/scavenger and feeds on decaying material and mycorrhiza (a root fungus).

*Helminthoglypta walkeriana* could shelter, breed, feed in some agricultural areas and developed areas (Julie Vanderwier, pers. comm 2016 co-occurrence information, USFWS field office request).

**Overall Risk:** ☐ **High** ☐ **Medium** ☒ **Low**

***USAGE***
***(Anticipated usage within the range based on past usage data)***

**Agricultural usage based on CalPUR data**

| Use type | Risk to species[1] | Use overlap with range | | Estimated usage in range[2] | |
|---|---|---|---|---|---|
| | | Acres | % | acres | % |
| Mosquito Control | D | 191,274 | 49.74 | 0 | 0 |
| Nurseries | D | 23.6 | < 0.01 | 3.3 | <0.01 |

[1] Direct effects (D), Indirect effects (I), No effects expected (N), Use site not utilized by the species (*)
[2] Estimated usage in the range is based on information about annual past usage.

| Use type | Risk to species[1] | Use overlap with range | | Estimated usage in range[2] | |
|---|---|---|---|---|---|
| | | Acres | % | acres | % |
| Vegetables and Ground Fruit | D | 427 | 0.11 | 216 | 0.06 |
| Open space Developed | D | 12,252 | 3.19 | 613 | 0.16 |
| Other Crops | D | 6,121 | 1.59 | 0 | 0 |
| Other grains | D | 5,657 | 1.47 | 0 | 0 |
| Developed | D | 4,450 | 1.16 | 223 | 0.06 |
| Orchards and vineyards | D | 619 | 0.16 | 0 | 0 |
| Wheat | D | 137 | 0.04 | 0 | 0 |
| Pasture | D | 69 | 0.02 | 0 | 0 |
| Cotton | D | 8 | < 0.01 | 0 | 0 |
| Corn | D | 7 | < 0.01 | 0 | 0 |
| Rice | D | 2 | < 0.01 | 0 | 0 |
| Other Row Crops | D | 1 | < 0.01 | 0 | 0 |
| **Sub-TOTAL (D):** *Other uses with direct effects only*[3] | | 29,771 | 7.78 | 1054 | 0.28 |
| **Sub- TOTAL (I):** *Other uses with indirect effects only*[3] | | 0 | 0 | 0 | 0 |
| **TOTAL[4]:** | | 221,045 | 57.52 | 1054 | 0.28 |

**# acres in species range:** 384,534 acres
**% of range in California (i.e., where CalPUR data is available):** 100%
**Range overlap with Federal lands:** 192,684 acres, 50.108%

**Overall Usage:** ☐ **High** ☐ **Medium** ☒ **Low**

## *CONSERVATION MEASURES*

**Residential use label changes:** New restrictions to the method and frequency of application for residential use of malathion are expected to substantially reduce exposure to species that overlap with developed and open space developed areas. Label changes will ensure that residential use is limited to spot treatments only (rendering spray drift offsite unlikely) and reducing the extent of area which can be treated in the developed and open space developed areas by as much as 75% or more from modeled values. In addition, we expect the frequency of exposure to decrease as the number of allowable applications is reduced from "repeat as necessary" to a maximum of 2–4 applications per year (depending on the specific residential use). Retreatment intervals of 7-10 days between any repeated applications are expected to reduce environmental concentrations by allowing any initial residues to degrade prior to the next application. In addition, exposure to

[3] Mosquito control has the potential to overlap with other uses. It is not included in the Sub-TOTALs.
[4] TOTAL includes usage on all use sites with effects, including mosquito control.

aquatic organisms is reduced due to buffers from waterways, which specify on the label a distance from water bodies where pesticides are not to be applied, and restrictions to application during periods where rain is not forecasted within 24 hours or when the soil is not saturated.

**Reduced application number and rate:** New restrictions on corn, cotton, orchards and vineyards, pasture, other crops, and vegetables and ground fruit lower the maximum allowable number of applications to 2-4 per year (depending on the specific crop; previous allowable numbers of applications ranged from 3 to 13 applications per year). This will help reduce the amount of malathion used and decrease potential exposure to the species, thus decreasing the risk of both indirect and direct effects to the species.

***CONCLUSION***

After reviewing the current status of the species, the environmental baseline for the action area, the effects of the proposed registration of malathion, and the cumulative effects, it is the Service's biological opinion that the registration of malathion, as proposed, is not likely to jeopardize the continued existence of the Morro shoulderband snail. As discussed below, the vulnerability is medium for this species, the risk and likelihood of exposure to malathion is low, and the implementation of the general conservation measures described above is expected to further reduce the likelihood of exposure.

The Morro shoulderband snail has a medium vulnerability based on its status, distribution, and trends, as described above. The Morro shoulderband snail is terrestrial and lives in coastal dune, coastal dune scrub, and maritime chaparral plant communities in back dunes and stabilized dune systems. *Helminthoglypta walkeriana* could shelter, breed, and feed in some agricultural areas and developed areas (Julie Vanderwier, pers. comm 2016 co-occurrence information, USFWS field office request), leading to exposure.

The risk to the species from labeled uses across the range is expected to be low as we do not anticipate any measurable effects from malathion exposure to individuals, including mortality or sublethal effects to growth, reproduction, or behavior. There may be potential effects to the species' food base (e.g., algae, plants, detritus), however these effects are expected to be small and will not likely result in adverse effects to snails.

Usage outside the Federal portion of the species range is expected to be low (0.28%). We did not quantitatively evaluate use or usage on Federal lands that overlap with the species range, but we assume only low levels of usage for this species, per the rationale related to usage on Federal lands as described in the Biological Opinion. Additionally, the changes to residential use labels and reduced agricultural application rates and frequency will further reduce risk of exposure and impacts to the individuals of the species.

Due to the lack of measurable effects to individuals, including mortality and sublethal effects, the lack of appreciable effects to its food base and habitat, low expected usage within the range, as well as the incorporation of conservation measures that would further reduce the risk of

exposure, we anticipate minimal, if any, adverse effects (i.e., not enough to result in take) will occur throughout the duration of the action. Therefore, we do not anticipate that the proposed action would appreciably reduce survival and recovery of the Morro shoulderband snail.

**Conclusion:** Not likely to jeopardize

**Integration and Synthesis Summary: Snails *(Terrestrial)***

| Scientific Name: | Common Name: | Entity ID: |
|---|---|---|
| *Novisuccinea chittenangoensis (*previously *Succinea chittenangoensis)* | Chittenango ovate amber snail | 389 |

***VULNERABILITY***
***(Summary of status, environmental baseline and cumulative effects)***

**Status:** Threatened, Five-Year Review Recommendation (5/28/2019): Uplist to Endangered
**Distribution:** Small, endemic, constrained, and/or isolated population(s)
**Number of Populations:** Single population
**Species Trends:** Unknown population trends
**Pesticides noted** ☒

**Environmental Baseline/Cumulative Effects (EB/CE) Summary:**
Since its discovery in 1905, only one extant *N. chittenangoensis* colony has been verified, from a site within the Chittenango Falls State Park in Madison County, New York. The Chittenango ovate amber snail is a terrestrial species that requires the cool, mild-temperature, moist conditions provided by the waterfalls and mist in its environment. Its habitat lies within a ravine at the base of a 167-foot waterfall, and the ledges where it is found comprise an early successional sere that is periodically rejuvenated to a bare substrate by floodwaters. As described in the 2006 5-Year Review, the Chittenango ovate amber snail population was estimated to be 178 in 2003, 680 in 2004, and 819 in 2005. Analyses have since been rerun (Campbell et al. 2010) with estimates of 262.4 (±35.68), 225.1 (±31.76), 716.5 (±68.97), and 784.2 (±38.10) for 2002-2005, respectively. However, all work at the Falls was stopped in July 2006 due to a massive flood event that caused a rockslide in the primary Chittenango ovate amber snail habitat. Surveys were reinitiated in 2007 after human safety concerns were addressed at the site. Campbell et al. (2010) reported population estimates for 2007, 2008, and 2009 of 551.1 (±50.01), 322.6(±27.59), and 339.2 (±52.85), respectively. Population estimates for the species were 271.1 (± 98.91) in 2016, 159.9 (±24.61) in 2017, and 260.8 (±97.96) in 2018 (FWS 2019). The USGS obtained samples from 34 Chittenango ovate amber snails for genetics research and successfully developed and characterized 12 microsatellite markers (King et al. 2012). Of the 12 primers, overall allelic diversity ranged from 2 to 9 with an average of 5.2 alleles/locus. While Chittenango ovate amber snail are hermaphroditic, allelic diversity indicates no evidence of individuals reproducing with themselves as the fewest number of allele differences detected among the 34 individuals sampled was six. The USGS also estimated effective population size using the same samples. Results indicate an effective population size of 74 individuals (95% CL, 44 and 195) that has remained constant over time, suggesting that flooding events in 2006 did not result in significant changes in genetic variation. Flooding events continue to be a threat to the species. In 2017, major flooding washed away a large group of joe pye weed (*Eutrochium purpureum*) plants from the Chittenango ovate amber snail habitat where the species are

regularly found, leaving the substrate baren. A new potential threat was recently identified at the Falls. Pale swallowwort (*Cynanchum rossicwn*) has been found within the areas occupied by Chittenango ovate amber snail. From captive observations, the Chittenango ovate amber snail does not consume dead or fresh pale swallowwort leaves (Gilbertson pers. com *in* FWS 2019); therefore, if the species takes over the habitat, it may reduce foraging options for the Chittenango ovate amber snail (FWS 2019).

The Regional Facilities Manager and Park Manager that oversee the Chittenango Falls State Park have no knowledge of malathion usage in the park and have no plans to use it in the future. The primary concern for the species is rockslides that have removed suitable habitat and changed the microclimate. Other threats have been ruled out, but there has not been any water quality monitoring to know if that is a threat (Niver 2021, pers. comm.). Most of the Chittenango Creek watershed is used for agriculture, with fertilizers, herbicides and pesticides entering the drainage. In the winter months, road salt causes high salinity. Although water quality appears to be generally high, the effects of short-term pulses of polluted runoff from these agents may be deleterious to the population (New York State Department of Environmental Conservation, http://www.dec.ny.gov/animals/7122.html, accessed July 2020).

**EB/CE Sources:** Niver, R. 2021. Personal communication. June 15, 2021, email exchange between Robyn Niver, Karen Myers and Jennifer Thompson, U.S. Fish and Wildlife Service, regarding malathion usage at the Chittenango Falls State Park and the Chittenango ovate amber snail.

U.S. Fish and Wildlife Service. November 8, 2012. Chittenango ovate amber snail (*Novisuccinea chittenangoensis*) 5-Year Review: Summary and Evaluation. Cortland, New York. 12 pp.

U.S. Fish and Wildlife Service. 2019. Chittenango ovate amber snail (*Novisuccinea chittenangoensis*) 5-Year Review: Summary and Evaluation. Cortland, New York. 14 pp + Appendix.

New York State Department of Environmental Conservation. Chittenango Ovate Amber Snail Fact Sheet. http://www.dec.ny.gov/animals/7122.html, accessed July 2020.

**Overall Vulnerability:** ☒ **High** ☐ **Medium** ☐ **Low**

***RISK***
***(Risk is based on species exposure and response from labeled uses across the range)***

**Risk to individuals if exposed:** We do not anticipate effects to the species from exposure to malathion at labeled use rates.

**Risk to the species from labeled uses across the range:** The table below summarizes the risk to the species from labeled uses across the range based on range overlaps with use sites and anticipated effects associated with the particular uses.

| ALL USES except mosquito control | |
|---|---|
| Mortality | no effects expected |
| MOSQUITO CONTROL | |
| Mortality | no effects expected |

**Risk modifiers:** The Chittenango ovate amber snail is only known to be extant from a single location in Chittenango State Park, New York. It prefers cool, mild-temperatures, and moist conditions provided by the waterfalls and mist in this area (USFWS SOS 2016). The Chittenango ovate amber snail inhabits the wet cliff walls and talus in a ravine at the base of Chittenango Falls (a 167-foot waterfall). The ravine ledges comprise an early successional sere that is periodically rejuvenated to a bare substrate by floodwaters. It has also been found in the vegetation both within the saturated spray of the falls, and surrounding a nearby spring-fed area. The species requires a substrate rich in calcium carbonate and appears to prefer green vegetation such as the various mosses, liverworts, and other low herbaceous vegetation found within the spray zone adjacent to the falls (USFWS, 1997; 2006; NatureServe, 2015).

The Chittenango ovate amber snail mates from May through July, ovipositing from June through July after the spring thaw. They are hermaphroditic; however, it is unclear if selfing is possible. Egg clusters are deposited at the base of plants, under matted vegetation, or in loose, wet soil. The young snails hatch in 2 to 3 weeks. The species feeds on microflora and must obtain high levels of calcium carbonate from their environment for proper shell formation.

The lifespan of this species is approximately 2 to 2.5 years, based on shell characters and range of sizes seen. It appears in May, copulates in June, deposits eggs in July, suffers an abrupt die-off, becomes cryptic in August, and overwinters under thick ice overhangs. The species are most often seen on green, dry *Eupatorium purpureum*, *Angelica purpurea* and blue Aster.

**Overall Risk:** ☐ **High** ☐ **Medium** ☒ **Low**

***USAGE***
***(Anticipated usage within the range based on past usage data)***

| Use type | Risk to species[1] | Use overlap with range | | Estimated usage in range[2] | |
|---|---|---|---|---|---|
| | | Acres | % | acres | % |
| Mosquito Control | D | 716.5 | 0.17 | 0 | 0 |
| Corn | D | 31,9338 | 7.53 | 2,482 | 0.59 |
| Pasture | D | 25,484 | 6.01 | 16,163 | 3.81 |

[1] Direct effects (D), Indirect effects (I), No effects expected (N), Use site not utilized by the species (*)
[2] Estimated usage in the range is based on information about annual past usage.

| Use type | Risk to species[1] | Use overlap with range | | Estimated usage in range[2] | |
|---|---|---|---|---|---|
| | | Acres | % | acres | % |
| Open Space Developed | D | 14,639 | 3.45 | 732 | 0.17 |
| Developed | D | 5,849 | 1.38 | 292 | 0.07 |
| Other Crops | D | 4,203 | 0.99 | 0 | 0 |
| Other Grains | D | 1,287 | 0.30 | 1,287 | 0.30 |
| Wheat | D | 943 | 0.22 | 943 | 0.22 |
| Vegetables and Ground Fruit | D | 882 | 0.21 | 882 | 0.21 |
| Nurseries | D | 41 | <0.01 | 40 | < 0.01 |
| Christmas Trees | D | 21 | <0.01 | 10 | < 0.01 |
| Orchards and Vineyards | D | 19 | <0.01 | 19 | < 0.01 |
| Other Row Crops | D | 3 | <0.01 | 3 | < 0.01 |
| Rice | D | <1 | <0.01 | <0.01 | < 0.01 |
| **Sub-TOTAL (D):** *Other uses with direct effects only*[3] | | 85,303 | 20.14 | 22,854 | 5.37 |
| **Sub- TOTAL (I):** *Other uses with indirect effects only*[3] | | 0 | 0 | 0 | 0 |
| **TOTAL[4]:** | | 86,019.8 | 20.31 | 22,854 | 5.37 |

**# acres in species range:** 424,143 acres
**% of range in California (i.e., where CalPUR data is available):** 0%
**Range overlap with Federal lands:** 0 acres, 0.000%

**Overall Usage:** ☐ **High** ☒ **Medium** ☐ **Low**

## *CONSERVATION MEASURES*

**Residential use label changes:** New restrictions to the method and frequency of application for residential use of malathion are expected to substantially reduce exposure to species that overlap with developed and open space developed areas. Label changes will ensure that residential use is limited to spot treatments only (rendering spray drift offsite unlikely) and reducing the extent of area which can be treated in the developed and open space developed areas by as much as 75% or more from modeled values. In addition, we expect the frequency of exposure to decrease as the number of allowable applications is reduced from "repeat as necessary" to a maximum of 2–4 applications per year (depending on the specific residential use). Retreatment intervals of 7-10 days between any repeated applications are expected to reduce environmental concentrations by allowing any initial residues to degrade prior to the next application. In addition, exposure to

[3] Mosquito control has the potential to overlap with other uses. It is not included in the Sub-TOTALs.
[4] TOTAL includes usage on all use sites with effects, including mosquito control.

aquatic organisms is reduced due to buffers from waterways, which specify on the label a distance from water bodies where pesticides are not to be applied, and restrictions to application during periods where rain is not forecasted within 24 hours or when the soil is not saturated.

**Reduced application number and rate:** New restrictions on corn, cotton, orchards and vineyards, pasture, other crops, and vegetables and ground fruit lower the maximum allowable number of applications to 2-4 per year (depending on the specific crop; previous allowable numbers of applications ranged from 3 to 13 applications per year). This will help reduce the amount of malathion used and decrease potential exposure to the species, thus decreasing the risk of both indirect and direct effects to the species.

---

***CONCLUSION***

After reviewing the current status of the species, the environmental baseline for the action area, the effects of the proposed registration of malathion, and the cumulative effects, it is the Service's biological opinion that the registration of malathion, as proposed, with the implementation of the general conservation measures described above, is not likely to jeopardize the continued existence of the Chittenango ovate amber snail. As discussed below, although the vulnerability is high for this species, the risk is low, and the likelihood of exposure is medium, we anticipate the limited distribution of the species, and, to a lesser degree, the conservation measures above, would further reduce the likelihood of exposure.

The Chittenango ovate amber snail has a high vulnerability based on its status, distribution, and trends, as described above. However, the Chittenango ovate amber snail is only known to be extant from a single location in Chittenango State Park, New York. The species inhabits the wet cliff walls and talus in a ravine at the base of Chittenango Falls (a 167-foot waterfall). It has also been found in the vegetation both within the saturated spray of the falls, and surrounding a nearby spring-fed area.

The risk to the species from labeled uses across the range is expected to be low as we do not anticipate any measurable effects from malathion exposure to individuals, including mortality or sublethal effects to growth, reproduction, or behavior. There may be potential effects to the species' food base (e.g., algae, plants, detritus), however these effects are expected to be small and will not likely result in adverse effects to snails.

We anticipate usage within the range will be medium (5.37%), based primarily on the standard usage data we acquired, as described in the Opinion, and summarized for this species above. However, malathion usage is not known occur near the areas within the State Park where the species is found, nor is usage expected to occur in the future. We therefore anticipate that exposure to malathion within the non-Federal portion of the species range would not result in adverse effects to the species. Additionally, we expect that conservation measures, such as changes to residential use labels and reduced agricultural application rates and frequency that would limit exposure from offsite sources, will further reduce likelihood of exposure.

Due to the lack of measurable effects to individuals, including mortality and sublethal effects, the lack of appreciable effects to its food base and habitat, and the incorporation of conservation measures that would further reduce the risk of exposure, we anticipate minimal, if any, adverse effects (i.e., not enough to result in take) will occur throughout the duration of the action. Therefore, the proposed action is not likely to appreciably reduce survival and recovery of the Chittenango ovate amber snail in the wild.

**Conclusion:** Not likely to jeopardize

**Integration and Synthesis Summary: Snails *(Terrestrial)***

| Scientific Name: | Common Name: | Entity ID: |
|---|---|---|
| *Triodopsis platysayoides* | Flat-spired three-toothed snail | 390 |

***VULNERABILITY***
***(Summary of status, environmental baseline and cumulative effects)***

**Status:** Threatened
**Distribution:** Small, endemic, constrained, and/or isolated population(s)
**Number of Populations:** Size/location(s) unknown
**Species Trends:** Unknown population trends
**Pesticides noted** ☐

**Environmental Baseline/Cumulative Effects (EB/CE) Summary:**
The flat-spired three-toothed snail is endemic to the Cheat River gorge of northern West Virginia. Little is known of the life history of this secretive animal. The species is typically observed within one meter of a rock feature. It can be found in cool moist, deep fissures in shale, sandstone and limestone outcrops and in talus. This snail occurs in outcrops from the river bottoms to the ridgetops. Rock outcrops one meter or more in height are considered potential habitat if there are cracks and crevices at least one meter deep. *T. platysayoides* is primarily active at night. Most snail activity is observed during spring to early summer during cool, moist weather conditions. It is unknown whether the snail hibernates during winter. It is believed that the tree cover provides essential cooling that contributes to the preferred microclimate for the snail.

Little is known about population sizes or trends because the snail is difficult to survey. The biological principles that allow us to evaluate the rangewide population status of the snail relative to its long-term conservation are representation, redundancy, and resiliency. At the time of listing, this species was thought to be an extremely rare and declining taxon that occurred within a very small range. We now know that occupancy of available habitat is much more widespread than formerly thought, and that the geographic extent of the snail's range approximates the Cheat gorge. Although the sandstone/limestone oak-dominated ecosystem upon which the snail depends has not rebounded to pre-logging conditions, we have learned that flat-spired three-toothed snail individuals have persisted at 99 locations in the largely contiguous second-growth forest that has come back since the widespread logging and fires that occurred at the turn of the 20th century. From this, we can infer that there is more representation (i.e., occupancy of representative habitats formerly occupied by the snail across its range) and redundancy (i.e., distribution of individuals in a pattern that offsets unforeseen losses across a portion of the snail's range) of the species than was known at the time of listing.

However, the snail is still considered a rare, narrowly ranging species that is endemic to the Cheat gorge. We lack sufficient information to detect population trends because the species is

extremely difficult to survey and site locations have not been grouped into populations. Genetic diversity was found to be low or low-to-moderate by Garner et al. (2012). They noted that the allele richness and diversity they found was similar to other both endangered and non-endangered snails. Further research by King et al. (2015) found similar levels of allele diversity in *T. platysayoides*. It is unclear if low genetic diversity poses a threat to the species (e.g., by reducing its adaptive capacity). Further sampling and research would be helpful in understanding more about this aspect of the species' viability.

Even though almost all known sites occur on public land, human recreational effects still pose a significant threat to the species. The installation of a new trail has increased the risk of direct human effects and signals the need for increased communication regarding the snail in the absence of a management plan. While the threat of logging by private landowners has been reduced, there is still potential for future logging activity on State lands. Natural gas extraction poses a new threat to the species within a portion of its range. The growing threat of climate change poses a threat to the snail and its habitat and increases the magnitude of other threats like defoliation. The species' forested ecosystem also faces a low or unknown but increasing degree of risk from deer herbivory, and invasive plants. Natural predation, cannibalism, and competition with other snail species are suspected threats, but the magnitude of their impact is largely unknown.

**EB/CE Sources:** U. S. Fish and Wildlife Service. 2007. Flat-spired Three-toothed Land Snail (Tridopsis platysayoides) 5-Year Review: Summary and Evaluation. Elkins, West Virginia. 25 pp.

U.S. Fish and Wildlife Service. 2019. Flat-spired Three-toothed Land Snail (Cheat Three-tooth Snail) (*Triodopsis platysayoides*) 5-Year Review: Summary and Evaluation. Elkins, West Virginia. 57 pp.

**Overall Vulnerability:** ☐ **High** ☒ **Medium** ☐ **Low**

***RISK***
***(Risk is based on species exposure and response from labeled uses across the range)***

**Risk to individuals if exposed:** We do not anticipate effects to the species from exposure to malathion at labeled use rates.

**Risk to the species from labeled uses across the range:** The table below summarizes the risk to the species from labeled uses across the range based on range overlaps with use sites and anticipated effects associated with the particular uses.

| ALL USES except mosquito control | |
|---|---|
| Mortality | no effects expected |
| MOSQUITO CONTROL | |
| Mortality | no effects expected |

**Risk modifiers:** The flat-spired three tooth snail is found within a narrow range but is known from nearly 100 occurrences distributed on both sides of Cheat Gorge within an approximately 14-mile stretch including portions of major tributary ravines. Range begins near the mouth of Muddy Run near Ruthbelle in Preston Co. and extends to the lower reaches of the Cheat River near Tyrone in Monongalia (USFWS SOS 2016).

The species has coevolved with a rare mammal, the Alleghany woodrat, *Neotoma magister*, and where the wood rat and snail coexist, woodrats furnish a nearly constant food supply for the snail, including wood-rat excrement and a host of woodrat harvested provisions carried into the snail's location (NatureServe, 2015).

Optimum snail activity occurs during the spring and early summer at elevations of 548-610 ft.

The flat-spired three tooth snail feeds at crevices of exposed sandstone and talus of rock and caves; it also feeds in deep litter at base of major rocks. This species has a close association with massive sandstone outcrops and talus; it is also found at cave mouths and on limestone. The plant species frequently found associated include sweet birch (*Betula lenta*), eastern hemlock (*Tsuga canadensis*), yellow birch (*Betula allegheniensis*) and great Laurel (*Rhododendron maximum*) (Hotopp, 2005).

Diet includes fungi, lichens, flower blossoms of the tulip tree *Liriodendron tulipifera*, deceased gray cave crickets *Euhadenoecus fragilis*, gray cave cricket excrement, yellow birch *Betula allegheniensis*, and sweet birch *Betula lenta* leaves. It also feeds on vacant shells of *Xolotrema denotatum*, *Mesomphix cupreus*, and its own kind (Dourson, 2008). Peak activity for the species occurs after nightfall whereas peak feeding occurs when temperatures are between 18 and 23C.

The species is likely to use managed forests for the entire lifecycle, unless heavily timbered (Barbara Douglas pers. comm 2016 co-occurrence information, USFWS field office request).

**Overall Risk:** ☐ **High** ☐ **Medium** ☒ **Low**

***USAGE***
***(Anticipated usage within the range based on past usage data)***

| Use type | Risk to species[1] | Use overlap with range | | Estimated usage in range[2] | |
|---|---|---|---|---|---|
| | | Acres | % | acres | % |
| Mosquito Control | D | 297,559 | 28.2 | 0 | 0 |
| Open Space Developed | D | 65,726 | 6.24 | 3,286 | 0.31 |
| Developed | D | 20,151 | 1.91 | 1,008 | 0.10 |

[1] Direct effects (D), Indirect effects (I), No effects expected (N), Use site not utilized by the species (*)
[2] Estimated usage in the range is based on information about annual past usage.

| Use type | Risk to species[1] | Use overlap with range | | Estimated usage in range[2] | |
|---|---|---|---|---|---|
| | | Acres | % | acres | % |
| Corn | D | 5,173 | 0.49 | 1,139 | 0.11 |
| Pasture | D | 1,222 | 0.12 | 1,222 | 0.12 |
| Other Grains | D | 306 | 0.03 | 101 | < 0.01 |
| Other Crops | D | 286 | 0.03 | 0 | 0 |
| Nurseries | D | 65 | < 0.01 | 65 | < 0.01 |
| Wheat | D | 30 | < 0.01 | 17 | < 0.01 |
| Orchards and vineyards | D | 8 | < 0.01 | <1 | < 0.01 |
| Vegetables and Ground Fruit | D | 5 | < 0.01 | 2 | < 0.01 |
| Christmas Trees | D | 1 | < 0.01 | 1 | < 0.01 |
| Other Row Crops | D | <1 | < 0.01 | <1 | < 0.01 |
| **Sub-TOTAL (D):** *Other uses with direct effects only*[3] | | 92,974 | 8.88 | 6,841 | 0.65 |
| **Sub- TOTAL (I):** *Other uses with indirect effects only*[3] | | 0 | 0 | 0 | 0 |
| **TOTAL[4]:** | | 390,532 | 37.08 | 6,841 | 0.65 |

**# acres in species range:** 1,053,762 acres
**% of range in California (i.e., where CalPUR data is available):** 0%
**Range overlap with Federal lands:** 50,875 acres, 4.828%

**Overall Usage:** ☐ **High** ☐ **Medium** ☒ **Low**

***CONSERVATION MEASURES***

**Residential use label changes:** New restrictions to the method and frequency of application for residential use of malathion are expected to substantially reduce exposure to species that overlap with developed and open space developed areas. Label changes will ensure that residential use is limited to spot treatments only (rendering spray drift offsite unlikely) and reducing the extent of area which can be treated in the developed and open space developed areas by as much as 75% or more from modeled values. In addition, we expect the frequency of exposure to decrease as the number of allowable applications is reduced from "repeat as necessary" to a maximum of 2–4 applications per year (depending on the specific residential use). Retreatment intervals of 7-10 days between any repeated applications are expected to reduce environmental concentrations by allowing any initial residues to degrade prior to the next application. In addition, exposure to aquatic organisms is reduced due to buffers from waterways, which specify on the label a distance from water bodies where pesticides are not to be applied, and restrictions to application during periods where rain is not forecasted within 24 hours or when the soil is not saturated.

[3] Mosquito control has the potential to overlap with other uses. It is not included in the Sub-TOTALs.
[4] TOTAL includes usage on all use sites with effects, including mosquito control.

***CONCLUSION***

After reviewing the current status of the species, the environmental baseline for the action area, the effects of the proposed registration of malathion, and the cumulative effects, it is the Service's biological opinion that the registration of malathion, as proposed, is not likely to jeopardize the continued existence of the flat-spired three-toothed snail. As discussed below, although the vulnerability is high for this species, we anticipate the risk and likelihood of exposure to malathion is low; the implementation of the general conservation measure described above is expected to further reduce the likelihood of exposure.

The flat-spired three-toothed snail has a high vulnerability based on its status, distribution, and trends. The flat-spired three-toothed snail is endemic to the Cheat River gorge of northern West Virginia. This species depends on a sandstone/limestone oak-dominated ecosystem. It occurs in outcrops from the river bottoms to the ridgetops and can be found in cool moist, deep fissures in shale, sandstone and limestone outcrops, and in talus. The flat-spired three tooth snail feeds at crevices of exposed sandstone and talus of rock and caves and in deep litter at the base of major rocks. Diet of the species includes fungi, lichens, flower blossoms of the tulip tree *Liriodendron tulipifera*, deceased gray cave crickets *Euhadenoecus fragilis*, gray cave cricket excrement, yellow birch *Betula allegheniensis*, and sweet birch *Betula lenta* leaves. It also feeds on vacant shells of *Xolotrema denotatum*, *Mesomphix cupreus*, and its own kind (Dourson, 2008).

The risk to the species from labeled uses across the range is expected to be low as we do not anticipate any measurable effects from malathion exposure to individuals, including mortality or sublethal effects to growth, reproduction, or behavior. There may be potential effects to the species' food base (e.g., algae, plants, detritus), however these effects are expected to be small and will not likely result in adverse effects to snails.

We anticipate usage within the range will be low based primarily on the usage data we acquired, as described in the Opinion, and summarized for this species above. There is a high overlap with mosquito control use, but we do not expect mosquito control with malathion to occur within the non-Federal portions of the species range based on past usage data, as shown above. We did not quantitatively evaluate use or usage on Federal lands that overlap with the species range, but we assume only low levels of usage for this species, per the rationale related to usage on Federal lands as described in the Biological Opinion. Additionally, label restrictions for developed and open space developed uses incorporated in the developed/open spaced developed use conservation measures, will further reduce exposure and subsequent negative impacts from malathion.

Due to the lack of measurable effects to individuals, including mortality and sublethal effects, the lack of appreciable effects to its food base and habitat, low expected usage, and the incorporation of conservation measures that would further reduce the risk of exposure, we anticipate minimal, if any, adverse effects (i.e., not enough to result in take) will occur throughout the duration of the

action. Therefore, we do not anticipate that the proposed action would appreciably reduce survival and recovery of the flat-spired three-toothed snail.

**Conclusion:** Not likely to jeopardize

**Integration and Synthesis Summary: Snails *(Terrestrial)***

| Scientific Name: | Common Name: | Entity ID: |
|---|---|---|
| *Discus macclintocki* | Iowa Pleistocene snail | 391 |

***VULNERABILITY***
***(Summary of status, environmental baseline and cumulative effects)***

**Status:** Endangered
**Distribution:** Small, endemic, constrained, and/or isolated population(s)
**Number of Populations:** Multiple populations (numerous)
**Species Trends:** Unknown population trends
**Pesticides noted** ☒

**Environmental Baseline/Cumulative Effects (EB/CE) Summary:**
The Iowa Pleistocene snail was listed as a federally endangered species in 1978 based on only one known location threatened by direct pesticide application for land clearing. Today there are 38 known sites where the species is found, in Illinois, Iowa, and Wisconsin. In 2014 and 2015, the Service monitored 36 of the 38 known locations (access to two sites was not permitted by the private landowner) and documented live shells at 22 locations, relict shells at ten, and no shells at four. These monitoring efforts indicate that live individuals were present at fewer sites during the 2014 and 2015 surveys than in the 1980s (USFWS 2020). The species has survived many interglacial warming periods during the Pleistocene Epoch and other warming or dry periods during the Holocene Epoch, so the species has historically been resilient. The recovery of the Iowa Pleistocene snail is feasible and reasonable even considering current threats. It is a small land snail that is found on a unique talus slope ecosystem of a rocky plateau known as the Paleozoic Plateau in the Midwest. The adult Iowa Pleistocene snail is seven to eight millimeters. They can live for several years. The land snails mature during the third year. The eggs are deposited in small clusters under logs, under bark or in the soil. They aestivate at warm temperatures and hibernate at extreme cold temperatures. The land snails are preyed upon by shrews and beetles. The land snail diet is predominately birch and maple leaves on the forest floor.

Most of the original threats outlined in the final listing rule and recovery plan are present on the 12 algific talus slopes that are not protected. Invasive plant species have encroached into the habitats of the Iowa Pleistocene snail (Cathy Henry. U.S. Fish and Wildlife Service, Wapello, Iowa. pers. comm. 2013). The invasive plant species include garlic mustard (*Alliaria periolaia*) and stinging nettle (*Urrica* sp.). Competition for nutrients and light by the invasive plant species over the natural climate relict plant assemblage of bryophytes, golden saxifrage and Canada yew may have yet undetermined adverse effects on the suitability of the habitat for the Iowa Pleistocene snail (C. Hemy pers. comm. 2013).

Pesticide drift from crop fields over algific talus slopes is identified as a threat to the species. The exposure pathway to the Iowa Pleistocene snail and its habitat is through application of

pesticides or pesticides that drift over native habitats, or from pesticides that have volitized and re-deposited in the rainfall (Hatfield et al. 1996 *in* USFWS 2013).

**EB/CE Sources:** U. S. Fish and Wildlife Service. 2013. Iowa Pleistocene Snail (*Discus macclinktocki*) 5-Year Review: Summary and Evaluation. U. S. Fish and Wildlife Service, Midwest Region, Rock Island, Illinois. 25 pp.

U. S. Fish and Wildlife Service. 2020. Iowa Pleistocene Snail (*Discus macclinktocki*) 5-Year Review: Summary and Evaluation. U. S. Fish and Wildlife Service, Midwest Region, Rock Island, Illinois. 7 pp.

**Overall Vulnerability: ☒ High ☐ Medium ☐ Low**

***RISK***
***(Risk is based on species exposure and response from labeled uses across the range)***

**Risk to individuals if exposed:** We do not anticipate effects to the species from exposure to malathion at labeled use rates.

**Risk to the species from labeled uses across the range:** The table below summarizes the risk to the species from labeled uses across the range based on range overlaps with use sites and anticipated effects associated with the particular uses.

| ALL USES except mosquito control | |
|---|---|
| Mortality | no effects expected |
| MOSQUITO CONTROL | |
| Mortality | no effects expected |

**Risk modifiers:** Iowa Pleistocene Snail habitat is referred to as algific (cold producing) talus slopes (Kristen Lundh, pers. comm. 2016 biological information, USFWS field office request). This snail is presently in only about 37 (USFWS, 2013) small areas in northeast Iowa and northwest Illinois, and 50% of the individuals are in 4 colonies. Only about 40,000 individuals remain and this density varies from year to year (NatureServe, 2015). The species is hermaphroditic, but not self-fertilizing, and all adults can both lay and fertilize eggs. Hatching occurs 28 days after eggs are laid, with 90% viability. Eggs are laid under logs, protected moist rock crevices, and under the soil from late March/April-August.

The species feeds on fallen leaves of birch and maple trees, dogwood saplings. The Iowa Pleistocene snail has a rather limited diet. It prefers white and yellow birch leaves and those of hard maples, trees with limited distribution in Iowa. It will also eat dogwood and willow leaves but refuses a wide variety of food sources commonly utilized by other land snails (Frest, 1981).

**Overall Risk: ☐ High ☐ Medium ☒ Low**

***USAGE***

***(Anticipated usage within the range based on past usage data)***

| Use type | Risk to species[1] | Use overlap with range | | Estimated usage in range[2] | |
|---|---|---|---|---|---|
| | | Acres | % | acres | % |
| Mosquito Control | D | 374,284 | 87.52 | 0 | 0 |
| Corn | D | 87,098 | 20.37 | 26,161 | 6.12 |
| Open Spaced Developed | D | 16,953 | 3.96 | 848 | 0.20 |
| Developed | D | 7,924 | 1.85 | 396 | 0.09 |
| Pasture | D | 7,527 | 1.76 | 3,481 | 0.81 |
| Wheat | D | 672 | 0.16 | 672 | 0.16 |
| Other Grains | D | 305 | 0.07 | 305 | 0.08 |
| Vegetables and Ground Fruit | D | 97 | 0.02 | 95 | 0.02 |
| Nurseries | D | 15 | < 0.01 | 15 | < 0.01 |
| Other Crops | D | 15 | < 0.01 | 0 | 0 |
| Orchards and vineyards | D | 12 | < 0.01 | 5 | < 0.01 |
| Other row Crops | D | 2 | < 0.01 | <1 | < 0.01 |
| Christmas Trees | D | 1 | < 0.01 | 1 | < 0.01 |
| **Sub-TOTAL (D):** *Other uses with direct effects only*[3] | | 120,621 | 28.24 | 31,978 | 7.53 |
| **Sub- TOTAL (I):** *Other uses with indirect effects only*[3] | | 0 | 0 | 0 | 0 |
| **TOTAL[4]:** | | 494,905 | 115.76 | 31,978 | 7.53 |

**# acres in species range:** 427,670 acres
**% of range in California (i.e., where CalPUR data is available):** 0%
**Range overlap with Federal lands:** 22,079 acres, 5.163%

**Overall Usage:** ☐ **High** ☒ **Medium** ☐ **Low**

***CONSERVATION MEASURES***

**Residential use label changes:** New restrictions to the method and frequency of application for residential use of malathion are expected to substantially reduce exposure to species that overlap with developed and open space developed areas. Label changes will ensure that residential use is limited to spot treatments only (rendering spray drift offsite unlikely) and reducing the extent of area which can be treated in the developed and open space developed areas by as much as 75%

[1] Direct effects (D), Indirect effects (I), No effects expected (N), Use site not utilized by the species (*)
[2] Estimated usage in the range is based on information about annual past usage.
[3] Mosquito control has the potential to overlap with other uses. It is not included in the Sub-TOTALs.
[4] TOTAL includes usage on all use sites with effects, including mosquito control.

or more from modeled values. In addition, we expect the frequency of exposure to decrease as the number of allowable applications is reduced from "repeat as necessary" to a maximum of 2–4 applications per year (depending on the specific residential use). Retreatment intervals of 7-10 days between any repeated applications are expected to reduce environmental concentrations by allowing any initial residues to degrade prior to the next application. In addition, exposure to aquatic organisms is reduced due to buffers from waterways, which specify on the label a distance from water bodies where pesticides are not to be applied, and restrictions to application during periods where rain is not forecasted within 24 hours or when the soil is not saturated.

**Reduced application number and rate:** New restrictions on corn, cotton, orchards and vineyards, pasture, other crops, and vegetables and ground fruit lower the maximum allowable number of applications to 2-4 per year (depending on the specific crop; previous allowable numbers of applications ranged from 3 to 13 applications per year). This will help reduce the amount of malathion used and decrease potential exposure to the species, thus decreasing the risk of both indirect and direct effects to the species.

***CONCLUSION***

After reviewing the current status of the species, the environmental baseline for the action area, the effects of the proposed registration of malathion, and the cumulative effects, it is the Service's biological opinion that the registration of malathion, as proposed, is not likely to jeopardize the continued existence of the Iowa Pleistocene snail. As discussed below, although the vulnerability is high for this species, the risk is low, and the likelihood of exposure is medium. The implementation of the general conservation measures described above is expected to substantially reduce the likelihood of exposure.

The Iowa Pleistocene snail has a high vulnerability based on its status, distribution, and trends, as described above. The species is presently found in only about 22 (updated to 37 talus slopes in Henry, 2003 and 38 in USFWS, 2013) small areas in northeast Iowa and northwest Illinois, and 50% of the individuals are in 4 colonies. Only about 40,000 individuals remain and this density varies from year to year. (NatureServe, 2015). Recent survey efforts have found live snails at 22 locations; 12, or just over half, of known locations are unprotected algific talus slopes where pesticide spray drift has been identified as a concern (USFWS 2020).

The risk to the species from labeled uses across the range is expected to be low as we do not anticipate any measurable effects from malathion exposure to individuals, including mortality or sublethal effects to growth, reproduction, or behavior. There may be potential effects to the species' food base (e.g., algae, plants, detritus), however these effects are expected to be small and will not likely result in adverse effects to snails.

We anticipate usage within the non-Federal lands portion of the range will be medium, based primarily on the standard usage data we acquired, as described in the Opinion, and summarized for this species above. We did not quantitatively evaluate use or usage on Federal lands that overlap with the species range (5.16%), but we assume only low levels of usage for this species,

per the rationale related to usage on Federal lands as described in the Biological Opinion. The usage areas presented above are areas within the species range that the species is unlikely to use, reducing the likelihood of exposure. Additionally, conservation measures, such as changes to developed and open spaced developed use labels and reductions in the number of applications and application rates, are anticipated to substantially reduce environmental concentrations of malathion, further reducing the likelihood of exposure.

Due to the lack of measurable effects to individuals, including mortality and sublethal effects, the lack of appreciable effects to its food base and habitat, and the incorporation of conservation measures that would further reduce the risk of exposure, we anticipate minimal, if any, adverse effects (i.e., not enough to result in take) will occur throughout the duration of the action. Therefore, we do not anticipate that the proposed action would appreciably reduce survival and recovery of the Iowa Pleistocene snail in the wild.

**Conclusion:** Not likely to jeopardize

***ADDITIONAL REFERENCES***

U. S. Fish and Wildlife Service. 2013. Iowa Pleistocene Snail (*Discus macclinktocki*) 5-Year Review: Summary and Evaluation. U. S. Fish and Wildlife Service, Midwest Region, Rock Island, Illinois. 25 pp.

U. S. Fish and Wildlife Service. 2020. Iowa Pleistocene Snail (*Discus macclinktocki*) 5-Year Review: Summary and Evaluation. U. S. Fish and Wildlife Service, Midwest Region, Rock Island, Illinois. 7 pp.

**Integration and Synthesis Summary: Snails *(Terrestrial)***

| Scientific Name: | Common Name: | Entity ID: |
|---|---|---|
| *Patera clarki nantahala* | Noonday globe | 392 |

***VULNERABILITY***
***(Summary of status, environmental baseline and cumulative effects)***

**Status:** Threatened
**Distribution:** Small, endemic, constrained, and/or isolated population(s)
**Number of Populations:** Single population
**Species Trends:** Declining population(s) – one or more populations declining
**Pesticides noted** ☐

**Environmental Baseline/Cumulative Effects (EB/CE) Summary:**
The noonday Globe has been documented only from the southeast side of the Nantahala River Gorge in Swain County, North Carolina. Although the majority of the species' habitat occurs within the boundaries of Nantahala National Forest, loss of habitat associated with development of adjacent private lands and private in-holdings, highway maintenance activities, spread of exotic vegetation and prolonged drought appear to have reduced the species' range and numbers. As of the 2020 5-Year Review, the species has continued to decline. Additional comprehensive surveys are needed to determine the extent of the effects these activities have had on the snail and available suitable habitat.

As of the 2020 review, the primary factors affecting and/or threatening the noonday globe and its habitat were associated with commercial development (off of U.S. Forest Service lands) at the northern end of the gorge, and the North Carolina Department of Transportation's (NCDOT) maintenance of US Highway 19, which runs between the Nantahala River and the southeast slope of the Nantahala Gorge. Private lands within the gorge continue to be developed, primarily to cater to rafters, kayakers, hikers and other recreational users. Forest clearing and disturbance associated with this development results in the direct loss of noonday globe habitat and appears to be contributing to encroachment of kudzu, Japanese honeysuckle, and other invasive, exotic plants that eliminate suitable habitat for the snail within disturbed areas of the gorge. Also, vegetative clearing associated with the NCDOT's routine right-of way and ditch maintenance along US Highway 19 within the gorge adversely affects noonday globe habitat in a narrow corridor along the highway and also appears to be contributing to the spread of invasive, non-native plants within the gorge. In addition, because of the extremely restricted range of the noonday snail, a forest fire or other significant impact affecting the health of the forest canopy or understory, and/or moisture levels on the southeastern slope of the Nantahala Gorge could have a devastating effect on the status of the snail and could result in the species' extirpation. The state of North Carolina recognizes the noonday globe as a state threatened species and prohibits the collection of the species for scientific purposes without a valid state collecting permit. However, the state's regulations do not provide any protection to the species from other forms of take or

any protection to its habitat, except on state-owned lands (NC ST § 113-331 to 113-350). Because the noonday globe requires cool, moist habitat, wildfire, drought, and exotic insect tree pests continue to pose a significant threat to the species. Persistent (summer of 2007- spring 2009), exceptional drought conditions resulted in at least a temporary loss of habitat of the species. The extent of impacts on population levels and reproduction is currently unknown and cannot be determined until conditions improve.

**EB/CE Source:** U. S. Fish and Wildlife Service. 2020. Noonday Globe *Patera (=Mesodon) clarki nantahala* 5-Year Review: Summary and Evaluation. Asheville, North Carolina. 24 pp.

**Overall Vulnerability: ☒ High ☐ Medium ☐ Low**

***RISK***
***(Risk is based on species exposure and response from labeled uses across the range)***

**Risk to individuals if exposed:** We do not anticipate effects to the species from exposure to malathion at labeled use rates.

**Risk to the species from labeled uses across the range:** The table below summarizes the risk to the species from labeled uses across the range based on range overlaps with use sites and anticipated effects associated with the particular uses.

| ALL USES except mosquito control | |
|---|---|
| Mortality | no effects expected |
| MOSQUITO CONTROL | |
| Mortality | no effects expected |

**Risk modifiers:** The noonday globe snail is known from only about two miles (3.2 kilometers) of high cliffs within the Nantahala Gorge in Western North Carolina (USFWS 1984).

The noonday globe is known to be endemic only to the southeast side of the Nantahala River Gorge in the Nantahala National Forest, Swain County, North Carolina (Service 1984; J. Fridell, Service, Asheville, NC, personal observation 1985, 1993, 2012 and 2013) (USFWS 2013).

Nothing is known about the noonday globe reproductive strategy.

It is known from high cliffs (1900 to 3100 feet, in a half mile stretch) along the southeast bank of the Nantahala River in the Nantahala Gorge. Cliffs are mesic, interrupted frequently by small streams and waterfalls, and there is much exposed rock, and the forest floor often has a thick humus layer (USFWS, 1984). High site fidelity is inferred based on specific site location.

Nothing is known about the snail's food preferences or feeding behavior (USFWS 1984). Most likely feed on fungal mycelia, based on closely related species (USFWS 1984).

**Overall Risk: ☐ High ☐ Medium ☒ Low**

***USAGE***
***(Anticipated usage within the range based on past usage data)***

| Use type | Risk to species[1] | Use overlap with range | | Estimated usage in range[2] | |
|---|---|---|---|---|---|
| | | Acres | % | acres | % |
| Mosquito Control | D | 0 | 0 | 0 | 0 |
| Open Space Developed | D | 3,385 | 0.98 | 169 | 0.05 |
| Developed | D | 820 | 0.24 | 41 | 0.01 |
| Corn | D | 122 | 0.04 | 122 | 0.04 |
| Vegetables and Ground Fruit | D | 82 | 0.02 | 59 | 0.02 |
| Other Crops | D | 59 | 0.02 | 0 | < 0.01 |
| Wheat | D | 32 | < 0.01 | 0 | < 0.01 |
| Pasture | D | 7 | < 0.01 | 6 | < 0.01 |
| Other Grains | D | 3 | < 0.01 | 3 | < 0.01 |
| Nurseries | D | 1 | < 0.01 | 1 | < 0.01 |
| Christmas trees | D | 1 | < 0.01 | 1 | < 0.01 |
| Orchards and Vin0.eyards | D | 1 | < 0.01 | 0 | < 0.01 |
| Cotton | D | 0 | < 0.01 | 0 | < 0.01 |
| **Sub-TOTAL (D):** *Other uses with direct effects only*[3] | | 4,513 | 1.30 | 402 | 0.12 |
| **Sub- TOTAL (I):** *Other uses with indirect effects only*[3] | | 0 | 0 | 0 | 0 |
| **TOTAL[4]:** | | 4,513 | 1.30 | 402 | 0.12 |

**# acres in species range:** 345,992 acres
**% of range in California (i.e., where CalPUR data is available):** 0%
**Range overlap with Federal lands:** 307,129 acres, 88.768%

**Overall Usage:** ☐ **High** ☐ **Medium** ☒ **Low**

***CONSERVATION MEASURES***

**Residential use label changes:** New restrictions to the method and frequency of application for residential use of malathion are expected to substantially reduce exposure to species that overlap with developed and open space developed areas. Label changes will ensure that residential use is

[1] Direct effects (D), Indirect effects (I), No effects expected (N), Use site not utilized by the species (*)
[2] Estimated usage in the range is based on information about annual past usage.
[3] Mosquito control has the potential to overlap with other uses. It is not included in the Sub-TOTALs.
[4] TOTAL includes usage on all use sites with effects, including mosquito control.

limited to spot treatments only (rendering spray drift offsite unlikely) and reducing the extent of area which can be treated in the developed and open space developed areas by as much as 75% or more from modeled values. In addition, we expect the frequency of exposure to decrease as the number of allowable applications is reduced from "repeat as necessary" to a maximum of 2–4 applications per year (depending on the specific residential use). Retreatment intervals of 7-10 days between any repeated applications are expected to reduce environmental concentrations by allowing any initial residues to degrade prior to the next application. In addition, exposure to aquatic organisms is reduced due to buffers from waterways, which specify on the label a distance from water bodies where pesticides are not to be applied, and restrictions to application during periods where rain is not forecasted within 24 hours or when the soil is not saturated.

***CONCLUSION***

After reviewing the current status of the species, the environmental baseline for the action area, the effects of the proposed registration of malathion, and the cumulative effects, it is the Service's biological opinion that the registration of malathion, as proposed, is not likely to jeopardize the continued existence of the Noonday globe. As discussed below, although the vulnerability is high for this species, we anticipate the risk and likelihood of exposure to malathion are low; the implementation of the general conservation measures described above is expected to further reduce the likelihood of exposure.

The Noonday globe has a high vulnerability based on its status, distribution, and trends, as described above. The risk to the species posed by labeled malathion uses across the range is anticipated to be low, with a low amount of estimated usage within the range based primarily on the usage data we acquired, as described in the Opinion, and summarized for this species above.

The risk to the species from labeled uses across the range is expected to be low as we do not anticipate any measurable effects from malathion exposure to individuals, including mortality or sublethal effects to growth, reproduction, or behavior. There may be potential effects to the species' food base (e.g., algae, plants, detritus), however these effects are expected to be small and will not likely result in adverse effects to snails.

The species range overlap with usage areas is extremely low (0.12%). The majority of the species habitat is within Nantahala National Forest and is federally managed. We did not quantitatively evaluate use or usage on Federal lands that overlap with the species range, but we assume only low levels of usage for this species, per the rationale related to usage on Federal lands as described in the Biological Opinion. Additionally, we expect restrictions for developed and open space developed uses described above would result in decreased environmental concentrations of malathion and further reduce likelihood of exposure to malathion.

Due to the lack of measurable effects to individuals, including mortality and sublethal effects, the lack of appreciable effects to its food base and habitat, low expected usage, and the incorporation of conservation measures that would further reduce the risk of exposure, we anticipate minimal,

if any, adverse effects (i.e., not enough to result in take) will occur throughout the duration of the action. Therefore, we do not anticipate that the proposed action would appreciably reduce survival and recovery of the Noonday globe in the wild.

**Conclusion:** Not likely to jeopardize

**Integration and Synthesis Summary: Snails *(Terrestrial)***

| Scientific Name: | Common Name: | Entity ID: |
|---|---|---|
| *Anguispira picta* | Painted snake coiled forest snail | 393 |

***VULNERABILITY***
***(Summary of status, environmental baseline and cumulative effects)***

**Status:** Threatened
**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** ☐

**Environmental Baseline/Cumulative Effects (EB/CE) Summary:**
The species range is now known to encompass limestone outcrops within approximately 1,950 ac along 9.8 miles of the Cumberland Plateau escarpment in Tennessee in the Crow Creek drainage, rather than the 325 ac that were estimated in the 1982 Recovery Plan to be occupied in Buck Creek Cove. Microhabitat characteristics for this species require investigation, as evidenced by observations of Painted snake coiled forest snail in habitats that have typically been considered unsuitable for the species. However, the species remains narrowly distributed. The species total population has been estimated to number greater than 1.5 million individuals, but the need for repeatable survey methods to monitor population trends remains. Recovery efforts for this species are hindered by a lack of basic information on reproductive biology, demographics, dispersal ability, and food habits.

The threatened destruction, modification, or curtailment of habitat within the range of the species extends primarily from three land uses: timber harvest, residential development, and limestone quarrying. The species is properly classified as threatened because it is narrowly distributed with approximately half of the species total population on private property, and an increase in timber harvest rates or extensive limestone quarry development within the species' range could cause the species to become endangered within the foreseeable future throughout all or a significant portion of its range. Limestone quarrying is not regulated by the federal Office of Surface Mining. In Tennessee, such activities are only subjected to State air and water quality regulations unless they would result in the discharge of fill materials into the waters of the United States, in which case they would require a section 404 permit from the Corps of Engineers under the Clean Water Act. The opening in 2007 of an open-pit quarry by Sherwood Mining Company (SMC) threatened to cause the destruction of several hundred acres of habitat occupied by the species. The magnitude of this threat has been reduced SMC's commitment to operate an underground mine with limited surface disturbance. And, SMC's sale of 3,895 ac to The Conservation Fund (TCF), combined with donation of approximately 172 ac, has protected approximately 50 percent of the species' total population from habitat destruction. Because areas within the lands acquired by TCF from SMC where the species is present will be designated as a State Natural Area once

the lands are transferred to the State of Tennessee, approximately 50 percent of the species' total population will benefit from regulations protecting such lands. Because the species is restricted to limestone outcrops throughout its range in Crow Creek Valley, limestone quarrying poses a potential threat to the species in other parts of its range. We are not aware of any proposed quarry developments in Crow Creek Valley at this time. Potential habitat alteration resulting from residential development on the Cumberland Plateau also poses a threat to the species, but no adverse effects from residential development are currently known to be occurring. And, there is a potential threat of over utilization for commercial purposes, as shells of this species are available for purchase on the internet.

**EB/CE Source:** U. S. Fish and Wildlife Service. July 29, 2016. Painted Snake Coiled Forest Snail (*Anguispira picta*) 5-Year Review: Summary and Evaluation. 22 pp.

**Overall Vulnerability:** ☒ **High** ☐ **Medium** ☐ **Low**

***RISK***
***(Risk is based on species exposure and response from labeled uses across the range)***

**Risk to individuals if exposed:** We do not anticipate effects to the species from exposure to malathion at labeled use rates.

**Risk to the species from labeled uses across the range:** The table below summarizes the risk to the species from labeled uses across the range based on range overlaps with use sites and anticipated effects associated with the particular uses.

| ALL USES except mosquito control | |
|---|---|
| Mortality | no effects expected |
| MOSQUITO CONTROL | |
| Mortality | no effects expected |

**Risk modifiers:** The range map provided for this analysis may be over-estimating the percent overlap with uses based on a more recent map provided in the 5-Year Review (US FWS Painted Snake Coiled Forest Snail (*Anguispira picta*) 5-Year Review: Summary and Evaluation 2016).

The Painted snake coiled forest snail was historically known from Buck Creek Cove, Franklin Co., Tennessee; but has a larger more recent range (NatureServe, 2015). This snail is associated with Monteagle limestone outcrops and cliff faces in the escarpment of the Cumberland Plateau (NatureServe, 2015). It inhabits outcrops of the monteagle limestone formation; native hardwood forest with mixed silvicultural history (Geoff Call, pers. comm. 2016 biological information, USFWS field office request). The reproductive strategy for this species is unknown.

The species feeds on lichen on rock formations within its habitat using a rasping feeding mechanism.

**Overall Risk:** ☐ **High** ☐ **Medium** ☒ **Low**

***USAGE***
***(Anticipated usage within the range based on past usage data)***

| Use type | Risk to species[1] | Use overlap with range | | Estimated usage in range[2] | |
|---|---|---|---|---|---|
| | | Acres | % | acres | % |
| Mosquito Control | D | 345,420 | 93.73 | 0 | < 0.01 |
| Corn | D | 20,527 | 5.57 | 1,660 | 0.45 |
| Open Space Developed | D | 14,612 | 3.97 | 731 | 0.20 |
| Developed | D | 5,634 | 1.53 | 282 | 0.08 |
| Cotton | D | 2,501 | 0.68 | 2,501 | 0.68 |
| Wheat | D | 273 | 0.07 | 254 | 0.07 |
| Nurseries | D | 221 | 0.06 | 221 | 0.06 |
| Other Crops | D | 163 | 0.04 | 0 | 0 |
| Other Grains | D | 52 | 0.01 | 44 | 0.01 |
| Pasture | D | 16 | < 0.01 | 16 | < 0.01 |
| Other Row Crops | D | 10 | < 0.01 | 10 | < 0.01 |
| Vegetables and Ground Fruit | D | 10 | < 0.01 | 10 | < 0.01 |
| **Sub-TOTAL (D):** *Other uses with direct effects only*[3] | | 44,019 | 11.96 | 5,729 | 1.55 |
| **Sub- TOTAL (I):** *Other uses with indirect effects only*[3] | | 0 | 0 | 0 | 0 |
| **TOTAL[4]:** | | 389,439 | 105.69 | 5,729 | 1.55 |

**# acres in species range:** 368,510 acres
**% of range in California (i.e., where CalPUR data is available):** 0%
**Range overlap with Federal lands:** 22,325 acres, 6.058%

**Overall Usage:** ☐ **High** ☐ **Medium** ☒ **Low**

***CONSERVATION MEASURES***

**Residential use label changes:** New restrictions to the method and frequency of application for residential use of malathion are expected to substantially reduce exposure to species that overlap with developed and open space developed areas. Label changes will ensure that residential use is limited to spot treatments only (rendering spray drift offsite unlikely) and reducing the extent of

[1] Direct effects (D), Indirect effects (I), No effects expected (N), Use site not utilized by the species (*)
[2] Estimated usage in the range is based on information about annual past usage.
[3] Mosquito control has the potential to overlap with other uses. It is not included in the Sub-TOTALs.
[4] TOTAL includes usage on all use sites with effects, including mosquito control.

area which can be treated in the developed and open space developed areas by as much as 75% or more from modeled values. In addition, we expect the frequency of exposure to decrease as the number of allowable applications is reduced from "repeat as necessary" to a maximum of 2–4 applications per year (depending on the specific residential use). Retreatment intervals of 7-10 days between any repeated applications are expected to reduce environmental concentrations by allowing any initial residues to degrade prior to the next application. In addition, exposure to aquatic organisms is reduced due to buffers from waterways, which specify on the label a distance from water bodies where pesticides are not to be applied, and restrictions to application during periods where rain is not forecasted within 24 hours or when the soil is not saturated.

**Reduced application number and rate:** New restrictions on corn, cotton, orchards and vineyards, pasture, other crops, and vegetables and ground fruit lower the maximum allowable number of applications to 2-4 per year (depending on the specific crop; previous allowable numbers of applications ranged from 3 to 13 applications per year). This will help reduce the amount of malathion used and decrease potential exposure to the species, thus decreasing the risk of both indirect and direct effects to the species.

---

***CONCLUSION***

After reviewing the current status of the species, the environmental baseline for the action area, the effects of the proposed registration of malathion, and the cumulative effects, it is the Service's biological opinion that the registration of malathion, as proposed, is not likely to jeopardize the continued existence of the painted snake coiled forest snail. As discussed below, the vulnerability is high for this species, the risk and likelihood of exposure to malathion is low; and the implementation of the general conservation measures described above is expected to further reduce the likelihood of exposure.

The painted snake coiled forest snail has a high vulnerability based on its status, distribution, and trends, as described above. The risk to the species from labeled uses across the range is expected to be low as we do not anticipate any measurable effects from malathion exposure to individuals, including mortality or sublethal effects to growth, reproduction, or behavior. There may be potential effects to the species' food base (e.g., algae, plants, detritus), however these effects are expected to be small and will not likely result in adverse effects to snails.

We estimate a low amount of usage within the range (1.55%), based primarily on the standard usage data we acquired, as described in the Opinion, and summarized for this species above. While there is a high overlap with mosquito control use, we do not expect mosquito control with malathion to occur within the non-Federal portion of the species range based on past usage data, as shown above. We did not quantitatively evaluate use or usage on Federal lands that overlap with the species range (6.06%), but we assume only low levels of usage for this species, per the rationale related to usage on Federal lands as described in the Biological Opinion. Also, as noted above, the range map used for this analysis may be overestimating the amount of the species range that overlaps with usage areas based on a more recently available range map (USFWS 2016). Additionally, we expect that label restrictions incorporated in the conservation measures

described above, such as changes to residential use labels and reductions in application number and rates for agricultural uses, would substantially reduce environmental concentrations of malathion and further reduce likelihood of exposure.

Due to the lack of measurable effects to individuals, including mortality and sublethal effects, the lack of appreciable effects to its food base and habitat, low expected usage, and the incorporation of conservation measures that would further reduce the risk of exposure, we anticipate minimal, if any, adverse effects (i.e., not enough to result in take) will occur throughout the duration of the action. Therefore, we do not anticipate that the proposed action would appreciably reduce survival and recovery of the painted snake coiled forest snail in the wild.

**Conclusion:** Not likely to jeopardize

***ADDITIONAL REFERENCES***

U. S. Fish and Wildlife Service. July 29, 2016. Painted Snake Coiled Forest Snail (*Anguispira picta*) 5-Year Review: Summary and Evaluation. 22 pp.

**Integration and Synthesis Summary: Snails *(Terrestrial)***

| Scientific Name: | Common Name: | Entity ID: |
|---|---|---|
| *Orthalicus reses (not incl. nesodryas)* | Stock Island tree snail | 394 |

***VULNERABILITY***
***(Summary of status, environmental baseline and cumulative effects)***

**Status:** Threatened
**Distribution:** Small, endemic, constrained, and/or isolated population(s)
**Number of Populations:** Single population
**Species Trends:** Declining population(s) – one or more populations declining
**Pesticides noted** ☒

**Environmental Baseline/Cumulative Effects (EB/CE) Summary:**
As of 2006, a tabulation of all well-known and poorly documented sites indicated that the species occupied approximately 25 sites in the Florida Keys (Monroe County) and two sites on the mainland (Miami-Dade County) (Service 2006a). Whereas the species occupies more sites at present than in the recorded past, the total area occupied remains unknown, as are trends in abundance and demographics. Overall, however, the species population status appears to be more secure than when it was listed, due to the widespread translocations that occurred subsequently (Service 2006a).

Species abundance and range declined throughout the 20th century (Service 1999). The predominant threat described at the time Stock Island tree snail was listed was habitat destruction. Additional threats include: non-native predators, inadequacy of existing regulatory mechanisms, climate change, hurricane winds, right-of-way maintenance, Key deer browsing, and invasive exotic plants. None of these threats has been eliminated, although many have been reduced. Threats relating to climate change and predation have increased. Associated with climate change is sea-level rise and enhanced impacts due to storm surges. These factors not only serve to alter plant communities over different time-frames, but may increase the probability that entire cohorts of young snails are eliminated due to catastrophic storm surges. The magnitude of threats from stochastic events such as hurricanes is exacerbated by small population sizes and the limited range of the species. Given these factors, catastrophic loss of adults (arboreal) or eggs and neonates (terrestrial) is a potential threat of high magnitude. Because catastrophic events affect further reductions in abundance over time, they increase the probability that detrimental impacts may subsequently arise due to demographic or genetic stochasticity, or from additional, adverse environmental conditions. Relatively recent or expanded predatory threats potentially include green iguanas and opossums. Threats from fire ants persist. Poaching and mosquito control practices remain as potential threats.

Due to translocations, the species is now roughly as widespread as any time in the past. Additionally, a substantial portion of populations occur on public lands managed for conservation purposes. Threats of habitat destruction due to human population growth and associated development have been significantly reduced. In addition to acquisition efforts, regulatory mechanisms have provided for substantial reductions in the rate of habitat loss.

However, detrimental habitat impacts associated with earlier development, including fragmentation and proliferation of fire ants (and likely other predators), persists over much of the historic range. Significant areas of suitable and occupied habitat remain vulnerable to development pressure. Vegetation clearing along utility corridors results in localized threats, but requires further investigation to determine the full extent of impact on the species.

**EB/CE Source:** U. S. Fish and Wildlife Service. 2009. Stock Island tree snail (*Orthalicus reses (not including nesodryas*) 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service Southeast Region South Florida Ecological Services Office Vero Beach, Florida. 26 pp. Review approved September 11, 2009.

**Overall Vulnerability: ☒ High ☐ Medium ☐ Low**

***RISK***
***(Risk is based on species exposure and response from labeled uses across the range)***

**Risk to individuals if exposed:** We do not anticipate effects to the species from exposure to malathion at labeled use rates.

**Risk to the species from labeled uses across the range:** The table below summarizes the risk to the species from labeled uses across the range based on range overlaps with use sites and anticipated effects associated with the particular uses.

| ALL USES except mosquito control | |
|---|---|
| Mortality | no effects expected |
| MOSQUITO CONTROL | |
| Mortality | no effects expected |

**Risk modifiers:** The Stock Island tree snail originally occurred exclusively in hardwood hammocks of the Florida Keys. The species survives best in hammocks and are active mainly during the May through November wet season when breeding, feeding, and dispersion takes place. Dry periods (December through April) are spent in aestivation, in which the snail forms a tight sealed barrier between the aperture and a tree trunk or branch. Snails secrete a mucus seal that cements their shell to a tree to protect them from desiccation in the dry period. Snails may come out of aestivation briefly to feed during dry-season rains or go into aestivation during summer dry spells.

Snails are estimated to live for up to 6 years. The snails are hermaphroditic, but cross-fertilization appears to be common. They lay about 15 eggs per clutch in a cavity dug into the soil humus layer, usually at the base of a tree, and take anywhere from 24 to 105 hours to deposit their eggs (Deisler 1987, McNeese 1989). The snail's age can be estimated by counting the number of dark "suture-like" lines resulting from pigment deposition during long dry spells (the dry season) (US FWS SOS 2016).

Feeding can occur anytime during the day or night with peak feeding activity occurring from late afternoon through the night to midmorning and during or immediately after rainfall.

They feed on epiphytic growth on hardwood tree trunks, branches, and leaves. Little is known about the feeding habits or food preferences of the species. Probable food items include a variety of fungi, algae, and lichens found on many of the native hammock trees. Myxobacteria and some small mites may serve as a secondary food source.

The species spends its entire lifecycle in developed areas and rights-of-way; this species would not be associated with any agricultural uses (Shawn Christopher pers.comm. 2016 co-occurrence information, USFWS field office request).

**Overall Risk: ☐ High ☐ Medium ☒ Low**

***USAGE***
***(Anticipated usage within the range based on past usage data)***

| Use type | Risk to species[1] | Use overlap with range | | Estimated usage in range[2] | |
|---|---|---|---|---|---|
| | | Acres | % | acres | % |
| Mosquito Control | D | 995,806 | 25.22 | 427,653 | 10.83 |
| Developed | D | 205,799 | 5.21 | 10,290 | 0.26 |
| Open Space Developed | D | 64,868 | 1.64 | 3,243 | 0.08 |
| Orchards and Vineyards | * | 27,351 | 0.69 | 8,209 | 0.21 |
| Vegetables and Ground Fruit | * | 11,177 | 0.28 | 1,785 | 0.05 |
| Other Crops | * | 8,184 | 0.21 | 0 | 0 |
| Other Grains | * | 2,652 | 0.07 | 2652 | 0.07 |
| Nurseries | * | 1,974 | 0.05 | 1,974 | 0.05 |
| Corn | * | 125 | < 0.01 | 0 | < 0.01 |
| Rice | * | 14 | < 0.01 | <1 | < 0.01 |
| Other Row Crops | * | 1 | < 0.01 | 1 | < 0.01 |

[1] Direct effects (D), Indirect effects (I), No effects expected (N), Use site not utilized by the species (*)
[2] Estimated usage in the range is based on information about annual past usage.

| Use type | Risk to species[1] | Use overlap with range | | Estimated usage in range[2] | |
|---|---|---|---|---|---|
| | | Acres | % | acres | % |
| **Sub-TOTAL (D):** *Other uses with direct effects only*[3] | | 270,667 | 6.85 | 13,533 | 0.34 |
| **Sub- TOTAL (I):** *Other uses with indirect effects only*[3] | | 0 | 0 | 0 | 0 |
| **TOTAL[4]:** | | 1,266,473 | 32.07 | 441,186 | 11.17 |

**# acres in species range:** 3,947,862 acres
**% of range in California (i.e., where CalPUR data is available):** 0%
**Range overlap with Federal lands:** 1,910,911 acres, 48.404%

**Overall Usage:** ☒ **High** ☐ **Medium** ☐ **Low**

***CONSERVATION MEASURES***

**Residential use label changes:** New restrictions to the method and frequency of application for residential use of malathion are expected to substantially reduce exposure to species that overlap with developed and open space developed areas. Label changes will ensure that residential use is limited to spot treatments only (rendering spray drift offsite unlikely) and reducing the extent of area which can be treated in the developed and open space developed areas by as much as 75% or more from modeled values. In addition, we expect the frequency of exposure to decrease as the number of allowable applications is reduced from "repeat as necessary" to a maximum of 2–4 applications per year (depending on the specific residential use). Retreatment intervals of 7-10 days between any repeated applications are expected to reduce environmental concentrations by allowing any initial residues to degrade prior to the next application. In addition, exposure to aquatic organisms is reduced due to buffers from waterways, which specify on the label a distance from water bodies where pesticides are not to be applied, and restrictions to application during periods where rain is not forecasted within 24 hours or when the soil is not saturated.

**Reduced application number and rate:** New restrictions on corn, cotton, orchards and vineyards, pasture, other crops, and vegetables and ground fruit lower the maximum allowable number of applications to 2-4 per year (depending on the specific crop; previous allowable numbers of applications ranged from 3 to 13 applications per year). This will help reduce the amount of malathion used and decrease potential exposure to the species, thus decreasing the risk of both indirect and direct effects to the species.

***CONCLUSION***

After reviewing the current status of the species, the environmental baseline for the action area, the effects of the proposed registration of malathion, and the cumulative effects, it is the

[3] Mosquito control has the potential to overlap with other uses. It is not included in the Sub-TOTALs.
[4] TOTAL includes usage on all use sites with effects, including mosquito control.

Service's biological opinion that the registration of malathion, as proposed, is not likely to jeopardize the continued existence of the Stock Island tree snail. As discussed below, the vulnerability is high for this species, the risk is low, and likelihood of exposure to malathion is also low (despite having high usage overlap). The implementation of the general conservation measures described above is expected to substantially reduce the likelihood of exposure.

The Stock Island tree snail has a high vulnerability based on its status, distribution, and trends, as described above. The risk to the species from labeled uses across the range is expected to be low as we do not anticipate any measurable effects from malathion exposure to individuals, including mortality or sublethal effects to growth, reproduction, or behavior. There may be potential effects to the species' food base (e.g., algae, plants, detritus), however these effects are expected to be small and will not likely result in adverse effects to snails.

We anticipate a high amount of estimated usage within the non-Federal portions of the species range based primarily on the standard usage data we acquired (11.17%), as described in the Opinion and summarized for this species above. However, the species is not likely to utilize areas associated with agriculture, reducing the likelihood of exposure. While the species' predominant occurrence within developed areas and rights-of-way still places the species at risk of exposure; usage for developed and open space developed areas is relatively low (0.26% and 0.08%, respectively). Approximately half of its range occurs within federally managed lands. We did not quantitatively evaluate use or usage on Federal lands that overlap with the species range, but we assume only low levels of usage for this species, per the rationale related to usage on Federal lands as described in the Biological Opinion. Mosquito adulticide has high levels of usage (>10%) in the non-Federal portions of the species range, however we do not expect mosquito adulticide usage will result in environmental concentrations of malathion high enough to cause observable effects to the species. Conservation measures, such as changes to developed and open space developed use labels and reductions in the number of allowable applications each year for a variety of crops, are expected to substantially reduce the likelihood of exposure to malathion.

While usage data shows a high likelihood that malathion is applied within the species range annually, due to the lack of measurable effects to individuals, including mortality and sublethal effects, the lack of appreciable effects to its food base and habitat, and the incorporation of conservation measures that would further reduce the risk of exposure, we anticipate minimal, if any, adverse effects (i.e., not enough to result in take) will occur throughout the duration of the action. Therefore, we anticipate that the proposed action would not appreciably reduce survival and recovery of the Stock Island tree snail in the wild.

**Conclusion:** Not likely to jeopardize

**Integration and Synthesis Summary: Snails *(Terrestrial)***

| Scientific Name: | Common Name: | Entity ID: |
|---|---|---|
| *Polygyriscus virginianus* | Virginia fringed mountain snail | 395 |

***VULNERABILITY***
***(Summary of status, environmental baseline and cumulative effects)***

**Status:** Endangered
**Distribution:** Small, endemic, constrained, and/or isolated population(s)
**Number of Populations:** Single population
**Species Trends:** Unknown population trends
**Pesticides noted** ☐

**Environmental Baseline/Cumulative Effects (EB/CE) Summary:**
The Virginia fringed mountain snail was originally descibed in 1947 from weathered shells found in the soil and was presumed to be extinct. It was not until 1971 that live individuals were found. This snail is known only from six miles of bluffs along the New River in Pulaski County Virginia, confined to a strip of steep embankment, bluff and limestone talus. This snail is fossorial (i.e., adapted to digging and life underground). As a monotypic genus, the Virginia fringed mountain snail (*Polygyriscus virginianus*) is a globally rare species, and, like all fossorial species, it is difficult to find. It inhabits fragmented and weathered dolomite outcroppings with loose clay-like soils in an area covered with small trees and vines. Site conditions and the snail's burrowing behavior make surveying for the species difficult at best.

The last living adult was observed in 1986, and the last living juvenile was observed in 1971. Surveys undertaken to date have generally been small and spotty, indicating the need for a comprehensive survey of known habitat and suspected habitat areas. Until such a survey is completed and it can be determined whether the species is extant, our provisional conclusion is that the snail continues to be in danger of extinction throughout its range, due to extreme scarcity compounded by lack of permanent habitat protection. Inadvertent loss of individuals or populations through human activity or naturally changing environmental conditions, as well as the potential for deleterious small-population effects, could lead to the demise of this species.

To date, the snail's limited distribution within an area that has not, to date, been subject to development pressure has made conservation of its habitat relatively easy. Available regulatory mechanisms provide adequate protection at this time, although the situation could change if development pressures increase. At this time there is no long-term land protection in place for the known habitat; all sites are on private property. Although the creation of Claytor Lake Reservoir inundated portions of the snail's habitat, and operation of the power generating facility continues to result in periods of high water flows, it is unknown whether these actions have caused past or ongoing impacts on the distribution and survival of the species.

The snail has a very limited range. The snail may have always been rare, based on the limited historical distribution evidence. Historically, shells or living specimens were only found within the identified section of this bluff (Batie 1987). Recent survey work by Ken Hotopp has located a few relic shells in additional sites, but no living specimens (K. Hotopp, Appalachian Conservation Biology, pers. comm. 2007). Lack of observed live specimens since 1986 has led some biologists to speculate that the species may be extinct; however, lack of sightings could also be due to factors that make *P. virginianus* very difficult to survey. These factors include: (1) low population numbers within a highly restricted habitat preference, (2) the fact that the snail is a burrower that can be found up to 60 to 200 centimeters (24 to 80 inches) below the surface, and (3) a shell of only about 4 millimeters in size (Batie 1987). This burrowing snail is found among fragments of weathered dolomite in loose clay-like soil broken by roots and further refined due to earth worm activity. Living individuals typically occur in the soil at depths of 4 to 24 inches. Live snails have never been observed on the soil surface. Immediate threats include herbicides, fire, widening of a nearby road, and reactivation of a nearby quarry.

**EB/CE Sources:**

U.S. Fish and Wildlife Service. 1983. Virginia fringed mountain snail (*Polygyriscus virginianus*) recovery plan. U.S. Fish and wildlife Service, Newton Corner, MA. 20 pp.

U. S. Fish and Wildlife Service. 2008. Virginia fringed mountain snail (*Polygyriscus virginianus*) 5-Year Review: Summary and Evaluation. 11 pp.

**Overall Vulnerability:** ☒ **High** ☐ **Medium** ☐ **Low**

***RISK***
***(Risk is based on species exposure and response from labeled uses across the range)***

**Risk to individuals if exposed:** We do not anticipate effects to the species from exposure to malathion at labeled use rates.

**Risk to the species from labeled uses across the range:**
The table below summarizes the risk to the species from labeled uses across the range based on range overlaps with use sites and anticipated effects associated with the particular uses.

| ALL USES except mosquito control | |
|---|---|
| Mortality | no effects expected |
| MOSQUITO CONTROL | |
| Mortality | no effects expected |

**Risk modifiers:** The entire known range is confined to a six-mile strip of steep embankment, bluff, and limestone talus. This snail is fossorial (i.e., adapted to digging and life underground). This burrowing snail is found among fragments of weathered dolomite in loose clay-like soil

broken by roots and further refined due to earth worm activity. Living individuals occur in the soil at depths of 24 to 80 inches. Live snails have never been observed on the soil surface. While results indicate high mortality to snails from estimated environmental concentrations of malathion as calculated using the most sensitive terrestrial invertebrate (*A. mellifera*) as a surrogate, data in the primary literature for aquatic snails indicate this taxa group tends to be less sensitive to malathion and are generally at low risk of adverse effects from malathion exposure. While terrestrial species may not be exposed to malathion via this same exposure route (i.e., in water), we consider aquatic snails to be a more suitable surrogate and assume terrestrial snails exhibit similar tolerance to malathion from contact exposure. With this high tolerance for malathion in mind, the expected mortality reported above is likely an overestimation of what will happen over the duration of the Action. Therefore, we assume that the Virginia fringed mountain snail is unlikely to experience direct effects from terrestrial estimated environmental concentrations of malathion.

**Overall Risk: ☐ High ☐ Medium ☒ Low**

***USAGE***
***(Anticipated usage within the range based on past usage data)***

Usage within the species range is anticipated to be low due to lack of use sites in the river bluff environment where this species occurs.

| Use type | Risk to species[1] | Use overlap with range | | Estimated usage in range[2] | |
|---|---|---|---|---|---|
| | | Acres | % | Acres | % |
| Mosquito Control | D | 0 | 0 | 0 | 0 |
| Open Space Developed | D | 1,738 | 7.29 | 87 | 0.36 |
| Developed | D | 1,415 | 5.94 | 71 | 0.3 |
| Pasture | D | 253 | 1.1 | 248 | 1 |
| Corn | D | 179 | 0.75 | 179 | 0.75 |
| Other Crops | D | 14 | 0.06 | 0.18 | <0.01 |
| Wheat | D | 3 | 0.01 | 2.9 | 0.01 |
| Other Grains | D | 3 | 0.01 | 2.6 | 0.01 |
| Vegetables & Ground Fruit | D | 2 | 0.01 | 1.6 | 0.01 |
| Orchards and Vineyards | D | 0.11 | <0.01 | 0.11 | <0.01 |
| Other Row Crops | D | 0.1 | <0.01 | 0.07 | <0.01 |
| **Sub-TOTAL (D):** *Other uses with direct effects*[3] | | 3,606 | 15.14 | 592 | 2.48 |
| **Sub-TOTAL (I):** *Other uses with indirect effects*[3] | | 0 | 0 | 0 | 0 |

[1] Direct effects (D), Indirect effects (I), No effects expected (N), Use site not utilized by the species (*)
[2] Estimated usage in the range is based on information about annual past usage.
[3] Mosquito control has the potential to overlap with other uses. It is not included in the Sub-TOTALs.

| Use type | Risk to species[1] | Use overlap with range | | Estimated usage in range[2] | |
|---|---|---|---|---|---|
| | | Acres | % | Acres | % |
| | **TOTAL[4]:** | 3,606 | 15.14 | 592 | 2.48 |

**# acres in species range:** Not available; Pulaski County, VA
**% of range in California (i.e., where CalPUR data is available):** 0%
**Range overlap with Federal lands:** 0 acres, 0%

**Overall Usage:** ☐ **High** ☐ **Medium** ☒ **Low**

***CONCLUSION***

After reviewing the current status of the species, the environmental baseline for the action area, the effects of the proposed registration of malathion, and the cumulative effects, it is the Service's biological opinion that the registration of malathion, as proposed, is not likely to jeopardize the continued existence of the Virginia fringed mountain snail. As discussed below, the vulnerability is high for this species, the risk and likelihood of exposure to malathion is low.

The Virginia fringed mountain snail has a high vulnerability based on its status, distribution, and trends. The entire known range for this species is confined to a six-mile strip of steep embankment, bluff, and limestone talus. This snail is fossorial (i.e., adapted to digging and life underground), found among fragments of weathered dolomite in loose clay-like soil broken by roots and further refined due to earth worm activity. Living individuals occur in the soil at depths of 24 to 80 inches below the surface. Live snails have never been observed on the soil surface.

The risk to the species from labeled uses across the range is expected to be low as we do not anticipate any measurable effects from malathion exposure to individuals, including mortality or sublethal effects to growth, reproduction, or behavior. There may be potential effects to the species' food base (e.g., algae, plants, detritus), however these effects are expected to be small and will not likely result in adverse effects to snails.

Usage is expected to be low within the range of the species (2.48%). Malathion uses allowed by the labels do not pose a high risk to the Virginia fringed mountain snail as this species is fossorial in upland habitats where we do not expect direct exposure. Additionally, we do not anticipate mortality from direct exposure nor measurable effects to its food base or habitat.

Due to the lack of measurable effects to individuals, including mortality and sublethal effects, the lack of appreciable effects to its food base and habitat, and the low level of expected usage, we anticipate minimal, if any, adverse effects (i.e., not enough to result in take) will occur

[4] TOTAL includes usage on all use sites with effects, including mosquito control.

throughout the duration of the action. Therefore, we do not anticipate that the proposed action would appreciably reduce the survival and recovery of the Virginia fringed mountain snail in the wild.

**Conclusion:** Not likely to jeopardize

**Integration and Synthesis Summary: Snails *(Aquatic)***

| Scientific Name: | Common Name: | Entity ID: |
|---|---|---|
| *Athearnia anthonyi* | Anthony's riversnail | 396 |

***VULNERABILITY***
***(Summary of status, environmental baseline and cumulative effects)***

**Status:** Endangered
**Distribution:** Small, endemic, constrained, and/or isolated population(s)
**Number of Populations:** Multiple populations (few)
**Species Trends:** Unknown population trends
**Pesticides noted ☒**

**Environmental Baseline/Cumulative Effects (EB/CE) Summary:**
The species prefers medium to large river habitats with cobble/boulder substrates in the vicinity of riffles with strong current. This freshwater snail was once fairly widespread in the Tennessee River system, where it was associated with shoal areas in the main stem of the Tennessee River and the lower reaches of some of its tributaries in eastern Tennessee, northern Alabama, and northwestern Georgia. Many of these populations have been lost as a result of impoundments and the general deterioration of water quality from siltation and other pollutants contributed to by past mining activities, poor land-use practices, and waste discharges. Only two populations of Anthony's riversnail are known to survive--one in the Tennessee River in Jackson County, Alabama, and Marion County, Tennessee, extending into the lower Sequatchie River, Marion County, Tennessee; and one restricted to the lower reaches of Limestone Creek, Limestone County, Alabama. Anthony's riversnail has been recorded from both large and relatively small streams; however, the majority of the historic and recent records of the species suggest that it is primarily a big-river species. It is typically found on large submerged objects (e.g., rocks and logs) or gravelly substrata in relatively shallow, moderately to fast-flowing water. The species has been recorded from impounded stream reaches. In the Sequatchie River and the Tennessee River, the species has been found primarily in areas of transition between the swiftly flowing water of runs and riffles and the calmer water of pools. In Limestone Creek, the species is generally found in the moderately flowing water of stream runs and riffles. As of the 2018 5-year review, there were no current surveys or population status assessments for this species. The Limestone Creek population might be declining and biologists note an increase in urbanization in the watershed (Johnson 2017, pers. comm.). There are no changes in the historic range of Anthony's riversnail since the Recovery Plan was written in 1997. Two recent observations represent new localities for the species. In 2007, Anthony's riversnail was reportedly common adjacent to the State Route 28 bridge crossing of the Little Sequatchie River (TDEC 2010). In 2009, Tennessee Valley Authority biologists collected one live and one dead Anthony's riversnail in Guntersville Reservoir at TRM 409 in a ponar sample (Howard 2009, pers. comm.).

The potential for degradation of the water and substrata quality in the two areas where Anthony's riversnail still survives is the most significant threat to the species' continued survival. Unless new populations are found or reestablished and existing populations are maintained, this species will remain in danger of extinction for the foreseeable future. As indicated in the Recovery Plan (USFWS 1997), impoundments, mining, toxic chemical spills, siltation, agriculture, timber harvest, runoff and discharge of organic and inorganic pollutants, channelization, dredging, and streambank erosion remain threats to the Anthony's riversnail. In addition, the Limestone Creek population is threatened by increased urbanization (Garner and Haggerty 2010). Overall, the greatest threat to the riversnail is habitat modification and destruction due to point and non-point source pollution. Habitat destruction resulting from a variety of human-induced impacts such as siltation, disturbance of riparian corridors, and changes in channel morphology continues to impact the Anthony's riversnail. The most significant of these impacts is siltation caused by excessive releases of sediment from activities such as agriculture, resource extraction (e.g., coal mining, silviculture), road construction, and urban development (Waters 1995). Activities that contribute sediment discharges into a stream system change the erosion or sedimentation pattern, which can lead to the destruction of riparian vegetation, bank collapse, excessive instream sediment deposition, and increased water turbidity and temperatures (Waters 1995). The effects of these types of threats will likely increase as human populations grow in the Tennessee River watershed in response to human demands for water, housing, transportation, and places of employment. The Anthony's riversnail's limited geographic range and apparent small population size also leaves the species extremely vulnerable to localized extinctions from accidental toxic chemical spills or other stochastic disturbances and to decreased fitness from reduced genetic diversity.

**EB/CE Sources:** U. S. Fish and Wildlife Service. 1997. Recovery Plan for Anthony's Riversnail. Atlanta, GA. 21 pp.

U.S. Fish and Wildlife Service. 2018. Anthony's riversnail (*Athearnia anthonyi*) 5-Year Review: Summary and Evaluation. Southeast Region, Tennessee Ecological Services Field Office, Cookeville, Tennessee. 17 pp.

**Overall Vulnerability:** ☒ **High** ☐ **Medium** ☐ **Low**

***RISK***
***(Risk is based on species exposure and response from labeled uses across the range)***

**Risk to individuals if exposed:** We do not anticipate effects to the species from exposure to malathion at labeled use rates.

**Risk to the species from labeled uses across the range:**
The table below summarizes the risk to the species from labeled uses across the range based on range overlaps with use sites and anticipated effects associated with the particular uses.

| | |
|---|---|
| ALL USES except mosquito control | |
| Mortality | No effects expected |
| MOSQUITO CONTROL | |
| Mortality | No effects expected |

**Risk modifiers:** Assumed to be oviparous (as other *Pleuroceridae*). It probably lays eggs only for a very short period annually. New recruits appear between May and July with many individuals suspected of having at least two breeding seasons (Garner and Haggerty, 2010) (USFWS, 2015).

The species prefers medium to large river habitats with cobble/boulder substrates in the vicinity of riffles with strong current (USFWS, 1997; USFWS, 2011). High site fidelity, low tolerance ranges/thresholds and narrow/specialist environmental specificity are inferred based on strict habitat needs as is clumped spatial arrangement (USFWS, 2012; NatureServe, 2015).

As described in the "Approach to the Effects Analysis" section of the main body of the Opinion, we made specific considerations for species that occur in bins 3 and 4 as they were modeled in such a way that likely resulted in overestimation of estimated environmental concentrations, thus overestimating potential exposure. Individuals that inhabit higher flowing aquatic habitats would have much lower exposure to malathion. Thus, exposure across the entire population is less likely than initially assumed.

**Overall Risk:** ☐ **High** ☐ **Medium** ☒ **Low**

***USAGE***
***(Anticipated usage within the range based on past usage data)***

| Use type | Risk to species[1] | Use overlap with range | | Estimated usage in range[2] | | Bins associated with use type^ | Effect associated with bin (H, M, L) |
|---|---|---|---|---|---|---|---|
| | | Acres | % | Acres | % | | |
| Mosquito Control | D | 432,409 | 20.2 | 68,662 | 2.54 | 2,3,4 | 2L<br>3L<br>4L |
| Other Crops | D | 850 | 0.04 | 0 | 0 | 2,3,4 | 2L<br>3L<br>4L |

[1] Direct effects (D), Indirect effects (I), No effects expected (N), Use site not utilized by the species (*)
[2] Estimated usage in the range is based on information about annual past usage.

| Use type | Risk to species[1] | Use overlap with range | | Estimated usage in range[2] | | Bins associated with use type^ | Effect associated with bin (H, M, L) |
|---|---|---|---|---|---|---|---|
| | | Acres | % | Acres | % | | |
| Other Grains | D | 498 | 0.02 | 498 | 0.02 | 2,3,4 | 2L<br>3L<br>4L |
| Corn | D | 19,930 | 0.93 | 2,548 | 0.07 | 2,3,4 | 2L<br>3L<br>4L |
| Cotton | D | 6,517 | 0.3 | 6,517 | 0.22 | 2,3,4 | 2L<br>3L<br>4L |
| Developed | D | 118,278 | 5.52 | 5,914 | 0.28 | 2,3,4 | 2L<br>3L<br>4L |
| Wheat | D | 1561 | 0.07 | 646 | 0.02 | 2,3,4 | 2L<br>3L<br>4L |
| Vegetables & Ground Fruit | D | 83 | < 0.01 | 83 | < 0.01 | 2,3,4 | 2L<br>3L<br>4L |
| Orchards & Vineyards | D | 5 | < 0.01 | 5 | <0.01 | 2,3,4 | 2L<br>3L<br>4L |
| Pasture | D | 30 | < 0.01 | 30 | <0.01 | 2,3,4 | 2L<br>3L<br>4L |
| Other Row Crops | D | 40 | < 0.01 | 40 | <0.01 | 22,3,4 | 2L<br>3L<br>4L |
| Nurseries | D | 671 | 0.03 | 671 | 0.03 | 2,3,4 | 2L<br>3L<br>4L |
| **Sub-TOTAL (D):** | | 148,463 | 6.95 | 17,489 | 0.69 | | |

| Use type | Risk to species[1] | Use overlap with range | | Estimated usage in range[2] | | Bins associated with use type^ | Effect associated with bin (H, M, L) |
|---|---|---|---|---|---|---|---|
| | | Acres | % | Acres | % | | |
| *Other uses with direct effects*[3] | | | | | | | |
| **Sub-TOTAL (I):** *Other uses with indirect effects*[3] | | 0 | 0 | 0 | 0 | | |
| **TOTAL[4]:** | | 580,872 | 27.15 | 106,917 | 3.18 | | |

^We consider the bin 2 estimates as an upper bound of bin 3 & 4 exposures.

**# acres in species range:** 3,526,577 acres
**% of range in California (i.e., where CalPUR data is available):** 0%
**Range overlap with Federal lands:** 520,299 acres, 19.247%

**Overall Usage:** ☐ **High** ☐ **Medium** ☒ **Low**

***CONSERVATION MEASURES***

**Rain restriction:** Given the relatively short half-life of malathion and rapid degradation via hydrolysis and other processes, persistence of malathion in storm run-off into most aquatic habitats is not anticipated to last longer than 48 hours under typical pH values, (i.e., 6.5-8.5) and water temperatures corresponding to growing season. Restricting malathion application to periods where rain is not forecasted for at least 48 hours or when the soil is not saturated will provide time for the pesticide to degrade before runoff into aquatic habitats can occur, decreasing exposure and risk.

**Aquatic habitat buffers:** Application buffers, which specify on the label a distance from water bodies where pesticides are not to be applied, are designed to reduce spray drift from entering sensitive non-target areas, thereby providing protection to aquatic species. While the exact amount of spray drift reduction depends on the physical traits of the aquatic ecosystem (e.g., flow rate, volume, etc.) as well as the application method, we can expect (based on AgDRIFT modeling) spray drift reductions ranging from 40 to 91%, with low flow and low volume aquatic habitats receiving the most reduction in spray drift deposition. In many cases, these buffers substantially reduce exposure to aquatic organisms and subsequent risk of direct and indirect effects.

**Residential use label changes:** New restrictions to the method and frequency of application for residential use of malathion are expected to substantially reduce exposure to species that overlap with developed and open space developed areas. Label changes will ensure that residential use is limited to spot treatments only (rendering spray drift offsite unlikely) and reducing the extent of area which can be treated in the developed and open space developed areas by as much as 75%

[3] Mosquito control has the potential to overlap with other uses. It is not included in the Sub-TOTALs.
[4] TOTAL includes usage on all use sites with effects, including mosquito control.

or more from modeled values. In addition, we expect the frequency of exposure to decrease as the number of allowable applications is reduced from "repeat as necessary" to a maximum of 2–4 applications per year (depending on the specific residential use). Retreatment intervals of 7-10 days between any repeated applications are expected to reduce environmental concentrations by allowing any initial residues to degrade prior to the next application. In addition, exposure to aquatic organisms is reduced due to buffers from waterways, which specify on the label a distance from water bodies where pesticides are not to be applied, and restrictions to application during periods where rain is not forecasted within 24 hours or when the soil is not saturated.

**Reduced application number and rate:** New restrictions on corn, cotton, orchards and vineyards, pasture, other crops, and vegetables and ground fruit lower the maximum allowable number of applications to 2-4 per year (depending on the specific crop; previous allowable numbers of applications ranged from 3 to 13 applications per year). This will help reduce the amount of malathion used and decrease potential exposure to the species, thus decreasing the risk of both indirect and direct effects to the species.

---

***CONCLUSION***

After reviewing the current status of the species, the environmental baseline for the action area, the effects of the proposed registration of malathion, and the cumulative effects, it is the Service's biological opinion that the registration of malathion, as proposed, with the implementation of the general conservation measures described above, is not likely to jeopardize the continued existence of the Anthony's riversnail. As discussed below, the vulnerability is high for this species, the risk and likelihood of exposure to malathion is low; and the implementation of the general conservation measures described above is expected to further reduce the likelihood of exposure.

The Anthony's riversnail has a high vulnerability based on its status, distribution, and trends, as described above. Only two populations of Anthony's riversnail are known to survive: one in the Tennessee River in Jackson County, Alabama, and Marion County, Tennessee, extending into the lower Sequatchie River, Marion County, Tennessee; and one restricted to the lower reaches of Limestone Creek, Limestone County, Alabama. It is typically found on large, submerged objects (e.g., rocks and logs) or gravelly substrata in relatively shallow, moderately to fast-flowing water.

The risk to the species from labeled uses across the range is expected to be low as we do not anticipate any measurable effects from malathion exposure to individuals, including mortality or sublethal effects to growth, reproduction, or behavior. There may be potential effects to the species' food base (e.g., algae, plants, detritus), however these effects are expected to be small and will not likely result in adverse effects to snails.

We anticipate usage within the range will be low (3.23%, expected to occur on the non-Federal lands portion), based primarily on the standard usage data we acquired, as described in the Opinion, and summarized for this species above. We did not quantitatively evaluate use or usage on Federal lands that overlap with the species range, but we assume only low levels of usage for

this species, per the rationale related to usage on Federal lands as described in the Opinion. Conservation measures, such as aquatic habitat buffers, rain restrictions, changes to residential use labels, and reduced allowable number of applications and application rates, would substantially reduce environmental concentrations of malathion, further reducing the likelihood of exposure.

Due to the lack of measurable effects to individuals, including mortality and sublethal effects, the lack of appreciable effects to its food base and habitat, the low expected usage, and the incorporation of conservation measures that would further reduce the risk of exposure, we anticipate minimal, if any, adverse effects (i.e., not enough to result in take) will occur throughout the duration of the action. Therefore, we do not anticipate that the proposed action would appreciably reduce survival and recovery of the Anthony's riversnail in the wild.

**Conclusion:** Not likely to jeopardize

**Integration and Synthesis Summary: Snails *(Aquatic)***

| Scientific Name: | Common Name: | Entity ID: |
|---|---|---|
| *Taylorconcha serpenticola* | Bliss Rapids snail | 398 |

***VULNERABILITY***
***(Summary of status, environmental baseline and cumulative effects)***

**Status:** Threatened
**Distribution:** Small, endemic, constrained, and/or isolated population(s)
**Number of Populations:** Multiple populations (few)
**Species Trends:** Unknown population trends
**Pesticides noted** ☒

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

The Bliss Rapids snail is restricted to a small geographic area, occurring in cold water springs and spring-fed tributaries to the Snake River, and in some reaches of the Snake River. Individuals are primarily found on cobble boulder substrate, and generally in water temperatures between 59 and 61 degrees Fahrenheit (FWS 2009). Bliss rapids snails hatch, reproduce, and die in a single year (Hershler *et al.* 1994 in FWS 2009). This species primarily consumes epilithic periphyton (diatom films that primarily grow on rock surfaces), as do many freshwater snails (Richards 2006b in FWS 2009). They may also consume quantities of detritus, bacteria, and protozoa embedded in the simple sugar matrix (*i.e.*, the periphyton) on the surfaces of benthic (bottom) substrates (FWS 2009).

In 2009, the Bliss Rapids snail was known to occur in 14 springs or tributaries to the Snake River. The species does not occur in reservoirs. Three pre-determined river sites were previously identified in the Bliss Rapids snail recovery plan for long-term monitoring. Based on our improved understanding of the species' distribution and biology, these sites may no longer represent the best locations for long-term monitoring though they may still "represent the outer most boundaries of the recovery area" within the river as stated in the Plan, and as such provide crucial information on changes in the species' range. Starting in 2010, numerous other river areas were included in annual monitoring and indicate these populations fluctuate greatly between years likely influenced by environmental factors such as river flow (FWS 2018). These colonies are self-reproducing and the 5-year period of 2012 through 2016 show increasing detections. However, other years (2011 and 2017) show drastic declines (FWS 2018). Since 2010, the three spring colonies identified in the recovery plan have been regularly monitored. While monitoring confirmed that these colonies are self-reproducing, none have demonstrated increasing populations, showing both increases and decreases in numbers of individuals or occupancy among years (FWS 2018). While these data do not reveal a steadily increasing trend, neither do they illustrate a steady decline, and are more reflective of naturally fluctuating populations influenced by hydrologic and other environmental parameters. Importantly, not all spring

populations being monitored since 2010 show consistent, fluctuating trends, two (Fisher Lake, Hagerman National Fish Hatchery) of nine showing regular declines and a single, up-river colony has since become extirpated.

Recent monitoring conducted as part of projects conducted by Idaho Power Company has shown that populations of Bliss Rapids snail can rebound if the disturbed habitat is returned to pre-project conditions within certain timeframes (FWS 2018). In one well documented case, a tributary population was greatly reduced after an extended exposure to high water flows, greatly reducing local densities. Two years after stream discharges had stabilized to pre-project conditions the population rebounded to healthy levels (Bean 2014 in FWS 2018). This understanding has enabled certain construction projects to go forward so long as habitat quality is restored, and water quality is not overly impaired by the activity (FWS 2018). In addition, annual monitoring conducted in the Snake River since 2010 has revealed that while the species' range includes an estimated 23 miles in the Snake River, the snails are not evenly distributed throughout that area. Monitoring indicates that while the species may reach moderate densities in some river areas, they have not been detected in others or may be present only at very low densities (FWS 2018). Furthermore, ongoing monitoring has documented the extirpation of one upstream, spring-dwelling population since 2010 (FWS 2018). This last observation illustrates the vulnerability of small, isolated populations and supports the need to consider water quality, which is reduced in upstream aquifer springs (Schorzman et al. 2009 in FWS 2018), as an important consideration in the species conservation.

At the time of federal listing in 1992, free-flowing, cool water environments required by the Bliss Rapids snail were impacted by, and were vulnerable to, continued adverse habitat modifications and deteriorating water quality. The deterioration of the species' water quality was determined to be from one or more of the following: hydroelectric development, peak-loading effects from existing hydroelectric project operations, water pollution, inadequate regulatory mechanisms, and invasion of the non-native New Zealand mudsnail. While some threats have been eliminated or moderated (i.e., proposed hydroelectric dams are no longer a threat), other threats have emerged. The dependence of the species on cold water aquatic habitat makes them particularly susceptible to changes in water quality and ground water levels. Ground water levels in the Eastern Snake Plain Aquifer (ESPA) have been declining and are expected to maintain that trajectory into the future (FWS 2018). We currently lack direct evidence that reduced spring discharge has led to mortality of Bliss Rapids snail; however, this is due in part to the small size of the snail (about 2 mm) which makes detection and documentation of such mortality difficult. By contrast, large numbers of dead Banbury Springs limpet (*Idaholanx fresti*) have been found after human-caused dewatering events (Burak and Hopper 2014 and 2016 *in* FWS 2018). Given the co-occurrence of these species and their strict aquatic nature, it is reasonable to conclude that Bliss Rapids snails have also been affected by dewatering events. Such mortality events are likely to occur as spring discharges decline and/or human water use, via groundwater pumping or spring diversion, increases or claims an increasing share of spring discharge (FWS 2018). Therefore, the most upstream snail colonies (i.e., those that depend on the uppermost strata of ground water) are especially vulnerable with little chance for successful recolonization. Recent

data show that these spring colonies contain rare alleles and loss of one or more colonies successively reduces genetic diversity and the ability for the species to adapt to changing environmental conditions (FWS 2009). The limited range, narrow habitat requirements, and presence of non-native snails that compete for space and food, exacerbates this threat.

Spring water quality has also shown signs of deterioration, with nitrate levels showing increases at monitored springs. For example, wastewater from confined animal feeding operations has been identified as a major contributor to water quality degradation in surface waters, groundwater, and springs in southern Idaho (Clark et al. 1998; Bahr and Carlson 2000; Schorzman et al. 2009, *in* FWS 2018), and cattle production and confinement has increased by 170 percent since 1992 in areas overlaying the ESPA and in close proximity to springs occupied by Bliss Rapids snail (FWS 2018). While regulatory efforts to stabilize the ESPA have been implemented, it will require many years if not decades to determine if these efforts will be effective. Therefore, existing regulatory mechanisms that oversee ESPA groundwater management may not be adequate to reverse the declining cold-water spring quantity and quality upon which the Bliss Rapids snail depends (FWS 2018). In addition, activities such as aquifer recharge have the potential to further reduce water quality at occupied springs. While the critical thresholds of nutrients and most other contaminants for the Bliss Rapids snail are unknown, many such contaminants are known to adversely affect other aquatic invertebrates. Degraded water quality could have both acute and chronic toxic effects as well as indirect impacts on habitat, such as increased growth of aquatic macrophytes (FWS 2018). Land use changes, most importantly in agriculture, are likely the drivers for both aquifer depletion and water quality degradation (FWS 2018). Over 23,310 square kilometers (9,000 square miles) of irrigated land are located within the Snake River drainage or that of its tributaries (Johnson, unpub. 2013 *in* FWS 2018). Most of the crops grown in this area are subject to modern agricultural practices which include the use of herbicides (some of which include copper, a known toxicant (Besser et al. 2016 *in* FWS 2018)), insecticides, fungicides, and fertilizers; a proportion of which make their way into the Snake River via irrigation return flows and through ground water recharge (Clark et al. 1998 *in* FWS 2018). Clark et al. (1998 *in* FWS 2018) found the largest amounts of pesticides to be present in wells adjacent to agricultural areas around the Snake River between Burley and Hagerman, which are also the locations with the highest frequencies and concentrations of nitrates in ground water. The presence of nitrates and other agrochemical contaminants in the groundwater (Holloway et al. 2004; Carlson and Atlakson 2006; Schorzman et al. 2009, *in* FWS 2018) illustrates the pathway through which these agricultural contaminants can reach the habitats of the Bliss Rapids snails and other sensitive species living within the aquifer springs and the Snake River.

**EB/CE Sources:**

U.S. Fish and Wildlife Service. 2009. 12-Month Finding on a Petition to Remove the Bliss Rapids Snail (*Taylorconcha serpenticola*) From the List of Endangered and Threatened Wildlife. Federal Register Vol. 74, No. 178, September 16, 2009. pp 47536-47545.

U.S. Fish and Wildlife Service. 2018. Bliss Rapids Snail (*Taylorconcha serpenticola*) 5-Year Review: Summary and Evaluation. Idaho Fish and Wildlife Office, Boise, Idaho. 45 pp.

**Overall Vulnerability: ☒ High ☐ Medium ☐ Low**

***RISK***
***(Risk is based on species exposure and response from labeled uses across the range)***

**Risk to individuals if exposed:** We do not anticipate effects to the species from exposure to malathion at labeled use rates.

**Risk to the species from labeled uses across the range:**
The table below summarizes the risk to the species from labeled uses across the range based on range overlaps with use sites and anticipated effects associated with the particular uses.

| ALL USES except mosquito control | |
|---|---|
| Mortality | no effects expected |
| MOSQUITO CONTROL | |
| Mortality | no effects expected |

**Risk modifiers:** Found in springs and unpolluted, unimpounded riverine habitats on stable rocky substrates. In rivers is found in areas associated with spring influences or rapids edge environments and tends to flank shorelines (USFWS, 1992; Hershler et al., 1994). The snails do not burrow and avoid habitats with fine sediments. The Bliss Rapids snails are moderately photophobic, residing on the lateral sides and undersides of rocks during daylight and they migrate to the uppermost surfaces of rocks at night (USFWS 2009, Stockton et al. 2012).

We described in the "Approach to the Effects Analysis" section of the main body of the Opinion specific considerations we made for species that occur in bins 3 and 4 as they were modeled in such a way that likely resulted in overestimation of estimated environmental concentrations, thus overestimating potential exposure. While the Bliss Rapids snail does occupy other aquatic habitats that contain higher concentrations of malathion (e.g., bin 2), individuals of the species that occupy habitats with higher flow rates (e.g., bins 3 and 4) will experience lower exposure than those occupying low flow areas, reducing the risk of effects across the species in general.

**Overall Risk: ☐ High ☐ Medium ☒ Low**

***USAGE***
***(Anticipated usage within the range based on past usage data)***

| Use type | Risk to species[1] | Use overlap with range | | Estimated usage in range[2] | | Bins associated with use type^ | Effect associated with bin (H, M, L) |
|---|---|---|---|---|---|---|---|
| | | Acres | % | Acres | % | | |
| Mosquito Control | D | 220,486 | 38.1 | 0 | 0 | 2,3,4 | 2L<br>3L<br>4L |
| Other Crops | D | 15,452 | 2.67 | 0 | 0 | 2,3,4 | 2L<br>3L<br>4L |
| Other Grains | D | 21,637 | 3.74 | 21,637 | 3.74 | 2,3,4 | 2L<br>3L<br>4L |
| Corn | D | 71,838 | 12.41 | 694 | 0.12 | 2,3,4 | 2L<br>3L<br>4L |
| Developed | D | 9,372 | 1.62 | 469 | 0.08 | 2,3,4 | 2L<br>3L<br>4L |
| Wheat | D | 18,856 | 3.26 | 18,856 | 3.26 | 2,3,4 | 2L<br>3L<br>4L |
| Vegetables & Ground Fruit | D | 25,822 | 4.46 | 25,822 | 4.46 | 2,3,4 | 2L<br>3L<br>4L |
| Orchards & Vineyards | D | 5 | < 0.01 | 1 | < 0.01 | 2,3,4 | 2L<br>3L<br>4L |
| Pasture | D | 71,095 | 12.28 | 37,464 | 6.47 | 2,3,4 | 2L<br>3L<br>4L |
| Other row Crops | D | 7,290 | 1.26 | 4,249 | 0.73 | 2,3,4 | 2L<br>3L<br>4L |
| Nurseries | D | 254 | 0.04 | 254 | 0.04 | 2,3,4 | 2L |

[1] Direct effects (D), Indirect effects (I), No effects expected (N), Use site not utilized by the species (*)
[2] Estimated usage in the range is based on information about annual past usage. “NA” = Not available.

| Use type | Risk to species[1] | Use overlap with range | | Estimated usage in range[2] | | Bins associated with use type^ | Effect associated with bin (H, M, L) |
|---|---|---|---|---|---|---|---|
| | | Acres | % | Acres | % | | |
| | | | | | | | 3L<br>4L |
| Christmas Trees | D | 11 | < 0.01 | 11 | < 0.01 | 2,3,4 | 2L<br>3L<br>4L |
| **Sub-TOTAL (D):** *Other uses with direct effects*[3] | | 241,632 | 41.74 | 109,457 | 18.90 | | |
| **Sub-TOTAL (I):** *Other uses with indirect effects*[3] | | 0 | 0 | 0 | 0 | | |
| **TOTAL[4]:** | | 462,118 | 79.84 | 109,457 | 18.90 | | |

^We consider the bin 2 estimates as an upper bound of bin 3 & 4 exposures.

**# acres in species range:** 578,986 acres
**% of range in California (i.e., where CalPUR data is available):** 0%
**Range overlap with Federal lands:** 186,543 acres, 32.219%

**Overall Usage:** ☒ **High** ☐ **Medium** ☐ **Low**

***CONSERVATION MEASURES***

**Rain restriction:** Given the relatively short half-life of malathion and rapid degradation via hydrolysis and other processes, persistence of malathion in storm run-off into most aquatic habitats is not anticipated to last longer than 48 hours under typical pH values, (i.e., 6.5-8.5) and water temperatures corresponding to growing season. Restricting malathion application to periods where rain is not forecasted for at least 48 hours or when the soil is not saturated will provide time for the pesticide to degrade before runoff into aquatic habitats can occur, decreasing exposure and risk.

**Aquatic habitat buffers:** Application buffers, which specify on the label a distance from water bodies where pesticides are not to be applied, are designed to reduce spray drift from entering sensitive non-target areas, thereby providing protection to aquatic species. While the exact amount of spray drift reduction depends on the physical traits of the aquatic ecosystem (e.g., flow rate, volume, etc.) as well as the application method, we can expect (based on AgDRIFT modeling) spray drift reductions ranging from 40 to 91%, with low flow and low volume aquatic habitats receiving the most reduction in spray drift deposition. In many cases,

[3] Mosquito control has the potential to overlap with other uses. It is not included in the Sub-TOTALs.
[4] TOTAL includes usage on all use sites with effects, including mosquito control.

these buffers substantially reduce exposure to aquatic organisms and subsequent risk of direct and indirect effects.

**Residential use label changes:** New restrictions to the method and frequency of application for residential use of malathion are expected to substantially reduce exposure to species that overlap with developed and open space developed areas. Label changes will ensure that residential use is limited to spot treatments only (rendering spray drift offsite unlikely) and reducing the extent of area which can be treated in the developed and open space developed areas by as much as 75% or more from modeled values. In addition, we expect the frequency of exposure to decrease as the number of allowable applications is reduced from "repeat as necessary" to a maximum of 2–4 applications per year (depending on the specific residential use). Retreatment intervals of 7-10 days between any repeated applications are expected to reduce environmental concentrations by allowing any initial residues to degrade prior to the next application. In addition, exposure to aquatic organisms is reduced due to buffers from waterways, which specify on the label a distance from water bodies where pesticides are not to be applied, and restrictions to application during periods where rain is not forecasted within 24 hours or when the soil is not saturated.

**Reduced application number and rate:** New restrictions on corn, cotton, orchards and vineyards, pasture, other crops, and vegetables and ground fruit lower the maximum allowable number of applications to 2-4 per year (depending on the specific crop; previous allowable numbers of applications ranged from 3 to 13 applications per year). This will help reduce the amount of malathion used and decrease potential exposure to the species, thus decreasing the risk of both indirect and direct effects to the species.

---

***CONCLUSION***

After reviewing the current status of the species, the environmental baseline for the action area, the effects of the proposed registration of malathion, and the cumulative effects, it is the Service's biological opinion that the registration of malathion, as proposed, with the implementation of the general conservation measures described above, is not likely to jeopardize the continued existence of the Bliss Rapids snail. As discussed below, the vulnerability is high for this species, the risk is low, and likelihood of exposure to malathion is high. The implementation of the general conservation measures described above is expected to substantially reduce the likelihood of exposure.

The Bliss Rapids snail has a high vulnerability based on its status, distribution, and trends, as described above. The species is vulnerable due to stressors associated with small populations, such as increased susceptibility to impacts by genetic bottlenecks and/or stochastic events. Data show that spring colonies of the Bliss Rapids snail contain rare alleles and loss of one or more colonies successively reduces genetic diversity and the ability for the species to adapt to changing environmental conditions (FWS 2009). The limited species range, narrow habitat requirements, and presence of non-native snails that compete for space and food exacerbate these threats.

The risk to the species from labeled uses across the range is expected to be low as we do not anticipate any measurable effects from malathion exposure to individuals, including mortality or sublethal effects to growth, reproduction, or behavior. There may be potential effects to the species' food base (e.g., algae, plants, detritus), however these effects are expected to be small and will not likely result in adverse effects to snails.

While a large portion of the range overlaps with Federal lands (32%), we anticipate usage within the range on lands that are outside of Federal lands will be high (19.08% of the range, expected to occur on the non-Federal portion), based primarily on the standard usage data we acquired, as described in the Opinion, and summarized for this species above. We did not quantitatively evaluate use or usage on Federal lands that overlap with the species range, but we expect any adverse effects in these areas would be minimal, considering the small scale and low levels of past malathion usage on Federal lands, and in light of Federal agency programs that are designed to understand, avoid, and minimize the effects to listed species (see the Approach to Usage section of the Opinion). While past data indicates usage will be high, we do not anticipate this high level of usage will result in environmental concentrations of malathion that will cause any effects to the species given the high tolerance snails have to malathion. Additionally, conservation measures, such as rain restrictions, aquatic buffer habitats, developed and open space developed use label changes, and reductions in the number of applications and application rates for certain agricultural crops, are expected to substantially reduce environmental concentrations of malathion in the species range and decrease the likelihood of exposure to malathion.

Due to the lack of measurable effects to individuals, including mortality and sublethal effects, the lack of appreciable effects to its food base and habitat, and the incorporation of conservation measures that would further reduce the risk of exposure, we anticipate minimal, if any, adverse effects (i.e., not enough to result in take) will occur throughout the duration of the action. Therefore, we anticipate that the proposed action would not appreciably reduce survival and recovery of the Bliss Rapids snail in the wild.

**Conclusion:** Not likely to jeopardize

***ADDITIONAL REFERENCES***

U. S. Fish and Wildlife Service. 2009. 5-Year Review Short Form Summary: Species Reviewed: Bliss Rapids snail (*Taylorconcha serpenticola*). 4 pp.

U.S. Fish and Wildlife Service. 2018. Bliss Rapids Snail (*Taylorconcha serpenticola*) 5-Year Review: Summary and Evaluation. Idaho Fish and Wildlife Office, Boise, Idaho. 45 pp.

**Integration and Synthesis Summary: Snails *(Aquatic)***

| Scientific Name: | Common Name: | Entity ID: |
|---|---|---|
| *Physa natricina* | Snake River physa snail | 399 |

***VULNERABILITY***
***(Summary of status, environmental baseline and cumulative effects)***

**Status:** Endangered
**Distribution:** Small, endemic, constrained, and/or isolated population(s)
**Number of Populations:** Multiple populations (few)
**Species Trends:** Unknown population trends
**Pesticides noted** ☐

**Environmental Baseline/Cumulative Effects (EB/CE) Summary:**
The Snake River physa is listed as endangered and is restricted to 494 river kilometers (RKM) or less in the Snake River in southern Idaho from RKM 1086 at Minidoka Dam downstream to RKM 592 near Ontario, Oregon. (USFWS 2014) The species' highest abundance and densities currently occur in the 18.5 kilometer river segment downstream of Minidoka Dam (i.e., Minidoka reach), though the species rarely exhibits high-density colony behavior in this area (Gates and Kerans 2010; U.S. Bureau of Reclamation 2018 *in* FWS 2018). Gates and Kerans (2010) reported Snake River physa from 19.7 percent of their samples with relatively high density samples ranging from 30 to 64 individuals per square meter (Gates and Kerans 2010 *in* FWS 2018). The Snake River physa has only been found within the Snake River itself. Suitable habitat includes pebble to gravel substrates, and possibly cobble to gravel, that are largely free of macrophytes and substrates finer than gravel which can fill in the interstitial spaces. Within the Minidoka reach the Snake River physa population is considered to be relatively robust and stable, and has been successfully collected annually between 2006-2008 and in 2012. The species continues to be regularly found within the Minidoka reach, although densities have fluctuated in recent years (USFWS 2018). At the time of listing in 1992, the primary threats to the Snake River physa included construction of new hydropower dams; operation of existing hydropower dams; water quality degradation; water diversions and groundwater withdrawals for agriculture and aquaculture; small hydroelectric development; lack of State regulations, pollution regulations, and Federal consultation regulations; and competition with the non-native New Zealand mudsnail. There has been a lot of new information gathered regarding the factors affecting the Snake River physa since the 1992 listing. The exotic New Zealand mudsnail does not appear to either compete or affect the Snake River physa given the two species preferred habitats do not appear to entirely overlap. Additional, new information regarding the favored habitats of the Snake River physa has led us to determine that multiple factors including operations of existing dams, degraded water quality, and climate change currently constitute the primary threat to the species. The effect from degraded water quality is not uniform throughout the species range, but appears to be affecting the species distribution and suitable habitat more so outside of the Minidoka reach. This is likely due to decreased water flow during summer months

outside of the Minidoka reach, while increased flows during summer in the Minidoka reach keep substrates relatively free of fine sediments and resulting macrophyte growth. While Federal consultation is now required for the Snake River physa through section 7 of the ESA, the inadequacy of existing regulatory mechanisms continues to be a factor affecting the Snake River physa. The threat of small population size, habitat fragmentation, and loss of connectivity is an emerging and increasing threat. The Minidoka reach population is essentially isolated during certain periods from the rest of its possible downstream range due to the presence and operation of Milner Dam. As described in the previous 5-year status review, Milner Dam regularly diverts the entire flow of the Snake River for irrigation, leaving the river essentially dry for approximately 2.6 km (1.6 mi) downstream of Milner Dam. The Snake River physa cannot survive when its river habitat is dry. Given the species can only be reliably found within the Minidoka reach (approximately 4 percent of its known range), and even though that population is considered stable, its occupation of this relatively small river reach also makes it susceptible to stochastic or other events that would affect its persistence.

**EB/CE Sources:** U.S. Fish and Wildlife Service. 2014. 5-Year Status Review for Snake River physa (*Physa (Haitia) natricina*). U.S. Fish and Wildlife Service, Region 1, Idaho Fish and Wildlife Office, Boise, ID. 45 pages.

U.S. Fish and Wildlife Service. 2018. 5-Year Review Short Form Summary for Snake River physa (*Physa (Haitia) natricina*). U.S. Fish and Wildlife Service, Region 1, Idaho Fish and Wildlife Office, Boise, Idaho. 13 pp.

**Overall Vulnerability:** ☒ **High** ☐ **Medium** ☐ **Low**

***RISK***
***(Risk is based on species exposure and response from labeled uses across the range)***

**Risk to individuals if exposed:** We do not anticipate effects to the species from exposure to malathion at labeled use rates.

**Risk to the species from labeled uses across the range:**
The table below summarizes the risk to the species from labeled uses across the range based on range overlaps with use sites and anticipated effects associated with the particular uses.

| ALL USES except mosquito control | |
|---|---|
| Mortality | no effects expected |
| MOSQUITO CONTROL | |
| Mortality | no effects expected |

**Risk modifiers:** Much remains unknown regarding the basic biology of the Snake River physa, including reproduction and life history traits, and diet preferences (USFWS, 2016).

Analysis of Snake River physa substrate preferences indicates the species selects for gravel to pebble, possibly gravel to cobble, substrates where water velocity keeps the substrate relatively free of fine sediments and macrophyte plant growth. The highest abundance and densities of Snake River physa (between 32 to 64 per square meter) have been found in relatively large, relatively contiguous areas of gravel to pebble beds, in braided areas of the Snake River that are largely absent of fine sediments and macrophytes at depths between 1.5 to 2.5 meters in 18.5 km (11.5 mi) downstream of Minidoka Dam.

As described in the "Approach to the Effects Analysis" section of the main body of the Opinion, we made specific considerations for species that occur in bins 3 and 4 as they were modeled in such a way that likely resulted in overestimation of estimated environmental concentrations, thus overestimating potential exposure. While the Snake River physa snail does occupy other aquatic habitats with higher concentrations of malathion (e.g., bin 2), individuals of the species that occupy habitats with higher flow rates (e.g., bins 3 and 4) will experience lower exposure than those occupying low flow areas, reducing the risk of effects across the species in general.

**Overall Risk: ☐ High ☐ Medium ☒ Low**

***USAGE***
***(Anticipated usage within the range based on past usage data)***

| Use type | Risk to species[1] | Use overlap with range | | Estimated usage in range[2] | | Bins associated with use type^ | Effect associated with bin (H, M, L) |
|---|---|---|---|---|---|---|---|
| | | Acres | % | Acres | % | | |
| Mosquito Control | D | 744,195 | 29.9 | 0 | 0 | 2,3,4 | 2L<br>3L<br>4L |
| Other Crops | D | 276,055 | 11.08 | 15,291 | 0.61 | 2,3,4 | 2L<br>3L<br>4L |
| Pasture | D | 182,376 | 7.32 | 52,049 | 2.09 | 2,3,4 | 2L<br>3L<br>4L |
| Other Grains | D | 84,267 | 3.38 | 25,910 | 1.04 | 2,3,4 | 2L<br>3L<br>4L |
| Corn | D | 177,251 | 7.11 | 875 | 0.04 | 2,3,4 | 2L<br>3L |

[1] Direct effects (D), Indirect effects (I), No effects expected (N), Use site not utilized by the species (*)
[2] Estimated usage in the range is based on information about annual past usage. "NA" = Not available.

| Use type | Risk to species[1] | Use overlap with range | | Estimated usage in range[2] | | Bins associated with use type^ | Effect associated with bin (H, M, L) |
|---|---|---|---|---|---|---|---|
| | | Acres | % | Acres | % | | |
| | | | | | | | 4L |
| Other Row Crops | D | 64,492 | 2.59 | 4,735 | 0.19 | 2,3,4 | 2L<br>3L<br>4L |
| Developed | D | 32,376 | 1.3 | 1,619 | 0.06 | 2,3,4 | 2L<br>3L<br>4L |
| Nurseries | D | 504 | 0.02 | 504 | 0.02 | 2,3,4 | 2L<br>3L<br>4L |
| Wheat | D | 182,467 | 7.32 | 82,179 | 3.3 | 2,3,4 | 2L<br>3L<br>4L |
| Vegetables & Ground Fruit | D | 140,819 | 5.65 | 56,103 | 2.25 | 2,3,4 | 2L<br>3L<br>4L |
| Orchards & Vineyards | D | 3,239 | 0.13 | 1,879 | 0.08 | 2,3,4 | 2L<br>3L<br>4L |
| Christmas Trees | D | 21 | < 0.01 | 21 | < 0.01 | 2,3,4 | 2L<br>3L<br>4L |
| **Sub-TOTAL (D):** *Other uses with direct effects*[3] | | 1,143,877 | 45.91 | 241,163 | 9.69 | | |
| **Sub-TOTAL (I):** *Other uses with indirect effects*[3] | | 0 | 0 | 0 | 0 | | |
| **TOTAL[4]:** | | 1,768,328 | 75.81 | 241,163 | 9.69 | | |

^We consider the bin 2 estimates as an upper bound of bin 3 & 4 exposures.

**# acres in species range:** 2,491,473 acres
**% of range in California (i.e., where CalPUR data is available):** 0%
**Range overlap with Federal lands:** 1,040,584 acres, 41.766%

[3] Mosquito control has the potential to overlap with other uses. It is not included in the Sub-TOTALs.
[4] TOTAL includes usage on all use sites with effects, including mosquito control.

**Overall Usage:** ☐ **High** ☒ **Medium** ☐ **Low**

***CONSERVATION MEASURES***

**Rain restriction:** Given the relatively short half-life of malathion and rapid degradation via hydrolysis and other processes, persistence of malathion in storm run-off into most aquatic habitats is not anticipated to last longer than 48 hours under typical pH values, (i.e., 6.5-8.5) and water temperatures corresponding to growing season. Restricting malathion application to periods where rain is not forecasted for at least 48 hours or when the soil is not saturated will provide time for the pesticide to degrade before runoff into aquatic habitats can occur, decreasing exposure and risk.

**Aquatic habitat buffers:** Application buffers, which specify on the label a distance from water bodies where pesticides are not to be applied, are designed to reduce spray drift from entering sensitive non-target areas, thereby providing protection to aquatic species. While the exact amount of spray drift reduction depends on the physical traits of the aquatic ecosystem (e.g., flow rate, volume, etc.) as well as the application method, we can expect (based on AgDRIFT modeling) spray drift reductions ranging from 40 to 91%, with low flow and low volume aquatic habitats receiving the most reduction in spray drift deposition. In many cases, these buffers substantially reduce exposure to aquatic organisms and subsequent risk of direct and indirect effects.

**Residential use label changes:** New restrictions to the method and frequency of application for residential use of malathion are expected to substantially reduce exposure to species that overlap with developed and open space developed areas. Label changes will ensure that residential use is limited to spot treatments only (rendering spray drift offsite unlikely) and reducing the extent of area which can be treated in the developed and open space developed areas by as much as 75% or more from modeled values. In addition, we expect the frequency of exposure to decrease as the number of allowable applications is reduced from “repeat as necessary” to a maximum of 2–4 applications per year (depending on the specific residential use). Retreatment intervals of 7-10 days between any repeated applications are expected to reduce environmental concentrations by allowing any initial residues to degrade prior to the next application. In addition, exposure to aquatic organisms is reduced due to buffers from waterways, which specify on the label a distance from water bodies where pesticides are not to be applied, and restrictions to application during periods where rain is not forecasted within 24 hours or when the soil is not saturated.

**Reduced application number and rate:** New restrictions on corn, cotton, orchards and vineyards, pasture, other crops, and vegetables and ground fruit lower the maximum allowable number of applications to 2-4 per year (depending on the specific crop; previous allowable numbers of applications ranged from 3 to 13 applications per year). This will help reduce the amount of malathion used and decrease potential exposure to the species, thus decreasing the risk of both indirect and direct effects to the species.

***CONCLUSION***

After reviewing the current status of the species, the environmental baseline for the action area, the effects of the proposed registration of malathion, and the cumulative effects, it is the Service's biological opinion that the registration of malathion, as proposed, with the implementation of the general conservation measures described above, is not likely to jeopardize the continued existence of the Snake River physa snail. As discussed below, the vulnerability is high for this species, the risk is low, and likelihood of exposure to malathion is medium. The implementation of the general conservation measures described above is expected to further reduce the likelihood of exposure.

The Snake River physa snail has a high vulnerability based on its status, distribution, and trends, as described above. The species remains patchily distributed and is generally found at low densities where it occurs. This species is extremely sensitive to stochastic events, with recolonization of suitable habitat following localized extirpation unlikely due to lack of additional populations, connectivity, and the isolated nature of the species' habitats. The Snake River physa has only been found within the Snake River itself (USFWS 2014).

The risk to the species from labeled uses across the range is expected to be low as we do not anticipate any measurable effects from malathion exposure to individuals, including mortality or sublethal effects to growth, reproduction, or behavior. There may be potential effects to the species' food base (e.g., algae, plants, detritus), however these effects are expected to be small and will not likely result in adverse effects to snails.

A large portion of the range overlaps with Federal lands (41%), we anticipate usage within non-Federal areas of the range will be medium (9.69%), based primarily on the standard usage data we acquired, as described in the Opinion, and summarized for this species above. We did not quantitatively evaluate use or usage on Federal lands that overlap with the species range, but we expect any adverse effects in these areas would be minimal, considering the small scale and low levels of past malathion usage on Federal lands, and in light of Federal agency programs that are designed to understand, avoid, and minimize the effects to listed species (see the Approach to Usage section of the Opinion). While usage outside of Federal lands is medium, we do not expect any effects to occur at the environmental concentrations that are predicted to result from labeled usage rates. Conservation measures, such as rain restrictions, aquatic habitat buffers, changes to residential use labels, and reductions in the allowable number of applications and application rates for certain crops, are expected to substantially reduce environmental concentrations of malathion, reducing the likelihood of exposure.

Due to the lack of measurable effects to individuals, including mortality and sublethal effects, the lack of appreciable effects to its food base and habitat, and the incorporation of conservation measures that would further reduce the risk of exposure, we anticipate minimal, if any, adverse effects (i.e., not enough to result in take) will occur throughout the duration of the action. Therefore, we anticipate that the proposed action would not appreciably reduce survival and recovery of the Snake River physa snail in the wild.

**Conclusion:** Not likely to jeopardize

***ADDITIONAL REFERENCES***

U.S. Fish and Wildlife Service. 2014. 5-Year Status Review for Snake River physa (Physa (Haitia) natricina). U.S. Fish and Wildlife Service, Region 1, Idaho Fish and Wildlife Office, Boise, ID. 45 pages.

**Integration and Synthesis Summary: Snails *(Aquatic)***

| Scientific Name: | Common Name: | Entity ID: |
|---|---|---|
| *Pyrgulopsis ogmorhaphe* | Royal marstonia (snail) | 401 |

***VULNERABILITY***
***(Summary of status, environmental baseline and cumulative effects)***

**Status:** Endangered
**Distribution:** Small, endemic, constrained, and/or isolated population(s)
**Number of Populations:** Multiple populations (few)
**Species Trends:** Unknown population trends
**Pesticides noted** ☐

**Environmental Baseline/Cumulative Effects (EB/CE) Summary:**
The royal marstonia has a narrow distribution, known from only two spring runs in the Sequatchie River system in Marion County, Tennessee. Habitat and water quality degradation are the greatest threats to the species. Recently, the Alabama Aquatic Biodiversity Center completed a life history study (AABC, 2019) for this species from samples collected between August 2012 and May 2013. Sample sizes of 6,493 and 3,481 for the entire project at Owen Spring Branch and Town Creek, respectively, indicate that, while spatially constrained, the Royal Marstonia is locally abundant. (USFWS 2020) The recharge areas for the springs are unknown, so it is difficult to evaluate the geographic scope within which threats may be occurring. However, habitat has been impacted by several types of human activities including direct habitat destruction at the Town of Jasper's water treatment plant, water withdrawal, and habitat destruction from ORV use, littering, and dumping in the Owen Spring Branch. Additionally, beaver activity constrains royal snail use of downstream habitat in both Town Creek and Owen Spring Branch. The limited and disjunct distribution of the royal marstonia populations, as well as the snail's presumed annual life cycle, makes it vulnerable to extinction from stochastic events, even when of short duration. Because of the royal marstonia's limited distribution and continued threats to the two populations, it remains in danger of extinction throughout all or a significant portion of its range. (USFWS 2011, USFWS 2020)

**EB/CE Sources:** U. S. Fish and Wildlife Service. 2011. Royal Marstonia (Snail) (*Pyrgulopsis ogmorhaphe*) 5-Year Review: Summary and Evaluation. Cookeville, Tennessee. 19 pp.

U.S. Fish and Wildlife Service. 2020. Royal Marstonia (Snail) (*Pyrgulopsis ogmorhaphe*) 5-Year Review: Summary and Evaluation. Cookeville, Tennessee. 17 pp.

**Overall Vulnerability:** ☒ **High** ☐ **Medium** ☐ **Low**

***RISK***
***(Risk is based on species exposure and response from labeled uses across the range)***

**Risk to individuals if exposed:** We do not anticipate effects to the species from exposure to malathion at labeled use rates.

**Risk to the species from labeled uses across the range:**
The table below summarizes the risk to the species from labeled uses across the range based on range overlaps with use sites and anticipated effects associated with the particular uses.

| ALL USES except mosquito control | |
|---|---|
| Mortality | no effects expected |
| MOSQUITO CONTROL | |
| Mortality | no effects expected |

**Risk modifiers:**

Royal snails occupy spring runs flowing out of two caves in the Sequatchie River system. They are generally found in the diatomaceous "ooze" and on leaves and twigs in the quieter pools downstream from the spring source. This species is subject to sudden extinction should its habitat deteriorate. No other life history information is known. The snail is found in about a 50-meter (150-foot) stretch of the spring outflow, about 50 meters (150 feet) from where surface flow begins (USFWS, 1995).

*Allowable uses driving effects/other considerations:*

**Overall Risk: ☐ High ☐ Medium ☒ Low**

***USAGE***
***(Anticipated usage within the range based on past usage data)***

| Use type | Risk to species[1] | Use overlap with range | | Estimated usage in range[2] | | Bins associated with use type^ | Effect associated with bin (H, M, L) |
|---|---|---|---|---|---|---|---|
| | | Acres | % | Acres | % | | |
| Mosquito Control | D | 41,343 | 6.3 | 40,977 | 6.25 | 2 | 2L |
| Open Space Developed | D | 25,248 | 3.85 | 1,262 | 0.19 | 2 | 2L |
| Developed | D | 10,990 | 1.68 | 550 | 0.08 | 2 | 2L |
| Corn | D | 3,056 | 0.47 | 2,261 | 0.34 | 2 | 2L |
| Other Crops | D | 493 | 0.08 | 0 | 0 | 2 | 2L |
| Wheat | D | 66 | 0.01 | 44 | 0.01 | 2 | 2L |
| Nurseries | D | 53 | < 0.01 | 53 | <0.01 | 2 | 2L |
| Vegetables & Ground Fruit | D | 14 | < 0.01 | 14 | <0.01 | 2 | 2L |

[1] Direct effects (D), Indirect effects (I), No effects expected (N), Use site not utilized by the species (*)
[2] Estimated usage in the range is based on information about annual past usage.

| Use type | Risk to species[1] | Use overlap with range | | Estimated usage in range[2] | | Bins associated with use type^ | Effect associated with bin (H, M, L) |
|---|---|---|---|---|---|---|---|
| | | Acres | % | Acres | % | | |
| Other Grains | D | 13 | < 0.01 | 13 | <0.01 | 2 | 2L |
| Cotton | D | 11 | < 0.01 | 8 | <0.01 | 2 | 2L |
| Other Row Crops | D | 4 | < 0.01 | 4 | <0.01 | 2 | 2L |
| Pasture | D | 2 | < 0.01 | 2 | <0.01 | 2 | 2L |
| Orchards and Vineyards | D | 0.44 | < 0.01 | 0.45 | <0.01 | 2 | 2L |
| **Sub-TOTAL (D):** *Other uses with direct effects*[3] | | 39,950 | 6.09 | 4,211 | 0.64 | | |
| **Sub-TOTAL (I):** *Other uses with indirect effects*[3] | | 0 | 0 | 0 | 0 | | |
| **TOTAL[4]:** | | 81,293 | 12.39 | 45,188 | 6.89 | | |

^species found only in bin 2

**# acres in species range:** 655,961 acres
**% of range in California (i.e., where CalPUR data is available):** 0%
**Range overlap with Federal lands:** 7,806 acres, 1.190%

**Overall Usage:** ☐ **High** ☒ **Medium** ☐ **Low**

***CONSERVATION MEASURES***

**Rain restriction:** Given the relatively short half-life of malathion and rapid degradation via hydrolysis and other processes, persistence of malathion in storm run-off into most aquatic habitats is not anticipated to last longer than 48 hours under typical pH values, (i.e., 6.5-8.5) and water temperatures corresponding to growing season. Restricting malathion application to periods where rain is not forecasted for at least 48 hours or when the soil is not saturated will provide time for the pesticide to degrade before runoff into aquatic habitats can occur, decreasing exposure and risk.

**Aquatic habitat buffers:** Application buffers, which specify on the label a distance from water bodies where pesticides are not to be applied, are designed to reduce spray drift from entering sensitive non-target areas, thereby providing protection to aquatic species. While the exact amount of spray drift reduction depends on the physical traits of the aquatic ecosystem (e.g., flow rate, volume, etc.) as well as the application method, we can expect (based on AgDRIFT modeling) spray drift reductions ranging from 40 to 91%, with low flow and low volume aquatic habitats receiving the most reduction in spray drift deposition. In many cases, these buffers substantially reduce exposure to aquatic organisms and subsequent risk of direct and indirect effects.

[3] Mosquito control has the potential to overlap with other uses. It is not included in the Sub-TOTALs.
[4] TOTAL includes usage on all use sites with effects, including mosquito control.

**Residential use label changes:** New restrictions to the method and frequency of application for residential use of malathion are expected to substantially reduce exposure to species that overlap with developed and open space developed areas. Label changes will ensure that residential use is limited to spot treatments only (rendering spray drift offsite unlikely) and reducing the extent of area which can be treated in the developed and open space developed areas by as much as 75% or more from modeled values. In addition, we expect the frequency of exposure to decrease as the number of allowable applications is reduced from "repeat as necessary" to a maximum of 2–4 applications per year (depending on the specific residential use). Retreatment intervals of 7-10 days between any repeated applications are expected to reduce environmental concentrations by allowing any initial residues to degrade prior to the next application. In addition, exposure to aquatic organisms is reduced due to buffers from waterways, which specify on the label a distance from water bodies where pesticides are not to be applied, and restrictions to application during periods where rain is not forecasted within 24 hours or when the soil is not saturated.

---

***CONCLUSION***

After reviewing the current status of the species, the environmental baseline for the action area, the effects of the proposed registration of malathion, and the cumulative effects, it is the Service's biological opinion that the registration of malathion, as proposed, with the implementation of the general conservation measures described above, is not likely to jeopardize the continued existence of the Royal marstonia (snail). As discussed below, the vulnerability is high for this species, the risk is low, and likelihood of exposure to malathion is medium. The implementation of the general conservation measures described above is expected to further reduce the likelihood of exposure.

The Royal marstonia (snail) has a high vulnerability based on its status, distribution, and trends, as described above. The royal marstonia has a narrow distribution, known from only two spring runs in the Sequatchie River system in Tennessee. Habitat and water quality degradation are the greatest threats to the species. (USFWS 2011). The limited and disjunct distribution of the species populations, as well as the snail's presumed short life cycle (1-2 years), makes it vulnerable to extinction from stochastic events, even when of short duration (USFWS 2020).

The risk to the species from labeled uses across the range is expected to be low as we do not anticipate any measurable effects from malathion exposure to individuals, including mortality or sublethal effects to growth, reproduction, or behavior. There may be potential effects to the species' food base (e.g., algae, plants, detritus), however these effects are expected to be small and will not likely result in adverse effects to snails.

We anticipate usage within the range will be medium (6.76%), based primarily on the standard usage data we acquired, as described in the Opinion, and summarized for this species above. While usage may be medium, we do not expect this level of usage will affect the species given the relatively high tolerance snails have towards malathion. Furthermore, the conservation measures, such as rain restrictions, aquatic habitat buffers, and changes to residential use labels,

are expected to substantially reduce environmental concentrations of malathion, reducing the likelihood of exposure.

Due to the low level of mortality of individuals anticipated to result from exposure to malathion, the lack of appreciable effects to its food base and habitat, as well as the incorporation of conservation measures that would further reduce the risk of exposure, we do not expect adverse effects will occur throughout the duration of the action. Therefore, we anticipate that the proposed action would not appreciably reduce survival and recovery of the Royal marstonia in the wild.

**Conclusion:** Not likely to jeopardize

***ADDITIONAL REFERENCES***

U.S. Fish and Wildlife Service. 2020. Royal Marstonia (Snail) (*Pyrgulopsis ogmorhaphe*) 5-Year Review: Summary and Evaluation. Cookeville, Tennessee. 17 pp.

**Integration and Synthesis Summary: Snails *(Aquatic)***

| Scientific Name: | Common Name: | Entity ID: |
|---|---|---|
| *Pyrgulopsis (=Marstonia) pachyta* | Armored snail | 402 |

***VULNERABILITY***
***(Summary of status, environmental baseline and cumulative effects)***

**Status:** Endangered
**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** ☒

**Environmental Baseline/Cumulative Effects (EB/CE) Summary:**
The armored snail is a small hydrobiid snail (usually less than 4 mm in length) (Thompson 1977 and Garner 2004a), with relatively little known about its life history and ecology. The armored snail is assumed to be an annual species like other similar hydrobiid species (P.D. Johnson, Alabama Department of Conservation and Natural Resources, pers. comm., 2008). The armored snail is currently only known from Limestone and Piney Creeks, Limestone County, Alabama, and appears to be most abundant in submerged root masses and bryophytes (non-vascular land plants, e.g. mosses) along the creek edges, but also may occur on rocks and leafy/woody debris, and on other aquatic macrophytes (aquatic plants) (Garner 2004a, Haggerty and Garner 2007, 2008). Haggerty and Garner (2008) collected qualitative samples during their latest status survey (August-September 2006, January 2007) in Limestone and Piney Creeks, and roughly estimated catch per unit effort, and found the armored snail in relatively good numbers if suitable habitat was present. Of the 13 Limestone Creek sites surveyed during that study, nearly 70% (n=9) had the snail present, while Piney Creek had armored snails present at 3 of the 10 (30%) sites surveyed. All sites where snails were present contained approximately 10 to 50+ individuals (Haggerty and Garner 2007) and a mean catch per unit effort of 34 individuals/hour/observer (Haggerty and Garner 2008). Haggerty and Garner (2008) expanded the number of collection locations considerably from what was reported by Garner (1993). In Limestone Creek, Haggerty and Garner (2008) found armored snails at two sites where Garner (1993) did not find it, and found six additional occupied sites not surveyed by Garner (1993); also, they discovered the snail at one additional site in Piney Creek. AST Environmental Group found a sizeable population of armored snail in Little Piney Creek at the Huntsville Browns Ferry Road crossing in 2012. Where found, the armored snail was generally described as common or abundant. The armored snail's range was extended into Little Limestone Creek in 2014 where they were found to be common on the filamentous algae mats, and they were reconfirmed there in 2017.

The armored snail continues to be in danger of extinction due to stressors occurring in its limited range and its habitat. Its range is limited to the Limestone Creek and Piney Creek watersheds, occupying approximately 15 miles (24 km) of streams in the Limestone Creek watershed and

approximately 10.5 miles (17 km) of stream in the Piney Creek watershed. Because the armored snail is geographically isolated to these watersheds, catastrophic events such as spills or natural events (e.g. drought) could greatly reduce the geographic or genetic viability of the snail. Additionally, the presence of an introduced competitor (ghost marstonia) has the potential to have substantial negative effects on armored snail populations.

Agriculture continues to affect the quality of the streams this species inhabits as evidenced by sections of the range being listed as impaired under Section 303d of the Clean Water Act. In addition, forested lands and agriculture fields are increasingly becoming converted to commercial or residential developments. Development and its associated point and non-point discharges increase within the basin as human populations continue to migrate from the surrounding cities such as Huntsville, Athens, and Decatur. Habitat destruction or modification continues to be a substantial threat to this species.

**EB/CE Source:** U. S. Fish and Wildlife Service. 2020. 5-Year Review of the Armored Snail (Marstonia pachyta). Daphne, Alabama. 26 pp.

**Overall Vulnerability:** ☒ **High** ☐ **Medium** ☐ **Low**

***RISK***
***(Risk is based on species exposure and response from labeled uses across the range)***

**Risk to individuals if exposed:** We do not anticipate effects to the species from exposure to malathion at labeled use rates.

**Risk to the species from labeled uses across the range:**
The table below summarizes the risk to the species from labeled uses across the range based on range overlaps with use sites and anticipated effects associated with the particular uses.

| ALL USES except mosquito control | |
|---|---|
| Mortality | no effects expected |
| MOSQUITO CONTROL | |
| Mortality | no effects expected |

**Risk modifiers:**

As described in the "Approach to the Effects Analysis" section of the main body of the Opinion, we made specific considerations for species that occur in bins 3 and 4 as they were modeled in such a way that likely resulted in overestimation of estimated environmental concentrations, thus overestimating potential exposure. While the Armored snail does occupy other aquatic habitats that contain higher concentrations of malathion (e.g., bin 2), individuals of the species that occupy habitats with higher flow rates (e.g., bin 3) will experience lower exposure than those occupying low flow areas, reducing the risk of effects across the species in general.

*Allowable uses driving effects/other considerations:*

The armored snail is found and appears to be most common in submerged roots, leaves, and bryophytes along the edges, submerged bryophytes growing on rocks in moderate current, and in water willow. They are also found in areas of slow to moderate flow in the submerged detritus, leaves, and tree rootlets along pool edges (Thompson 1974, FWS 1994, Haggerty and Garner 2007, 2008) (inferred from USFWS, 2009; NatureServe, 2015).

**Overall Risk: ☐ High ☐ Medium ☒ Low**

***USAGE***
***(Anticipated usage within the range based on past usage data)***

| Use type | Risk to species[1] | Use overlap with range | | Estimated usage in range[2] | | Bins associated with use type^ | Effect associated with bin (H, M, L) |
|---|---|---|---|---|---|---|---|
| | | Acres | % | Acres | % | | |
| Mosquito Control | D | 341,791 | 86.2 | 36,300 | 9.15 | 2,3 | 2L<br>3L |
| Developed | D | 34,420 | 8.68 | 1,721 | 0.43 | 2,3 | 2L<br>3L |
| Corn | D | 25,289 | 6.38 | 2,242 | 0.57 | 2,3 | 2L<br>3L |
| Cotton | D | 18,243 | 4.6 | 10,086 | 2.54 | 2,3 | 2L<br>3L |
| Wheat | D | 619 | 0.16 | 249 | 0.06 | 2,3 | 2L<br>3L |
| Other grains | D | 428 | 0.11 | 428 | 0.11 | 2,3 | 2L<br>3L |
| Other Crops | D | 401 | 0.1 | 0 | 0 | 2,3 | 2L<br>3L |
| Nurseries | D | 363 | 0.09 | 363 | 0.09 | 2,3 | 2L<br>3L |
| Vegetables & Ground Fruit | D | 59 | 0.01 | 48 | 0.01 | 2,3 | 2L<br>3L |
| Other Row Crops | D | 13 | < 0.01 | 11 | < 0.01 | 2,3 | 2L<br>3L |
| Pasture | D | 8 | < 0.01 | 7 | < 0.01 | 2,3 | 2L<br>3L |
| Orchards & Vineyards | D | 4 | < 0.01 | 4 | < 0.01 | 2,3 | 2L<br>3L |
| Christmas Trees | D | <1 | < 0.01 | <1 | < 0.01 | 2,3 | 2L<br>3L |
| **Sub-TOTAL (D):** | | 79,847 | 20.17 | 15,225 | 3.87 | | |

[1] Direct effects (D), Indirect effects (I), No effects expected (N), Use site not utilized by the species (*)
[2] Estimated usage in the range is based on information about annual past usage.

| Use type | Risk to species[1] | Use overlap with range | | Estimated usage in range[2] | | Bins associated with use type^ | Effect associated with bin (H, M, L) |
|---|---|---|---|---|---|---|---|
| | | Acres | % | Acres | % | | |
| *Other uses with direct effects*[3] | | | | | | | |
| **Sub-TOTAL (I):** *Other uses with indirect effects*[3] | | 0 | 0 | 0 | 0 | | |
| **TOTAL[4]:** | | 421,638 | 106.37 | 51,525 | 13.02 | | |

^We consider the bin 2 estimates as an upper bound of bin 3 & 4 exposures;

**# acres in species range:** 396,510 acres
**% of range in California (i.e., where CalPUR data is available):** 0%
**Range overlap with Federal lands:** 37,902 acres, 9.559%

**Overall Usage:** ☒ **High** ☐ **Medium** ☐ **Low**

***CONSERVATION MEASURES***

**Rain restriction:** Given the relatively short half-life of malathion and rapid degradation via hydrolysis and other processes, persistence of malathion in storm run-off into most aquatic habitats is not anticipated to last longer than 48 hours under typical pH values, (i.e., 6.5-8.5) and water temperatures corresponding to growing season. Restricting malathion application to periods where rain is not forecasted for at least 48 hours or when the soil is not saturated will provide time for the pesticide to degrade before runoff into aquatic habitats can occur, decreasing exposure and risk.

**Aquatic habitat buffers:** Application buffers, which specify on the label a distance from water bodies where pesticides are not to be applied, are designed to reduce spray drift from entering sensitive non-target areas, thereby providing protection to aquatic species. While the exact amount of spray drift reduction depends on the physical traits of the aquatic ecosystem (e.g., flow rate, volume, etc.) as well as the application method, we can expect (based on AgDRIFT modeling) spray drift reductions ranging from 40 to 91%, with low flow and low volume aquatic habitats receiving the most reduction in spray drift deposition. In many cases, these buffers substantially reduce exposure to aquatic organisms and subsequent risk of direct and indirect effects.

**Residential use label changes:** New restrictions to the method and frequency of application for residential use of malathion are expected to substantially reduce exposure to species that overlap with developed and open space developed areas. Label changes will ensure that residential use is limited to spot treatments only (rendering spray drift offsite unlikely) and reducing the extent of area which can be treated in the developed and open space developed areas by as much as 75% or more from modeled values. In addition, we expect the frequency of exposure to decrease as the number of allowable applications is reduced from "repeat as necessary" to a maximum of 2–

[3] Mosquito control has the potential to overlap with other uses. It is not included in the Sub-TOTALs.
[4] TOTAL includes usage on all use sites with effects, including mosquito control.

4 applications per year (depending on the specific residential use). Retreatment intervals of 7-10 days between any repeated applications are expected to reduce environmental concentrations by allowing any initial residues to degrade prior to the next application. In addition, exposure to aquatic organisms is reduced due to buffers from waterways, which specify on the label a distance from water bodies where pesticides are not to be applied, and restrictions to application during periods where rain is not forecasted within 24 hours or when the soil is not saturated.

**Reduced application number and rate:** New restrictions on corn, cotton, orchards and vineyards, pasture, other crops, and vegetables and ground fruit lower the maximum allowable number of applications to 2-4 per year (depending on the specific crop; previous allowable numbers of applications ranged from 3 to 13 applications per year). This will help reduce the amount of malathion used and decrease potential exposure to the species, thus decreasing the risk of both indirect and direct effects to the species.

---

***CONCLUSION***

After reviewing the current status of the species, the environmental baseline for the action area, the effects of the proposed registration of malathion, and the cumulative effects, it is the Service's biological opinion that the registration of malathion, as proposed, with the implementation of the general conservation measures described above, is not likely to jeopardize the continued existence of the Armored snail. As discussed below, the vulnerability is high for this species, the risk is low, and likelihood of exposure to malathion is high, however the implementation of the general conservation measures described above is expected to substantially reduce the likelihood of exposure.

The Armored snail has a high vulnerability based on its status, distribution, and trends, as described above. The armored snail is currently only known from Limestone and Piney Creeks, Limestone County, Alabama, and appears to be most abundant in submerged root masses and bryophytes (non-vascular land plants, e.g. mosses) along the creek edges, but also may occur on rocks and leafy/woody debris, and on other aquatic macrophytes (aquatic plants) (Garner 2004a, Haggerty and Garner 2007, 2008 *in* USFWS 2010). The area surrounding Limestone and Piney creeks remains heavily agricultural (e.g., cotton production, livestock, sod farming), potentially making the armored snail susceptible to pollution from agricultural pesticides and fertilizers, excessive irrigation, and sedimentation (Garner 1993, 2004b, Haggerty and Garner 2007 *in* USFWS 2010).

The risk to the species from labeled uses across the range is expected to be low as we do not anticipate any measurable effects from malathion exposure to individuals, including mortality or sublethal effects to growth, reproduction, or behavior. There may be potential effects to the species' food base (e.g., algae, plants, detritus), however these effects are expected to be small and will not likely result in adverse effects to snails.

We anticipate usage within the range will be high (13.02%), based primarily on the standard usage data we acquired, as described in the Opinion, and summarized for this species above. However, despite the high usage rate, we do not expect any effects to the species will occur at the environmental concentrations of malathion that will result from labeled uses due to the high tolerance that snails exhibit towards malathion. Furthermore, conservation measures, such as rain restrictions, aquatic habitat buffers, residential use label changes, and reductions in the number of applications and application rates allowed, are expected to substantially reduce the environmental concentrations of malathion, decreasing the likelihood of exposure.

Due to the lack of measurable effects to individuals, including mortality and sublethal effects, the lack of appreciable effects to its food base and habitat, and the incorporation of conservation measures that would further reduce the risk of exposure, we anticipate minimal, if any, adverse effects (i.e., not enough to result in take) will occur throughout the duration of the action. Therefore, we anticipate that the proposed action would not appreciably reduce survival and recovery of the Armored snail in the wild.

**Conclusion:** Not likely to jeopardize

***ADDITIONAL REFERENCES***

U. S. Fish and Wildlife Service. 2020. 5-Year Review of the Armored Snail (Marstonia pachyta). Daphne, Alabama. 26 pp.

**Integration and Synthesis Summary: Snails *(Aquatic)***

| Scientific Name: | Common Name: | Entity ID: |
|---|---|---|
| *Tryonia alamosae* | Alamosa springsnail | 403 |

***VULNERABILITY***
***(Summary of status, environmental baseline and cumulative effects)***

**Status:** Endangered
**Distribution:** Small, endemic, constrained, and/or isolated population(s)
**Number of Populations:** Single population
**Species Trends:** Unknown population trends; some populations increasing, others unchanged.
**Pesticides noted** ☐

**Environmental Baseline/Cumulative Effects (EB/CE) Summary:**
The Alamosa springsnail is a rare, hydrobiid snail endemic to a wetland complex of Ojo Caliente, a thermal spring located within Alamosa Creek Canyon in southwestern Socorro County, New Mexico. Alamosa springsnails are only known to occur upstream of Monticello Box in Alamosa Creek. Upstream from Monticello Box, the species did not occur in colder, more thermally variable waters of the perennial channel of Alamosa Creek, or in intermittent flows along the south stream bank. On November 16, 2016, the Service visited the Ojo Caliente site with the New Mexico Department of Game and Fish (NMDGF) and discovered that only a few Alamosa springsnails were present. Locals report that a large flood event occurred on November 4, 2016. This event may have scoured, inundated, and deposited sediment into Ojo Caliente, adversely affecting the springsnails there. The springsnails in the thermal springs about 800 meters to the west appears unaffected from the flood event. On 21 December 2016, the Service and NMDGF revisited all sites to initiate monitoring. Springsnails appear to be slowly increasing in numbers at Ojo Caliente and unchanged in the western thermal springs. Population numbers appear to be rebounding to historic levels after a reported flood event.

A habitat management plan has not been written for the species, as directed by the recovery plan. Translocation to other springs, a criterion for delisting, may not be a viable option. Surveys are being conducted infrequently so difficulties will continue in regards to assessing the status of the species. If the effects of climate change include widespread drought, decreased spring discharge, or a change in water chemistry, it would be considered a newly recognized threat that could eliminate the species. Any conditions that would lessen the flow of water from the springs would threaten the species, which are dependent upon continuous surface flows. Under the present system of use in the spring complex that contains the species, water is allowed to flow from the springs through a canyon and then diverted for irrigation use. The snail populations are secure under this system of use. However, should changes occur to this system, and as a result the flow from the springs diminish, or stop, the snails would suffer. These springs are the water supply for agriculture and villages downstream near Monticello, New Mexico. Possible future development of the springs to maximize water supply is a potential threat. The springs in which the species

occurs are used by people for bathing. Channel modifications to make pools have destroyed snail habitat and caused erosion.

**EB/CE Sources:** U.S. Fish and Wildlife Service. 1991. Final Rule to List the Alamosa Springsnail and the Socorro Springsnail as Endangered. 56 FR 49646 49649.

U.S. Fish and Wildlife Service. 2018. Alamosa springsnail (*Tyronia alamosae*) 5-Year Review: Summary and Evaluation. New Mexico Ecological Services Field Office, Albuquerque. 22 pp.

**Overall Vulnerability:** ☒ **High** ☐ **Medium** ☐ **Low**

***RISK***
***(Risk is based on species exposure and response from labeled uses across the range)***

**Risk to individuals if exposed:** We do not anticipate effects to the species from exposure to malathion at labeled use rates.

**Risk to the species from labeled uses across the range:**
The table below summarizes the risk to the species from labeled uses across the range based on range overlaps with use sites and anticipated effects associated with the particular uses.

| ALL USES except mosquito control | |
|---|---|
| Mortality | no effects expected |
| MOSQUITO CONTROL | |
| Mortality | no effects expected |

**Risk modifiers:** The Alamosa springsnail is endemic to central New Mexico. The species is known only from a thermal spring complex in Socorro County, New Mexico. The spring complex consists of five individual springheads that flow together. The species also occurs in minor rivulets out of the main channel in the canyon where the springs arise (Taylor 1987) (USFWS, 1994).

**Overall Risk:** ☐ **High** ☐ **Medium** ☒ **Low**

***USAGE***
***(Anticipated usage within the range based on past usage data)***

| Use type | Risk to species[1] | Use overlap with range | | Estimated usage in range[2] | | Bins associated with use type^ | Effect associated with bin (H, M, L) |
|---|---|---|---|---|---|---|---|
| | | Acres | % | Acres | % | | |
| Mosquito Control | D | 2,393,192 | 43.8 | 0 | 0 | 2 | 2L |
| Pasture | D | 7,030 | 0.13 | 5,016 | 0.09 | 2 | 2L |
| Developed | D | 5647 | 0.1 | 282 | < 0.01 | 2 | 2L |
| Orchards & Vineyards | D | 488 | < 0.01 | 488 | < 0.01 | 2 | 2L |
| Vegetables & Ground Fruit | D | 201 | < 0.01 | 196 | < 0.01 | 2 | 2L |
| Other Crops | D | 126 | < 0.01 | 0 | < 0.01 | 2 | 2L |
| Corn | D | 111 | < 0.01 | 111 | < 0.01 | 2 | 2L |
| Wheat | D | 109 | < 0.01 | 62 | < 0.01 | 2 | 2L |
| Other Grains | D | 105 | < 0.01 | 105 | < 0.01 | 2 | 2L |
| Cotton | D | 11 | < 0.01 | 4 | < 0.01 | 2 | 2L |
| Nurseries | D | 2 | < 0.01 | 2 | < 0.01 | 2 | 2L |
| **Sub-TOTAL (D):** *Other uses with direct effects*[3] | | 13,830 | 0.25 | 6,266 | 0.18 | | |
| **Sub-TOTAL (I):** *Other uses with indirect effects*[3] | | 0 | 0 | 0 | 0 | | |
| **TOTAL[4]:** | | 2,407,022 | 46.9 | 6,266 | 0.18 | | |

^ Species only found in bin 2.

**# acres in species range:** 5,466,545 acres
**% of range in California (i.e., where CalPUR data is available):** 0%
**Range overlap with Federal lands:** 2,715,543 acres, 49.68%

**Overall Usage:** ☐ **High** ☐ **Medium** ☒ **Low**

***CONSERVATION MEASURES***

**Rain restriction:** Given the relatively short half-life of malathion and rapid degradation via hydrolysis and other processes, persistence of malathion in storm run-off into most aquatic habitats is not anticipated to last longer than 48 hours under typical pH values, (i.e., 6.5-8.5) and water temperatures corresponding to growing season. Restricting malathion application to periods where rain is not forecasted for at least 48 hours or when the soil is not saturated will

[1] Direct effects (D), Indirect effects (I), No effects expected (N), Use site not utilized by the species (*)
[2] Estimated usage in the range is based on information about annual past usage.
[3] Mosquito control has the potential to overlap with other uses. It is not included in the Sub-TOTALs.
[4] TOTAL includes usage on all use sites with effects, including mosquito control.

provide time for the pesticide to degrade before runoff into aquatic habitats can occur, decreasing exposure and risk.

**Aquatic habitat buffers:** Application buffers, which specify on the label a distance from water bodies where pesticides are not to be applied, are designed to reduce spray drift from entering sensitive non-target areas, thereby providing protection to aquatic species. While the exact amount of spray drift reduction depends on the physical traits of the aquatic ecosystem (e.g., flow rate, volume, etc.) as well as the application method, we can expect (based on AgDRIFT modeling) spray drift reductions ranging from 40 to 91%, with low flow and low volume aquatic habitats receiving the most reduction in spray drift deposition. In many cases, these buffers substantially reduce exposure to aquatic organisms and subsequent risk of direct and indirect effects.

---

***CONCLUSION***

After reviewing the current status of the species, the environmental baseline for the action area, the effects of the proposed registration of malathion, and the cumulative effects, it is the Service's biological opinion that the registration of malathion, as proposed, with the implementation of the general conservation measures described above, is not likely to jeopardize the continued existence of the Alamosa springsnail. As discussed below, the vulnerability is high for this species, the risk and likelihood of exposure to malathion is low, and the implementation of the general conservation measures described above is expected to further reduce the likelihood of exposure.

The Alamosa springsnail has a high vulnerability based on its status, distribution, and trends, as described above. The species is known only from a thermal spring complex in Socorro County. The spring complex consists of five individual springheads that flow together.

The risk to the species from labeled uses across the range is expected to be low as we do not anticipate any measurable effects from malathion exposure to individuals, including mortality or sublethal effects to growth, reproduction, or behavior. There may be potential effects to the species' food base (e.g., algae, plants, detritus), however these effects are expected to be small and will not likely result in adverse effects to snails.

However, we anticipate usage within the range will be low (0.18%), based primarily on the standard usage data we acquired, as described in the Opinion, and summarized for this species above. About 50% of the range overlaps with Federal lands where any adverse effects are expected to be minimal, considering the small scale and low levels of past malathion usage on Federal lands, and in light of Federal agency programs that are designed to understand, avoid, and minimize the effects to listed species (see the Approach to Usage section of the Opinion). Furthermore, conservation measures, such as rain restrictions and aquatic habitat buffers, would substantially decrease the environmental concentration of malathion in the species' range, reducing the likelihood of exposure.

Due to the lack of measurable effects to individuals, including mortality and sublethal effects, the lack of appreciable effects to its food base and habitat, the low rate of expected usage, and the incorporation of conservation measures that would further reduce the risk of exposure, we anticipate minimal, if any, adverse effects (i.e., not enough to result in take) will occur throughout the duration of the action. Therefore, we do not anticipate that the proposed action would appreciably reduce survival and recovery of the Alamosa springsnail in the wild.

**Conclusion:** Not likely to jeopardize

**Integration and Synthesis Summary: Snails *(Aquatic)***

| Scientific Name: | Common Name: | Entity ID: |
|---|---|---|
| *Pyrgulopsis bruneauensis* | Bruneau Hot springsnail | 404 |

***VULNERABILITY***
***(Summary of status, environmental baseline and cumulative effects)***

**Status:** Endangered
**Distribution:** Small, endemic, constrained, and/or isolated population(s)
**Number of Populations:** Single population
**Species Trends:** Declining population(s) – one or more populations declining
**Pesticides noted** ☐

**Environmental Baseline/Cumulative Effects (EB/CE) Summary:**
The tiny Bruneau hot springsnail (Pyrgulopsis bruneauensis) is about 2 millimeters in size, and is only found in geothermal springs and seeps along an 8-kilometer length of the Bruneau River in Southwest Idaho. It prefers wetted rock faces of springs and flowing water, with large cobbles and boulders. Using data from 2007-2017, populations of springsnails declined further than was reported in the 2007 5-Year Review due to an increase in loss and fragmentation of geothermal spring habitat. Since 2007, the total number of hot springs detected range-wide has decreased by 45 percent. Of the 72 springs recorded in 2017, only 25 percent were occupied by springsnails. The general trend in densities has also declined, with colonies exhibiting medium densities declining by 50 percent (from six to three). One colony was categorized as high density in 2017, while no high density colonies were detected in 2007. High density colonies have always been of low abundance, never exceeding three since 2007. In 2009, Bruneau hot springsnails were collected from six sites from both Hot Creek and the Bruneau River and analyzed for genetic differences (Hershler and Liu 2010, entire). Based on the results, the springsnail populations were found to be genetically diverse and consisted of two distinct groups. Some of this decline is attributable to the disappearance of the upper most geothermal springs along the west side of the Bruneau River that were last detected and measured in 2014. The loss of these springs represent a 300 m (5%) constriction of the species' total range. While the number of springs in the downstream portion of the species' range has also declined (58 %), the extent of the downstream range has remained the same since the last 5-year review.

At the time of listing, threats to Bruneau hot springsnails were identified as groundwater withdrawal and springflow reduction; livestock grazing; surface water diversion; recreation; over collection; predation from introduced fishes; inadequate state regulations; and flash flood sedimentation (Hot Creek). Since the last 5-year review, overcollection and flash flood sedimentation are no longer considered threats. The principal threat to the Bruneau hot springsnail is the reduction and/or elimination of its geothermal habitats as a result of groundwater withdrawal, primarily for agriculture. Spring temperatures are the predominant factor that determines the springsnail's distribution and abundance; the springsnail requires

constant springwater temperatures to survive. In particular, groundwater levels are not stable or increasing and there is a decline in the number of geothermal springs occupied by the springsnail. Bruneau hot springsnail populations show declining trends, and connectivity between the remaining colonies has been reduced. Current conservation measures are falling short of addressing the highest-ranking threats to the species. Conservation actions include efforts to increase and stabilize geothermal water levels. These actions might include: voluntary conservation easements (lease/purchase water rights), irrigation system improvements to reduce agricultural water use, continued monitoring of water levels and snail distribution, control of non-native fish known to prey upon the springsnail, and establishment of regulatory measures that are adequate to permanently protect the springsnail from future groundwater reductions. Since the time of listing, review of the data demonstrate continued threats and substantial reduction in the number and total habitat area of geothermal springs and seeps upon which the species depends.

**EB/CE Source:** U. S. Fish and Wildlife Service. 2018. Bruneau hot springsnail (*Pyrgulopsis bruneauensis*) 5-Year Review Summary and Evaluation. Boise, Idaho. 25 pp.

**Overall Vulnerability:** ☒ **High** ☐ **Medium** ☐ **Low**

***RISK***
***(Risk is based on species exposure and response from labeled uses across the range)***

**Risk to individuals if exposed:** We do not anticipate effects to the species from exposure to malathion at labeled use rates.

**Risk to the species from labeled uses across the range:**
The table below summarizes the risk to the species from labeled uses across the range based on range overlaps with use sites and anticipated effects associated with the particular uses.

| ALL USES except mosquito control | |
|---|---|
| Mortality | no effects expected |
| MOSQUITO CONTROL | |
| Mortality | no effects expected |

**Risk modifiers:**

As described in the "Approach to the Effects Analysis" section of the main body of the Opinion, we made specific considerations for species that occur in bins 3 and 4 as they were modeled in such a way that likely resulted in overestimation of estimated environmental concentrations, thus overestimating potential exposure. While the Bruneau Hot springsnail does occupy other aquatic habitats that contain higher concentrations of malathion (e.g., bin 2), individuals of the species that occupy habitats with higher flow rates (e.g., bins 3 and 4) will experience lower exposure than those occupying low flow areas, reducing the risk of effects across the species in general.

*Allowable uses driving effects/other considerations:* The Bruneau hot springsnail is restricted to thermal springs and seeps and thermally-influenced portions of the river along a 9 km (5.5 mi) segment of the Bruneau River in southwest Idaho. The Bruneau hot springsnail currently occurs in geothermal springs on both the east and west sides of the Bruneau River with a distribution extending 4.4 km (2.73 mi) downstream of the confluence of Hot Creek and the Bruneau River, and 4.4 km (2.73 mi) upstream from the confluence of Hot Creek and within the Bruneau River with sufficient geothermal influence (Mladenka 1992, p. 68). The species can be found in a variety of habitat types including sands and fine sediments, cobble and boulder, and aquatic vegetation, but is restricted to waters ranging from 11°-35° C (52°-95° F) (Mladenka 1992, pg. 85) (USFWS, 2016).

**Overall Risk: ☐ High ☐ Medium ☒ Low**

***USAGE***
***(Anticipated usage within the range based on past usage data)***

| Use type | Risk to species[1] | Use overlap with range | | Estimated usage in range[2] | | Bins associated with use type^ | Effect associated with bin (H, M, L) |
|---|---|---|---|---|---|---|---|
| | | Acres | % | Acres | % | | |
| Mosquito Control | * | - | - | - | - | - | - |
| Other Crops | D | 144 | 0.16 | 0 | 0 | 2,3,4 | 2L<br>3L<br>4L |
| Other Row Crops | D | 25 | 0.03 | 25 | 0.03 | 2,3,4 | 2L<br>3L<br>4L |
| Other Grains | D | 51 | 0.06 | 22 | 0.02 | 2,3,4 | 2L<br>3L<br>4L |
| Corn | D | 241 | 0.27 | 241 | 0.27 | 2,3,4 | 2L<br>3L<br>4L |
| Developed | D | 48 | 0.05 | 2 | < 0.01 | 2,3,4 | 2L<br>3L<br>4L |
| Wheat | D | 1,040 | 1.19 | 1,040 | 1.19 | 2,3,4 | 2L<br>3L<br>4L |
| Vegetables & Ground Fruit | D | 33 | 0.04 | 33 | 0.04 | 2,3,4 | 2L<br>3L<br>4L |

[1] Direct effects (D), Indirect effects (I), No effects expected (N), Use site not utilized by the species (*)
[2] Estimated usage in the range is based on information about annual past usage.

| Use type | Risk to species[1] | Use overlap with range | | Estimated usage in range[2] | | Bins associated with use type^ | Effect associated with bin (H, M, L) |
|---|---|---|---|---|---|---|---|
| | | Acres | % | Acres | % | | |
| Orchards & Vineyards | D | <1 | < 0.01 | <1 | < 0.01 | 2,3,4 | 2L<br>3L<br>4L |
| Pasture | D | 972 | 1.11 | 958 | 1.09 | 2,3,4 | 2L<br>3L<br>4L |
| **Sub-TOTAL (D):** *Other uses with direct effects*[3] | | 2,554 | 2.92 | 2,321 | 2.64 | | |
| **Sub-TOTAL (I):** *Other uses with indirect effects*[3] | | 0 | 0 | 0 | 0 | | |
| **TOTAL[4]:** | | 2,554 | 2.92 | 2,321 | 2.64 | | |

^We consider the bin 2 estimates as an upper bound of bin 3 & 4 exposures.

**# acres in species range:** 87,717 acres
**% of range in California (i.e., where CalPUR data is available):** 0%
**Range overlap with Federal lands:** 78,742 acres, 89.769%

**Overall Usage:** ☐ **High** ☐ **Medium** ☒ **Low**

***CONSERVATION MEASURES***

**Rain restriction:** Given the relatively short half-life of malathion and rapid degradation via hydrolysis and other processes, persistence of malathion in storm run-off into most aquatic habitats is not anticipated to last longer than 48 hours under typical pH values, (i.e., 6.5-8.5) and water temperatures corresponding to growing season. Restricting malathion application to periods where rain is not forecasted for at least 48 hours or when the soil is not saturated will provide time for the pesticide to degrade before runoff into aquatic habitats can occur, decreasing exposure and risk.

**Aquatic habitat buffers:** Application buffers, which specify on the label a distance from water bodies where pesticides are not to be applied, are designed to reduce spray drift from entering sensitive non-target areas, thereby providing protection to aquatic species. While the exact amount of spray drift reduction depends on the physical traits of the aquatic ecosystem (e.g., flow rate, volume, etc.) as well as the application method, we can expect (based on AgDRIFT modeling) spray drift reductions ranging from 40 to 91%, with low flow and low volume aquatic habitats receiving the most reduction in spray drift deposition. In many cases, these buffers substantially reduce exposure to aquatic organisms and subsequent risk of direct and indirect effects.

[3] Mosquito control has the potential to overlap with other uses. It is not included in the Sub-TOTALs.
[4] TOTAL includes usage on all use sites with effects, including mosquito control.

**Reduced application number and rate:** New restrictions on corn, cotton, orchards and vineyards, pasture, other crops, and vegetables and ground fruit lower the maximum allowable number of applications to 2-4 per year (depending on the specific crop; previous allowable numbers of applications ranged from 3 to 13 applications per year). This will help reduce the amount of malathion used and decrease potential exposure to the species, thus decreasing the risk of both indirect and direct effects to the species.

***CONCLUSION***

After reviewing the current status of the species, the environmental baseline for the action area, the effects of the proposed registration of malathion, and the cumulative effects, it is the Service's biological opinion that the registration of malathion, as proposed, with the implementation of the general conservation measures described above, is not likely to jeopardize the continued existence of the Bruneau Hot springsnail. As discussed below, the vulnerability is high for this species, the risk and likelihood of exposure to malathion is low, and the implementation of the general conservation measures described above is expected to further reduce the likelihood of exposure.

The Bruneau Hot springsnail has a high vulnerability based on its status, distribution, and trends, as described above. The tiny Bruneau hot springsnail (Pyrgulopsis bruneauensis) is about 2 millimeters in size, and is only found in geothermal springs and seeps along an 8-kilometer length of the Bruneau River in Southwest Idaho.

The risk to the species from labeled uses across the range is expected to be low as we do not anticipate any measurable effects from malathion exposure to individuals, including mortality or sublethal effects to growth, reproduction, or behavior. There may be potential effects to the species' food base (e.g., algae, plants, detritus), however these effects are expected to be small and will not likely result in adverse effects to snails.

About 90% of the species range is on Federal lands where we expect any adverse effects would be minimal, considering the small scale and low levels of past malathion usage on Federal lands, and in light of Federal agency programs that are designed to understand, avoid, and minimize the effects to listed species (see the Approach to Usage section of the Opinion). We anticipate usage within the range and outside boundaries of Federal lands will be low (2.64%, expected to occur on the non-Federal portion), based primarily on the standard usage data we acquired, as described in the Opinion, and summarized for this species above. Additionally, conservation measures, such as rain restrictions, aquatic habitat buffers, and reduced allowable application number and rates, are expected to substantially decrease the environmental concentration of malathion within the species' range, further reducing the risk of exposure.

Due to the lack of measurable effects to individuals, including mortality and sublethal effects, the lack of appreciable effects to its food base and habitat, the low level of expected usage, and the incorporation of conservation measures that would further reduce the risk of exposure, we

anticipate minimal, if any, adverse effects (i.e., not enough to result in take) will occur throughout the duration of the action. Therefore, we do not anticipate that the proposed action would appreciably reduce survival and recovery of the Bruneau Hot springsnail in the wild.

**Conclusion:** Not likely to jeopardize

**Integration and Synthesis Summary: Snails *(Aquatic)***

| Scientific Name: | Common Name: | Entity ID: |
|---|---|---|
| *Antrobia culveri* | Tumbling Creek cavesnail | 406 |

***VULNERABILITY***
***(Summary of status, environmental baseline and cumulative effects)***

**Status:** Endangered
**Distribution:** Small, endemic, constrained, and/or isolated population(s)
**Number of Populations:** Single population
**Species Trends:** Declining population(s) – one or more populations declining
**Pesticides noted** ☐

**Environmental Baseline/Cumulative Effects (EB/CE) Summary:**
The Tumbling Creek cavesnail (Antrobia culveri) is restricted to a single cave stream in Tumbling Creek Cave in Taney County, southwestern Missouri. The number of cavesnails has significantly decreased over the past few decades, to the point where only one individual was found within survey areas between January 11, 2001 and April 22, 2003. A small population containing approximately 40 individuals exists in a small area upstream of the area that is regularly surveyed. Based on the decline of the Tumbling Creek cavesnail, it was listed as endangered in 2002. Tumbling Creek cavesnail lives on the underside of rocks in areas of Tumbling Creek that have little or no silt. Not much is known about the species and its life history, but it is believed to feed on microscopic animals in the stream. Although the primary limiting factor appears to be decreased water quality due to increased erosion and pollution in the cave's recharge area, scientific research is needed to confirm this hypothesis. The species is on the verge of extinction with only a few individuals being documented during the last 25 surveys conducted between January 11, 2001 and April 22, 2003. Since the completion of the recovery plan in 2003 (U.S. Fish and Wildlife Service 2003), population numbers of *Antrobia culveri* have remained precariously low (i.e., ~ 35 individuals: ~ 30 in refugium area and no more than 5 in the transect area since 2007: Ashley, pers. comm. 25 Sep. 2013) and there is insufficient data to attempt any characterization of any demographic parameters, trends, or basic life history requirements. There have been no new study results regarding the life history requirements of this species since the recovery plan was completed in 2003.

The Tumbling Creek cavesnail is likely threatened by habitat degradation through diminished water quality from upstream locations within the unprotected or improperly managed areas within the cave's delineated recharge zone. As of the last 5-year review in 2018, habitat conditions for *Antrobia culveri* within Tumbling Creek have apparently remained stable or improved. It is not known how the cave's ecosystem will be impacted by climate change. Due to the numerous recovery actions undertaken on surface areas within the recharge area of Tumbling Creek Cave, current sediment levels have lowered and dissolve oxygen levels have remained stable (Tom Aley, Ozark Underground Laboratory, pers. comm. Aug. 26, 2013). New

information has come to light regarding threat of predation by the invasive Ringed Crayfish on *Antrobia culveri* and the indirect effects of adverse impacts of a rapidly spreading disease called White-Nose Syndrome (WNS) that has resulted in the death of millions of bats. These invasive crayfish may be entering Tumbling Creek Cave via the movement of individuals from Bull Shoals Reservoir to Big Creek and then habitat occupied by the cavesnail within the cave, especially during periods of excessive rainfall when water in the reservoir backs up and facilitates the emigration of crayfish upstream. The causative agent of WNS is a recently described fungus [Pseudogymnoascus destructans (formerly Geomyces destructans)]. Potential deaths of gray bats from WNS could adversely impact the energy input and resulting indirect food source for the cavesnail.

**EB/CE Sources:** U.S. Fish and Wildlife Service. 2003. Tumbling Creek Cavesnail Recovery Plan (Antrobia culveri). U.S. Fish and Wildlife Service, Ft. Snelling, Minnesota. 97 pp.

U.S. Fish and Wildlife Service. 2014. Tumbling Creek Cavesnail 5-Year Review: Summary and Evaluation. Columbia, Missouri Ecological Services Field Office. 25 pp.

**Overall Vulnerability: ☒ High ☐ Medium ☐ Low**

***RISK***
***(Risk is based on species exposure and response from labeled uses across the range)***

**Risk to individuals if exposed:** We do not anticipate effects to the species from exposure to malathion at labeled use rates.

**Risk to the species from labeled uses across the range:**
The table below summarizes the risk to the species from labeled uses across the range based on range overlaps with use sites and anticipated effects associated with the particular uses.

| ALL USES except mosquito control | |
|---|---|
| Mortality | no effects expected |
| MOSQUITO CONTROL | |
| Mortality | no effects expected |

**Risk modifiers:** Greenlee (1974) reported that the species was found primarily on "3-inch gravel substrate", with a few individuals observed using the recesses of a solid rock stream bottom. The species is usually observed on the undersurface of rocks and gravel of various sizes (Ashley unpub. data; McKenzie in litt., September 16, 1996; Ashley and McKenzie, pers. obs.). Although Greenlee (1974) stated that the Tumbling Creek cavesnail was absent from areas of the stream that contained bat guano, subsequent observers (Ashley 2001a; Ashley and McKenzie, pers. obs.) have noted it in portions of Tumbling Creek where bat guano occurs.

**Overall Risk: ☐ High ☐ Medium ☒ Low**

***USAGE***
***(Anticipated usage within the range based on past usage data)***

| Use type | Risk to species[1] | Use overlap with range | | Estimated usage in range[2] | | Bins associated with use type^ | Effect associated with bin (H, M, L) |
|---|---|---|---|---|---|---|---|
| | | Acres | % | Acres | % | | |
| Mosquito Control | D | 0 | 0 | 0 | 0 | 2 | - |
| Developed | D | 14,276 | 2.08 | 714 | 0.10 | 2 | 2L |
| Wheat | D | 195 | 0.03 | 64 | < 0.01 | 2 | 2L |
| Corn | D | 141 | 0.02 | 53 | < 0.01 | 2 | 2L |
| Other Crops | D | 15 | < 0.01 | 0 | 0 | 2 | 2L |
| Nurseries | D | 15 | < 0.01 | 15 | < 0.01 | 2 | 2L |
| Pasture | D | 9 | < 0.01 | 10 | < 0.01 | 2 | 2L |
| Orchards & Vineyards | D | 1 | < 0.01 | 1 | < 0.01 | 2 | 2L |
| Other Grains | D | <1 | < 0.01 | <1 | < 0.01 | 2 | 2L |
| Other Row Crops | D | <1 | < 0.01 | <1 | < 0.01 | 2 | 2L |
| **Sub-TOTAL (D):** *Other uses with direct effects*[3] | | 14,654 | 2.19 | 857 | 0.16 | | |
| **Sub-TOTAL (I):** *Other uses with indirect effects*[3] | | 0 | 0 | 0 | 0 | | |
| **TOTAL[4]:** | | 14,654 | 2.19 | 857 | 0.16 | | |

^Species only found in bin 2.

**# acres in species range:** 685,983 acres
**% of range in California (i.e., where CalPUR data is available):** 0%
**Range overlap with Federal lands:** 197,042 acres, 28.724%

**Overall Usage:** ☐ **High** ☐ **Medium** ☒ **Low**

***CONSERVATION MEASURES***

**Rain restriction:** Given the relatively short half-life of malathion and rapid degradation via hydrolysis and other processes, persistence of malathion in storm run-off into most aquatic habitats is not anticipated to last longer than 48 hours under typical pH values, (i.e., 6.5-8.5) and water temperatures corresponding to growing season. Restricting malathion application to periods where rain is not forecasted for at least 48 hours or when the soil is not saturated will provide time for the pesticide to degrade before runoff into aquatic habitats can occur, decreasing exposure and risk.

[1] Direct effects (D), Indirect effects (I), No effects expected (N), Use site not utilized by the species (*)
[2] Estimated usage in the range is based on information about annual past usage.
[3] Mosquito control has the potential to overlap with other uses. It is not included in the Sub-TOTALs.
[4] TOTAL includes usage on all use sites with effects, including mosquito control.

**Aquatic habitat buffers:** Application buffers, which specify on the label a distance from water bodies where pesticides are not to be applied, are designed to reduce spray drift from entering sensitive non-target areas, thereby providing protection to aquatic species. While the exact amount of spray drift reduction depends on the physical traits of the aquatic ecosystem (e.g., flow rate, volume, etc.) as well as the application method, we can expect (based on AgDRIFT modeling) spray drift reductions ranging from 40 to 91%, with low flow and low volume aquatic habitats receiving the most reduction in spray drift deposition. In many cases, these buffers substantially reduce exposure to aquatic organisms and subsequent risk of direct and indirect effects.

**Residential use label changes:** New restrictions to the method and frequency of application for residential use of malathion are expected to substantially reduce exposure to species that overlap with developed and open space developed areas. Label changes will ensure that residential use is limited to spot treatments only (rendering spray drift offsite unlikely) and reducing the extent of area which can be treated in the developed and open space developed areas by as much as 75% or more from modeled values. In addition, we expect the frequency of exposure to decrease as the number of allowable applications is reduced from "repeat as necessary" to a maximum of 2–4 applications per year (depending on the specific residential use). Retreatment intervals of 7-10 days between any repeated applications are expected to reduce environmental concentrations by allowing any initial residues to degrade prior to the next application. In addition, exposure to aquatic organisms is reduced due to buffers from waterways, which specify on the label a distance from water bodies where pesticides are not to be applied, and restrictions to application during periods where rain is not forecasted within 24 hours or when the soil is not saturated.

---

***CONCLUSION***

After reviewing the current status of the species, the environmental baseline for the action area, the effects of the proposed registration of malathion, and the cumulative effects, it is the Service's biological opinion that the registration of malathion, as proposed, with the implementation of the general conservation measures described above, is not likely to jeopardize the continued existence of the Tumbling Creek cavesnail. As discussed below, the vulnerability is high for this species, the risk and likelihood of exposure to malathion is low, and the implementation of the general conservation measures described above is expected to further reduce the likelihood of exposure.

The Tumbling Creek cavesnail has a high vulnerability based on its status, distribution, and trends, as described above. The Tumbling Creek cavesnail is restricted to a single cave stream in Tumbling Creek Cave in Taney County, southwestern Missouri. (USFWS 2003)

The risk to the species from labeled uses across the range is expected to be low as we do not anticipate any measurable effects from malathion exposure to individuals, including mortality or sublethal effects to growth, reproduction, or behavior. There may be potential effects to the species' food base (e.g., algae, plants, detritus), however these effects are expected to be small and will not likely result in adverse effects to snails.

About 29% of the species range is on Federal lands where we expect any adverse effects would be minimal, considering the small scale and low levels of past malathion usage on Federal lands, and in light of Federal agency programs that are designed to understand, avoid, and minimize the effects to listed species (see the Approach to Usage section of the Opinion). We anticipate usage within the range will be low (0.18%, expected to occur on the non-Federal portion), based primarily on the standard usage data we acquired, as described in the Opinion, and summarized for this species above. Additionally, conservation measures, such as rain restrictions, aquatic habitat buffers, and changes to residential use labels, are expected to substantially reduce environmental concentrations of malathion in the species' range, reducing the likelihood of exposure.

Due to the lack of measurable effects to individuals, including mortality and sublethal effects, the lack of appreciable effects to its food base and habitat, the low level of expected usage, and the incorporation of conservation measures that would further reduce the risk of exposure, we anticipate minimal, if any, adverse effects (i.e., not enough to result in take) will occur throughout the duration of the action. Therefore, we do not anticipate that the proposed action would appreciably reduce survival and recovery of the Tumbling Creek cavesnail in the wild.

**Conclusion:** Not likely to jeopardize

***ADDITIONAL REFERENCES***

U.S. Fish and Wildlife Service. 2003. Tumbling Creek Cavesnail Recovery Plan (Antrobia culveri). U.S. Fish and Wildlife Service, Ft. Snelling, Minnesota. 97 pages.

**Integration and Synthesis Summary: Snails *(Aquatic)***

| Scientific Name: | Common Name: | Entity ID: |
|---|---|---|
| *Tulotoma magnifica* | Tulotoma snail | 407 |

***VULNERABILITY***
***(Summary of status, environmental baseline and cumulative effects)***

**Status:** Threatened
**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** ☐

**Environmental Baseline/Cumulative Effects (EB/CE) Summary:**
The tulotoma snail is a gill-breathing, operculate snail in the family Viviparidae. The shell is spherical and can reach a size somewhat larger than a golf ball, and is typically ornamented with spiral lines of knoblike structures. They produce live-born offspring year round, but reproduction peaks during the months of May to July and at sizes of about 3 to 5 mm height of last whorl. They grow rapidly during their first year reaching sizes of 11 to 14 mm. Females produce an average of 16 offspring in their second year. Those females that live beyond their second year, grow more slowly and produce an average of 28 juveniles per year. In the lower Coosa River, it was observed that few tulotoma survived longer than 2 years of life. Tulotoma populations have been recorded in nine stream reaches within the Coosa and Alabama River drainages including the Coosa River, Ohatchee Creek, Choccolocco Creek, Kelly Creek, Yellowleaf Creak, Weogufka Creek, Hatchet Creek, Weoka Creek, and the Alabama River. The Coosa River, Choccolocco Creek, Kelly Creek, Hatchet Creek, Yellowleaf Creek, and Alabama River populations are robust. The Weogufka and Weoka Creek populations were healthy at the time of the previous 5-year review but extensive surveys have not been conducted for over 10 years so their status cannot be confidently assessed. It is believed to be extirpated from the Ohatchee Creek. Where the tulotoma is found, it continues to be highly localized and isolated. Tulotoma occur in cool, well-oxygenated, clean, free-flowing streams, including rivers and the lower portions of the rivers' larger tributaries. This species is generally found in shoals and riffles with moderate to strong currents. Although this species is typically associated with shoals and riffles, it inhabits rivers that rise and fall, and tulotoma have been collected at depths more than 5 m. The species is strongly associated with boulder, cobble, and bedrock stream bottoms and is generally found clinging tightly to the underside of large rocks or between cracks in bedrock. Historical habitats included large coastal plain rivers, large high-gradient rivers, and multiple upland tributary streams.

The 2019 5-year review of the status of tulotoma documented an improvement for one population (below Jordan Dan) through a beneficial discharge regime. However, tributary populations continue to be isolated and vulnerable to nonpoint source pollution from agriculture,

urbanization, and general construction activities, and to natural or manmade catastrophic events. While a management plan is in existence for the Lower Coosa Basin, there are no management or monitoring plans for tributary populations.

Habitat-related threats have been addressed in the Coosa River through establishing minimum flows or pulsing flows below Jordan and Logan Martin Dam, respectively. Habitat conditions have improved; occupied habitat has expanded in the Coosa River below Jordan Dam; and tulotoma numbers are now estimated at greater than 100 million individuals. The ranges of tulotoma populations in Kelly, Weogufka, and Hatchet Creek have expanded 2- to 5-fold since listing. Tulotoma colony densities within these populations have remained stable or increased. While a program to address nonpoint source pollution in the Coosa and Alabama Rivers and their tributaries has been established by the Alabama Clean Water Partnership and the Alabama Department of Environmental Management, the tulotoma isolated populations continue to remain vulnerable to changes in water quality, land use runoff, toxic spills, as well as floods and droughts.

**EB/CE Source:** U.S. Fish and Wildlife Service. 2019. Tulotoma Snail (*Tulotoma magnifica*) 5-Year Review: Summary and Evaluation. Alabama Ecological Services, Daphne, Alabama. 19 pp.

**Overall Vulnerability:** ☒ **High** ☐ **Medium** ☐ **Low**

***RISK***
***(Risk is based on species exposure and response from labeled uses across the range)***

**Risk to individuals if exposed:** We do not anticipate effects to the species from exposure to malathion at labeled use rates.

**Risk to the species from labeled uses across the range:**
The table below summarizes the risk to the species from labeled uses across the range based on range overlaps with use sites and anticipated effects associated with the particular uses.

| ALL USES except mosquito control | |
|---|---|
| Mortality | no effects expected |
| MOSQUITO CONTROL | |
| Mortality | no effects expected |

**Risk modifiers:** The habitat is riffles and shoals on the undersides of large rocks (Hershler et.al., 1990). DeVries (1993) found that habitat, specifically substrate, velocities, and depth, ranged significantly among sampling sites. He noted that the snail was always observed on rocks (never on the substrate) and appeared to require some degree of moving water.

As described in the "Approach to the Effects Analysis" section of the main body of the Opinion, we made specific considerations for species that occur in bins 3 and 4 as they were modeled in such a way that likely resulted in overestimation of estimated environmental concentrations, thus overestimating potential exposure. While the Tulotoma snail does occupy other aquatic habitats

that contain higher concentrations of malathion (e.g., bin 2), individuals of the species that occupy habitats with higher flow rates (e.g., bins 3 and 4) will experience lower exposure than those occupying low flow areas, reducing the risk of effects across the species in general.

**Overall Risk: ☐ High ☐ Medium ☒ Low**

***USAGE***
***(Anticipated usage within the range based on past usage data)***

| Use type | Risk to species[1] | Use overlap with range | | Estimated usage in range[2] | | Bins associated with use type^ | Effect associated with bin (H, M, L) |
|---|---|---|---|---|---|---|---|
| | | Acres | % | Acres | % | | |
| Mosquito Control | D | 1,223,994 | 50.1 | 81,864 | 3.35 | 2,3,4 | 2L<br>3L<br>4L |
| Developed | D | 47,841 | 1.96 | 2,392 | 0.1 | 2,3,4 | 2L<br>3L<br>4L |
| Cotton | D | 37,555 | 1.54 | 9,720 | 0.4 | 2,3,4 | 2L<br>3L<br>4L |
| Other Crops | D | 13,009 | 0.53 | 643 | 0.03 | 2,3,4 | 2L<br>3L<br>4L |
| Corn | D | 11,798 | 0.48 | 585 | 0.02 | 2,3,4 | 2L<br>3L<br>4L |
| Other Row Crops | D | 3,540 | 0.14 | 3,540 | 0.14 | 2,3,4 | 2L<br>3L<br>4L |
| Wheat | D | 1,324 | 0.05 | 303 | 0.01 | 2,3,4 | 2L<br>3L<br>4L |
| Other Grains | D | 1,229 | 0.05 | 1,219 | 0.05 | 2,3,4 | 2L<br>3L<br>4L |
| Vegetables & Ground Fruit | D | 272 | 0.01 | 1203.35 | < 0.01 | 2,3,4 | 2L<br>3L<br>4L |
| Orchards & Vineyards | D | 752 | 0.03 | 334 | 0.01 | 2,3,4 | 2L<br>3L<br>4L |
| Nurseries | D | 658 | 0.03 | 658 | 0.03 | 2,3,4 | 2L<br>3L |

[1] Direct effects (D), Indirect effects (I), No effects expected (N), Use site not utilized by the species (*)
[2] Estimated usage in the range is based on information about annual past usage.

| Use type | Risk to species[1] | Use overlap with range | | Estimated usage in range[2] | | Bins associated with use type^ | Effect associated with bin (H, M, L) |
|---|---|---|---|---|---|---|---|
| | | Acres | % | Acres | % | | |
| | | | | | | | 4L |
| Pasture | D | 3 | < 0.01 | 3 | < 0.01 | 2,3,4 | 2L<br>3L<br>4L |
| **Sub-TOTAL (D):** *Other uses with direct effects*[3] | | 117,981 | 4.83 | 19,517 | 0.79 | | |
| **Sub-TOTAL (I):** *Other uses with indirect effects*[3] | | 0 | 0 | 0 | 0 | | |
| **TOTAL[4]:** | | 1,341,974 | 54.93 | 101,381 | 4.14 | | |

^We consider the bin 2 estimates as an upper bound of bin 3 & 4 exposures.

**# acres in species range:** 2,445,605 acres
**% of range in California (i.e., where CalPUR data is available):** 0%
**Range overlap with Federal lands:** 10,549 acres, 0.431%

**Overall Usage:** ☐ **High** ☐ **Medium** ☒ **Low**

***CONSERVATION MEASURES***

**Rain restriction:** Given the relatively short half-life of malathion and rapid degradation via hydrolysis and other processes, persistence of malathion in storm run-off into most aquatic habitats is not anticipated to last longer than 48 hours under typical pH values, (i.e., 6.5-8.5) and water temperatures corresponding to growing season. Restricting malathion application to periods where rain is not forecasted for at least 48 hours or when the soil is not saturated will provide time for the pesticide to degrade before runoff into aquatic habitats can occur, decreasing exposure and risk.

**Aquatic habitat buffers:** Application buffers, which specify on the label a distance from water bodies where pesticides are not to be applied, are designed to reduce spray drift from entering sensitive non-target areas, thereby providing protection to aquatic species. While the exact amount of spray drift reduction depends on the physical traits of the aquatic ecosystem (e.g., flow rate, volume, etc.) as well as the application method, we can expect (based on AgDRIFT modeling) spray drift reductions ranging from 40 to 91%, with low flow and low volume aquatic habitats receiving the most reduction in spray drift deposition. In many cases, these buffers substantially reduce exposure to aquatic organisms and subsequent risk of direct and indirect effects.

**Residential use label changes:** New restrictions to the method and frequency of application for residential use of malathion are expected to substantially reduce exposure to species that overlap

[3] Mosquito control has the potential to overlap with other uses. It is not included in the Sub-TOTALs.
[4] TOTAL includes usage on all use sites with effects, including mosquito control.

with developed and open space developed areas. Label changes will ensure that residential use is limited to spot treatments only (rendering spray drift offsite unlikely) and reducing the extent of area which can be treated in the developed and open space developed areas by as much as 75% or more from modeled values. In addition, we expect the frequency of exposure to decrease as the number of allowable applications is reduced from "repeat as necessary" to a maximum of 2–4 applications per year (depending on the specific residential use). Retreatment intervals of 7-10 days between any repeated applications are expected to reduce environmental concentrations by allowing any initial residues to degrade prior to the next application. In addition, exposure to aquatic organisms is reduced due to buffers from waterways, which specify on the label a distance from water bodies where pesticides are not to be applied, and restrictions to application during periods where rain is not forecasted within 24 hours or when the soil is not saturated.

**Reduced application number and rate:** New restrictions on corn, cotton, orchards and vineyards, pasture, other crops, and vegetables and ground fruit lower the maximum allowable number of applications to 2-4 per year (depending on the specific crop; previous allowable numbers of applications ranged from 3 to 13 applications per year). This will help reduce the amount of malathion used and decrease potential exposure to the species, thus decreasing the risk of both indirect and direct effects to the species.

---

***CONCLUSION***

After reviewing the current status of the species, the environmental baseline for the action area, the effects of the proposed registration of malathion, and the cumulative effects, it is the Service's biological opinion that the registration of malathion, as proposed, with the implementation of the general conservation measures described above, is not likely to jeopardize the continued existence of the Tulotoma snail. As discussed below, the vulnerability is high for this species, the risk and likelihood of exposure to malathion is low, and the implementation of the general conservation measures described above is expected to further reduce the likelihood of exposure.

The Tulotoma snail has a high vulnerability based on its status, distribution, and trends, as described above. Tulotoma is currently known from eight separate populations inhabiting a cumulative total of about 35 miles of river and creek channels. (USFWS 2008).

The risk to the species from labeled uses across the range is expected to be low as we do not anticipate any measurable effects from malathion exposure to individuals, including mortality or sublethal effects to growth, reproduction, or behavior. There may be potential effects to the species' food base (e.g., algae, plants, detritus), however these effects are expected to be small and will not likely result in adverse effects to snails.

We anticipate usage within the range will be low (4.14%), based primarily on the standard usage data we acquired, as described in the Opinion, and summarized for this species above. Additionally, conservation measures, such as rain restrictions, aquatic habitat buffers, changes to residential use labels, and reduced allowable application numbers and rates, are expected to

substantially reduce environmental concentrations of malathion, further decreasing risk of exposure.

Due to the lack of measurable effects to individuals, including mortality and sublethal effects, the lack of appreciable effects to its food base and habitat, the low level of expected usage, and the incorporation of conservation measures that would further reduce the risk of exposure, we anticipate minimal, if any, adverse effects (i.e., not enough to result in take) will occur throughout the duration of the action. Therefore, we do not anticipate that the proposed action would appreciably reduce survival and recovery of the Tulotoma snail in the wild.

**Conclusion:** Not likely to jeopardize

***ADDITIONAL REFERENCES***

U.S. Fish and Wildlife Service. 2019. Tulotoma Snail (*Tulotoma magnifica*) 5-Year Review: Summary and Evaluation. Alabama Ecological Services, Daphne, Alabama. 19 pp.

**Integration and Synthesis Summary: Snails *(Aquatic)***

| Scientific Name: | Common Name: | Entity ID: |
|---|---|---|
| *Pyrgulopsis neomexicana* | Socorro springsnail | 408 |

***VULNERABILITY***
***(Summary of status, environmental baseline and cumulative effects)***

**Status:** Endangered
**Distribution:** Small, endemic, constrained, and/or isolated population(s)
**Number of Populations:** Single population
**Species Trends:** Unknown population trends
**Pesticides noted** ☐

**Environmental Baseline/Cumulative Effects (EB/CE) Summary:**
The Socorro springsnail is a rare, hydrobiid snail that survives in only one spring (Torreon Spring) on private land in Socorro County, New Mexico. Because access to the spring has been denied by the landowner since 1995, one year after the recovery plan was written, there is no new information on the species biology or its habitat. Designation of critical habitat was determined to not be prudent at the time of listing because the threats of vandalism and collection outweighed benefits that designation may have bestowed. Population numbers are unknown, status of habitat is unknown, and the magnitude of current threats is unknown. Specific life history and habitat needs have not been documented. The effects of climate change, if they include widespread drought, decreased spring discharge, or a change in water chemistry is a newly recognized threat that could eliminate the species. A habitat management plan has not been written for the species, as directed by the recovery plan. Translocation to other springs, a criterion for delisting, is no longer viewed as a viable option. It will continue to be very difficult to assess the status of the species until the land owner grants access to the site or land ownership changes. Because this species only occurs in one location where it could easily be extirpated by biological or environmental threats, we recommend that Socorro springsnail remain listed as endangered. Because access to the one spring where the Socorro springsnail exists (Torreon Spring) has been denied since 1995, no current information on the species, its habitat, or the magnitude of threats is available. Lack of cooperation by the private land owner and impacts caused by their actions were not specifically identified as a threat. Inability to protect the habitat and monitor the population is a much greater threat than identified in the listing rule. The 2020 5-Year Review did not include any additional information due to continued lack of access to Torreon Spring.

**EB/CE Sources:** U. S. Fish and Wildlife Service. 2010. Socorro Springsnail (*Pyrgulopsis neomexicana*) 5-Year Review: Summary and Evaluation. Albuquerque, New Mexico. 12 pp.

U. S. Fish and Wildlife Service. 2020. Socorro Springsnail (*Pyrgulopsis neomexicana*) 5-Year Review: Summary and Evaluation. Albuquerque, New Mexico. 6 pp.

**Overall Vulnerability:** ☒ **High** ☐ **Medium** ☐ **Low**

***RISK***
***(Risk is based on species exposure and response from labeled uses across the range)***

**Risk to individuals if exposed:** We do not anticipate effects to the species from exposure to malathion at labeled use rates.

**Risk to the species from labeled uses across the range:**
The table below summarizes the risk to the species from labeled uses across the range based on range overlaps with use sites and anticipated effects associated with the particular uses.

| ALL USES except mosquito control | |
|---|---|
| Mortality | no effects expected |
| MOSQUITO CONTROL | |
| Mortality | no effects expected |

**Risk modifiers:** Originally inhabited at least one thermal (17 degrees C) spring system and possibly two or more. All habitat has been destroyed except a small 8 ft (2.4m) run from a leak in the base of a windmill. The principal spring source where the snail is found has been impounded, which reduced the flowing-water habitat to a very small pool and one tiny spring source has a small, improved pool that remains; however, snails were found in the source and outflow tributary (USFWS, 1993). Benthic (NatureServe, 2015)

**Overall Risk:** ☐ **High** ☐ **Medium** ☒ **Low**

***USAGE***
***(Anticipated usage within the range based on past usage data)***

| Use type | Risk to species[1] | Use overlap with range | | Estimated usage in range[2] | | Bins associated with use type^ | Effect associated with bin (H, M, L) |
|---|---|---|---|---|---|---|---|
| | | Acres | % | Acres | % | | |
| Mosquito Control | D | 2,393,192 | 43.7 | 0 | 0 | 2,5 | 2L<br>5L |
| Pasture | D | 7,030 | 0.13 | 5,016 | 0.09 | 2,5 | 2L<br>5L |
| Developed | D | 5,647 | 0.1 | 282 | < 0.01 | 2,5 | 2L<br>5L |
| Orchards & Vineyards | D | 488 | < 0.01 | 488 | <0.01 | 2,5 | 2L<br>5L |

[1] Direct effects (D), Indirect effects (I), No effects expected (N), Use site not utilized by the species (*)
[2] Estimated usage in the range is based on information about annual past usage.

| Use type | Risk to species[1] | Use overlap with range | | Estimated usage in range[2] | | Bins associated with use type^ | Effect associated with bin (H, M, L) |
|---|---|---|---|---|---|---|---|
| | | Acres | % | Acres | % | | |
| Vegetables & Ground Fruit | D | 201 | < 0.01 | 196 | < 0.01 | 2,5 | 2L<br>5L |
| Other Crops | D---------- -- | 126 | < 0.01 | 0 | 0 | 2,5 | 2L<br>5L |
| Corn | D | 111 | < 0.01 | 111 | < 0.01 | 2,5 | 2L<br>5L |
| Wheat | D | 109 | < 0.01 | 62 | < 0.01 | 2,5 | 2L<br>5L |
| Other Grains | D | 105 | < 0.01 | 105 | < 0.01 | 2,5 | 2L<br>5L |
| Cotton | D | 11 | < 0.01 | 4 | < 0.01 | 2,5 | 2L<br>5L |
| Nurseries | D | 2 | < 0.01 | 2 | < 0.01 | 2,5 | 2L<br>5L |
| **Sub-TOTAL (D):** *Other uses with direct effects*[3] | | 13,830 | 0.31 | 6,266 | 0.11 | | |
| **Sub-TOTAL (I):** *Other uses with indirect effects*[3] | | 0 | 0 | 0 | 0 | | |
| **TOTAL[4]:** | | 2,407,023 | 44.01 | 6,266 | 0.11 | | |

^species found only in bins 2 and 5.

**# acres in species range:** 5,466,545 acres
**% of range in California (i.e., where CalPUR data is available):** 0%
**Range overlap with Federal lands:** 2,715,543 acres, 49.676%

**Overall Usage:** ☐ **High** ☐ **Medium** ☒ **Low**

***CONSERVATION MEASURES***

**Rain restriction:** Given the relatively short half-life of malathion and rapid degradation via hydrolysis and other processes, persistence of malathion in storm run-off into most aquatic habitats is not anticipated to last longer than 48 hours under typical pH values, (i.e., 6.5-8.5) and water temperatures corresponding to growing season. Restricting malathion application to periods where rain is not forecasted for at least 48 hours or when the soil is not saturated will provide time for the pesticide to degrade before runoff into aquatic habitats can occur, decreasing exposure and risk.

**Aquatic habitat buffers:** Application buffers, which specify on the label a distance from water bodies where pesticides are not to be applied, are designed to reduce spray drift from entering

[3] Mosquito control has the potential to overlap with other uses. It is not included in the Sub-TOTALs.
[4] TOTAL includes usage on all use sites with effects, including mosquito control.

sensitive non-target areas, thereby providing protection to aquatic species. While the exact amount of spray drift reduction depends on the physical traits of the aquatic ecosystem (e.g., flow rate, volume, etc.) as well as the application method, we can expect (based on AgDRIFT modeling) spray drift reductions ranging from 40 to 91%, with low flow and low volume aquatic habitats receiving the most reduction in spray drift deposition. In many cases, these buffers substantially reduce exposure to aquatic organisms and subsequent risk of direct and indirect effects.

***CONCLUSION***

After reviewing the current status of the species, the environmental baseline for the action area, the effects of the proposed registration of malathion, and the cumulative effects, it is the Service's biological opinion that the registration of malathion, as proposed, with the implementation of the general conservation measures described above, is not likely to jeopardize the continued existence of the Socorro springsnail. As discussed below, the vulnerability is high for this species, the risk and likelihood of exposure to malathion is low, and the implementation of the general conservation measures described above is expected to further reduce the likelihood of exposure.

The Socorro springsnail has a high vulnerability based on its status, distribution, and trends, as described above. The Socorro springsnail is a rare, hydrobiid snail that survives in only one spring (Torreon Spring) on private land in Socorro County, New Mexico. Because access to the spring has been denied by the landowner since 1995, one year after the recovery plan was written, there is no new information on the species biology or its habitat. (USFWS 2010).

The risk to the species from labeled uses across the range is expected to be low as we do not anticipate any measurable effects from malathion exposure to individuals, including mortality or sublethal effects to growth, reproduction, or behavior. There may be potential effects to the species' food base (e.g., algae, plants, detritus), however these effects are expected to be small and will not likely result in adverse effects to snails.

About 50% of the species range is on Federal lands where we expect any adverse effects would be minimal, considering the small scale and low levels of past malathion usage on Federal lands, and in light of Federal agency programs that are designed to understand, avoid, and minimize the effects to listed species (see the Approach to Usage section of the Opinion). Mosquito control is identified as the largest contributing factor to risk for this species; however, it is not expected to occur within the species range. Further, we anticipate usage within the range outside of Federal land boundaries will be low (0.11% of the range, expected on the non-Federal portion), based primarily on the standard usage data we acquired, as described in the Opinion, and summarized for this species above. Conservation measures, such as rain restrictions and aquatic habitat buffers, are expected to substantially decrease the environmental concentrations of malathion within the species range, further decreasing the likelihood of exposure.

Due to the lack of measurable effects to individuals, including mortality and sublethal effects, the lack of appreciable effects to its food base and habitat, the low level of expected usage, and the incorporation of conservation measures that would further reduce the risk of exposure, we anticipate minimal, if any, adverse effects (i.e., not enough to result in take) will occur throughout the duration of the action. Therefore, we do not anticipate that the proposed action would appreciably reduce survival and recovery of the Socorro springsnail in the wild.

**Conclusion:** Not likely to jeopardize

***ADDITIONAL REFERENCES***

U. S. Fish and Wildlife Service. 2010. Socorro Springsnail (*Pyrgulopsis neomexicana*) 5-Year Review: Summary and Evaluation. Albuquerque, New Mexico. 12 pp.

**Integration and Synthesis Summary: Snails *(Aquatic)***

| Scientific Name: | Common Name: | Entity ID: |
|---|---|---|
| *Lanx sp.* | Banbury Springs limpet | 409 |

***VULNERABILITY***
***(Summary of status, environmental baseline and cumulative effects)***

**Status:** Endangered
**Distribution:** Small, endemic, constrained, and/or isolated population(s)
**Number of Populations:** Multiple populations (few)
**Species Trends:** Unknown population trends
**Pesticides noted ☒**

**Environmental Baseline/Cumulative Effects (EB/CE) Summary:**
The Banbury Springs limpet is found within portions of 4 large spring complexes that discharge Eastern Snake Plain Aquifer water into the middle-Snake River in the Thousand Springs Area: Briggs Springs, Banbury Springs, Box Canyon Springs, and Thousand Springs. The species is still found at the four springs as described in the previous 5-year status review (USFWS 2006, USFWS 2017), with each population remaining as isolated as they did at the time of the previous 5-year status review completed in 2006. (USFWS 2018) Banbury Springs limpet are known to occur in large, undisturbed springs containing cold, clear, and well oxygenated water where they avoid areas with large, attached plants or areas with fluctuating water levels and are generally absent from turbid environments (Frest and Johannes 1992 *in* USFWS 2018). They likely feed on periphyton (which has not been verified through stomach content analysis) and occur primarily on the lateral sides of rocks, but not in contact with the sediment (Frest and Johannes 1992 *in* USFWS 2018). Limpets move very little and reside in localized populations. A one year life span is expected for the majority of individuals in a population (Frest and Johannes 1992 *in* USFWS 2018). The primary factors that threaten the existence of the Banbury Springs lanx (=limpet) in its four remaining coldwater spring complexes and tributaries of the middle Snake River include the effects from habitat modification, spring flow reduction, reduced groundwater quality, the invasive New Zealand mudsnail, and inadequate regulatory mechanisms. The respiratory requirements and life history attributes of the Banbury Springs lanx make this species susceptible to small fluctuations in water temperature, dissolved oxygen, sediment, or the effects of pollutants. This species appears to prefer deep, cold water springflows of high quality and stable substrate. Habitat modification has affected this species by reducing the availability of suitable coldwater spring habitats. Examples of habitat modification at the four known locations include: hydroelectric development in the Thousand Springs Preserve; aquaculture diversions in Box Canyon and Briggs Springs; and past impoundments of the springflows at Banbury Springs. Coldwater springflows from the Snake River aquifer at the four Banbury Springs lanx sites are also declining. As spring flows continue to decline throughout the range of this species, flows appropriated for hydroelectric power generating facilities and coldwater springflows diverted for aquaculture facilities and other uses will continue to compete for and likely reduce the available

water for the Banbury Springs lanx. Degraded groundwater quality of the Snake River aquifer from agricultural and aquaculture practices will continue to affect the coldwater spring outflows upon which this species exists. The non-native New Zealand mudsnail has invaded the coldwater springflows where the Banbury Springs lanx colonies occur, and occupation of nearby coldwater spring habitat could alter the trophic dynamics of these tributary springs. Further, expansion of the mudsnail likely limits the ability of the Banbury Springs lanx to migrate and disperse to other suitable nearby locations. The human population has also grown within southern Idaho. For example, from 2006 through 2011, the human population in Gooding, Jerome, and Lincoln Counties in southern Idaho grew 15 percent (U.S. Census Bureau in litt. 2013 *in* USFWS 2018), with the city of Twin Falls growing by 20 percent from 2000 to 2010 (City of Twin Falls Data in litt. 2013 *in* USFWS 2018). Sewage treatment facilities from these municipalities have permitted National Pollutant Discharge Elimination System discharges of nutrients, ammonia, suspended solids, organic matter, and industrial wastes into the Snake River (Clark et al. 1998; U.S. Environmental Protection Agency 2002 *in* USFWS 2018). Other nonpoint discharges from urban areas, such as parking lot run-off and urban-use pesticides (Clark et al. 1998 *in* USFWS 2018), do not undergo treatment but can be reasonably expected to make their way into the Snake River and/or its tributaries. Although urban run-off likely contributes to declines in water quality in the Snake River, it is not considered to be a major source of pollutants (Clark et al. 1998 *in* USFWS 2018). Over 23,310 square kilometers of irrigated land are located within the Snake River drainage or that of its tributaries (Johnson et al. in litt. 2013 *in* 2018). Most of the crops grown in this area are subject to modern agricultural practices which include the use of herbicides, insecticides, fungicides, and fertilizers; a proportion of which make their way into the Snake River via irrigation return flows and through ground water recharge (Clark et al. 1998 *in* 2018). Clark et al. (1998) found the largest amounts of pesticides to be present in wells adjacent to agricultural areas around the Snake River between Burley and Hagerman, which are also the locations with the highest frequencies and concentrations of nitrates in ground water.

**EB/CE Sources:** U. S. Fish and Wildlife Service. 2006. Banbury Springs Lanx (*Lanx* n sp.) (undescribed) 5-Year Review: Summary and Evaluation. Boise, Idaho. 40 pp.

U.S. Fish and Wildlife Service. 2018. Banbury Springs Lanx (*Lanx* n sp.) (undescribed) 5-Year Review: Summary and Evaluation. Boise, Idaho. 42 pp.

**Overall Vulnerability: ☒ High ☐ Medium ☐ Low**

***RISK***
***(Risk is based on species exposure and response from labeled uses across the range)***

**Risk to individuals if exposed:** We do not anticipate effects to the species from exposure to malathion at labeled use rates.

**Risk to the species from labeled uses across the range:**

The table below summarizes the risk to the species from labeled uses across the range based on range overlaps with use sites and anticipated effects associated with the particular uses.

| ALL USES except mosquito control | |
|---|---|
| Mortality | no effects expected |
| MOSQUITO CONTROL | |
| Mortality | no effects expected |

**Risk modifiers:** The Banbury Springs lanx requires cold, clear and well-oxygenated water with swift currents. Lanx are found on smooth basalt, boulders, or cobble-sized grounds ranging from 2 to 20 inches deep, but they avoid areas with green algae. Currently this species only exists at four cold-spring locations that are isolated from each other: Thousand Springs, Box Canyon Springs, Briggs Springs and Banbury Springs (USFWS, 2016).

As described in the "Approach to the Effects Analysis" section of the main body of the Opinion, we made specific considerations for species that occur in bins 3 and 4 as they were modeled in such a way that likely resulted in overestimation of estimated environmental concentrations, thus overestimating potential exposure. While the Banbury Springs limpet does occupy other aquatic habitats that contain higher concentrations of malathion (e.g., bin 2), individuals of the species that occupy habitats with higher flow rates (e.g., bin 3) will experience lower exposure than those occupying low flow areas, reducing the risk of effects across the species in general.

**Overall Risk:** ☐ **High** ☐ **Medium** ☒ **Low**

***USAGE***
***(Anticipated usage within the range based on past usage data)***

| Use type | Risk to species[1] | Use overlap with range | | Estimated usage in range[2] | | Bins associated with use type^ | Effect associated with bin (H, M, L) |
|---|---|---|---|---|---|---|---|
| | | Acres | % | Acres | % | | |
| Mosquito Control | D | 21,5986 | 29.01 | 0 | 0 | 2,3 | 2L<br>3L |
| Corn | D | 17,611 | 23.65 | 694 | 0.93 | 2,3 | 2L<br>3L |
| Pasture | D | 12,165 | 16.34 | 12,074 | 16.22 | 2,3 | 2L<br>3L |
| Other Crops | D | 2,957 | 3.97 | 0 | 0 | 2,3 | 2L<br>3L |
| Vegetables & Ground Fruit | D | 2,906 | 3.9 | 2,906 | 3.9 | 2,3 | 2L<br>3L |
| Other Grains | D | 2,803 | 3.77 | 2,803 | 3.77 | 2,3 | 2L<br>3L |

[1] Direct effects (D), Indirect effects (I), No effects expected (N), Use site not utilized by the species (*)
[2] Estimated usage in the range is based on information about annual past usage.

| Use type | Risk to species[1] | Use overlap with range | | Estimated usage in range[2] | | Bins associated with use type^ | Effect associated with bin (H, M, L) |
|---|---|---|---|---|---|---|---|
| | | Acres | % | Acres | % | | |
| Wheat | D | 1,349 | 1.81 | 1,269 | 1.71 | 2,3 | 2L<br>3L |
| Developed | D | 1,024 | 1.38 | 51 | 0.07 | 2,3 | 2L<br>3L |
| Other Row Crops | D | 844 | 1.13 | 844 | 1.13 | 2,3 | 2L<br>3L |
| Nurseries | D | 42.06 | 0.06 | 42 | 0.06 | 2,3 | 2L<br>3L |
| Christmas Trees | D | 2 | < 0.01 | 2 | < 0.01 | 2,3 | 2L<br>3L |
| Orchards & Vineyards | D | 1 | < 0.01 | <1 | < 0.01 | 2,3 | 2L<br>3L |
| **Sub-TOTAL (D):** *Other uses with direct effects*[3] | | 41,704 | 56.03 | 20,685 | 27.79 | | |
| **Sub-TOTAL (I):** *Other uses with indirect effects*[3] | | 0 | 0 | 0 | 0 | | |
| **TOTAL[4]:** | | 63,302 | 85.04 | 20,685 | 27.79 | | |

^We consider the bin 2 estimates as an upper bound of bin 3 & 4 exposures.

**# acres in species range:** 74,451 acres
**% of range in California (i.e., where CalPUR data is available):** 0%
**Range overlap with Federal lands:** 6,208 acres, 8.338%

**Overall Usage:** ☒ **High** ☐ **Medium** ☐ **Low**

## *CONSERVATION MEASURES*

**Rain restriction:** Given the relatively short half-life of malathion and rapid degradation via hydrolysis and other processes, persistence of malathion in storm run-off into most aquatic habitats is not anticipated to last longer than 48 hours under typical pH values, (i.e., 6.5-8.5) and water temperatures corresponding to growing season. Restricting malathion application to periods where rain is not forecasted for at least 48 hours or when the soil is not saturated will provide time for the pesticide to degrade before runoff into aquatic habitats can occur, decreasing exposure and risk.

**Aquatic habitat buffers:** Application buffers, which specify on the label a distance from water bodies where pesticides are not to be applied, are designed to reduce spray drift from entering sensitive non-target areas, thereby providing protection to aquatic species. While the exact amount of spray drift reduction depends on the physical traits of the aquatic ecosystem

[3] Mosquito control has the potential to overlap with other uses. It is not included in the Sub-TOTALs.
[4] TOTAL includes usage on all use sites with effects, including mosquito control.

(e.g., flow rate, volume, etc.) as well as the application method, we can expect (based on AgDRIFT modeling) spray drift reductions ranging from 40 to 91%, with low flow and low volume aquatic habitats receiving the most reduction in spray drift deposition. In many cases, these buffers substantially reduce exposure to aquatic organisms and subsequent risk of direct and indirect effects.

**Residential use label changes:** New restrictions to the method and frequency of application for residential use of malathion are expected to substantially reduce exposure to species that overlap with developed and open space developed areas. Label changes will ensure that residential use is limited to spot treatments only (rendering spray drift offsite unlikely) and reducing the extent of area which can be treated in the developed and open space developed areas by as much as 75% or more from modeled values. In addition, we expect the frequency of exposure to decrease as the number of allowable applications is reduced from "repeat as necessary" to a maximum of 2–4 applications per year (depending on the specific residential use). Retreatment intervals of 7-10 days between any repeated applications are expected to reduce environmental concentrations by allowing any initial residues to degrade prior to the next application. In addition, exposure to aquatic organisms is reduced due to buffers from waterways, which specify on the label a distance from water bodies where pesticides are not to be applied, and restrictions to application during periods where rain is not forecasted within 24 hours or when the soil is not saturated.

**Reduced application number and rate:** New restrictions on corn, cotton, orchards and vineyards, pasture, other crops, and vegetables and ground fruit lower the maximum allowable number of applications to 2-4 per year (depending on the specific crop; previous allowable numbers of applications ranged from 3 to 13 applications per year). This will help reduce the amount of malathion used and decrease potential exposure to the species, thus decreasing the risk of both indirect and direct effects to the species.

---

***CONCLUSION***

After reviewing the current status of the species, the environmental baseline for the action area, the effects of the proposed registration of malathion, and the cumulative effects, it is the Service's biological opinion that the registration of malathion, as proposed, with the implementation of the general conservation measures described above, is not likely to jeopardize the continued existence of the Banbury Springs limpet. As discussed below, the vulnerability is high for this species, the risk is low, and likelihood of exposure to malathion is high, however the implementation of the general conservation measures described above is expected to substantially reduce the likelihood of exposure.

The Banbury Springs limpet has a high vulnerability based on its status, distribution, and trends, as described above. The species requires cold, clear and well-oxygenated water with swift currents. Currently this species is restricted to four isolated colonies with no possible conduit for dispersal or range expansion. (USFWS, 2006; 2018). Because this species is currently restricted to four isolated colonies, future stochastic as well as anthropogenic disturbances could negatively impact this species. (USFWS, 2006, 2011) Pesticide use on agricultural lands within the Snake

River drainage enters the habitat of Banbury Springs limpit in the Snake River via irrigation return flows and ground water recharge, and is a known threat to the species. (USFWS 2018).

The risk to the species from labeled uses across the range is expected to be low as we do not anticipate any measurable effects from malathion exposure to individuals, including mortality or sublethal effects to growth, reproduction, or behavior. There may be potential effects to the species' food base (e.g., algae, plants, detritus), however these effects are expected to be small and will not likely result in adverse effects to snails.

About 8% of the species range is on Federal lands where we expect any adverse effects would be minimal, considering the small scale and low levels of past malathion usage on Federal lands, and in light of Federal agency programs that are designed to understand, avoid, and minimize the effects to listed species (see the Approach to Usage section of the Opinion). We anticipate usage within the range and existing outside of the boundaries of Federal lands will be high (27.79%, expected on the non-Federal portion), based primarily on the usage data we acquired, as described in the Opinion and summarized for this species above. However, given the high tolerance snails have towards malathion, we do not expect this high usage will result in any effects to the species. Additionally, conservation measures, such as rain restrictions, aquatic habitat buffers, changes to residential use labels, and reductions in the number of allowable applications and application rates, are expected to substantially reduce the environmental concentrations of malathion within the range of the species, greatly reducing the likelihood of exposure.

Due to the lack of measurable effects to individuals, including mortality and sublethal effects, the lack of appreciable effects to its food base and habitat, and the incorporation of conservation measures that would further reduce the risk of exposure, we anticipate minimal, if any, adverse effects (i.e., not enough to result in take) will occur throughout the duration of the action. Therefore, we do not anticipate that the proposed action would appreciably reduce survival and recovery of the Banbury Springs limpet in the wild.

**Conclusion:** Not likely to jeopardize

***ADDITIONAL REFERENCES***

U. S. Fish and Wildlife Service. 2006. Banbury Springs Lanx (*Lanx* n sp.) (undescribed) 5-Year Review: Summary and Evaluation. Boise, Idaho. 40 pp.

U.S. Fish and Wildlife Service. 2018. Banbury Springs Lanx (*Lanx* n sp.) (undescribed) 5-Year Review: Summary and Evaluation. Boise, Idaho. 42 pp.

**Integration and Synthesis Summary: Snails *(Aquatic)***

| Scientific Name: | Common Name: | Entity ID: |
|---|---|---|
| *Elimia crenatella* | Lacy elimia (snail) | 411 |

***VULNERABILITY***
***(Summary of status, environmental baseline and cumulative effects)***

**Status:** Threatened
**Distribution:** Small, endemic, constrained, and/or isolated population(s)
**Number of Populations:** Single population
**Species Trends:** Declining population(s) – one or more populations declining
**Pesticides noted** ☐

**Environmental Baseline/Cumulative Effects (EB/CE) Summary:**
The lacy elimia inhabits shoals, rapids and riffles of large streams and rivers above the Fall Line in Alabama, and they require stable hard substrates, such as boulders and cobbles, and clean unpolluted water. Elimia snails are gill-breathing snails that typically inhabit highly oxygenated waters on rock shoals and gravel bars. They mostly graze on periphyton (attached algae) growing on benthic (bottom) substrates. Eggs are laid in early spring and hatch in about 2 weeks. Snails apparently become sexually mature in their first year, but, in some cases, females may not lay eggs until their second year. Some elimia species may live as long as 5 years (Dillon, 1988). The lacy elimia was historically abundant in the Coosa River main stem from St. Clair to Chilton County, Alabama, and was also known in several Coosa River tributaries--Big Will's Creek, DeKalb County; Kelley's Creek, St. Clair County; and Choccolocco and Tallaseehatchee Creeks, Talladega County, Alabama (Goodrich, 1936). The recovery plan noted three extant populations of the lacy elimia in Cheaha, Emauhee, and Weewoka Creeks in Talladega County, Alabama (Bogan and Pierson, 1993, Service 2005). Successive surveys have failed to document a population in Emauhee or Weewoka (Pierson and Pursifull 2006), and the lacy elimia is currently only known to persist in Cheaha Creek, Talladega County, Alabama (Pierson and Pursifull 2006, P. Johnson pers. comm. 2015). While the lacy elimia has been successfully propagated, limited reintroduction options have precluded reintroduction attempts (P. Johnson pers. comm. 2015).

Limiting factors include activities which affect stream and river flow, or water and substrate quality. Thirty dams have changed this system from a continuum of free-flowing riverine habitats into a series of impoundments connected by short, free-flowing reaches and the lacey elimia has disappeared from more than 90 percent of its historic range. Dams change such areas by eliminating or reducing currents, and allowing sediments to accumulate on inundated channel habitats. Impounded waters also experience changes in water chemistry which could affect survival or reproduction of riverine snails. Dams also form barriers to snail movement, isolating the snail populations. Unable to emigrate, the isolated snail populations are vulnerable to local discharges as well as any detrimental land surface runoff within their watersheds. In addition to

point and nonpoint source pollution, excessive sediments are believed to impact riverine snails requiring clean, hard shoal stream and river bottoms, by making the habitat unsuitable for feeding or reproduction. All streams where the lacy elimia is found are variously impacted by sediments and nutrients from a variety of upstream rural, suburban, and/or urban sources. Because of their small sizes and limited flows, their water and habitat quality can be rapidly affected by local and off site pollution sources.

**EB/CE Sources:** U.S. Fish and Wildlife Service. 2005. Recovery Plan for 6 Mobile River Basin Aquatic Snails. U.S. Fish and Wildlife Service, Jackson, Mississippi. pp. 70.

U.S. Fish and Wildlife Service. 2016. Cylindrical Lioplax (*Lioplax cyclostomaformis*), Flat Pebblesnail (*Lepyrium showalteri*), Plicate Rocksnail (*Leptoxis plicata*), Painted Rocksnail (Leptoxis taeniata), Round Rocksnail (*Leptoxis ampla*), Lacy Elimia (*Elimia crenatella*) 5-Year Review: Summary and Evaluation. Alabama Ecological Services Field Office, Daphne Alabama. 39 pp.

**Overall Vulnerability:** ☒ **High** ☐ **Medium** ☐ **Low**

***RISK***
***(Risk is based on species exposure and response from labeled uses across the range)***

**Risk to individuals if exposed:** We do not anticipate effects to the species from exposure to malathion at labeled use rates.

**Risk to the species from labeled uses across the range:**
The table below summarizes the risk to the species from labeled uses across the range based on range overlaps with use sites and anticipated effects associated with the particular uses.

| ALL USES except mosquito control | |
|---|---|
| Mortality | no effects expected |
| MOSQUITO CONTROL | |
| Mortality | no effects expected |

**Risk modifiers:** Little is known specific to the lacy elimia, however, elimia snails are gill-breathing snails that typically inhabit highly oxygenated waters on rock shoals and gravel bars (USFWS, 2005). High site fidelity, low tolerance ranges/thresholds and Narrow/ specialist environmental specificity are inferred based on strict habitat needs as is clumped spatial arrangement (USFWS, 2005; NatureServe, 2015).

**Overall Risk:** ☐ **High** ☐ **Medium** ☒ **Low**

***USAGE***
***(Anticipated usage within the range based on past usage data)***

| Use type | Risk to species[1] | Use overlap with range | | Estimated usage in range[2] | | Bins associated with use type^ | Effect associated with bin (H, M, L) |
|---|---|---|---|---|---|---|---|
| | | Acres | % | Acres | % | | |
| Mosquito Control | D | 33,420 | 6.43 | 4,755 | 0.91 | 2 | 2L |
| Developed | D | 10,355 | 1.99 | 518 | 0.10 | 2 | 2L |
| Cotton | D | 8,857 | 1.7 | 8,093 | 1.56 | 2 | 2L |
| Corn | D | 6,529 | 1.26 | 585 | 0.11 | 2 | 2L |
| Other Crops | D | 479 | 0.09 | 0 | 0 | 2 | 2L |
| Wheat | D | 231 | 0.04 | 154 | 0.03 | 2 | 2L |
| Other Grains | D | 139 | 0.03 | 155 | 0.03 | 2 | 2L |
| Nurseries | D | 85 | 0.02 | 85 | 0.02 | 2 | 2L |
| Vegetables & Ground Fruit | D | 26 | < 0.01 | 21 | < 0.01 | 2 | 2L |
| Pasture | D | 9 | < 0.01 | 9 | < 0.01 | 2 | 2L |
| Other Row Crops | D | 8 | < 0.01 | 10 | < 0.01 | 2 | 2L |
| Orchards & Vineyards | D | 4 | < 0.01 | 4 | < 0.01 | 2 | 2L |
| **Sub-TOTAL (D):** *Other uses with direct effects*[3] | | 26,723 | 5.17 | 9,633 | 1.90 | | |
| **Sub-TOTAL (I):** *Other uses with indirect effects*[3] | | 0 | 0 | 0 | 0 | | |
| **TOTAL[4]:** | | 60,143 | 11.60 | 14,388 | 2.81 | | |

^Species only occurs in bin 2.

**# acres in species range:** 519,997 acres
**% of range in California (i.e., where CalPUR data is available):** 0%
**Range overlap with Federal lands:** 147,515 acres, 28.368%

**Overall Usage:** ☐ **High** ☐ **Medium** ☒ **Low**

***CONSERVATION MEASURES***

**Rain restriction:** Given the relatively short half-life of malathion and rapid degradation via hydrolysis and other processes, persistence of malathion in storm run-off into most aquatic habitats is not anticipated to last longer than 48 hours under typical pH values, (i.e., 6.5-8.5) and water temperatures corresponding to growing season. Restricting malathion application to periods where rain is not forecasted for at least 48 hours or when the soil is not saturated will provide time for the pesticide to degrade before runoff into aquatic habitats can occur, decreasing exposure and risk.

[1] Direct effects (D), Indirect effects (I), No effects expected (N), Use site not utilized by the species (*)
[2] Estimated usage in the range is based on information about annual past usage.
[3] Mosquito control has the potential to overlap with other uses. It is not included in the Sub-TOTALs.
[4] TOTAL includes usage on all use sites with effects, including mosquito control.

**Aquatic habitat buffers:** Application buffers, which specify on the label a distance from water bodies where pesticides are not to be applied, are designed to reduce spray drift from entering sensitive non-target areas, thereby providing protection to aquatic species. While the exact amount of spray drift reduction depends on the physical traits of the aquatic ecosystem (e.g., flow rate, volume, etc.) as well as the application method, we can expect (based on AgDRIFT modeling) spray drift reductions ranging from 40 to 91%, with low flow and low volume aquatic habitats receiving the most reduction in spray drift deposition. In many cases, these buffers substantially reduce exposure to aquatic organisms and subsequent risk of direct and indirect effects.

**Residential use label changes:** New restrictions to the method and frequency of application for residential use of malathion are expected to substantially reduce exposure to species that overlap with developed and open space developed areas. Label changes will ensure that residential use is limited to spot treatments only (rendering spray drift offsite unlikely) and reducing the extent of area which can be treated in the developed and open space developed areas by as much as 75% or more from modeled values. In addition, we expect the frequency of exposure to decrease as the number of allowable applications is reduced from "repeat as necessary" to a maximum of 2–4 applications per year (depending on the specific residential use). Retreatment intervals of 7-10 days between any repeated applications are expected to reduce environmental concentrations by allowing any initial residues to degrade prior to the next application. In addition, exposure to aquatic organisms is reduced due to buffers from waterways, which specify on the label a distance from water bodies where pesticides are not to be applied, and restrictions to application during periods where rain is not forecasted within 24 hours or when the soil is not saturated.

**Reduced application number and rate:** New restrictions on corn, cotton, orchards and vineyards, pasture, other crops, and vegetables and ground fruit lower the maximum allowable number of applications to 2-4 per year (depending on the specific crop; previous allowable numbers of applications ranged from 3 to 13 applications per year). This will help reduce the amount of malathion used and decrease potential exposure to the species, thus decreasing the risk of both indirect and direct effects to the species.

---

***CONCLUSION***

After reviewing the current status of the species, the environmental baseline for the action area, the effects of the proposed registration of malathion, and the cumulative effects, it is the Service's biological opinion that the registration of malathion, as proposed, with the implementation of the general conservation measures described above, is not likely to jeopardize the continued existence of the Lacy elimia (snail). As discussed below, the vulnerability is high for this species, the risk and likelihood of exposure to malathion is low, and the implementation of the general conservation measures described above is expected to further reduce the likelihood of exposure.

The Lacy elimia (snail) has a high vulnerability based on its status, distribution, and trends, as described above. The lacey elimia inhabits shoals, rapids and riffles of large streams and rivers above the Fall Line in Alabama. The recovery plan (USFWS 2005) listed three extant

populations of lacy elimia: Cheaha, Emauhee, and Weewoka Creeks all in Talladega County, Alabama. Successive surveys have failed to document a population in Emauhee or Weewoka (Pierson and Pursifull 2006), and the lacy elimia is currently only known to persist in Cheaha Creek (Pierson and Pursifull 2006, P. Johnson pers. comm. 2015).

The risk to the species from labeled uses across the range is expected to be low as we do not anticipate any measurable effects from malathion exposure to individuals, including mortality or sublethal effects to growth, reproduction, or behavior. There may be potential effects to the species' food base (e.g., algae, plants, detritus), however these effects are expected to be small and will not likely result in adverse effects to snails.

About 28% of the species range is on Federal lands where we expect any adverse effects would be minimal, considering the small scale and low levels of past malathion usage on Federal lands, and in light of Federal agency programs that are designed to understand, avoid, and minimize the effects to listed species (see the Approach to Usage section of the Opinion). We anticipate usage within the range will be low (2.81%, expected to occur on the non-Federal portion), based primarily on the standard usage data we acquired, as described in the Opinion and summarized for this species above. Conservation measures, such as rain restrictions, aquatic habitat buffers, changes to residential use labels, and reduced allowable application numbers and application rates, are expected to substantially reduce the environmental concentrations of malathion in the species' range, reducing the risk of exposure.

Due to the lack of measurable effects to individuals, including mortality and sublethal effects, the lack of appreciable effects to its food base and habitat, the low level of expected usage, and the incorporation of conservation measures that would further reduce the risk of exposure, we anticipate minimal, if any, adverse effects (i.e., not enough to result in take) will occur throughout the duration of the action. Therefore, we do not anticipate that the proposed action would appreciably reduce survival and recovery of the Lacy elimia (snail) in the wild.

**Conclusion:** Not likely to jeopardize

***ADDITIONAL REFERENCES***

U.S. Fish and Wildlife Service. 2005. Recovery Plan for 6 Mobile River Basin Aquatic Snails. Jackson, Mississippi. pp. 70

**Integration and Synthesis Summary: Snails *(Aquatic)***

| Scientific Name: | Common Name: | Entity ID: |
|---|---|---|
| *Lioplax cyclostomaformis* | Cylindrical lioplax (snail) | 412 |

***VULNERABILITY***
***(Summary of status, environmental baseline and cumulative effects)***

**Status:** Endangered
**Distribution:** Small, endemic, constrained, and/or isolated population(s)
**Number of Populations:** Multiple populations (few)
**Species Trends:** Unknown population trends
**Pesticides noted** ☐

**Environmental Baseline/Cumulative Effects (EB/CE) Summary:**
The cylindrical lioplax inhabits shoals, rapids and riffles of large streams and rivers above the Fall Line in Alabama. Like other members of the family Viviparidae, the cylindrical lioplax gives live birth (young hatch internally and born as juveniles) and may live 3 to 11 years (Service 2005). The cylindrical lioplax lives in the mud under large rocks in rapid shoal currents.

It continues to experience significant curtailment of its historical range and habitat. Deterioration of water and habitat quality through non-point source pollution continues to affect the surviving populations. In addition to the Cahaba River populations in Shelby and Bibb counties indentified in the recovery plan (Service 2005), three additional populations of cylindrical lioplax have been discovered: Yellowleaf Creek, Shelby County, Alabama (Johnson 2006); Choccolocco Creek, Talladega County, Alabama (A. Ford pers. obs. 2014); and the lower Little Cahaba River, Bibb County, Alabama (Johnson 2012). Its limited distributions and small populations render the species vulnerable to random natural or human-induced events such as droughts or spills. Many roads and railroad crossings dissect the rivers and streams that support these snails and a random toxic spill could have dramatic impacts on the survival of impacted populations. A Total Maximum Daily Load (TMDL) for phosphorous and siltation has been established for the Cahaba River above the Fall Line, and for E. coli between U.S. Highway 208, in Jefferson County, to Shades Creek, in Shelby County, Alabama (ADEM 2014). TMDL's for fecal coliform, siltation, and turbidity have also been prepared for Shades Creek from its source to its confluence with the Cahaba River (EPA 2003, 2004). A TMDL for phosphorous and siltation has been established for the Cahaba River above the Fall Line, and for *E. coli* between U.S. Highway 208 in Jefferson County to Shades Creek in Shelby County, Alabama (ADEM 2014). Reducing pollutants in the Cahaba will likely benefit the cylindrical lioplax, flat pebblesnail, and round rocksnail. TMDL's for fecal coliform, siltation, and turbidity have also been prepared for Shades Creek from its source to its confluence with the Cahaba River (EPA 2003, 2004). TMDL's have been prepared for organic enrichment/dissolved oxygen and nutrients within Lay Lake, Buxahatchee Creek, and Watson Creek (ADEM 1996, 2008). The 2014 303(d) list identifies Choccolocco Creek and Lay Lake as impaired for metals (mercury) and priority organics

(PCBs). The affected section in the 303(d) listing begins at the confluence of an unnamed tributary near Boiling Springs, and goes downstream to its confluence with the Coosa River. This stretch of Choccolocco Creek supports a newly rediscovered population of cylindrical lioplax (P. Johnson pers. comm. 2010).

**EB/CE Source:** U. S. Fish and Wildlife Service. 2016. Cylindrical Lioplax (Lioplax cyclostomaformis) Flat Pebblesnail (*Lepyrium showalteri*) Plicate Rocksnail (*Leptoxis plicata*) Painted Rocksnail (*Leptoxis taeniata*) Round Rocksnail (*Leptoxis ampla*) Lacy Elimia (*Elimia crenatella*) 5-Year Review: Summary and Evaluation. Alabama Ecological Services Field Office, Daphne, Alabama. 39 pp.

**Overall Vulnerability:** ☒ **High** ☐ **Medium** ☐ **Low**

***RISK***
***(Risk is based on species exposure and response from labeled uses across the range)***

**Risk to individuals if exposed:** We do not anticipate effects to the species from exposure to malathion at labeled use rates.

**Risk to the species from labeled uses across the range:**
The table below summarizes the risk to the species from labeled uses across the range based on range overlaps with use sites and anticipated effects associated with the particular uses.

| ALL USES except mosquito control | |
|---|---|
| Mortality | no effects expected |
| MOSQUITO CONTROL | |
| Mortality | no effects expected |

**Risk modifiers:** Habitat for the cylindrical lioplax is unusual for the genus, as well as for other genera of viviparid snails. It lives in isolated mud deposits found under large rocks in the rapid flowing sections of stream and river shoals. Other lioplax species are usually found along the margins of rivers in exposed muddy substrates (USFWS, 2005). High site fidelity, low tolerance ranges/thresholds and narrow/specialist environmental specificity are inferred based on strict habitat needs (inferred from USFWS, 2005).

As described in the "Approach to the Effects Analysis" section of the main body of the Opinion, we made specific considerations for species that occur in bins 3 and 4 as they were modeled in such a way that likely resulted in overestimation of estimated environmental concentrations, thus overestimating potential exposure. While the Cylindrical lioplax (snail) does occupy other aquatic habitats that contain higher concentrations of malathion (e.g., bin 2), individuals of the species that occupy habitats with higher flow rates (e.g., bins 3 and 4) will experience lower exposure than those occupying low flow areas, reducing the risk of effects across the species in general.

**Overall Risk:** ☐ **High** ☐ **Medium** ☒ **Low**

***USAGE***
***(Anticipated usage within the range based on past usage data)***

| Use type | Risk to species[1] | Use overlap with range | | Estimated usage in range[2] | | Bins associated with use type^ | Effect associated with bin (H, M, L) |
|---|---|---|---|---|---|---|---|
| | | Acres | % | Acres | % | | |
| Mosquito Control | D,I | 408,602 | 33.99 | 9,267 | 0.77 | 2,3,4 | 2L<br>3L<br>4L |
| Developed | D,I | 69,826 | 5.8 | 3,491 | 0.29 | 2,3,4 | 2L<br>3L<br>4L |
| Cotton | D,I | 6,234 | 0.52 | 5,771 | 0.48 | 2,3,4 | 2L<br>3L<br>4L |
| Corn | D,I | 4000 | 0.33 | 585 | 0.05 | 2,3,4 | 2L<br>3L<br>4L |
| Other Crops | D,I | 884 | 0.07 | 0 | 0 | 2,3,4 | 2L<br>3L<br>4L |
| Nurseries | D,I | 296 | 0.02 | 296 | 0.02 | 2,3,4 | 2L<br>3L<br>4L |
| Wheat | D,I | 147 | 0.01 | 80 | < 0.01 | 2,3,4 | 2L<br>3L<br>4L |
| Other Grains | D,I | 105 | < 0.01 | 105 | < 0.01 | 2,3,4 | 2L<br>3L<br>4L |
| Vegetables & Ground Fruit | D,I | 48 | < 0.01 | 41 | < 0.01 | 2,3,4 | 2L<br>3L<br>4L |
| Orchards & Vineyards | D,I | 41 | < 0.01 | 35 | < 0.01 | 2,3,4 | 2L<br>3L<br>4L |
| Other Row Crops | D,I | 18 | < 0.01 | 18 | < 0.01 | 2,3,4 | 2L<br>3L<br>4L |
| Pasture | D,I | 1 | < 0.01 | 1 | < 0.01 | 2,3,4 | 2L<br>3L<br>4L |
| **Sub-TOTAL (D):** | | 81,601 | 6.8 | 10,423 | 0.91 | | |

[1] Direct effects (D), Indirect effects (I), No effects expected (N), Use site not utilized by the species (*)
[2] Estimated usage in the range is based on information about annual past usage.

| Use type | Risk to species[1] | Use overlap with range | | Estimated usage in range[2] | | Bins associated with use type^ | Effect associated with bin (H, M, L) |
|---|---|---|---|---|---|---|---|
| | | Acres | % | Acres | % | | |
| *Other uses with direct effects*[3] | | | | | | | |
| **Sub-TOTAL (I):** *Other uses with indirect effects*[3] | | 0 | 0 | 0 | 0 | | |
| **TOTAL[4]:** | | 490,203 | 41 | 19,690 | 1.68 | | |

^We consider the bin 2 estimates as an upper bound of bin 3 & 4 exposures.

**# acres in species range:** 1,202,047 acres
**% of range in California (i.e., where CalPUR data is available):** 0%
**Range overlap with Federal lands:** 106,476 acres, 8.858%

**Overall Usage:** ☐ **High** ☐ **Medium** ☒ **Low**

***CONSERVATION MEASURES***

**Rain restriction:** Given the relatively short half-life of malathion and rapid degradation via hydrolysis and other processes, persistence of malathion in storm run-off into most aquatic habitats is not anticipated to last longer than 48 hours under typical pH values, (i.e., 6.5-8.5) and water temperatures corresponding to growing season. Restricting malathion application to periods where rain is not forecasted for at least 48 hours or when the soil is not saturated will provide time for the pesticide to degrade before runoff into aquatic habitats can occur, decreasing exposure and risk.

**Aquatic habitat buffers:** Application buffers, which specify on the label a distance from water bodies where pesticides are not to be applied, are designed to reduce spray drift from entering sensitive non-target areas, thereby providing protection to aquatic species. While the exact amount of spray drift reduction depends on the physical traits of the aquatic ecosystem (e.g., flow rate, volume, etc.) as well as the application method, we can expect (based on AgDRIFT modeling) spray drift reductions ranging from 40 to 91%, with low flow and low volume aquatic habitats receiving the most reduction in spray drift deposition. In many cases, these buffers substantially reduce exposure to aquatic organisms and subsequent risk of direct and indirect effects.

**Residential use label changes:** New restrictions to the method and frequency of application for residential use of malathion are expected to substantially reduce exposure to species that overlap with developed and open space developed areas. Label changes will ensure that residential use is limited to spot treatments only (rendering spray drift offsite unlikely) and reducing the extent of area which can be treated in the developed and open space developed areas by as much as 75% or more from modeled values. In addition, we expect the frequency of exposure to decrease as the number of allowable applications is reduced from "repeat as necessary" to a maximum of 2–

[3] Mosquito control has the potential to overlap with other uses. It is not included in the Sub-TOTALs.
[4] TOTAL includes usage on all use sites with effects, including mosquito control.

4 applications per year (depending on the specific residential use). Retreatment intervals of 7-10 days between any repeated applications are expected to reduce environmental concentrations by allowing any initial residues to degrade prior to the next application. In addition, exposure to aquatic organisms is reduced due to buffers from waterways, which specify on the label a distance from water bodies where pesticides are not to be applied, and restrictions to application during periods where rain is not forecasted within 24 hours or when the soil is not saturated.

***CONCLUSION***

After reviewing the current status of the species, the environmental baseline for the action area, the effects of the proposed registration of malathion, and the cumulative effects, it is the Service's biological opinion that the registration of malathion, as proposed, with the implementation of the general conservation measures described above, is not likely to jeopardize the continued existence of the Cylindrical lioplax (snail). As discussed below, the vulnerability is high for this species, the risk and likelihood of exposure to malathion is low, and the implementation of the general conservation measures described above is expected to further reduce the likelihood of exposure.

The Cylindrical lioplax (snail) has a high vulnerability based on its status, distribution, and trends, as described above. The cylindrical lioplax inhabits shoals, rapids and riffles of large streams and rivers above the Fall Line in Alabama. Its limited distributions and small populations render the species vulnerable to random natural or human-induced events such as droughts or spills.

The risk to the species from labeled uses across the range is expected to be low as we do not anticipate any measurable effects from malathion exposure to individuals, including mortality or sublethal effects to growth, reproduction, or behavior. There may be potential effects to the species' food base (e.g., algae, plants, detritus), however these effects are expected to be small and will not likely result in adverse effects to snails.

About 9% of the species range is on Federal lands where we expect any adverse effects would be minimal, considering the small scale and low levels of past malathion usage on Federal lands, and in light of Federal agency programs that are designed to understand, avoid, and minimize the effects to listed species (see the Approach to Usage section of the Opinion). We anticipate usage within the range will be low (1.68%, expected to occur on the non-Federal portion), based primarily on the standard usage data we acquired, as described in the Opinion and summarized for this species above. Additionally, conservation measures, such as rain restrictions, aquatic habitat buffers, and changes to residential use labels, are expected to substantially reduce environmental concentrations of malathion within the species' range, reducing the risk of exposure.

Due to the lack of measurable effects to individuals, including mortality and sublethal effects, the lack of appreciable effects to its food base and habitat, the low level of expected usage, and the incorporation of conservation measures that would further reduce the risk of exposure, we anticipate minimal, if any, adverse effects (i.e., not enough to result in take) will occur throughout the duration of the action. Therefore, we do not anticipate that the proposed action would appreciably reduce survival and recovery of the Cylindrical lioplax (snail) in the wild.

**Conclusion:** Not likely to jeopardize

**Integration and Synthesis Summary: Snails *(Aquatic)***

| Scientific Name: | Common Name: | Entity ID: |
|---|---|---|
| *Lepyrium showalteri* | Flat pebblesnail | 413 |

***VULNERABILITY***
***(Summary of status, environmental baseline and cumulative effects)***

**Status:** Endangered
**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** ☐

**Environmental Baseline/Cumulative Effects (EB/CE) Summary:**
Although there has been some progress in recovery efforts for the flat pebblesnail, the species remains vulnerable to habitat and water quality deterioration. The flat pebblesnail is a small snail in the family Lithoglyphidae, but with a comparatively large and distinct shell, relative to other hydrobiid snails. The flat pebblesnail is thought to be annual species, and its eggs are laid in capsules on hard surfaces. The flat pebblesnail can be found attached to clean, smooth stones in rapid shoal currents, where they also lay their eggs (Service 2005).

Its limited distribution and small populations render the species vulnerable to random natural or human-induced events such as droughts or spills. Many roads and railroad crossings dissect the rivers and streams that support these snails and a random toxic spill could have dramatic impacts on the survival of impacted populations. A Total Maximum Daily Load (TMDL) for phosphorous and siltation has been established for the Cahaba River above the Fall Line, and for E. coli between U.S. Highway 208, in Jefferson County, to Shades Creek, in Shelby County, Alabama (ADEM 2014). TMDL's for fecal coliform, siltation, and turbidity have also been prepared for Shades Creek from its source to its confluence with the Cahaba River (EPA 2003, 2004). A TMDL for phosphorous and siltation has been established for the Cahaba River above the Fall Line, and for E. coli between U.S. Highway 208, in Jefferson County, to Shades Creek, in Shelby County, Alabama (ADEM 2014). TMDL's for fecal coliform, siltation, and turbidity have also been prepared for Shades Creek from its source to its confluence with the Cahaba River (EPA 2003, 2004). TMDL's have been prepared for organic enrichment/dissolved oxygen and nutrients within Lay Lake, Buxahatchee Creek, and Watson Creek (ADEM 1996, 2008). The flat pebblesnail has been extended several miles in the Cahaba River and its tributary populations (e.g., Little Cahaba, Shades Creek). The flat pebblesnail has been successfully propagated in a hatchery, and experimental attempts have been made to reintroduce the species into historically occupied habitats.

**EB/CE Source:** U. S. Fish and Wildlife Service. 2016. Cylindrical Lioplax (*Lioplax cyclostomaformis*) Flat Pebblesnail (*Lepyrium showalteri*) Plicate Rocksnail (*Leptoxis plicata*)

Painted Rocksnail (*Leptoxis taeniata*) Round Rocksnail (*Leptoxis ampla*) Lacy Elimia (*Elimia crenatella*) 5-Year Review: Summary and Evaluation. Alabama Ecological Services Field Office, Daphne, Alabama. 39 pp.

**Overall Vulnerability: ☒ High ☐ Medium ☐ Low**

***RISK***
***(Risk is based on species exposure and response from labeled uses across the range)***

**Risk to individuals if exposed:** We do not anticipate effects to the species from exposure to malathion at labeled use rates.

**Risk to the species from labeled uses across the range:**
The table below summarizes the risk to the species from labeled uses across the range based on range overlaps with use sites and anticipated effects associated with the particular uses.

| ALL USES except mosquito control | |
|---|---|
| Mortality | no effects expected |
| MOSQUITO CONTROL | |
| Mortality | no effects expected |

**Risk modifiers:** Allowable uses driving effects/other considerations: The flat pebblesnail is found attached to clean, smooth stones in rapid currents of river shoals (USFWS, 2005). High site fidelity, low tolerance ranges/thresholds and narrow/ specialist environmental specificity are inferred based on strict habitat needs as is clumped spatial arrangement (USFWS, 2005; NatureServe, 2015).

As described in the "Approach to the Effects Analysis" section of the main body of the Opinion, we made specific considerations for species that occur in bins 3 and 4, and they were modeled in such a way that likely resulted in overestimation of estimated environmental concentrations, thus overestimating potential exposure. While the Flat pebblesnail does occupy other aquatic habitats that contain higher concentrations of malathion (e.g., bin 2), individuals of the species that occupy habitats with higher flow rates (e.g., bins 3 and 4) will experience lower exposure than those occupying low flow areas, reducing the risk of effects across the species in general.

**Overall Risk: ☐ High ☐ Medium ☒ Low**

***USAGE***
***(Anticipated usage within the range based on past usage data)***

| Use type | Risk to species[1] | Use overlap with range | | Estimated usage in range[2] | | Bins associated with use type^ | Effect associated with bin (H, M, L) |
|---|---|---|---|---|---|---|---|
| | | Acres | % | Acres | % | | |
| Mosquito Control | D | 134,737 | 24.7 | 5,467 | 1 | 2,3,4 | 2L<br>3L<br>4L |
| Developed | D | 33,082 | 6.07 | 1,654 | 0.3 | 2,3,4 | 2L<br>3L<br>4L |
| Corn | D | 330 | 0.06 | 9754 | 0.02 | 2,3,4 | 2L<br>3L<br>4L |
| Cotton | D | 282 | 0.05 | 181 | 0.03 | 2,3,4 | 2L<br>3L<br>4L |
| Other Crops | D | 234 | 0.04 | 0 | 0 | 2,3,4 | 2L<br>3L<br>4L |
| Nurseries | D | 92 | 0.02 | 92 | 0.02 | 2,3,4 | 2L<br>3L<br>4L |
| Orchards & Vineyards | D | 32 | < 0.01 | 28 | < 0.01 | 2,3,4 | 2L<br>3L<br>4L |
| Other Grains | D | 18 | < 0.01 | 18 | < 0.01 | 2,3,4 | 2L<br>3L<br>4L |
| Other Row Crops | D | 12 | < 0.01 | 12 | < 0.01 | 2,3,4 | 2L<br>3L<br>4L |
| Wheat | D | 11 | < 0.01 | 7 | < 0.01 | 2,3,4 | 2L<br>3L<br>4L |
| Vegetables & Ground Fruit | D | 7 | < 0.01 | 7 | < 0.01 | 2,3,4 | 2L<br>3L<br>4L |
| **Sub-TOTAL (D):** *Other uses with direct effects*[3] | | 34,101 | 6.29 | 2096 | 0.43 | | |
| **Sub-TOTAL (I):** *Other uses with indirect effects*[3] | | 0 | 0 | 0 | 0 | | |
| **TOTAL[4]:** | | 168,838 | 30.99 | 7,563 | 1.43 | | |

^We consider the bin 2 estimates as an upper bound of bin 3 & 4 exposures.

[1] Direct effects (D), Indirect effects (I), No effects expected (N), Use site not utilized by the species (*)
[2] Estimated usage in the range is based on information about annual past usage.
[3] Mosquito control has the potential to overlap with other uses. It is not included in the Sub-TOTALs.
[4] TOTAL includes usage on all use sites with effects, including mosquito control.

**# acres in species range:** 545,293 acres
**% of range in California (i.e., where CalPUR data is available):** 0%
**Range overlap with Federal lands:** 12,606 acres, 2.312%

**Overall Usage:** ☐ **High** ☐ **Medium** ☒ **Low**

***CONSERVATION MEASURES***

**Rain restriction:** Given the relatively short half-life of malathion and rapid degradation via hydrolysis and other processes, persistence of malathion in storm run-off into most aquatic habitats is not anticipated to last longer than 48 hours under typical pH values, (i.e., 6.5-8.5) and water temperatures corresponding to growing season. Restricting malathion application to periods where rain is not forecasted for at least 48 hours or when the soil is not saturated will provide time for the pesticide to degrade before runoff into aquatic habitats can occur, decreasing exposure and risk.

**Aquatic habitat buffers:** Application buffers, which specify on the label a distance from water bodies where pesticides are not to be applied, are designed to reduce spray drift from entering sensitive non-target areas, thereby providing protection to aquatic species. While the exact amount of spray drift reduction depends on the physical traits of the aquatic ecosystem (e.g., flow rate, volume, etc.) as well as the application method, we can expect (based on AgDRIFT modeling) spray drift reductions ranging from 40 to 91%, with low flow and low volume aquatic habitats receiving the most reduction in spray drift deposition. In many cases, these buffers substantially reduce exposure to aquatic organisms and subsequent risk of direct and indirect effects.

**Residential use label changes:** New restrictions to the method and frequency of application for residential use of malathion are expected to substantially reduce exposure to species that overlap with developed and open space developed areas. Label changes will ensure that residential use is limited to spot treatments only (rendering spray drift offsite unlikely) and reducing the extent of area which can be treated in the developed and open space developed areas by as much as 75% or more from modeled values. In addition, we expect the frequency of exposure to decrease as the number of allowable applications is reduced from “repeat as necessary” to a maximum of 2–4 applications per year (depending on the specific residential use). Retreatment intervals of 7-10 days between any repeated applications are expected to reduce environmental concentrations by allowing any initial residues to degrade prior to the next application. In addition, exposure to aquatic organisms is reduced due to buffers from waterways, which specify on the label a distance from water bodies where pesticides are not to be applied, and restrictions to application during periods where rain is not forecasted within 24 hours or when the soil is not saturated.

***CONCLUSION***

After reviewing the current status of the species, the environmental baseline for the action area, the effects of the proposed registration of malathion, and the cumulative effects, it is the

Service's biological opinion that the registration of malathion, as proposed, with the implementation of the general conservation measures described above, is not likely to jeopardize the continued existence of the Flat pebblesnail. As discussed below, the vulnerability is high for this species, the risk and likelihood of exposure to malathion is low, and the implementation of the general conservation measures described above is expected to further reduce the likelihood of exposure.

The Flat pebblesnail has a high vulnerability based on its status, distribution, and trends, as described above. The flat pebblesnail is a small snail in the family Lithoglyphidae, but with a comparatively large and distinct shell, relative to other hydrobiid snails. Its limited distribution and small populations render the species vulnerable to random natural or human-induced events such as droughts or spills.

The risk to the species from labeled uses across the range is expected to be low as we do not anticipate any measurable effects from malathion exposure to individuals, including mortality or sublethal effects to growth, reproduction, or behavior. There may be potential effects to the species' food base (e.g., algae, plants, detritus), however these effects are expected to be small and will not likely result in adverse effects to snails.

We anticipate usage within the range will be low (1.43%), based primarily on the standard usage data we acquired, as described in the Opinion and summarized for this species above. Additionally, conservation measures, such as rain restrictions, aquatic habitat buffers, and changes to residential use labels, are expected to substantially reduce environmental concentrations of malathion within the species' range, further reducing the risk of exposure.

Due to the low level of mortality of individuals anticipated to result from exposure to malathion, the lack of appreciable effects to its food base and habitat, low expected usage within the range, as well as the incorporation of conservation measures that would further reduce the risk of exposure, we do not anticipate adverse effects to occur over the duration of the proposed action. Therefore, we do not anticipate that the proposed action would appreciably reduce survival and recovery of the Flat pebblesnail in the wild.

**Conclusion:** Not likely to jeopardize

**Integration and Synthesis Summary: Snails *(Aquatic)***

| Scientific Name: | Common Name: | Entity ID: |
|---|---|---|
| *Leptoxis taeniata* | Painted rocksnail | 414 |

***VULNERABILITY***
***(Summary of status, environmental baseline and cumulative effects)***

**Status:** Threatened
**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** ☐

**Environmental Baseline/Cumulative Effects (EB/CE) Summary:**
Painted rocksnails are gill breathing snails found attached to cobble, gravel, or other hard substrates in the strong currents of riffles (a shallow area in a streambed that causes ripples in the water) and shoals. Adult rocksnails move very little, and females probably glue their eggs to stones in the same habitat (Goodrich, 1922). Longevity in the painted rocksnail is unknown; however, Heller (1990) reported a short life span (less than 2 years) in a Tennessee River rocksnail. The painted rocksnail had the largest range of any rocksnail in the Mobile River Basin (Goodrich, 1922). It was historically known from the Coosa River and tributaries from the northeastern corner of St. Clair County, Alabama, downstream into the mainstem of the Alabama River to Claiborne, Monroe County, Alabama, and the Cahaba River below the Fall Line in Perry and Dallas counties, Alabama (Goodrich, 1922, Burch, 1989). Surveys by Service biologists and others (Bogan and Pierson, 1993a, 1993b; M. Pierson, in litt., 1993) in the Cahaba River, unimpounded portions of the Alabama River, and a number of free-flowing Coosa River tributaries have located only three localized Coosa River drainage populations. The painted rocksnail is currently known from the lower reaches of three Coosa River tributaries--Choccolocco Creek, Talladega County; Buxahatchee Creek, Shelby County (Bogan and Pierson, 1993a); and Ohatchee Creek, Calhoun County, Alabama (Pierson in litt., 1993). The status of the Ohatchee Creek population is not presently known, as the species has not documented in the creek since the early 1990's (P. Johnson pers. comm. 2015). However, two new populations have been discovered since publication of the recovery plan: the Coosa River below Logan Martin Dam near Buzzard's Island, Shelby County, Alabama, and lower Watson Creek upstream of the confluence within Buxahatchee Creek, Shelby County, Alabama (P. Johnson pers. comm. 2015).

Dams have changed this system from a continuum of free-flowing riverine habitats into a series of impoundments connected by short, free-flowing reaches and the painted rocksnail has disappeared from more than 90 percent of its historic range. Dams change such areas by eliminating or reducing currents, and allowing sediments to accumulate on inundated channel habitats. Impounded waters also experience changes in water chemistry which could affect survival or reproduction of riverine snails. Dams also form barriers to snail movement, isolating

the snail populations. Unable to emigrate, the isolated snail populations are vulnerable to local discharges as well as any detrimental land surface runoff within their watersheds. In addition to point and nonpoint source pollution, excessive sediments are believed to impact riverine snails requiring clean, hard shoal stream and river bottoms, by making the habitat unsuitable for feeding or reproduction. The painted rocksnail currently survives in localized reaches of three other Coosa River tributaries, Choccolocco, Buxahatchee, and Ohatchee Creeks that are impacted by sediments and nutrients from a variety of upstream rural, suburban, and/or urban sources. Because of their small sizes and limited flows, their water and habitat quality can be rapidly affected by local and off site pollution sources.

**EB/CE Sources:** U.S. Fish and Wildlife Service. 2005. Recovery Plan for 6 Mobile River Basin Aquatic Snails. U.S. Fish and Wildlife Service, Jackson, Mississippi. pp. 70.

U. S. Fish and Wildlife Service. 2016. Cylindrical Lioplax (*Lioplax cyclostomaformis*) Flat Pebblesnail (*Lepyrium showalteri*) Plicate Rocksnail (*Leptoxis plicata*) Painted Rocksnail (*Leptoxis taeniata*) Round Rocksnail (*Leptoxis ampla*) Lacy Elimia (*Elimia crenatella*) 5-Year Review: Summary and Evaluation. Alabama Ecological Services Field Office, Daphne, Alabama. 39 pp.

**Overall Vulnerability:** ☒ **High** ☐ **Medium** ☐ **Low**

***RISK***
***(Risk is based on species exposure and response from labeled uses across the range)***

**Risk to individuals if exposed:** We do not anticipate effects to the species from exposure to malathion at labeled use rates.

**Risk to the species from labeled uses across the range:**
The table below summarizes the risk to the species from labeled uses across the range based on range overlaps with use sites and anticipated effects associated with the particular uses.

| ALL USES except mosquito control | |
|---|---|
| Mortality | no effects expected |
| MOSQUITO CONTROL | |
| Mortality | no effects expected |

**Risk modifiers:** Painted rocksnails are gill breathing snails found attached to cobble, gravel, or other hard substrates in the strong currents of riffles (a shallow area in a streambed that causes ripples in the water) and shoals (USFWS, 2005; NatureServe, 2015). High site fidelity, low tolerance ranges/thresholds and narrow/ specialist environmental specificity are inferred based on strict habitat needs (USFWS, 2005; NatureServe, 2015).

As described in the "Approach to the Effects Analysis" section of the main body of the Opinion, we made specific considerations for species that occur in bins 3 and 4 as they were modeled in such a way that likely resulted in overestimation of estimated environmental concentrations, thus

overestimating potential exposure. While the Painted rocksnail does occupy other aquatic habitats that contain higher concentrations of malathion (e.g., bin 2), individuals of the species that occupy habitats with higher flow rates (e.g., bins 3 and 4) will experience lower exposure than those occupying low flow areas, reducing the risk of effects across the species in general.

**Overall Risk: ☐ High ☐ Medium ☒ Low**

***USAGE***
***(Anticipated usage within the range based on past usage data)***

| Use type | Risk to species[1] | Use overlap with range | | Estimated usage in range[2] | | Bins associated with use type^ | Effect associated with bin (H, M, L) |
|---|---|---|---|---|---|---|---|
| | | Acres | % | Acres | % | | |
| Mosquito Control | D | 551,747 | 55.6 | 18,167 | 1.83 | 2,3,4 | 2L<br>3L<br>4L |
| Developed | D | 37,705 | 3.8 | 1,885 | 0.19 | 2,3,4 | 2L<br>3L<br>4L |
| Cotton | D | 10,144 | 1.02 | 9,124 | 0.92 | 2,3,4 | 2L<br>3L<br>4L |
| Corn | D | 7,231 | 0.73 | 585 | 0.06 | 2,3,4 | 2L<br>3L<br>4L |
| Other Crops | D | 1,101 | 0.11 | 0 | 0 | 2,3,4 | 2L<br>3L<br>4L |
| Nurseries | D | 802 | 0.08 | 802 | 0.08 | 2,3,4 | 2L<br>3L<br>4L |
| Wheat | D | 184 | 0.02 | 136 | 0.01 | 2,3,4 | 2L<br>3L<br>4L |
| Other Grains | D | 163 | 0.02 | 163 | 0.02 | 2,3,4 | 2L<br>3L<br>4L |
| Vegetables & Ground Fruit | D | 59 | < 0.01 | 51 | < 0.01 | 2,3,4 | 2L<br>3L<br>4L |
| Orchards & Vineyards | D | 26 | < 0.01 | 18 | < 0.01 | 2,3,4 | 2L<br>3L<br>4L |

[1] Direct effects (D), Indirect effects (I), No effects expected (N), Use site not utilized by the species (*)
[2] Estimated usage in the range is based on information about annual past usage.

| Use type | Risk to species[1] | Use overlap with range | | Estimated usage in range[2] | | Bins associated with use type^ | Effect associated with bin (H, M, L) |
|---|---|---|---|---|---|---|---|
| | | Acres | % | Acres | % | | |
| Other Row Crops | D | 13 | < 0.01 | 13 | < 0.01 | 2,3,4 | 2L<br>3L<br>4L |
| Pasture | D | 3 | < 0.01 | 3 | < 0.01 | 2,3,4 | 2L<br>3L<br>4L |
| Christmas Trees | D | <1 | < 0.01 | <1 | < 0.01 | 2,3,4 | 2L<br>3L<br>4L |
| **Sub-TOTAL (D):** *Other uses with direct effects*[3] | | 57,430 | 5.83 | 12,780 | 1.34 | | |
| **Sub-TOTAL (I):** *Other uses with indirect effects*[3] | | 0 | 0 | 0 | 0 | | |
| **TOTAL[4]:** | | 609,177 | 61.43 | 30,947 | 3.17 | | |

^We consider the bin 2 estimates as an upper bound of bin 3 & 4 exposures.

**# acres in species range:** 993,025 acres
**% of range in California (i.e., where CalPUR data is available):** 0%
**Range overlap with Federal lands:** 47,100 acres, 4.743%

**Overall Usage:** ☐ **High** ☐ **Medium** ☒ **Low**

***CONSERVATION MEASURES***

**Rain restriction:** Given the relatively short half-life of malathion and rapid degradation via hydrolysis and other processes, persistence of malathion in storm run-off into most aquatic habitats is not anticipated to last longer than 48 hours under typical pH values, (i.e., 6.5-8.5) and water temperatures corresponding to growing season. Restricting malathion application to periods where rain is not forecasted for at least 48 hours or when the soil is not saturated will provide time for the pesticide to degrade before runoff into aquatic habitats can occur, decreasing exposure and risk.

**Aquatic habitat buffers:** Application buffers, which specify on the label a distance from water bodies where pesticides are not to be applied, are designed to reduce spray drift from entering sensitive non-target areas, thereby providing protection to aquatic species. While the exact amount of spray drift reduction depends on the physical traits of the aquatic ecosystem (e.g., flow rate, volume, etc.) as well as the application method, we can expect (based on AgDRIFT modeling) spray drift reductions ranging from 40 to 91%, with low flow and low volume aquatic habitats receiving the most reduction in spray drift deposition. In many cases,

[3] Mosquito control has the potential to overlap with other uses. It is not included in the Sub-TOTALs.
[4] TOTAL includes usage on all use sites with effects, including mosquito control.

these buffers substantially reduce exposure to aquatic organisms and subsequent risk of direct and indirect effects.

**Residential use label changes:** New restrictions to the method and frequency of application for residential use of malathion are expected to substantially reduce exposure to species that overlap with developed and open space developed areas. Label changes will ensure that residential use is limited to spot treatments only (rendering spray drift offsite unlikely) and reducing the extent of area which can be treated in the developed and open space developed areas by as much as 75% or more from modeled values. In addition, we expect the frequency of exposure to decrease as the number of allowable applications is reduced from "repeat as necessary" to a maximum of 2–4 applications per year (depending on the specific residential use). Retreatment intervals of 7-10 days between any repeated applications are expected to reduce environmental concentrations by allowing any initial residues to degrade prior to the next application. In addition, exposure to aquatic organisms is reduced due to buffers from waterways, which specify on the label a distance from water bodies where pesticides are not to be applied, and restrictions to application during periods where rain is not forecasted within 24 hours or when the soil is not saturated.

**Reduced application number and rate:** New restrictions on corn, cotton, orchards and vineyards, pasture, other crops, and vegetables and ground fruit lower the maximum allowable number of applications to 2-4 per year (depending on the specific crop; previous allowable numbers of applications ranged from 3 to 13 applications per year). This will help reduce the amount of malathion used and decrease potential exposure to the species, thus decreasing the risk of both indirect and direct effects to the species.

---

***CONCLUSION***

After reviewing the current status of the species, the environmental baseline for the action area, the effects of the proposed registration of malathion, and the cumulative effects, it is the Service's biological opinion that the registration of malathion, as proposed, with the implementation of the general conservation measures described above, is not likely to jeopardize the continued existence of the Painted rocksnail. As discussed below, the vulnerability is high for this species, the risk and likelihood of exposure to malathion is low, and the implementation of the general conservation measures described above is expected to further reduce the likelihood of exposure.

The Painted rocksnail has a high vulnerability based on its status, distribution, and trends, as described above. The painted rocksnail is currently known from the lower reaches of three Coosa River tributaries--Choccolocco Creek, Talladega County; Buxahatchee Creek, Shelby County (Bogan and Pierson, 1993a); and Ohatchee Creek, Calhoun County, Alabama (Pierson in litt., 1993). Dams have changed this system from a continuum of free-flowing riverine habitats into a series of impoundments connected by short, free-flowing reaches and the painted rocksnail has disappeared from more than 90 percent of its historic range. Unable to emigrate, the isolated snail populations are vulnerable to local discharges as well as any detrimental land surface runoff within their watersheds.

The risk to the species from labeled uses across the range is expected to be low as we do not anticipate any measurable effects from malathion exposure to individuals, including mortality or sublethal effects to growth, reproduction, or behavior. There may be potential effects to the species' food base (e.g., algae, plants, detritus), however these effects are expected to be small and will not likely result in adverse effects to snails.

About 5% of the species range is on Federal lands where we expect any adverse effects would be minimal, considering the small scale and low levels of past malathion usage on Federal lands, and in light of Federal agency programs that are designed to understand, avoid, and minimize the effects to listed species (see the Approach to Usage section of the Opinion). We anticipate usage within the range will be low (3.17%, expected on the non-Federal portion), based primarily on the standard usage data we acquired, as described in the Opinion and summarized for this species above. Conservation measures, such as rain restrictions, aquatic habitat buffers, changes to residential use labels, and reduced allowable number of applications and application rates for agricultural crops, are expected to substantially reduce environmental concentrations of malathion within the species' range and further reduce the risk of exposure.

Due to the lack of measurable effects to individuals, including mortality and sublethal effects, the lack of appreciable effects to its food base and habitat, the low level of expected usage, and the incorporation of conservation measures that would further reduce the risk of exposure, we anticipate minimal, if any, adverse effects (i.e., not enough to result in take) will occur throughout the duration of the action. Therefore, we do not anticipate that the proposed action would appreciably reduce survival and recovery of the Painted rocksnail in the wild.

**Conclusion:** Not likely to jeopardize

**Integration and Synthesis Summary: Snails *(Aquatic)***

| Scientific Name: | Common Name: | Entity ID: |
|---|---|---|
| *Leptoxis plicata* | Plicate rocksnail | 415 |

***VULNERABILITY***
***(Summary of status, environmental baseline and cumulative effects)***

**Status:** Endangered
**Distribution:** Small, endemic, constrained, and/or isolated population(s)
**Number of Populations:** Single population
**Species Trends:** Declining population(s) – one or more populations declining
**Pesticides noted** ☐

**Environmental Baseline/Cumulative Effects (EB/CE) Summary:**
The plicate rocksnail is a member of the Pleuroceridae family, and can grow to about 20 mm (0.8 in) in length. Plicate rocksnails inhabit shallow gravel and cobble shoals in flowing waters. Their eggs are usually laid singly, but they have been observed occasionally depositing two eggs in close proximity (Whelan et al. 2015). While longevity has not been documented in the wild, specimens have reproduced for multiple years in captivity at the Atlanta Aquatic Biodiversity Center (AABC) in Marion, Alabama (Whelan et al. 2015). They reproduce for about 2 months each year (Johnson 2010) with temperatures between 24-29 degrees C (Whelan et al. 2015). The plicate rocksnail historically occurred in the Black Warrior River, the Little Warrior River, and the Tombigbee River (Goodrich, 1922). Surveys have located plicate rocksnail populations only in an approximately 88 km (55 mi) reach of the Locust Fork of the Black Warrior River, Jefferson and Blount counties, Alabama (Service Field Records, Jackson, Mississippi, 1991, 1992; Malcolm Pierson, Calera, Alabama, Field Notes, 1993). The snail disappeared from the upstream two-thirds portion of that habitat and appears to be restricted to an approximately 32 km (20 mi) reach in Jefferson County (Garner in litt., 1998, Johnson 2002). Richardson and Selby (2009) documented a downstream intrarange extension (~5km downstream of the Highway 78 crossing) for the plicate rocksnail in the Locust Fork. The plicate rocksnail has also been successfully reintroduced at the Wallstown site on the Locust Fork (Garner et al. 2014, P. Johnson pers. comm. 2015).

Dams have changed this system from a continuum of free-flowing riverine habitats into a series of impoundments connected by short, free-flowing reaches and the plicate rocksnail has disappeared from more than 90 percent of its historic range. Dams change such areas by eliminating or reducing currents, and allowing sediments to accumulate on inundated channel habitats. Impounded waters also experience changes in water chemistry which could affect survival or reproduction of riverine snails. Dams also form barriers to snail movement, isolating the snail populations. Unable to emigrate, the isolated snail populations are vulnerable to local discharges as well as any detrimental land surface runoff within their watersheds. In addition to point and nonpoint source pollution, excessive sediments are believed to impact riverine snails

requiring clean, hard shoal stream and river bottoms, by making the habitat unsuitable for feeding or reproduction. The plicate rocksnail inhabits a single short reach of the Locust Fork River in Jefferson County, Alabama (Black Warrior River drainage). This stream is impacted by sediments and nutrients from a variety of upstream rural, suburban, and/or urban sources. Because of their small sizes and limited flows, their water and habitat quality can be rapidly affected by local and off site pollution sources.

**EB/CE Sources:** U.S. Fish and Wildlife Service. 2005. Recovery Plan for 6 Mobile River Basin Aquatic Snails. Jackson, Mississippi. pp. 70.

U. S. Fish and Wildlife Service. 2016. Cylindrical Lioplax (*Lioplax cyclostomaformis*) Flat Pebblesnail (*Lepyrium showalteri*) Plicate Rocksnail (*Leptoxis plicata*) Painted Rocksnail (Leptoxis taeniata) Round Rocksnail (*Leptoxis ampla*) Lacy Elimia (*Elimia crenatella*) 5-Year Review: Summary and Evaluation. Alabama Ecological Services Field Office, Daphne, Alabama. 39 pp.

**Overall Vulnerability:** ☒ **High** ☐ **Medium** ☐ **Low**

***RISK***
***(Risk is based on species exposure and response from labeled uses across the range)***

**Risk to individuals if exposed:** We do not anticipate effects to the species from exposure to malathion at labeled use rates.

**Risk to the species from labeled uses across the range:**
The table below summarizes the risk to the species from labeled uses across the range based on range overlaps with use sites and anticipated effects associated with the particular uses.

| ALL USES except mosquito control | |
|---|---|
| Mortality | no effects expected |
| MOSQUITO CONTROL | |
| Mortality | no effects expected |

**Risk modifiers:**

As described in the "Approach to the Effects Analysis" section of the main body of the Opinion, we made specific considerations for species that occur in bins 3 and 4 as they were modeled in such a way that likely resulted in overestimation of estimated environmental concentrations, thus overestimating potential exposure. While the Plicate rocksnail does occupy other aquatic habitats that contain higher concentrations of malathion (e.g., bin 2), individuals of the species that occupy habitats with higher flow rates (e.g., bins 3 and 4) will experience lower exposure than those occupying low flow areas, reducing the risk of effects across the species in general.

**Overall Risk:** ☐ **High** ☐ **Medium** ☒ **Low**

***USAGE***
***(Anticipated usage within the range based on past usage data)***

| Use type | Risk to species[1] | Use overlap with range | | Estimated usage in range[2] | | Bins associated with use type^ | Effect associated with bin (H, M, L) |
|---|---|---|---|---|---|---|---|
| | | Acres | % | Acres | % | | |
| Mosquito Control | D | 288,270 | 49.7 | 18,167 | 3.13 | 2,3,4 | 2L<br>3L<br>4L |
| Developed | D | 12,748 | 2.2 | 637 | 0.11 | 2,3,4 | 2L<br>3L<br>4L |
| Corn | D | 673 | 0.12 | 585 | 0.1 | 2,3,4 | 2L<br>3L<br>4L |
| Cotton | D | 300 | 0.05 | 277 | 0.05 | 2,3,4 | 2L<br>3L<br>4L |
| Other Crops | D,I | 212 | 0.04 | 0 | 0 | 2,3,4 | 2L<br>3L<br>4L |
| Other Grains | D,I | 49 | < 0.01 | 29 | < 0.01 | 2,3,4 | 2L<br>3L<br>4L |
| .1Other Row Crops | D,I | 46 | < 0.01 | 46 | < 0.01 | 2,3,4 | 2L<br>3L<br>4L |
| Wheat | D,I | 19 | < 0.01 | 13 | < 0.01 | 2,3,4 | 2L<br>3L<br>4L |
| Vegetables & Ground Fruit | D,I | 17 | < 0.01 | 17 | < 0.01 | 2,3,4 | 2L<br>3L<br>4L |
| Orchards & Vineyards | D,I | 13 | < 0.01 | 13 | < 0.01 | 2,3,4 | 2L<br>3L<br>4L |
| Pasture | D,I | 4 | < 0.01 | 3 | < 0.01 | 2,3,4 | 2L<br>3L<br>4L |
| Nurseries | D,I | 2 | < 0.01 | 2 | < 0.01 | 2,3,4 | 2L<br>3L<br>4L |
| Christmas Trees | D,I | 1 | < 0.01 | 1 | < 0.01 | 2,3,4 | 2L |

[1] Direct effects (D), Indirect effects (I), No effects expected (N), Use site not utilized by the species (*)
[2] Estimated usage in the range is based on information about annual past usage.

| Use type | Risk to species[1] | Use overlap with range | | Estimated usage in range[2] | | Bins associated with use type^ | Effect associated with bin (H, M, L) |
|---|---|---|---|---|---|---|---|
| | | Acres | % | Acres | % | | |
| | | | | | | | 3L<br>4L |
| **Sub-TOTAL (D):** *Other uses with direct effects*[3] | | 14,085 | 2.49 | 1,623 | 0.34 | | |
| **Sub-TOTAL (I):** *Other uses with indirect effects*[3] | | 0 | 0 | 0 | 0 | | |
| **TOTAL[4]:** | | 302,354 | 52.19 | 19,790 | 3.47 | | |

^We consider the bin 2 estimates as an upper bound of bin 3 & 4 exposures.

**# acres in species range:** 580,298 acres
**% of range in California (i.e., where CalPUR data is available):** 0%
**Range overlap with Federal lands:** 1 acre, 0.000%

**Overall Usage:** ☐ **High** ☐ **Medium** ☒ **Low**

***CONSERVATION MEASURES***

**Rain restriction:** Given the relatively short half-life of malathion and rapid degradation via hydrolysis and other processes, persistence of malathion in storm run-off into most aquatic habitats is not anticipated to last longer than 48 hours under typical pH values, (i.e., 6.5-8.5) and water temperatures corresponding to growing season. Restricting malathion application to periods where rain is not forecasted for at least 48 hours or when the soil is not saturated will provide time for the pesticide to degrade before runoff into aquatic habitats can occur, decreasing exposure and risk.

**Aquatic habitat buffers:** Application buffers, which specify on the label a distance from water bodies where pesticides are not to be applied, are designed to reduce spray drift from entering sensitive non-target areas, thereby providing protection to aquatic species. While the exact amount of spray drift reduction depends on the physical traits of the aquatic ecosystem (e.g., flow rate, volume, etc.) as well as the application method, we can expect (based on AgDRIFT modeling) spray drift reductions ranging from 40 to 91%, with low flow and low volume aquatic habitats receiving the most reduction in spray drift deposition. In many cases, these buffers substantially reduce exposure to aquatic organisms and subsequent risk of direct and indirect effects.

**Residential use label changes:** New restrictions to the method and frequency of application for residential use of malathion are expected to substantially reduce exposure to species that overlap with developed and open space developed areas. Label changes will ensure that residential use is limited to spot treatments only (rendering spray drift offsite unlikely) and reducing the extent of

[3] Mosquito control has the potential to overlap with other uses. It is not included in the Sub-TOTALs.
[4] TOTAL includes usage on all use sites with effects, including mosquito control.

area which can be treated in the developed and open space developed areas by as much as 75% or more from modeled values. In addition, we expect the frequency of exposure to decrease as the number of allowable applications is reduced from "repeat as necessary" to a maximum of 2–4 applications per year (depending on the specific residential use). Retreatment intervals of 7-10 days between any repeated applications are expected to reduce environmental concentrations by allowing any initial residues to degrade prior to the next application. In addition, exposure to aquatic organisms is reduced due to buffers from waterways, which specify on the label a distance from water bodies where pesticides are not to be applied, and restrictions to application during periods where rain is not forecasted within 24 hours or when the soil is not saturated.

***CONCLUSION***

After reviewing the current status of the species, the environmental baseline for the action area, the effects of the proposed registration of malathion, and the cumulative effects, it is the Service's biological opinion that the registration of malathion, as proposed, with the implementation of the general conservation measures described above, is not likely to jeopardize the continued existence of the Plicate rocksnail. As discussed below, the vulnerability is high for this species, the risk and likelihood of exposure to malathion is low, and the implementation of the general conservation measures described above is expected to further reduce the likelihood of exposure.

The Plicate rocksnail has a high vulnerability based on its status, distribution, and trends, as described above. Recent status surveys have located plicate rocksnail populations only in an approximately 88 km (55 mi) reach of the Locust Fork of the Black Warrior River, Jefferson and Blount counties, Alabama (Service Field Records, Jackson, Mississippi, 1991, 1992; Malcolm Pierson, Calera, Alabama, Field Notes, 1993). Dams have changed this system from a continuum of free-flowing riverine habitats into a series of impoundments connected by short, free-flowing reaches and the plicate rocksnail has disappeared from more than 90 percent of its historic range. Unable to emigrate, the isolated snail populations are vulnerable to local discharges as well as any detrimental land surface runoff within their watersheds.

The risk to the species from labeled uses across the range is expected to be low as we do not anticipate any measurable effects from malathion exposure to individuals, including mortality or sublethal effects to growth, reproduction, or behavior. There may be potential effects to the species' food base (e.g., algae, plants, detritus), however these effects are expected to be small and will not likely result in adverse effects to snails.

We anticipate usage within the range will be low (3.47%), based primarily on the standard usage data we acquired, as described in the Opinion and summarized for this species above. Furthermore, conservation measures, such as rain restrictions, aquatic habitat buffers, and changes to residential use labels, are expected to substantially reduce environmental concentrations of malathion in the species' range, further reducing the likelihood of exposure.

Due to the low level of mortality of individuals anticipated to result from exposure to malathion, the lack of appreciable effects to its food base and habitat, low expected usage within the range, as well as the incorporation of conservation measures that would further reduce the risk of exposure, we do not anticipate adverse effects to occur over the duration of the proposed action. Therefore, we do not anticipate that the proposed action would appreciably reduce survival and recovery of the Plicate rocksnail in the wild.

**Conclusion:** Not likely to jeopardize

**Integration and Synthesis Summary: Snails *(Aquatic)***

| Scientific Name: | Common Name: | Entity ID: |
|---|---|---|
| *Leptoxis ampla* | Round rocksnail | 416 |

***VULNERABILITY***
***(Summary of status, environmental baseline and cumulative effects)***

**Status:** Threatened
**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** ☐

**Environmental Baseline/Cumulative Effects (EB/CE) Summary:**
The round rocksnail is a member of the Pleuroceridae family and has a subglobose shell, with an ovately rounded aperture and grows to about 20mm (0.8 inches) in length. Round rocksnails are gill breathing snails that are found attached to cobble, gravel, or other hard substrates in the strong currents of riffles and shoals. Since this snail is not very mobile and is not thought to migrate within the stream, it is thought that females live and attach their eggs to the same habitat (Goodrich 1922). Round rocksnails will lay their eggs in concentric rings, usually with one or two central eggs, at temperatures between 14-27 degrees C (Whelan et al. 2015). The round rocksnail was historically found in the Cahaba River and the Little Cahaba River, Bibb County, Alabama; and the Coosa River, Elmore County, and tributaries—Big Canoe and Kelly's creeks, St. Clair County; Ohatchee Creek, Calhoun County; Yellowleaf Creek, Shelby County; and Waxahatchee Creek, Shelby/Chilton counties, Alabama (Goodrich, 1922). The round rocksnail is currently known from a shoal series in the Cahaba River, Bibb and Shelby counties, Alabama, and from the lower reach of the Little Cahaba River, and the lower reaches of Shade and Six-mile creeks in Bibb County, Alabama (Bogan and Pierson, 1993b). The round rocksnail is currently stable and is not believed to have lost any known populations since the time of listing. The round rocksnail (Little Cahaba River and Shades Creek) has extended its range within existing populations, several miles in the Cahaba River and its tributary populations (e.g., Little Cahaba, Shades Creek).

Dams have changed this system from a continuum of free-flowing riverine habitats into a series of impoundments connected by short, free-flowing reaches and this snail species has disappeared from more than 90 percent of its historic range. Dams change such areas by eliminating or reducing currents, and allowing sediments to accumulate on inundated channel habitats. Impounded waters also experience changes in water chemistry which could affect survival or reproduction of riverine snails. Dams also form barriers to snail movement, isolating the snail populations. Unable to emigrate (i.e., move out of the area), the isolated snail populations are vulnerable to local discharges as well as any detrimental land surface runoff within their watersheds. In addition to point and nonpoint source pollution, excessive sediments are believed

to impact riverine snails requiring clean, hard shoal stream and river bottoms, by making the habitat unsuitable for feeding or reproduction. These streams are impacted by sediments and nutrients from a variety of upstream rural, urban and/or suburban sources. Because of their small sizes and limited flows, their water and habitat quality can be rapidly affected by local and off site pollution sources.

**EB/CE Sources:** U.S. Fish and Wildlife Service. 2005. Recovery Plan for 6 Mobile River Basin Aquatic Snails. Jackson, Mississippi. pp. 70.

U. S. Fish and Wildlife Service. 2016. Cylindrical Lioplax (*Lioplax cyclostomaformis*) Flat Pebblesnail (*Lepyrium showalteri*) Plicate Rocksnail (*Leptoxis plicata*) Painted Rocksnail (*Leptoxis taeniata*) Round Rocksnail (*Leptoxis ampla*) Lacy Elimia (*Elimia crenatella*) 5-Year Review: Summary and Evaluation. Alabama Ecological Services Field Office, Daphne, Alabama. 39 pp.

**Overall Vulnerability:** ☐ **High** ☒ **Medium** ☐ **Low**

***RISK***
***(Risk is based on species exposure and response from labeled uses across the range)***

**Risk to individuals if exposed:** We do not anticipate effects to the species from exposure to malathion at labeled use rates.

**Risk to the species from labeled uses across the range:**
The table below summarizes the risk to the species from labeled uses across the range based on range overlaps with use sites and anticipated effects associated with the particular uses.

| ALL USES except mosquito control | |
|---|---|
| Mortality | no effects expected |
| MOSQUITO CONTROL | |
| Mortality | no effects expected |

**Risk modifiers:** Rocksnails are gill breathing snails found attached to cobble, gravel, or other hard substrates in the strong currents of riffles and shoals (USFWS, 2005; NatureServe, 2015). High site fidelity, low tolerance ranges/thresholds and narrow/ specialist environmental specificity are inferred based on strict habitat needs as is clumped spatial arrangement (USFWS, 2005; NatureServe, 2015).

As described in the "Approach to the Effects Analysis" section of the main body of the Opinion, we made specific considerations for species that occur in bins 3 and 4 as they were modeled in such a way that likely resulted in overestimation of estimated environmental concentrations, thus overestimating potential exposure. While the Round rocksnail does occupy other aquatic habitats that contain higher concentrations of malathion (e.g., bin 2), individuals of the species that occupy habitats with higher flow rates (e.g., bins 3 and 4) will experience lower exposure than those occupying low flow areas, reducing the risk of effects across the species in general.

**Overall Risk: ☐ High ☐ Medium ☒ Low**

***USAGE***
***(Anticipated usage within the range based on past usage data)***

| Use type | Risk to species[1] | Use overlap with range | | Estimated usage in range[2] | | Bins associated with use type^ | Effect associated with bin (H, M, L) |
|---|---|---|---|---|---|---|---|
| | | Acres | % | Acres | % | | |
| Mosquito Control | D,I | 134,738 | 14.97 | 5,467 | 0.61 | 2,3,4 | 2L<br>3L<br>4L |
| Developed | D,I | 72,870 | 8.1 | 3,643 | 0.4 | 2,3,4 | 2L<br>3L<br>4L |
| Other Crops | D | 582 | 0.06 | 0 | 0 | 2,3,4 | 2L<br>3L<br>4L |
| Corn | D | 517 | 0.06 | 175 | 0.02 | 2,3,4 | 2L<br>3L<br>4L |
| Cotton | D | 455 | 0.05 | 323 | 0.04 | 2,3,4 | 2L<br>3L<br>4L |
| Nurseries | D | 98 | 0.01 | 98 | 0.01 | 2,3,4 | 2L<br>3L<br>4L |
| Orchards & Vineyards | D | 40 | < 0.01 | 35 | < 0.01 | 2,3,4 | 2L<br>3L<br>4L |
| Wheat | D | 32 | < 0.01 | 16 | < 0.01 | 2,3,4 | 2L<br>3L<br>4L |
| Other Grains | D | 24 | < 0.01 | 24 | < 0.01 | 2,3,4 | 2L<br>3L<br>4L |
| Vegetables & Ground Fruit | D | 20 | < 0.01 | 16 | < 0.01 | 2,3,4 | 2L<br>3L<br>4L |
| Other Row Crops | D | 20 | < 0.01 | 24 | < 0.01 | 2,3,4 | 2L<br>3L<br>4L |
| **Sub-TOTAL (D):** | | 74,657 | 8.33 | 4,354 | 0.53 | | |

[1] Direct effects (D), Indirect effects (I), No effects expected (N), Use site not utilized by the species (*)
[2] Estimated usage in the range is based on information about annual past usage.

| Use type | Risk to species[1] | Use overlap with range | | Estimated usage in range[2] | | Bins associated with use type^ | Effect associated with bin (H, M, L) |
|---|---|---|---|---|---|---|---|
| | | Acres | % | Acres | % | | |
| *Other uses with direct effects*[3] | | | | | | | |
| **Sub-TOTAL (I):** *Other uses with indirect effects*[3] | | 0 | 0 | 0 | 0 | | |
| **TOTAL[4]:** | | 209,235 | 23.3 | 9,821 | 1.14 | | |

^We consider the bin 2 estimates as an upper bound of bin 3 & 4 exposures.

**# acres in species range:** 899,841 acres
**% of range in California (i.e., where CalPUR data is available):** 0%
**Range overlap with Federal lands:** 103,499 acres, 11.502%

**Overall Usage:** ☐ **High** ☐ **Medium** ☒ **Low**

***CONSERVATION MEASURES***

**Rain restriction:** Given the relatively short half-life of malathion and rapid degradation via hydrolysis and other processes, persistence of malathion in storm run-off into most aquatic habitats is not anticipated to last longer than 48 hours under typical pH values, (i.e., 6.5-8.5) and water temperatures corresponding to growing season. Restricting malathion application to periods where rain is not forecasted for at least 48 hours or when the soil is not saturated will provide time for the pesticide to degrade before runoff into aquatic habitats can occur, decreasing exposure and risk.

**Aquatic habitat buffers:** Application buffers, which specify on the label a distance from water bodies where pesticides are not to be applied, are designed to reduce spray drift from entering sensitive non-target areas, thereby providing protection to aquatic species. While the exact amount of spray drift reduction depends on the physical traits of the aquatic ecosystem (e.g., flow rate, volume, etc.) as well as the application method, we can expect (based on AgDRIFT modeling) spray drift reductions ranging from 40 to 91%, with low flow and low volume aquatic habitats receiving the most reduction in spray drift deposition. In many cases, these buffers substantially reduce exposure to aquatic organisms and subsequent risk of direct and indirect effects.

**Residential use label changes:** New restrictions to the method and frequency of application for residential use of malathion are expected to substantially reduce exposure to species that overlap with developed and open space developed areas. Label changes will ensure that residential use is limited to spot treatments only (rendering spray drift offsite unlikely) and reducing the extent of area which can be treated in the developed and open space developed areas by as much as 75% or more from modeled values. In addition, we expect the frequency of exposure to decrease as the number of allowable applications is reduced from “repeat as necessary” to a maximum of 2–

[3] Mosquito control has the potential to overlap with other uses. It is not included in the Sub-TOTALs.
[4] TOTAL includes usage on all use sites with effects, including mosquito control.

4 applications per year (depending on the specific residential use). Retreatment intervals of 7-10 days between any repeated applications are expected to reduce environmental concentrations by allowing any initial residues to degrade prior to the next application. In addition, exposure to aquatic organisms is reduced due to buffers from waterways, which specify on the label a distance from water bodies where pesticides are not to be applied, and restrictions to application during periods where rain is not forecasted within 24 hours or when the soil is not saturated.

***CONCLUSION***

After reviewing the current status of the species, the environmental baseline for the action area, the effects of the proposed registration of malathion, and the cumulative effects, it is the Service's biological opinion that the registration of malathion, as proposed, with the implementation of the general conservation measures described above, is not likely to jeopardize the continued existence of the round rocksnail. As discussed below, the vulnerability is high for this species, the risk and likelihood of exposure to malathion is low, and the implementation of the general conservation measures described above is expected to further reduce the likelihood of exposure.

The round rocksnail has a medium vulnerability based on its status, distribution, and trends, as described above. The round rocksnail is currently known from a shoal series in the Cahaba River (Bibb and Shelby counties, Alabama), the lower reach of the Little Cahaba River, and the lower reaches of Shade and Six-mile creeks (Bogan and Pierson, 1993b). This species has gills for breathing and is found attached to cobble, gravel, or other hard substrates in the strong currents of riffles and shoals. Unable to emigrate, this species is vulnerable to local discharges and land surface runoff within its watershed.

The risk to the species from labeled uses across the range is expected to be low as we do not anticipate any measurable effects from malathion exposure to individuals, including mortality or sublethal effects to growth, reproduction, or behavior. There may be potential effects to the species' food base (e.g., algae, plants, detritus), however these effects are expected to be small and will not likely result in adverse effects to snails.

We anticipate malathion usage within the species range will be low (1.14%, expected on the non-Federal portion), based primarily on standard usage data we acquired, as described in the Opinion and summarized for this species above. About 12% of the species range is on Federal lands where we expect any adverse effects would be minimal, considering the small scale and low levels of past malathion usage on Federal lands, and in light of Federal agency programs that are designed to understand, avoid, and minimize the effects to listed species (see the Approach to Usage section of the Opinion). We did not quantitatively evaluate use or usage on Federal lands that overlap with the species range, but we assume only low levels of usage for this species, per the rationale related to usage on Federal lands as described in the Opinion. Conservation measures, such as aquatic habitat buffers, rain restrictions, and changes to residential use labels,

would substantially reduce environmental concentrations of malathion in the species' range, further reducing the likelihood of exposure.

Due to the lack of measurable effects to individuals, including mortality and sublethal effects, the lack of appreciable effects to its food base and habitat, the low level of expected usage, and the incorporation of conservation measures that would further reduce the risk of exposure, we anticipate minimal, if any, adverse effects (i.e., not enough to result in take) will occur throughout the duration of the action. Therefore, we do not anticipate that the proposed action would appreciably reduce survival and recovery of the round rocksnail.

**Conclusion:** Not likely to jeopardize

**Integration and Synthesis Summary: Snails *(Aquatic)***

| Scientific Name: | Common Name: | Entity ID: |
|---|---|---|
| *Campeloma decampi* | Slender campeloma | 417 |

***VULNERABILITY***
***(Summary of status, environmental baseline and cumulative effects)***

**Status:** Endangered
**Distribution:** Small, endemic, constrained, and/or isolated population(s)
**Number of Populations:** Multiple populations (few)
**Species Trends:** Stable
**Pesticides noted ☒**

**Environmental Baseline/Cumulative Effects (EB/CE) Summary:**
The existence of the slender campeloma continues to be threatened by stressors and impacts to habitat in its limited range. The species is known to occur in tributaries in the Tennessee River in northern Alabama (FWS 2020). The slender campeloma's current range includes the lower 14.5 miles (23.3 km) of Limestone Creek, the lower 19.3 miles (13.1 km) of Piney Creek, the lower 7.8 miles (12.6 km) of Round Island Creek (Garner 2008), the upper portions of Beaverdam Creek, and 1.86 mi (3 km) of Cypress Creek (Garner personal communication 2019). While slender campeloma has been collected from Williams Spring, this observation is limited to a single individual and the full range extent in this habitat is not currently known. Because the slender campeloma is still only known to occupy few stream reaches, catastrophic events such as spills or natural events (e.g., drought) could greatly reduce the geographic or genetic viability of the snail.

Relatively little is known about life history and ecology of the slender campeloma. The slender campeloma belongs to the family Viviparidae and as with other members of this family, they give birth to live young instead of laying eggs (FWS 2000), and their life span does not appear to extend beyond 3 years of age (Haggerty, et al. 2014). The slender campeloma is typically found burrowing in soft sediments (sand or mud) or detritus (ARC 1997). While the food habits of the slender campeloma are not known, it is thought that they most likely feed on detritus (FWS2020).

At the time of listing, the range of the slender campeloma snail was estimated to be reduced, by as much as three-quarters of its historical distribution (FWS 2000). The construction of the Tennessee River impoundments significantly reduced its historic range and caused the remaining populations to be isolated (FWS 2000). Urban growth and development continues to pose a threat to the slender campeloma. Expansion from the City of Huntsville and its annexation of lands in Limestone County has led to an increase in residential and industrial development near Limestone and Beaverdam creeks. For instance, in January 2018, Mazda Motor Corp. and Toyota Motor Corp. announced a joint venture to manufacture automobiles at a shared facility to

be located between Beaverdam Creek and Limestone Creek North of Old Highway 20 in Limestone County, Alabama. The proposed automotive manufacturing facility is anticipated to encompass approximately 2,400 acres of land historically used primarily for agriculture. This facility includes portions of a 2,010-acre Tennessee Valley Authority Megasite. Such a large-scale development has the potential to encroach upon and degrade habitat on which the slender campeloma depends. However, parties involved in this project (Toyota and the City of Huntsville) have been coordinating with the Service to develop site plans that would be compatible with conservation of imperiled and listed species adjacent to the manufacturing facility. Other examples of urban growth currently threatening slender campeloma habitat include water/sewer pipeline crossings, oil/natural gas pipeline crossings, bridge replacements and other infrastructure updates, commercial and residential building activity, discharge of fill material, and other point and nonpoint pollution discharge.

Habitat destruction or modification is presently the largest threat to this species. Agriculture and development continue to impact the quality of streams as evidenced by sections of the range being listed as impaired under Section 303d of the Clean Water Act for low dissolved oxygen, pathogens (associated with pasture grazing), and sediment. As human activities migrate out from the growing cities of Huntsville, Madison, Decatur, and Athens, forested lands and agricultural (present and historic) fields are increasingly becoming converted to commercial or residential developments ever encroaching on the slender campeloma's limited range. Analysis of land use and land coverage data from 2001 to 2016, provides support for a trend in habitat modification resulting from urban encroachment (FWS 2020). The six watersheds that constitute the known slender campeloma's range including the Cypress Creek, Round Island Creek, Piney Creek, Limestone Creek, Beaverdam Creek, and Williams Springs watersheds cover approximately 320,820 acres and are dominated by agricultural activities, natural landscapes, and commercialized land. Since 2001, natural and agricultural spaces have incrementally declined whereas acreage classified as developed and/or barren have steadily increased (FWS 2020). Urban land cover is most noticeable in the Piney Creek, Limestone Creek, Beaverdam Creek, and Williams Springs watersheds.

While the agricultural footprint in the watersheds has decreased since 2001, pastures and farmland still cover approximately 50 percent of the watersheds making agriculture the dominant land type in the area (FWS 2020). Agriculture poses a threat to slender campeloma through pesticide and fertilizer runoff, excessive water withdrawal and irrigation, and introduction of sedimentation (Garner 2004b, Haggerty and Garner 2007). Little toxicological research has been done on snails in general (Johnson et al. 2013) so the total ramifications of pesticide and fertilizer exposure on slender campeloma is not fully understood (FWS 2020).

**EB/CE Source:** U.S. Fish and Wildlife Service. 2020. Slender Campeloma (*Campeloma decampi*) 5-Year Review: Summary and Evaluation. Daphne, Alabama. 24 pp.

**Overall Vulnerability: ☒ High ☐ Medium ☐ Low**

***RISK***
***(Risk is based on species exposure and response from labeled uses across the range)***

**Risk to individuals if exposed:** We do not anticipate effects to the species from exposure to malathion at labeled use rates.

**Risk to the species from labeled uses across the range:**
The table below summarizes the risk to the species from labeled uses across the range based on range overlaps with use sites and anticipated effects associated with the particular uses.

| ALL USES except mosquito control | |
|---|---|
| Mortality | no effects expected |
| MOSQUITO CONTROL | |
| Mortality | no effects expected |

**Risk modifiers:** The slender campeloma is typically found burrowing in soft sediments (sand or mud) or detritus (ARC 1997) (USFWS, 2012). High site fidelity, low tolerance ranges/thresholds and narrow/ specialist environmental specificity are inferred based on strict habitat needs as is clumped spatial arrangement (USFWS, 2012; NatureServe, 2015).

**Overall Risk:** ☐ **High** ☐ **Medium** ☒ **Low**

***USAGE***
***(Anticipated usage within the range based on past usage data)***

| Use type | Risk to species[1] | Use overlap with range | | Estimated usage in range[2] | | Bins associated with use type^ | Effect associated with bin (H, M, L) |
|---|---|---|---|---|---|---|---|
| | | Acres | % | Acres | % | | |
| Mosquito Control | D | 612,773 | 57.5 | 36,300 | 3.41 | 2 | 2L |
| Developed | D | 74,178 | 6.96 | 3,709 | 0.35 | 2 | 2L |
| Corn | D | 54,123 | 5.08 | 2,059 | 0.19 | 2 | 2L |
| Cotton | D | 32,276 | 3.03 | 9,956 | 0.93 | 2 | 2L |
| Other Crops | D | 2,119 | 0.2 | 0 | 0 | 2 | 2L |
| Other Grains | D | 1,072 | 0.1 | 995 | 0.09 | 2 | 2L |
| Wheat | D | 981 | 0.09 | 310 | 0.03 | 2 | 2L |
| Nurseries | D | 871 | 0.08 | 871 | 0.08 | 2 | 2L |
| Other Row Crops | D | 236 | 0.02 | 129 | 0.01 | 2 | 2L |
| Vegetables & Ground Fruit | D | 60 | < 0.01 | 47 | < 0.01 | 2 | 2L |

[1] Direct effects (D), Indirect effects (I), No effects expected (N), Use site not utilized by the species (*)
[2] Estimated usage in the range is based on information about annual past usage.

| Use type | Risk to species[1] | Use overlap with range | | Estimated usage in range[2] | | Bins associated with use type^ | Effect associated with bin (H, M, L) |
|---|---|---|---|---|---|---|---|
| | | Acres | % | Acres | % | | |
| Orchards & Vineyards | D | 12 | < 0.01 | 12 | < 0.01 | 2 | 2L |
| Pasture | D | 8 | < 0.01 | 7 | < 0.01 | 2 | 2L |
| Christmas trees | D | 1 | < 0.01 | 1 | < 0.01 | 2 | 2L |
| **Sub-TOTAL (D):** *Other uses with direct effects*[3] | | 165,937 | 15.6 | 18,096 | 1.73 | | |
| **Sub-TOTAL (I):** *Other uses with indirect effects*[3] | | 0 | 0 | 0 | 0 | | |
| **TOTAL[4]:** | | 778,710 | 73.1 | 54,396 | 5.14 | | |

^Species occurs only in bin 2.

**# acres in species range:** 1,066,071 acres
**% of range in California (i.e., where CalPUR data is available):** 0%
**Range overlap with Federal lands:** 126,519 acres, 11.868%

**Overall Usage:** ☐ **High** ☒ **Medium** ☐ **Low**

***CONSERVATION MEASURES***

**Rain restriction:** Given the relatively short half-life of malathion and rapid degradation via hydrolysis and other processes, persistence of malathion in storm run-off into most aquatic habitats is not anticipated to last longer than 48 hours under typical pH values, (i.e., 6.5-8.5) and water temperatures corresponding to growing season. Restricting malathion application to periods where rain is not forecasted for at least 48 hours or when the soil is not saturated will provide time for the pesticide to degrade before runoff into aquatic habitats can occur, decreasing exposure and risk.

**Aquatic habitat buffers:** Application buffers, which specify on the label a distance from water bodies where pesticides are not to be applied, are designed to reduce spray drift from entering sensitive non-target areas, thereby providing protection to aquatic species. While the exact amount of spray drift reduction depends on the physical traits of the aquatic ecosystem (e.g., flow rate, volume, etc.) as well as the application method, we can expect (based on AgDRIFT modeling) spray drift reductions ranging from 40 to 91%, with low flow and low volume aquatic habitats receiving the most reduction in spray drift deposition. In many cases, these buffers substantially reduce exposure to aquatic organisms and subsequent risk of direct and indirect effects.

**Residential use label changes:** New restrictions to the method and frequency of application for residential use of malathion are expected to substantially reduce exposure to species that overlap

[3] Mosquito control has the potential to overlap with other uses. It is not included in the Sub-TOTALs.
[4] TOTAL includes usage on all use sites with effects, including mosquito control.

with developed and open space developed areas. Label changes will ensure that residential use is limited to spot treatments only (rendering spray drift offsite unlikely) and reducing the extent of area which can be treated in the developed and open space developed areas by as much as 75% or more from modeled values. In addition, we expect the frequency of exposure to decrease as the number of allowable applications is reduced from "repeat as necessary" to a maximum of 2–4 applications per year (depending on the specific residential use). Retreatment intervals of 7-10 days between any repeated applications are expected to reduce environmental concentrations by allowing any initial residues to degrade prior to the next application. In addition, exposure to aquatic organisms is reduced due to buffers from waterways, which specify on the label a distance from water bodies where pesticides are not to be applied, and restrictions to application during periods where rain is not forecasted within 24 hours or when the soil is not saturated.

**Reduced application number and rate:** New restrictions on corn, cotton, orchards and vineyards, pasture, other crops, and vegetables and ground fruit lower the maximum allowable number of applications to 2-4 per year (depending on the specific crop; previous allowable numbers of applications ranged from 3 to 13 applications per year). This will help reduce the amount of malathion used and decrease potential exposure to the species, thus decreasing the risk of both indirect and direct effects to the species.

---

***CONCLUSION***

After reviewing the current status of the species, the environmental baseline for the action area, the effects of the proposed registration of malathion, and the cumulative effects, it is the Service's biological opinion that the registration of malathion, as proposed, with the implementation of the general conservation measures described above, is not likely to jeopardize the continued existence of the slender campeloma. As discussed below, the vulnerability is high for this species, the risk is low, and likelihood of exposure to malathion is medium, however the implementation of the general conservation measures described above is expected to substantially reduce the likelihood of exposure.

The slender campeloma has a high vulnerability based on its status, distribution, and trends. The habitat of the slender campeloma snail has been reduced by about three-quarters of its historical distribution (FWS 2020). The construction of the Tennessee River impoundments significantly reduced its historic range, and caused the remaining populations to be isolated (FWS 2020). Agriculture and development continue to impact the quality of streams as evidenced by sections of the range being listed as impaired under Section 303d of the Clean Water Act for low dissolved oxygen, pathogens (associated with pasture grazing), and sediment (FWS 2020). More specifically, agriculture poses a threat to slender campeloma through pesticide and fertilizer runoff, excessive water withdrawal and irrigation, and introduction of sedimentation (Garner 2004b, Haggerty and Garner 2007). The agricultural footprint in the watersheds surrounding the areas occupied by the slender campeloma has decreased since 2001 due to conversion of agricultural (present and historic) fields to commercial and residential developments as people began migrating further out from nearby cities; however, pastures and farmland still cover approximately 50 percent of the watersheds making agriculture the dominant land type in the

area (FWS 2020). Rapid urban growth and infrastructure development compromises the slender campeloma, through the mechanisms discussed above, as development encroaches on the species' already limited habitat range.

The risk to the species from labeled uses across the range is expected to be low as we do not anticipate any measurable effects from malathion exposure to individuals, including mortality or sublethal effects to growth, reproduction, or behavior. There may be potential effects to the species' food base (e.g., algae, plants, detritus), however these effects are expected to be small and will not likely result in adverse effects to snails.

About 12% of the species range is on Federal lands, where we expect any adverse effects would be minimal, considering the small scale and low levels of past malathion usage on Federal lands, and in light of Federal agency programs that are designed to understand, avoid, and minimize the effects to listed species (see the Approach to Usage section of the Opinion). Usage across the non-Federal portion of the species range is anticipated to be medium (5.14%), based primarily on standard usage data we acquired, as described in the Opinion and summarized for this species above, and we anticipate similar levels of usage in the foreseeable future. Conservation measures, such as rain restrictions, aquatic habitat buffers, changes to residential use labels, and reductions in the allowable number of applications and application rates, are expected to substantially reduce environmental concentrations of malathion that will occur in the species' range, reducing the likelihood of exposure.

Due to the lack of measurable effects to individuals, including mortality and sublethal effects, the lack of appreciable effects to its food base and habitat, and the incorporation of conservation measures that would further reduce the risk of exposure, we anticipate minimal, if any, adverse effects (i.e., not enough to result in take) will occur throughout the duration of the action. Therefore, we anticipate that the proposed action would not appreciably reduce survival and recovery of the slender campeloma in the wild.

**Conclusion:** Not likely to jeopardize

***ADDITIONAL REFERENCES***

U. S. Fish and Wildlife Service. August 17, 2012. Slender Campeloma (Campeloma decampi, Binney) 5-Year Review: Summary and Evaluation. Daphne, Alabama. 19 pp.

**Integration and Synthesis Summary: Snails *(Aquatic)***

| Scientific Name: | Common Name: | Entity ID: |
|---|---|---|
| *Assiminea pecos* | Pecos assiminea snail | 1245 |

***VULNERABILITY***
***(Summary of status, environmental baseline and cumulative effects)***

**Status:** Endangered
**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** ☐

**Environmental Baseline/Cumulative Effects (EB/CE) Summary:**
Pecos assiminea is presently known from a total of six sites: four sites on the Bitter Lake National Wildlife Refuge, from a large population at Diamond Y Spring and its associated drainage in Pecos County, Texas, and at East Sandia Spring, in Reeves County, Texas. Populations of the Pecos assiminea snail occur sporadically along Bitter Creek, in a dense population around the perimeter of Sinkhole 31 within the Sago Springs Complex, on the western perimeter of Impoundment 7, in the extreme southwest corner of Impoundment 15, and in several springs adjacent to the Refuge owned by the City of Roswell (NMDGF 2005). Critical habitat is currently designated for the Pecos assiminea snail at the Texas sites. There is little new information on the biology and life history of this species, so population trends are difficult to determine. Pecos assiminea have low detection probabilities because they are difficult to find.

Water quantity and water quality are the greatest threats to these species. Groundwater withdrawal needed to supply an array of water uses could alter hydrologic characteristics of the spring systems that support these endemic species. This is based on imminent threats of water withdrawals within the immediate area of the four invertebrates' habitat (Balleau Groundwater, Inc. 1996, 1999; Butler and Tashjian 2016). Potential for increased impacts from drought and climate change exists, based on predictions of decreasing precipitation and increasing temperatures into the future for this region (Niraula et al. 2017). Climate-related effects including prolonged droughts and decreases in spring discharge could further exacerbate the impacts to water quantity and quality.

The primary threat to Pecos assiminea snail in Texas is the potential failure of spring flow due to excessive groundwater pumping or drought or both, which would result in total habitat loss for the species. There have been no continuous records of spring flow discharge at Diamond Y Spring by which to determine trends in flow. Characteristics of the species that make it vulnerable to extirpation/extinction included: a localized range, limited mobility, and fragmented habitat (Noss et al. 2006, Fagan et al. 2002). Having a small, localized range means that any perturbation (e.g., drought, water contamination) can eliminate the species. Consequently, the

species is unable to avoid pollution or other unfavorable changes to their habitat. Severe drought or wildfire, groundwater pollution and spring contamination, or spring development (impoundment, dredging, piping) could result in the extirpation or extinction of the species. The New Zealand mudsnail (Potamopyrgus antipodarum) is also a potential threat to the endemic aquatic snails on the Refuge and the spring systems in Texas. It was discovered in the Snake River, Idaho, in the mid-1980s and has quickly spread to every Western state except New Mexico (Montana State University 2010). Several invasive terrestrial plant species that may affect the Pecos assiminea are present on the Refuge, including saltcedar (Tamarix spp.), common reed, and Russian thistle (tumbleweed) (Salsola spp.). Control and removal of nonnative vegetation is a factor responsible for localized extirpations of populations of Pecos assiminea in Mexico and New Mexico (Taylor 1987), but uncontrolled nonnative vegetation invasion is also likely detrimental to the species. Saltcedar, found on the Refuge and at Diamond Y Spring Complex and East Sandia Spring, threatens spring habitats primarily through displacement of native plants, shading and/or cooling of spring runs, and from the chemical composition of the leaves and sap that drop to the ground and into the springs. Water contamination, particularly from oil and gas activities, catastrophic wildfire, and competition and predation from introduced species are additional threats to the species. A recovery plan was published in 2019, in which the degree of threat was increased for this species, in part because it is constrained to karst water features including sink holes and springs, reliant on clean groundwater sources, in localized areas of New Mexico and Texas.

**EB/CE Sources:** U. S. Fish and Wildlife Service. 2010. Roswell springsnail (*Pyrgulopsis roswellensis*), Koster's springsnail (*Juturnia kosteri*), Noel's amphipod (*Gammarus desperatus*), Pecos assiminea (*Assiminea pecos*) 5-Year Review: Summary and Evaluation. Southwest Region, Albuquerque, New Mexico. 25 pp.

U.S. Fish and Wildlife Service. 2019. Final Recovery Plan for Four Invertebrate Species of the Pecos River Valley: Noel's amphipod (*Gammarus desperatus*), Koster's springsnail (*Juturnia kosteri*), Roswell springsnail (*Pyrgulopsis roswellensis*), and Pecos assiminea (*Assiminea pecos*). Southwest Region, Albuquerque, New Mexico. 109 pp.

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

**Overall Vulnerability: ☒ High ☐ Medium ☐ Low**

***RISK***
***(Risk is based on species exposure and response from labeled uses across the range)***

**Risk to individuals if exposed:** We do not anticipate effects to the species from exposure to malathion at labeled use rates.

**Risk to the species from labeled uses across the range:**
The table below summarizes the risk to the species from labeled uses across the range based on range overlaps with use sites and anticipated effects associated with the particular uses.

| ALL USES except mosquito control | |
|---|---|
| Mortality | no effects expected |
| MOSQUITO CONTROL | |
| Mortality | no effects expected |

**Risk modifiers:** The species is associated with aquifer-fed, spring systems in desert grasslands of the Pecos River basin with abundant "karst" topography (USFWS, 2010). It is also found in vegetation dominated by American three-square (*Scirpus americanus*), common reed (*Phragmites australis*) and spike rush (Eleocharis spp.) (National Biological Infrastructure, n.d.). Along Bitter Creek, they occur at the water's edge and to a depth of 21 cm (New Mexico Department of Game and Fish, 2004). Taylor (1987) describes the habitat as moist earth beside flowing water (never beside standing water), beneath salt grass or sedges, less often on exposed surfaces. It is a marsh snail that seldom occurs immersed in water but prefers a humid microhabitat created by wet mud or beneath vegetation mats, typically within a few cm of running water (USFWS, 2005; 2010).

As described in the "Approach to the Effects Analysis" section of the main body of the Opinion, we made specific considerations for species that occur in bins 3 and 4 as they were modeled in such a way that likely resulted in overestimation of estimated environmental concentrations, thus overestimating potential exposure. While the Pecos assiminea snail does occupy other aquatic habitats that contain higher concentrations of malathion (e.g., bin 2), individuals of the species that occupy habitats with higher flow rates (e.g., bin 3) will experience lower exposure than those occupying low flow areas, reducing the risk of effects across the species in general.

**Overall Risk:** ☐ **High** ☐ **Medium** ☒ **Low**

***USAGE***
***(Anticipated usage within the range based on past usage data)***

| Use type | Risk to species[1] | Use overlap with range | | Estimated usage in range[2] | | Bins associated with use type^ | Effect associated with bin (H, M, L) |
|---|---|---|---|---|---|---|---|
| | | Acres | % | Acres | % | | |
| Mosquito Control | D | 3,197,221 | 27.24 | 0 | 0 | 2,3 | 2L<br>3L |
| Other Crops | D | 186,337 | 1.59 | 31 | < 0.01 | 2,3 | 2L |

[1] Direct effects (D), Indirect effects (I), No effects expected (N), Use site not utilized by the species (*)
[2] Estimated usage in the range is based on information about annual past usage.

| Use type | Risk to species[1] | Use overlap with range | | Estimated usage in range[2] | | Bins associated with use type^ | Effect associated with bin (H, M, L) |
|---|---|---|---|---|---|---|---|
| | | Acres | % | Acres | % | | |
| | | | | | | | 3L |
| Pasture | D | 43,467 | 0.37 | 7,669 | 0.07 | 2,3 | 2L<br>3L |
| Developed | D | 32,658 | 0.28 | 1,633 | 0.01 | 2,3 | 2L<br>3L |
| Wheat | D | 23,030 | 0.2 | 20,372 | 0.17 | 2,3 | 2L<br>3L |
| Cotton | D | 14,937 | 0.13 | 14,675 | 0.13 | 2,3 | 2L<br>3L |
| Other Grains | D | 13,381 | 0.11 | 7,074 | 0.06 | 2,3 | 2L<br>3L |
| Corn | D | 7,772 | 0.07 | 156 | < 0.01 | 2,3 | 2L<br>3L |
| Orchards & Vineyards | D | 4,526 | 0.04 | 2,430 | 0.02 | 2,3 | 2L<br>3L |
| Vegetables & Ground Fruit | D | 404 | < 0.01 | 402 | < 0.01 | 2,3 | 2L<br>3L |
| Other Row Crops | D | 221 | < 0.01 | 208 | < 0.01 | 2,3 | 2L<br>3L |
| Nurseries | D | 25 | < 0.01 | 25 | < 0.01 | 2,3 | 2L<br>3L |
| **Sub-TOTAL (D):** *Other uses with direct effects*[3] | | 326,759 | 2.82 | 54,675 | 0.51 | | |
| **Sub-TOTAL (I):** *Other uses with indirect effects*[3] | | 0 | 0 | 0 | 0 | | |
| **TOTAL[4]:** | | 3,523,980 | 30.06 | 54,675 | 0.51 | | |

^We consider the bin 2 estimates as an upper bound of bin 3 & 4 exposures.

**# acres in species range:** 11,737,314 acres
**% of range in California (i.e., where CalPUR data is available):** 0%
**Range overlap with Federal lands:** 1,649,002 acres, 14.049%

**Overall Usage:** ☐ **High** ☐ **Medium** ☒ **Low**

***CONSERVATION MEASURES***

**Rain restriction:** Given the relatively short half-life of malathion and rapid degradation via hydrolysis and other processes, persistence of malathion in storm run-off into most aquatic habitats is not anticipated to last longer than 48 hours under typical pH values, (i.e., 6.5-8.5) and

[3] Mosquito control has the potential to overlap with other uses. It is not included in the Sub-TOTALs.
[4] TOTAL includes usage on all use sites with effects, including mosquito control.

water temperatures corresponding to growing season. Restricting malathion application to periods where rain is not forecasted for at least 48 hours or when the soil is not saturated will provide time for the pesticide to degrade before runoff into aquatic habitats can occur, decreasing exposure and risk.

**Aquatic habitat buffers:** Application buffers, which specify on the label a distance from water bodies where pesticides are not to be applied, are designed to reduce spray drift from entering sensitive non-target areas, thereby providing protection to aquatic species. While the exact amount of spray drift reduction depends on the physical traits of the aquatic ecosystem (e.g., flow rate, volume, etc.) as well as the application method, we can expect (based on AgDRIFT modeling) spray drift reductions ranging from 40 to 91%, with low flow and low volume aquatic habitats receiving the most reduction in spray drift deposition. In many cases, these buffers substantially reduce exposure to aquatic organisms and subsequent risk of direct and indirect effects.

**Reduced application number and rate:** New restrictions on corn, cotton, orchards and vineyards, pasture, other crops, and vegetables and ground fruit lower the maximum allowable number of applications to 2-4 per year (depending on the specific crop; previous allowable numbers of applications ranged from 3 to 13 applications per year). This will help reduce the amount of malathion used and decrease potential exposure to the species, thus decreasing the risk of both indirect and direct effects to the species.

---

***CONCLUSION***

After reviewing the current status of the species, the environmental baseline for the action area, the effects of the proposed registration of malathion, and the cumulative effects, it is the Service's biological opinion that the registration of malathion, as proposed, with the implementation of the general conservation measures described above, is not likely to jeopardize the continued existence of the Pecos assiminea snail. As discussed below, the vulnerability is high for this species, the risk and likelihood of exposure to malathion is low, and the implementation of the general conservation measures described above is expected to further reduce the likelihood of exposure.

The Pecos assiminea snail has a high vulnerability based on its status, distribution, and trends, as described above. This aquatic snail has a very localized range and is currently known from six sites. The species has limited mobility and a fragmented habitat which could limit its ability to recover from a stochastic event or other stressors.

The risk to the species from labeled uses across the range is expected to be low as we do not anticipate any measurable effects from malathion exposure to individuals, including mortality or sublethal effects to growth, reproduction, or behavior. There may be potential effects to the species' food base (e.g., algae, plants, detritus), however these effects are expected to be small and will not likely result in adverse effects to snails.

About 14% of the species range is on Federal lands where we expect any adverse effects would be minimal, considering the small scale and low levels of past malathion usage on Federal lands, and in light of Federal agency programs that are designed to understand, avoid, and minimize the effects to listed species (see the Approach to Usage section of the Opinion). We anticipate usage within the range outside of Federal lands will be low (0.51% of the range, expected to occur on the non-Federal portion), based primarily on the standard usage data we acquired, as described in the Opinion and summarized for this species above. Conservation measures, such as rain restrictions, aquatic habitat buffers, and reductions in the allowable number of applications and application rates for agricultural crops, are expected to further reduce the likelihood of exposure.

Due to the lack of measurable effects to individuals, including mortality and sublethal effects, the lack of appreciable effects to its food base and habitat, the low level of expected usage, and the incorporation of conservation measures that would further reduce the risk of exposure, we anticipate minimal, if any, adverse effects (i.e., not enough to result in take) will occur throughout the duration of the action. Therefore, we do not anticipate that the proposed action would appreciably reduce survival and recovery of the Pecos assiminea snail in the wild.

**Conclusion:** Not likely to jeopardize

**Integration and Synthesis Summary: Snails *(Aquatic)***

| Scientific Name: | Common Name: | Entity ID: |
|---|---|---|
| *Pyrgulopsis roswellensis* | Roswell springsnail | 1246 |

***VULNERABILITY***
***(Summary of status, environmental baseline and cumulative effects)***

**Status:** Endangered
**Distribution:** Small, endemic, constrained, and/or isolated population(s)
**Number of Populations:** Multiple populations (few)
**Species Trends:** Unknown population trends
**Pesticides noted** ☐

**Environmental Baseline/Cumulative Effects (EB/CE) Summary:**
The Roswell springsnail is an aquatic species, distributed in five geographically separate populations in isolated limestone and gypsum springs, seeps, and wetlands on Bitter Lake National Wildlife Refuge (Refuge). As with other snails in the family Hydrobiidae, the Roswell springsnails can survive in seepage areas, as long as flows are perennial and within the species' physiological tolerance limits (NMDGF 2005). The Roswell springsnail is currently known only from the Middle Tract of Bitter Lake National Wildlife Refuge (Refuge) and a nearby complex of springs owned by the City of Roswell in Chaves County, New Mexico. The core population of Roswell springsnail is in the Sago Springs Complex and Bitter Creek on the Refuge. Roswell springsnail occurred at densities ranging from 1,125/$m^2$ (104/$ft^2$) to 27,924/$m^2$ (2,595/$ft^2$) at Sago Spring and only 64/$m^2$ (6/$ft^2$) to 512/$m^2$ (47/$ft^2$) at Bitter Creek in 1995 and 1996 (Lang 2002). The Sago Springs Complex is approximately 1,000 feet (ft) (304 meters [m]) long, half of which flows underground with aboveground flow in the upper reaches restricted to sinkholes. Bitter Creek is six times longer than the Sago Springs Complex and has a total length of 1.1 miles (mi) (1.8 kilometers [km]). Roswell springsnail formerly occurred on 5 private land at North Spring east of Roswell but has since been extirpated (NMDGF 2005). Fossil records indicate that at least one or more snail species was historically found at Berrendo Spring, North Spring, and South Spring River, and along the Pecos River (NMDGF 1999). This evidence suggests an apparent historical decline in the numbers, range, and distribution of the Roswell springsnail. There is little new information on the biology and life history of this species, so population trends are difficult to determine. Roswell springsnails have been translocated to the Rio Hondo system, increasing their number of populations and spatial distribution on the Refuge.

The loss or alteration of spring habitat continues to be the main threat to Roswell springsnail. The scattered distribution of springs makes them aquatic islands of unique habitat in an arid-land matrix (Myers and Resh 1999). Members of the snail family Hydrobiidae (including Roswell springsnails) are susceptible to extirpation or extinction because they often occur in isolated desert springs (Hershler 1989, Hershler and Pratt 1990, Hershler 1994, Lydeard et al. 2004). There is evidence these habitats have been historically reduced or eliminated by aquifer depletion (Jones and Balleau 1996). The lowering of water tables through aquifer withdrawals for irrigation and municipal use has degraded desert spring habitats, which the three snails and

Noel's amphipod depend upon for survival. Water contamination, particularly from oil and gas operations, is a significant threat for these springsnails. In order to assess the potential for contamination, a study was completed in September 1999 to delineate the area that serves as sources of water for the springs on the Refuge (Balleau Groundwater, Inc. 1999). This study reported that the sources of water that will reach the Refuge's springs include a broad area beginning west of Roswell near Eightmile Draw, extending to the northeast to Salt Creek, and southeast to the Refuge. This area represents possible pathways from which contaminants may enter the groundwater that feeds the springs on the Refuge. This broad area sits within a portion of the Roswell Basin and contains a mosaic of Federal, State, City, and private lands with multiple land uses including expanding urban development. There are 378 natural gas and oil wells in the 12-township area encompassing the source-water capture zone for the Middle Tract of the Refuge that are potential sources of contamination (Go-Tech 2010). The Bureau of Land Management (BLM) designated an area for protection of habitat from potential groundwater contamination by oil and gas well drilling operations (BLM 2002). A recovery plan was published in 2019, in which the degree of threat was increased for this species, in part because it is constrained to karst water features including sink holes and springs, reliant on clean groundwater sources, in localized areas of New Mexico and Texas.

**EB/CE Sources:** U. S. Fish and Wildlife Service. 2010. Roswell springsnail (*Pyrgulopsis roswellensis*), Koster's springsnail (*Juturnia kosteri*), Noel's amphipod (*Gammarus desperatus*), Pecos assiminea (*Assiminea pecos*) 5-Year Review: Summary and Evaluation. Southwest Region, Albuquerque, New Mexico. 25 pp.

U.S. Fish and Wildlife Service. 2019. Final Recovery Plan for Four Invertebrate Species of the Pecos River Valley: Noel's amphipod (*Gammarus desperatus*), Koster's springsnail (*Juturnia kosteri*), Roswell springsnail (*Pyrgulopsis roswellensis*), and Pecos assiminea (*Assiminea pecos*). Southwest Region, Albuquerque, New Mexico. 109 pp.

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

**Overall Vulnerability: ☒ High ☐ Medium ☐ Low**

***RISK***
***(Risk is based on species exposure and response from labeled uses across the range)***

**Risk to individuals if exposed:** We do not anticipate effects to the species from exposure to malathion at labeled use rates.

**Risk to the species from labeled uses across the range:**
The table below summarizes the risk to the species from labeled uses across the range based on range overlaps with use sites and anticipated effects associated with the particular uses.

| | |
|---|---|
| ALL USES except mosquito control | |
| Mortality | no effects expected |
| MOSQUITO CONTROL | |
| Mortality | no effects expected |

**Risk modifiers:** The species is found on pebbles, gypsum silt and to a lesser extent mud and submerged vegetation in seeps and high-volume springs and spring runs. The species co-occurs with *Juturnia kosteri*. It occupies spring heads and runs with variable water temperatures (10-20° C) and slow-to-moderate water velocities over compact substrate ranging from deep organic silts to gypsum sands and gravel and compact substrate (FWS, 2005).

As described in the "Approach to the Effects Analysis" section of the main body of the Opinion, we made specific considerations for species that occur in bins 3 and 4 as they were modeled in such a way that likely resulted in overestimation of estimated environmental concentrations, thus overestimating potential exposure. While the Roswell springsnail does occupy other aquatic habitats that contain higher concentrations of malathion (e.g., bin 2), individuals of the species that occupy habitats with higher flow rates (e.g., bin 3) will experience lower exposure than those occupying low flow areas, reducing the risk of effects across the species in general.

**Overall Risk: ☐ High ☐ Medium ☒ Low**

***USAGE***
***(Anticipated usage within the range based on past usage data)***

| Use type | Risk to species[1] | Use overlap with range | | Estimated usage in range[2] | | Bins associated with use type^ | Effect associated with bin (H, M, L) |
|---|---|---|---|---|---|---|---|
| | | Acres | % | Acres | % | | |
| Mosquito Control | D,I | 3,193,902 | 57.7 | 0 | 0 | 2,3 | 2L<br>3L |
| Other Crops | D,I | 58,628 | 1.06 | 0 | 0 | 2,3 | 2L<br>3L |
| Pasture | D,I | 31,990 | 0.58 | 5,313 | 0.10 | 2,3 | 2L<br>3L |
| Wheat | D,I | 20,114 | 0.36 | 18,453 | 0.33 | 2,3 | 2L<br>3L |
| Developed | D,I | 13,955 | 0.25 | 698 | 0.01 | 2,3 | 2L<br>3L |
| Other Grains | D,I | 11,082 | 0.2 | 4,692 | 0.08 | 2,3 | 2L<br>3L |
| Corn | D,I | 7,573 | 0.14 | 156 | 0.01 | 2,3 | 2L<br>3L |

[1] Direct effects (D), Indirect effects (I), No effects expected (N), Use site not utilized by the species (*)
[2] Estimated usage in the range is based on information about annual past usage.

| Use type | Risk to species[1] | Use overlap with range | | Estimated usage in range[2] | | Bins associated with use type^ | Effect associated with bin (H, M, L) |
|---|---|---|---|---|---|---|---|
| | | Acres | % | Acres | % | | |
| Orchards & Vineyards | D,I | 3,118 | 0.06 | 1,004 | 0.02 | 2,3 | 2L<br>3L |
| Cotton | D,I | 2,084 | 0.04 | 2,084 | 0.04 | 2,3 | 2L<br>3L |
| Vegetables & Ground Fruit | D,I | 44 | < 0.01 | 43 | < 0.01 | 2,3 | 2L<br>3L |
| Other Row Crops | D,I | 31 | < 0.01 | 24 | < 0.01 | 2,3 | 2L<br>3L |
| Nurseries | D,I | 18.67 | < 0.01 | 19 | < 0.01 | 2,3 | 2L<br>3L |
| **Sub-TOTAL (D):** *Other uses with direct effects*[3] | | 148,638 | 2.72 | 32,486 | 0.63 | | |
| **Sub-TOTAL (I):** *Other uses with indirect effects*[3] | | 0 | 0 | 0 | 0 | | |
| **TOTAL[4]:** | | 3,342,540 | 60.42 | 32,486 | 0.63 | | |

^We consider the bin 2 estimates as an upper bound of bin 3 & 4 exposures.

**# acres in species range:** 5,540,060 acres
**% of range in California (i.e., where CalPUR data is available):** 0%
**Range overlap with Federal lands:** 1,639,171 acres, 29.588%

**Overall Usage:** ☐ **High** ☐ **Medium** ☒ **Low**

***CONSERVATION MEASURES***

**Rain restriction:** Given the relatively short half-life of malathion and rapid degradation via hydrolysis and other processes, persistence of malathion in storm run-off into most aquatic habitats is not anticipated to last longer than 48 hours under typical pH values, (i.e., 6.5-8.5) and water temperatures corresponding to growing season. Restricting malathion application to periods where rain is not forecasted for at least 48 hours or when the soil is not saturated will provide time for the pesticide to degrade before runoff into aquatic habitats can occur, decreasing exposure and risk.

**Aquatic habitat buffers:** Application buffers, which specify on the label a distance from water bodies where pesticides are not to be applied, are designed to reduce spray drift from entering sensitive non-target areas, thereby providing protection to aquatic species. While the exact amount of spray drift reduction depends on the physical traits of the aquatic ecosystem (e.g., flow rate, volume, etc.) as well as the application method, we can expect (based on

[3] Mosquito control has the potential to overlap with other uses. It is not included in the Sub-TOTALs.
[4] TOTAL includes usage on all use sites with effects, including mosquito control.

AgDRIFT modeling) spray drift reductions ranging from 40 to 91%, with low flow and low volume aquatic habitats receiving the most reduction in spray drift deposition. In many cases, these buffers substantially reduce exposure to aquatic organisms and subsequent risk of direct and indirect effects.

**Reduced application number and rate:** New restrictions on corn, cotton, orchards and vineyards, pasture, other crops, and vegetables and ground fruit lower the maximum allowable number of applications to 2-4 per year (depending on the specific crop; previous allowable numbers of applications ranged from 3 to 13 applications per year). This will help reduce the amount of malathion used and decrease potential exposure to the species, thus decreasing the risk of both indirect and direct effects to the species.

---

***CONCLUSION***

After reviewing the current status of the species, the environmental baseline for the action area, the effects of the proposed registration of malathion, and the cumulative effects, it is the Service's biological opinion that the registration of malathion, as proposed, with the implementation of the general conservation measures described above, is not likely to jeopardize the continued existence of the Roswell springsnail. As discussed below, the vulnerability is high for this species, the risk and likelihood of exposure to malathion is low, and the implementation of the general conservation measures described above is expected to further reduce the likelihood of exposure.

The Roswell springsnail has a high vulnerability based on its status, distribution, and trends, as described above. This aquatic snail has a very localized range and is currently known only from the Middle Tract of Bitter Lake National Wildlife Refuge and a nearby complex of springs owned by the City of Roswell, in Chaves County, New Mexico. The species is susceptible to extirpation or extinction because it often occurs in isolated desert springs (Hershler 1989, Hershler and Pratt 1990, Hershler 1994, Lydeard et al. 2004). Water contamination, particularly from oil and gas operations, is a significant threat to the species.

The risk to the species from labeled uses across the range is expected to be low as we do not anticipate any measurable effects from malathion exposure to individuals, including mortality or sublethal effects to growth, reproduction, or behavior. There may be potential effects to the species' food base (e.g., algae, plants, detritus), however these effects are expected to be small and will not likely result in adverse effects to snails.

About 30% of the species range is on Federal lands where we expect any adverse effects would be minimal, considering the small scale and low levels of past malathion usage on Federal lands, and in light of Federal agency programs that are designed to understand, avoid, and minimize the effects to listed species (see the Approach to Usage section of the Opinion). We also anticipate usage of malathion within the species range will be low (0.63% of the range, expected on the non-Federal portion), based primarily on the standard usage data we acquired, as described in the

Opinion and summarized for this species above. Conservation measures, such as rain restrictions, aquatic habitat buffers, and reductions in the allowable number of applications and application rates, are expected to further reduce the likelihood of exposure.

Due to the lack of measurable effects to individuals, including mortality and sublethal effects, the lack of appreciable effects to its food base and habitat, the low level of expected usage, and the incorporation of conservation measures that would further reduce the risk of exposure, we anticipate minimal, if any, adverse effects (i.e., not enough to result in take) will occur throughout the duration of the action. Therefore, we do not anticipate that the proposed action would appreciably reduce survival and recovery of the Roswell springsnail in the wild.

**Conclusion:** Not likely to jeopardize

***ADDITIONAL REFERENCES***

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

**Integration and Synthesis Summary: Snails *(Aquatic)***

| Scientific Name: | Common Name: | Entity ID: |
|---|---|---|
| *Juturnia kosteri* | Koster's springsnail | 1247 |

***VULNERABILITY***
***(Summary of status, environmental baseline and cumulative effects)***

**Status:** Endangered
**Distribution:** Small, endemic, constrained, and/or isolated population(s)
**Number of Populations:** Multiple populations (few)
**Species Trends:** Unknown population trends
**Pesticides noted** ☐

**Environmental Baseline/Cumulative Effects (EB/CE) Summary:**
The Koster's springsnail is an aquatic species, distributed in five geographically separate populations in isolated limestone and gypsum springs, seeps, and wetlands on Bitter Lake National Wildlife Refuge (Refuge). As with other snails in the family Hydrobiidae, the Koster's springsnail can survive in seepage areas, as long as flows are perennial and within the species' physiological tolerance limits (NMDGF 2005). The Koster's springsnail is currently known only from the Middle Tract of Bitter Lake National Wildlife Refuge (Refuge) and a nearby complex of springs owned by the City of Roswell in Chaves County, New Mexico. Koster's springsnail is most abundant in the deep organic substrates (material on the bottom of the stream) of Bitter Creek and its headwaters on the Refuge (NMDGF 2005); it also occurs at the Sago Springs Complex, but in lower numbers: it ranged from 704/$m^2$ (65/$ft^2$) to 89,472/$m^2$ (8,315/$ft^2$) in Bitter Creek in 1995 and 1996; while at Sago Spring it ranged from 51/$m^2$ (5/$ft^2$) to 75/$m^2$ (7/$ft^2$)(Lang 2002). Koster's springsnail also occurs in Lake St. Francis, the southwestern corner of Impoundment 15, Hunter Marsh, springditches of Impoundments 6 and 7, and several springs adjacent to the Refuge owned by the City of Roswell (NMDGF 2005, Sanchez 2009, B. Lang, NMDGF, pers. comm. 2010). The species has not been found in recent times along the western boundary of the spring run originating from the saline waters of Bitter Lake, bordering Impoundment 3 on the Refuge (NMDGF 2005), and it was recently extirpated from North Spring (NMDGF 2005). Fossil records indicate that at least one snail species was historically found at Berrendo Spring, North Spring, and South Spring River, and along the Pecos River (NMDGF 1999). This evidence suggests an apparent historical decline in the numbers, range, and distribution of Koster's springsnails.

The loss or alteration of spring habitat continues to be the main threat to Koster's springsnail. The scattered distribution of springs makes them aquatic islands of unique habitat in an arid-land matrix (Myers and Resh 1999). Members of the snail family Hydrobiidae (including Koster's springsnails) are susceptible to extirpation or extinction because they often occur in isolated desert springs (Hershler 1989, Hershler and Pratt 1990, Hershler 1994, Lydeard et al. 2004). There is evidence these habitats have been historically reduced or eliminated by aquifer

depletion (Jones and Balleau 1996). The lowering of water tables through aquifer withdrawals for irrigation and municipal use has degraded desert spring habitats, which the snails depend upon for survival.

Water contamination, particularly from oil and gas operations, is a significant threat for these springsnails. In order to assess the potential for contamination, a study was completed in September 1999 to delineate the area that serves as sources of water for the springs on the Refuge (Balleau Groundwater, Inc. 1999). This study reported that the sources of water that will reach the Refuge's springs include a broad area beginning west of Roswell near Eightmile Draw, extending to the northeast to Salt Creek, and southeast to the Refuge. This area represents possible pathways from which contaminants may enter the groundwater that feeds the springs on the Refuge. This broad area sits within a portion of the Roswell Basin and contains a mosaic of Federal, State, City, and private lands with multiple land uses including expanding urban development. There are 378 natural gas and oil wells in the 12-township area encompassing the source-water capture zone for the Middle Tract of the Refuge that are potential sources of contamination (Go-Tech 2010).

**EB/CE Source:** U. S. Fish and Wildlife Service. 2010. Roswell springsnail (*Pyrgulopsis roswellensis*), Koster's springsnail (*Juturnia kosteri*), Noel's amphipod (*Gammarus desperatus*), Pecos assiminea (*Assiminea pecos*) 5-Year Review: Summary and Evaluation. Southwest Region, Albuquerque, New Mexico. 25 pp.

U.S. Fish and Wildlife Service. 2019. Final Recovery Plan for Four Invertebrate Species of the Pecos River Valley: Noel's amphipod (*Gammarus desperatus*), Koster's springsnail (*Juturnia kosteri*), Roswell springsnail (*Pyrgulopsis roswellensis*), and Pecos assiminea (*Assiminea pecos*). Southwest Region, Albuquerque, New Mexico. 109 pp.

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

**Overall Vulnerability: ☒ High ☐ Medium ☐ Low**

***RISK***
***(Risk is based on species exposure and response from labeled uses across the range)***

**Risk to individuals if exposed:** We do not anticipate effects to the species from exposure to malathion at labeled use rates.

**Risk to the species from labeled uses across the range:**
The table below summarizes the risk to the species from labeled uses across the range based on range overlaps with use sites and anticipated effects associated with the particular uses.

| ALL USES except mosquito control | |
|---|---|
| Mortality | no effects expected |
| MOSQUITO CONTROL | |
| Mortality | no effects expected |

**Risk modifiers:** This species is found on pebbles, gypsum silt and to a lesser extent mud and submerged vegetation in seeps and high-volume springs and spring runs. The species co-occurs with *Pyrgulopsis roswellensis*. It occupies spring heads and runs with variable water temperatures (10-20 °C) and slow-to-moderate water velocities over compact substrate ranging from deep organic silts to gypsum sands and gravel and compact substrate (FWS, 2005).

**Overall Risk:** ☐ **High** ☐ **Medium** ☒ **Low**

***USAGE***
***(Anticipated usage within the range based on past usage data)***

| Use type | Risk to species[1] | Use overlap with range | | Estimated usage in range[2] | | Bins associated with use type^ | Effect associated with bin (H, M, L) |
|---|---|---|---|---|---|---|---|
| | | Acres | % | Acres | % | | |
| Mosquito Control | D | 3,193,902 | 57.7 | 0 | 0 | 2,5,6 | 2L<br>5L<br>6L |
| Other Crops | D | 58,628 | 1.06 | 0 | 0 | 2,5,6 | 2L<br>5L<br>6L |
| Pasture | D | 31,990 | 0.58 | 5,313 | 0.10 | 2,5,6 | 2L<br>5L<br>6L |
| Wheat | D | 20,114 | 0.36 | 18,453 | 0.33 | 2,5,6 | 2L<br>5L<br>6L |
| Developed | D | 13,955 | 0.25 | 698 | 0.01 | 2,5,6 | 2L<br>5L<br>6L |
| Other Grains | D | 11,082 | 0.2 | 4,692 | 0.08 | 2,5,6 | 2L<br>5L<br>6L |
| Corn | D | 7,573 | 0.14 | 156 | 0.01 | 2,5,6 | 2L<br>5L<br>6L |
| Orchards & Vineyards | D | 3,118 | 0.06 | 1,004 | 0.02 | 2,5,6 | 2L<br>5L |

[1] Direct effects (D), Indirect effects (I), No effects expected (N), Use site not utilized by the species (*)
[2] Estimated usage in the range is based on information about annual past usage.

| Use type | Risk to species[1] | Use overlap with range | | Estimated usage in range[2] | | Bins associated with use type^ | Effect associated with bin (H, M, L) |
|---|---|---|---|---|---|---|---|
| | | Acres | % | Acres | % | | |
| | | | | | | | 6L |
| Cotton | D | 2,084 | 0.04 | 2,084 | 0.04 | 2,5,6 | 2L<br>5L<br>6L |
| Vegetables & Ground Fruit | D | 44 | < 0.01 | 43 | < 0.01 | 2,5,6 | 2L<br>5L<br>6L |
| Other Row Crops | D | 31 | < 0.01 | 24 | < 0.01 | 2,5,6 | 2L<br>5L<br>6L |
| Nurseries | D | 19 | < 0.01 | 19 | < 0.01 | 2,5,6 | 2L<br>5L<br>6L |
| **Sub-TOTAL (D):** *Other uses with direct effects*[3] | | 148,638 | 2.72 | 32,486 | 0.63 | | |
| **Sub-TOTAL (I):** *Other uses with indirect effects*[3] | | 0 | 0 | 0 | 0 | | |
| **TOTAL[4]:** | | 3,342,540 | 60.42 | 32,486 | 0.63 | | |

^We consider the bin 2 estimates as an upper bound of bin 3 & 4 exposures.

**# acres in species range:** 5,540,060 acres
**% of range in California (i.e., where CalPUR data is available):** 0%
**Range overlap with Federal lands:** 1,639,171 acres, 29.588%

**Overall Usage:** ☐ **High** ☐ **Medium** ☒ **Low**

***CONSERVATION MEASURES***

**Rain restriction:** Given the relatively short half-life of malathion and rapid degradation via hydrolysis and other processes, persistence of malathion in storm run-off into most aquatic habitats is not anticipated to last longer than 48 hours under typical pH values, (i.e., 6.5-8.5) and water temperatures corresponding to growing season. Restricting malathion application to periods where rain is not forecasted for at least 48 hours or when the soil is not saturated will provide time for the pesticide to degrade before runoff into aquatic habitats can occur, decreasing exposure and risk.

**Aquatic habitat buffers:** Application buffers, which specify on the label a distance from water bodies where pesticides are not to be applied, are designed to reduce spray drift from entering sensitive non-target areas, thereby providing protection to aquatic species. While the exact

[3] Mosquito control has the potential to overlap with other uses. It is not included in the Sub-TOTALs.
[4] TOTAL includes usage on all use sites with effects, including mosquito control.

amount of spray drift reduction depends on the physical traits of the aquatic ecosystem (e.g., flow rate, volume, etc.) as well as the application method, we can expect (based on AgDRIFT modeling) spray drift reductions ranging from 40 to 91%, with low flow and low volume aquatic habitats receiving the most reduction in spray drift deposition. In many cases, these buffers substantially reduce exposure to aquatic organisms and subsequent risk of direct and indirect effects.

**Reduced application number and rate:** New restrictions on corn, cotton, orchards and vineyards, pasture, other crops, and vegetables and ground fruit lower the maximum allowable number of applications to 2-4 per year (depending on the specific crop; previous allowable numbers of applications ranged from 3 to 13 applications per year). This will help reduce the amount of malathion used and decrease potential exposure to the species, thus decreasing the risk of both indirect and direct effects to the species.

---

***CONCLUSION***

After reviewing the current status of the species, the environmental baseline for the action area, the effects of the proposed registration of malathion, and the cumulative effects, it is the Service's biological opinion that the registration of malathion, as proposed, with the implementation of the general conservation measures described above, is not likely to jeopardize the continued existence of the Koster's springsnail. As discussed below, the vulnerability is high for this species, the risk and likelihood of exposure to malathion is low, and the implementation of the general conservation measures described above is expected to further reduce the likelihood of exposure.

The Koster's springsnail has a high vulnerability based on its status, distribution, and trends, as described above. This aquatic snail has a very localized range and is currently known only from the Middle Tract of Bitter Lake National Wildlife Refuge and a nearby complex of springs owned by the City of Roswell, in Chaves County, New Mexico. The species is susceptible to extirpation or extinction because it often occurs in isolated desert springs (Hershler 1989, Hershler and Pratt 1990, Hershler 1994, Lydeard et al. 2004). Water contamination, particularly from oil and gas operations, is a significant threat to the species.

The risk to the species from labeled uses across the range is expected to be low as we do not anticipate any measurable effects from malathion exposure to individuals, including mortality or sublethal effects to growth, reproduction, or behavior. There may be potential effects to the species' food base (e.g., algae, plants, detritus), however these effects are expected to be small and will not likely result in adverse effects to snails.

About 30% of the species range is on Federal lands where we expect any adverse effects would be minimal, considering the small scale and low levels of past malathion usage on Federal lands, and in light of Federal agency programs that are designed to understand, avoid, and minimize the effects to listed species (see the Approach to Usage section of the Opinion). We anticipate usage

of malathion within the range will be low (0.63%, expected on the non-Federal portion), based primarily on the standard usage data we acquired, as described in the Opinion and summarized for this species above. Additionally, conservation measures, such as rain restrictions, aquatic habitat buffers, and reducing the allowable number of applications and application rates for certain crops, are expected to substantially reduce environmental concentrations of malathion within the species' range, reducing the likelihood of exposure.

Due to the lack of measurable effects to individuals, including mortality and sublethal effects, the lack of appreciable effects to its food base and habitat, the low level of expected usage, and the incorporation of conservation measures that would further reduce the risk of exposure, we anticipate minimal, if any, adverse effects (i.e., not enough to result in take) will occur throughout the duration of the action. Therefore, we do not anticipate that the proposed action would appreciably reduce survival and recovery of the Koster's springsnail in the wild.

**Conclusion:** Not likely to jeopardize

***ADDITIONAL REFERENCES***

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

**Integration and Synthesis Summary: Snails *(Aquatic)***

| Scientific Name: | Common Name: | Entity ID: |
|---|---|---|
| *Planorbella magnifica* | Magnificent ramshorn | 1358 |

***VULNERABILITY***
***(Summary of status, environmental baseline and cumulative effects)***

**Status:** Candidate
**Distribution:** Population size/location unknown
**Number of Populations:** Population size/location(s) unknown
**Species Trends:** Unknown population trends
**Pesticides noted** ☐

**Environmental Baseline/Cumulative Effects (EB/CE) Summary:**
The Magnificent Ramshorn is a freshwater snail in the family Planorbidae (Pilsbry 1903), a family of airbreathing snails. It is the largest North American snail in this family. It has a discoidal (i.e., coiling in one plane), relatively thin shell that reaches a diameter commonly exceeding 35 millimeters (mm) (1.38 inches) and heights exceeding 20 mm (0.79 inch). The species has been recorded from only four sites in the lower Cape Fear River Basin in New Hanover and Brunswick Counties, North Carolina, but is believed to be extirpated from all four of these sites. Surveys of over a hundred potential sites over the last few decades have not uncovered any additional localities. The only known surviving individuals of the species are being held as part of captive populations; one established and maintained by a private individual at his residence in Pender County, North Carolina, one at NC State University's Veterinary School's Aquatic Epidemiology Conservation Laboratory in Raleigh, North Carolina, and another one at the NCWRC's Watha State Fish Hatchery in Watha, North Carolina (FWS 2019). Available information indicates that suitable habitat for the species is restricted to relatively shallow, sheltered portions of still or sluggish, freshwater bodies with an abundance and diversity of submerged aquatic vegetation and a circumneutral pH (pH within the range of 6.8–7.5). The only known records for the species are post-1900 and are from manmade millponds constructed in the 1700s to provide a freshwater source for rice agriculture. However, these impoundments closely replicate beaver-pond habitat, and it is plausible that the species was once a faunal component of beaver ponds.

The species may also have once inhabited backwater and other sluggish portions of the main channel of lower Cape Fear River. Beaver-pond habitat was eliminated for several decades throughout much of the lower Cape Fear River as a result of the extirpation of the North American beaver due to trapping and hunting during the 19th and early 20th centuries. This, together with draining and destruction of beaver ponds for development, agriculture, and other purposes, is believed to have led to a significant decline in the snail's habitat. Also, dredging and deepening of the Cape Fear River channel, which began as early as 1822, and opening of the Atlantic Intercoastal Waterway (through Snow's Cut) in 1930 for navigational purposes have

caused saltwater intrusion, altered the diversity and abundance of aquatic vegetation, and changed flows and current patterns far up the river channel and its lower tributaries. Under these circumstances, the magnificent ramshorn could have survived only in areas of tributary streams not affected by salt water intrusion and other changes, such as the millponds protected from saltwater intrusion by their dams. The species is believed to have been eliminated from the millponds from which it has been recorded due to saltwater intrusion during severe storms (Hurricane Fran) and drought conditions, increased input of nutrients and other pollutants from development activities adversely affecting water quality/chemistry and leading to increased nuisance aquatic plant and algae growth, and efforts, harmful to the snail, by landowners to control nuisance plant and algae growth. While efforts have been made to restore habitat for the magnificent ramshorn at one of the sites known to have previously supported the species, all of the sites known to have previously supported the snail continue to be affected or threatened by most of the same factors (i.e., saltwater intrusion and other water quality degradation, nuisance aquatic plant control, storms, sea level rise, etc.) believed to have resulted in extirpation of the species from the wild. Currently, only a single captive population of the species is known to exist. A single catastrophic event, such as a severe storm, disease, or predator infestation, affecting one of the captive populations would make the species more vulnerable to extinction. Accordingly, the magnitude of the threats to the species' survival is high.

**EB/CE Source:** U.S. Fish and Wildlife Service. 2020. Species Assessment and Listing Priority Assignment Form for Magnificent Ramshorn. Southeast Region, Raleigh, North Carolina. 17 pp.

**Overall Vulnerability:** ☒ **High** ☐ **Medium** ☐ **Low**

***RISK***
***(Risk is based on species exposure and response from labeled uses across the range)***

**Risk to individuals if exposed:** We do not anticipate effects to the species from exposure to malathion at labeled use rates.

**Risk to the species from labeled uses across the range:**
The table below summarizes the risk to the species from labeled uses across the range based on range overlaps with use sites and anticipated effects associated with the particular uses.

| ALL USES except mosquito control | |
|---|---|
| Mortality | no effects expected |
| MOSQUITO CONTROL | |
| Mortality | no effects expected |

**Risk modifiers:** Although the magnificent ramshorn is a large snail, its shell is thin and fragile indicating that it is adapted to lentic (still or slow flowing) aquatic habitats (Bartsch 1908, p. 697; Adams 1993, pp. 2 and 3). Available information indicates that suitable habitat for the species is restricted to relatively shallow, sheltered portions of still or sluggish, freshwater bodies with an abundance and diversity of submerged aquatic vegetation and a circumneutral pH (pH within the

range of 6.8 7.5) (Adams 1993, p. 8). The *Planorbidae* family of snails is on the whole a distinctly shallow-water group (Baker 1943, p. 17). Salinity and pH also are major factors limiting the distribution of the magnificent ramshorn.

**Overall Risk: ☐ High ☐ Medium ☒ Low**

***USAGE***
***(Anticipated usage within the range based on past usage data)***

| Use type | Risk to species[1] | Use overlap with range | | Estimated usage in range[2] | | Bins associated with use type^ | Effect associated with bin (H, M, L) |
|---|---|---|---|---|---|---|---|
| | | Acres | % | Acres | % | | |
| Mosquito Control | D | 840,185 | 80 | 17,305 | 1.65 | 2,5 | 2L<br>5L |
| Developed | D | 55,962 | 5.33 | 2,798 | 0.27 | 2,5 | 2L<br>5L |
| Corn | D | 13,732 | 1.31 | 2,285 | 0.22 | 2,5 | 2L<br>5L |
| Other Crops | D | 7,558 | 0.72 | 0 | 0 | 2,5 | 2L<br>5L |
| Cotton | D | 588 | 0.06 | 550 | 0.05 | 2,5 | 2L<br>5L |
| Nurseries | D | 223 | 0.02 | 223 | 0.02 | 2,5 | 2L<br>5L |
| Vegetables & Ground Fruit | D | 136 | 0.01 | 136 | 0.01 | 2,5 | 2L<br>5L |
| Wheat | D | 106 | < 0.01 | 105 | < 0.01 | 2,5 | 2L<br>5L |
| Other Row Crops | D | 89 | < 0.01 | 88 | < 0.01 | 2,5 | 2L<br>5L |
| Other Grains | D | 70 | < 0.01 | 70 | < 0.01 | 2,5 | 2L<br>5L |
| Orchards & Vineyards | D | 2 | < 0.01 | 2 | < 0.01 | 2,5 | 2L<br>5L |
| Pasture | D | <1 | < 0.01 | <1 | < 0.01 | 2,5 | 2L<br>5L |
| **Sub-TOTAL (D):** *Other uses with direct effects*[3] | | 78,467 | 7.5 | 6,257 | 0.62 | | |
| **Sub-TOTAL (I):** *Other uses with indirect effects*[3] | | 0 | 0 | 0 | 0 | | |

[1] Direct effects (D), Indirect effects (I), No effects expected (N), Use site not utilized by the species (*)
[2] Estimated usage in the range is based on information about annual past usage.
[3] Mosquito control has the potential to overlap with other uses. It is not included in the Sub-TOTALs.

| Use type | Risk to species[1] | Use overlap with range | | Estimated usage in range[2] | | Bins associated with use type^ | Effect associated with bin (H, M, L) |
|---|---|---|---|---|---|---|---|
| | | Acres | % | Acres | % | | |
| **TOTAL[4]:** | | 918,652 | 87.5 | 23,562 | 2.27 | | |

^We consider the bin 2 estimates as an upper bound of bin 3 & 4 exposures.

**# acres in species range:** 1,050,291 acres
**% of range in California (i.e., where CalPUR data is available):** 0%
**Range overlap with Federal lands:** 11,461 acres, 1.091%

**Overall Usage:** ☐ **High** ☐ **Medium** ☒ **Low**

***CONSERVATION MEASURES***

**Rain restriction:** Given the relatively short half-life of malathion and rapid degradation via hydrolysis and other processes, persistence of malathion in storm run-off into most aquatic habitats is not anticipated to last longer than 48 hours under typical pH values, (i.e., 6.5-8.5) and water temperatures corresponding to growing season. Restricting malathion application to periods where rain is not forecasted for at least 48 hours or when the soil is not saturated will provide time for the pesticide to degrade before runoff into aquatic habitats can occur, decreasing exposure and risk.

**Aquatic habitat buffers:** Application buffers, which specify on the label a distance from water bodies where pesticides are not to be applied, are designed to reduce spray drift from entering sensitive non-target areas, thereby providing protection to aquatic species. While the exact amount of spray drift reduction depends on the physical traits of the aquatic ecosystem (e.g., flow rate, volume, etc.) as well as the application method, we can expect (based on AgDRIFT modeling) spray drift reductions ranging from 40 to 91%, with low flow and low volume aquatic habitats receiving the most reduction in spray drift deposition. In many cases, these buffers substantially reduce exposure to aquatic organisms and subsequent risk of direct and indirect effects.

**Residential use label changes:** New restrictions to the method and frequency of application for residential use of malathion are expected to substantially reduce exposure to species that overlap with developed and open space developed areas. Label changes will ensure that residential use is limited to spot treatments only (rendering spray drift offsite unlikely) and reducing the extent of area which can be treated in the developed and open space developed areas by as much as 75% or more from modeled values. In addition, we expect the frequency of exposure to decrease as the number of allowable applications is reduced from "repeat as necessary" to a maximum of 2–4 applications per year (depending on the specific residential use). Retreatment intervals of 7-10 days between any repeated applications are expected to reduce environmental concentrations by allowing any initial residues to degrade prior to the next application. In addition, exposure to

[4] TOTAL includes usage on all use sites with effects, including mosquito control.

aquatic organisms is reduced due to buffers from waterways, which specify on the label a distance from water bodies where pesticides are not to be applied, and restrictions to application during periods where rain is not forecasted within 24 hours or when the soil is not saturated.

**Reduced application number and rate:** New restrictions on corn, cotton, orchards and vineyards, pasture, other crops, and vegetables and ground fruit lower the maximum allowable number of applications to 2-4 per year (depending on the specific crop; previous allowable numbers of applications ranged from 3 to 13 applications per year). This will help reduce the amount of malathion used and decrease potential exposure to the species, thus decreasing the risk of both indirect and direct effects to the species.

---

***CONCLUSION***

After reviewing the current status of the species, the environmental baseline for the action area, the effects of the proposed registration of malathion, and the cumulative effects, it is the Service's biological opinion that the registration of malathion, as proposed, with the implementation of the general conservation measures described above, is not likely to jeopardize the continued existence of the magnificent ramshorn. As discussed below, the vulnerability is high for this species, the risk and likelihood of exposure to malathion is low, and the implementation of the general conservation measures described above is expected to further reduce the likelihood of exposure.

The magnificent ramshorn has a high vulnerability because the species is likely extirpated from the wild and the only known surviving individuals are being held as part of captive populations; one established and maintained by a private individual at his residence in Pender County, North Carolina, one at NC State University's Veterinary School's Aquatic Epidemiology Conservation Laboratory in Raleigh, North Carolina, and another one at the NCWRC's Watha State Fish Hatchery in Watha, North Carolina (FWS 2019). Available information indicates that suitable habitat for the species is restricted to relatively shallow, sheltered portions of still or sluggish, freshwater bodies with an abundance and diversity of submerged aquatic vegetation and a circumneutral pH (pH within the range of 6.8–7.5; Adams 1993, p. 8).

The risk to the species from labeled uses across the range is expected to be low as we do not anticipate any measurable effects from malathion exposure to individuals, including mortality or sublethal effects to growth, reproduction, or behavior. There may be potential effects to the species' food base (e.g., algae, plants, detritus), however these effects are expected to be small and will not likely result in adverse effects to snails.

Furthermore, we anticipate usage of malathion within the range will be low (2.27%, expected to occur on the non-Federal portion), based primarily on the standard usage data we acquired, as described in the Opinion and summarized for this species above. Additionally, conservation measures, such as rain restrictions, aquatic habitat buffers, changes to residential use labels, and reducing the allowable number of applications and application rates for certain crops, are

expected to reduce environmental concentrations of malathion within the species' range, further decreasing the likelihood of exposure.

Due to the lack of measurable effects to individuals, including mortality and sublethal effects, the lack of appreciable effects to its food base and habitat, the low level of expected usage, and the incorporation of conservation measures that would further reduce the risk of exposure, we anticipate minimal, if any, adverse effects (i.e., not enough to result in take) will occur throughout the duration of the action. Therefore, we do not anticipate that the proposed action would appreciably reduce survival and recovery of the magnificent ramshorn in the wild.

**Conclusion:** Not likely to jeopardize

***ADDITIONAL REFERENCES***

U.S. Fish and Wildlife Service. 2020. Species Assessment and Listing Priority Assignment Form for Magnificent Ramshorn. Southeast Region, Raleigh, North Carolina. 17 pp.

**Integration and Synthesis Summary: Snails *(Aquatic)***

| Scientific Name: | Common Name: | Entity ID: |
|---|---|---|
| *Pyrgulopsis bernardina* | San Bernardino springsnail | 1380 |

***VULNERABILITY***
***(Summary of status, environmental baseline and cumulative effects)***

**Status:** Threatened
**Distribution:** Small, endemic, constrained, and/or isolated population(s)
**Number of Populations:** Declining population(s) – one or more populations declining
**Species Trends:** Multiple populations (few)
**Pesticides noted ☒**

**Environmental Baseline/Cumulative Effects (EB/CE) Summary:**
The primary factors likely to affect the San Bernardino springsnail's continued existence include the fire retardant chemicals, springhead inundation, and water depletion and diversion. In the United States, the San Bernardino springsnail occurs on the privately owned Slaughter Ranch. In Mexico, the springsnail occurs on private lands. We estimate land ownership comprises approximately 1 acre in the United States and about 50 acres in Mexico. The historical range of the San Bernardino springsnail in the United States may have included several springs in Cochise County, Arizona. In the arid Southwest, springsnails are largely relicts of the wetter Pleistocene Epoch (2.5 million to 10,000 years ago), and are typically distributed across the landscape as geographically isolated populations exhibiting a high degree of endemism (Bequart and Miller 1973, p. 214; Taylor 1987, pp. 5–6; Shepard 1993, p. 354; Hershler and Sada 2002, p. 255). Springsnails are strictly aquatic, and respiration occurs through an internal gill. The current range of the species in the United States is now believed to be limited to two springs on the John Slaughter Ranch Museum, Goat Tank Spring and Horse Spring (Martinez 2010, p. 2). Surveys by SBNWR staff confirmed the presence of San Bernardino springsnails in Horse Spring in 2009 (Martinez 2010, p. 2). Also, Horse Spring is now known to be directly connected via an underground pipeline to Goat Spring (which is occupied by thousands of springsnails), so the likelihood of springsnails being at both sites is high. The species was formerly collected and very abundant at Snail Spring on the John Slaughter Ranch Museum (Malcom et al. 2003, p. 17; Malcom et al. 2005, p. 74), but now appears to be extirpated having last been confirmed from that site in 2005 (Cox et al. 2007, p. 1; Malcom 2007, p. 1; Service 2007, p. 83; Martinez 2010, p. 1; Varela Romero and Myers 2010, p. 2). The San Bernardino springsnail was recently discovered to occur at five sites in Sonora, Mexico, in at least nine springs. Many springsnail species exhibit decreased abundance farther away from spring vents, presumably due to their need for stable water chemistry and flow provided by spring waters (Hershler 1984, p. 68; Hershler 1998, p. 11; Hershler and Sada 2002, p. 256; Martinez and Thome 2006, p. 14; Tsai et al. 2007, p. 216). They are sensitive to water quality, and each species is usually found within relatively narrow habitat parameters (Sada 2008, p. 59). The species' habitat is likely to be threatened in the foreseeable future with destruction, modification, and curtailment in part of its

range due to the potential use of fire retardant chemicals in the United States, and throughout its entire range in both the United States and Mexico due to potential springhead inundation, and water depletion and diversion. Also, we found that the San Bernardino springsnail is likely to become in danger of extinction in the foreseeable future throughout its entire range due to the potential invasion and predation by nonnative crayfish, invasion and competition with New Zealand springsnails, and climate change and drought drying its springhead habitat. Due to the species' endemic nature, the San Bernardino springsnail may be more vulnerable to extinction in the foreseeable future from these potential threats throughout its entire range.

**EB/CE Source:** U.S. Fish and Wildlife Service. 2012. Determination of Endangered Status for Three Forks Springsnail and Threatened Status for San Bernardino Springsnail Throughout Their Ranges and Designation of Critical Habitat for Both Species; Final Rule. 77 FR 23060 23092.

**Overall Vulnerability:** ☐ **High** ☒ **Medium** ☐ **Low**

***RISK***
***(Risk is based on species exposure and response from labeled uses across the range)***

**Risk to individuals if exposed:** We do not anticipate effects to the species from exposure to malathion at labeled use rates.

**Risk to the species from labeled uses across the range:**
The table below summarizes the risk to the species from labeled uses across the range based on range overlaps with use sites and anticipated effects associated with the particular uses.

| ALL USES except mosquito control | |
|---|---|
| Mortality | no effects expected |
| MOSQUITO CONTROL | |
| Mortality | no effects expected |

**Risk modifiers:** San Bernardino springsnails are clumped in freshwater rheocrene (emerging from the ground as a flowing stream) springs, seeps, spring pools, outflows, and diverse flowing waters at elevations around 1,160 m (3,800 ft.) and are rarely found in mud or soft sediments. San Bernardino springsnails need close proximity to springheads where water emerges from the ground. Springheads play a key role in the life history of springsnails; San Bernardino springsnails have a decreased abundance farther away from spring vents, because they need a habitat with the stable water chemistry and flow provided by spring waters.

Pesticides can be a threat to the San Bernardino springsnail. Private property owners at Slaughter Ranch use a number of pesticides to maintain desirable landscape conditions. Spring endemic species such as the San Bernardino springsnail are adapted to the unique environmental conditions provided by spring water and are sensitive to shifts in water quality, including those caused by contamination. A study found that pesticides affected growth, development, and egg-laying capacity, and can cause mortality.

As described in the "Approach to the Effects Analysis" section of the main body of the Opinion, we made specific considerations for species that occur in bins 3 and 4 as they were modeled in such a way that likely resulted in overestimation of estimated environmental concentrations, thus overestimating potential exposure. While the San Bernardino springsnail does occupy other aquatic habitats that contain higher concentrations of malathion (e.g., bin 2 and 5), individuals of the species that occupy habitats with higher flow rates (e.g., bin 3) will experience lower exposure than those occupying low flow areas, reducing the risk of effects across the species in general.

**Overall Risk:** ☐ **High** ☐ **Medium** ☒ **Low**

***USAGE***
***(Anticipated usage within the range based on past usage data)***

| Use type | Risk to species[1] | Use overlap with range | | Estimated usage in range[2] | | Bins associated with use type^ | Effect associated with bin (H, M, L) |
|---|---|---|---|---|---|---|---|
| | | Acres | % | Acres | % | | |
| Mosquito Control | N | 0 | 0 | 0 | 0 | 2,3,5,6 | 2L<br>3L<br>5L<br>6L |
| Other Crops | D | 17,257 | 0.13 | 0 | 0 | 2,3,5,6 | 2L<br>3L<br>5L<br>6L |
| Developed | D | 4,005 | 0.03 | 2 | < 0.01 | 2,3,5,6 | 2L<br>3L<br>5L<br>6L |
| Orchards & Vineyards | D | 1,134 | < 0.01 | 2 | < 0.01 | 2,3,5,6 | 2L<br>3L<br>5L<br>6L |
| Corn | D | 307 | < 0.01 | 0 | 0 | 2,3,5,6 | 2L<br>3L<br>5L<br>6L |
| Pasture | D | 182 | < 0.01 | <1 | < 0.01 | 2,3,5,6 | 2L<br>3L<br>5L<br>6L |
| Other Grains | D | 111 | < 0.01 | 1 | < 0.01 | 2,3,5,6 | 2L<br>3L |

[1] Direct effects (D), Indirect effects (I), No effects expected (N), Use site not utilized by the species (*)
[2] Estimated usage in the range is based on information about annual past usage.

| Use type | Risk to species[1] | Use overlap with range | | Estimated usage in range[2] | | Bins associated with use type^ | Effect associated with bin (H, M, L) |
|---|---|---|---|---|---|---|---|
| | | Acres | % | Acres | % | | |
| | | | | | | | 5L<br>6L |
| Cotton | D | 63 | < 0.01 | 1 | < 0.01 | 2,3,5,6 | 2L<br>3L<br>5L<br>6L |
| Wheat | D | 41 | < 0.01 | <1 | < 0.01 | 2,3,5,6 | 2L<br>3L<br>5L<br>6L |
| Vegetables & Ground Fruit | D | 11 | < 0.01 | <1 | < 0.01 | 2,3,5,6 | 2L<br>3L<br>5L<br>6L |
| **Sub-TOTAL (D):** *Other uses with direct effects*[3] | | 23,111 | 0.23 | 10 | 0.03 | | |
| **Sub-TOTAL (I):** *Other uses with indirect effects*[3] | | 0 | 0 | 0 | 0 | | |
| **TOTAL[4]:** | | 23,111 | 0.23 | 10 | 0.03 | | |

^We consider the bin 2 estimates as an upper bound of bin 3 & 4 exposures.

**# acres in species range:** 128,656 acres
**% of range in California (i.e., where CalPUR data is available):** 0%
**Range overlap with Federal lands:** 29,757 acres, 23.130%

**Overall Usage:** ☐ **High** ☐ **Medium** ☒ **Low**

***CONSERVATION MEASURES***

**Rain restriction:** Given the relatively short half-life of malathion and rapid degradation via hydrolysis and other processes, persistence of malathion in storm run-off into most aquatic habitats is not anticipated to last longer than 48 hours under typical pH values, (i.e., 6.5-8.5) and water temperatures corresponding to growing season. Restricting malathion application to periods where rain is not forecasted for at least 48 hours or when the soil is not saturated will provide time for the pesticide to degrade before runoff into aquatic habitats can occur, decreasing exposure and risk.

**Aquatic habitat buffers:** Application buffers, which specify on the label a distance from water bodies where pesticides are not to be applied, are designed to reduce spray drift from entering

[3] Mosquito control has the potential to overlap with other uses. It is not included in the Sub-TOTALs.
[4] TOTAL includes usage on all use sites with effects, including mosquito control.

sensitive non-target areas, thereby providing protection to aquatic species. While the exact amount of spray drift reduction depends on the physical traits of the aquatic ecosystem (e.g., flow rate, volume, etc.) as well as the application method, we can expect (based on AgDRIFT modeling) spray drift reductions ranging from 40 to 91%, with low flow and low volume aquatic habitats receiving the most reduction in spray drift deposition. In many cases, these buffers substantially reduce exposure to aquatic organisms and subsequent risk of direct and indirect effects.

***CONCLUSION***

After reviewing the current status of the species, the environmental baseline for the action area, the effects of the proposed registration of malathion, and the cumulative effects, it is the Service's biological opinion that the registration of malathion, as proposed, with the implementation of the general conservation measures described above, is not likely to jeopardize the continued existence of San Bernardino springsnail. As discussed below, the vulnerability is high for this species, the risk and likelihood of exposure to malathion is low, and the implementation of the general conservation measures described above is expected to further reduce the likelihood of exposure.

The San Bernardino springsnail has a medium vulnerability based on its status, distribution, and trends, as described above. However, due to the species' endemic nature, the San Bernardino springsnail may be more vulnerable to extinction in the foreseeable future from potential threats throughout its entire range (FWS 2012). In the United States, the San Bernardino springsnail occurs on the privately owned Slaughter Ranch where it is likely limited to two springs across an estimated 1 acre. In Mexico, the springsnail occurs on an estimated 50 acres of private lands (FWS 2012). Like other springsnails, this species is also sesitive to water quality. San Bernardino springsnails need close proximity to springheads where water emerges from the ground. They have a decreased abundance farther away from spring vents because they need a habitat with the stable water chemistry and flow provided by spring waters.

The risk to the species from labeled uses across the range is expected to be low as we do not anticipate any measurable effects from malathion exposure to individuals, including mortality or sublethal effects to growth, reproduction, or behavior. There may be potential effects to the species' food base (e.g., algae, plants, detritus), however these effects are expected to be small and will not likely result in adverse effects to snails.

About 23% of the species range is on Federal lands where we expect any adverse effects would be minimal, considering the small scale and low levels of past malathion usage on Federal lands, and in light of Federal agency programs that are designed to understand, avoid, and minimize the effects to listed species (see the Approach to Usage section of the Opinion). We also anticipate malathion usage within the range outside of Federal lands will be very low (0.03% of the range, expected to occur on the non-Federal portion), based primarily on standard usage data we

acquired, as described in the Opinion and summarized for this species above. Additionally, conservation measures, such as rain restrictions and aquatic habitat buffers, are expected to further reduce the likelihood of exposure.

Due to the lack of measurable effects to individuals, including mortality and sublethal effects, the lack of appreciable effects to its food base and habitat, the low level of expected usage, and the incorporation of conservation measures that would further reduce the risk of exposure, we anticipate minimal, if any, adverse effects (i.e., not enough to result in take) will occur throughout the duration of the action. Therefore, we do not anticipate that the proposed action would appreciably reduce survival and recovery of the San Bernardino springsnail.

**Conclusion:** Not likely to jeopardize

***ADDITIONAL REFERENCES***

U.S. Fish and Wildlife Service. 2012. Determination of Endangered Status for Three Forks Springsnail and Threatened Status for San Bernardino Springsnail Throughout Their Ranges and Designation of Critical Habitat for Both Species; Final Rule. 77 FR 23060 23092.

**Integration and Synthesis Summary: Snails *(Aquatic)***

| Scientific Name: | Common Name: | Entity ID: |
|---|---|---|
| *Leptoxis foremani* | Interrupted (=Georgia) Rocksnail | 2561 |

***VULNERABILITY***
***(Summary of status, environmental baseline and cumulative effects)***

**Status:** Endangered
**Distribution:** Small, endemic, constrained, and/or isolated population(s)
**Number of Populations:** Single population
**Species Trends:** Declining population(s) – one or more populations declining
**Pesticides noted** ☐

**Environmental Baseline/Cumulative Effects (EB/CE) Summary:**
The interrupted rocksnail is a member of the aquatic snail family Pleuroceridae. Rocksnails (*Pleurocera* spp.) live in shoals, riffles, and reefs (bedrock outcrops) of medium to large rivers of Eastern North America to the Rockies. Their habitats are generally subject to moderate currents during low flows and strong currents during high flows. The interrupted rocksnail lives attached to bedrock, boulders, cobbles, and gravel and tend to move slowly, except in response to changes in water level (Figure 4). They lay their adhesive eggs within the same habitat (Johnson 2004). In a hatchery setting, mean clutch size for 2 year old interrupted rocksnails was around 8.83 (3 – 18 eggs/clutch), and clutch size of females 3+ years was 13.63 (2-21 eggs/clutch) (Figure 4) (Johnson in litt. 2009). Interrupted rocksnails are found in shoal habitats with sand-boulder substrate, at water depths less than 50 centimeters (cm) (20 in), and in water currents less than 40 cm/second (sec) (16 in/sec) (Johnson 2004). Water temperature strongly influenced timing of initiation of oviposition (laying of eggs) for multiple Leptoxis species. Specifically, interrupted rocksnail began laying at 12 and ended at 22 degrees Celsius (˚C) (Whelan et al. 2015). Field observations in the Oostanaula River indicate eggs are laid on the undersides or vertical sides of clean, hard substrates. We know little of the life history of pleurocerid snails; however, they are considered generalist scrappers and generally feed by ingesting periphyton (algae attached to hard surfaces) and biofilm detritus scraped off of the substrate by the snail's radula (a horny band with minute teeth used to pull food into the mouth) (Morales and Ward 2000). Interrupted rocksnails have been observed grazing on silt-free gravel, cobble, and boulders (Johnson 2004). They have survived as long as 5 years in captivity (Johnson in litt. 2006a). The interrupted rocksnail was federally listed as endangered on November 2, 2010 (75 FR 67512). It is endemic to the Coosa River drainage of the Mobile River Basin in Alabama and Georgia and has disappeared from 90 percent or more of its historical range, primarily due to impoundment of riverine habitats. A single population of interrupted rocksnail is known to survive in the Oostanaula River, Georgia. Field collections conducted in November of 2014, in the Oostanaula River in Georgia found interrupted rocksnails were in good numbers based on qualitative observations (52 adults and 70 juveniles) (P. Johnson pers. comm. 2019). A select number of individuals from this survey were taken to Alabama Aquatic Biodiversity Center (AABC) for

propagation and their progeny are currently being held at AABC. Although the species has been successfully propagated and can be raised in captivity, reintroductions have not been successful.

This species requires flowing water, stable stream channels with minimal sediment and algae growth, and adequate water quality. Primary threats to the species include extreme curtailment of habitat and range, small population sizes, and their resulting vulnerability to natural or human induced catastrophic events (e.g., droughts, pollution spills, etc.). Surviving populations are threatened by water quality and habitat deterioration. Altered flows, fragmented habitat, and non-point discharges are expected to continue. Habitat destruction or modification is a substantial threat to this species. Though the species' range was extended slightly since it was listed, it is still limited to a very short reach of the Oostanaula River. Because the interrupted rocksnail is geographically isolated and occurs in a single, linear reach of the river, catastrophic events such as spills or natural events (e.g., drought) could greatly reduce the geographic or genetic viability of the snail. The 2019 Recovery Plan Amendment clarified recovery criteria.

**EB/CE Sources:** U.S. Fish and Wildlife Service. 2014. Recovery Plan for the Georgia pigtoe mussel, Interrupted rocksnail, and Rough hornsnail. Atlanta, Georgia. 55 pp.

U.S. Fish and Wildlife Service. 2019. Recovery Plan for Interrupted Rocksnail *(Leptoxis foremani*) Amendment. 4 pp.

U.S. Fish and Wildlife Service. 2020. Interrupted Rocksnail (*Leptoxis foremani*) 5-Year Review: Summary and Evaluation. Alabama Ecological Services Field Office, Daphne, Alabama. 24 pp.

**Overall Vulnerability: ☒ High ☐ Medium ☐ Low**

***RISK***
***(Risk is based on species exposure and response from labeled uses across the range)***

**Risk to individuals if exposed:** We do not anticipate effects to the species from exposure to malathion at labeled use rates.

**Risk to the species from labeled uses across the range:**
The table below summarizes the risk to the species from labeled uses across the range based on range overlaps with use sites and anticipated effects associated with the particular uses.

| ALL USES except mosquito control | |
|---|---|
| Mortality | no effects expected |
| MOSQUITO CONTROL | |
| Mortality | no effects expected |

**Risk modifiers:** Interrupted rocksnails are currently found in shoal habitats with sand-boulder substrate, at water depths less than 50 centimeters (cm) (20 in), and in water currents less than 40 cm/second (sec) (16 in/sec) (Johnson 2004) (USFWS, 2014). High site fidelity, low tolerance

ranges/thresholds and narrow/ specialist environmental specificity are inferred based on strict habitat needs as is clumped spatial arrangement (USFWS, 2014; NatureServe, 2015).

As described in the "Approach to the Effects Analysis" section of the main body of the Opinion, we made specific considerations for species that occur in bins 3 and 4 as they were modeled in such a way that likely resulted in overestimation of estimated environmental concentrations, thus overestimating potential exposure. While the Interrupted (=Georgia) Rocksnail does occupy other aquatic habitats that contain higher concentrations of malathion (e.g., bins 2 and 5), individuals of the species that occupy habitats with higher flow rates (e.g., bins 3 and 4) will experience lower exposure than those occupying low flow areas, reducing the risk of effects across the species in general.

**Overall Risk: ☐ High ☐ Medium ☒ Low**

***USAGE***
***(Anticipated usage within the range based on past usage data)***

| Use type | Risk to species[1] | Use overlap with range | | Estimated usage in range[2] | | Bins associated with use type^ | Effect associated with bin (H, M, L) |
|---|---|---|---|---|---|---|---|
| | | Acres | % | Acres | % | | |
| Mosquito Control | D | 439,010 | 35.8 | 18,167 | 1.48 | 2,3,4,5 | 2L<br>3L<br>4L<br>5L |
| Developed | D | 55,576 | 4.53 | 2,779 | 0.23 | 2,3,4,5 | 2L<br>3L<br>4L<br>5L |
| Cotton | D | 20,716 | 1.69 | 10,506 | 0.86 | 2,3,4,5 | 2L<br>3L<br>4L<br>5L |
| Other Crops | D | 9,840 | 0.8 | 35 | < 0.01 | 2,3,4,5 | 2L<br>3L<br>4L<br>5L |
| Corn | D | 7,468 | 0.61 | 1,588 | 0.13 | 2,3,4,5 | 2L<br>3L<br>4L<br>5L |
| Other Grains | D | 874 | 0.07 | 773 | 0.06 | 2,3,4,5 | 2L<br>3L |

[1] Direct effects (D), Indirect effects (I), No effects expected (N), Use site not utilized by the species (*)
[2] Estimated usage in the range is based on information about annual past usage.

| Use type | Risk to species[1] | Use overlap with range | | Estimated usage in range[2] | | Bins associated with use type^ | Effect associated with bin (H, M, L) |
|---|---|---|---|---|---|---|---|
| | | Acres | % | Acres | % | | |
| | | | | | | | 4L<br>5L |
| Nurseries | D | 588 | 0.05 | 588 | 0.05 | 2,3,4,5 | 2L<br>3L<br>4L<br>5L |
| Wheat | D | 332 | 0.01 | 165 | 0.01 | 2,3,4,5 | 2L<br>3L<br>4L<br>5L |
| Other Row Crops | D | 125 | 0.03 | 102 | < 0.01 | 2,3,4,5 | 2L<br>3L<br>4L<br>5L |
| Orchards & Vineyards | D | 43 | < 0.01 | 35 | < 0.01 | 2,3,4,5 | 2L<br>3L<br>4L<br>5L |
| Vegetables & Ground Fruit | D | 17 | < 0.01 | 17 | < 0.01 | 2,3,4,5 | 2L<br>3L<br>4L<br>5L |
| Pasture | D | 3 | < 0.01 | 3 | < 0.01 | 2,3,4,5 | 2L<br>3L<br>4L<br>5L |
| Christmas Trees | D | <1 | < 0.01 | <1 | < 0.01 | 2,3,4,5 | 2L<br>3L<br>4L<br>5L |
| **Sub-TOTAL (D):** *Other uses with direct effects*[3] | | 95,581 | 7.85 | 16,591 | 1.4 | | |
| **Sub-TOTAL (I):** *Other uses with indirect effects*[3] | | 0 | 0 | 0 | 0 | | |
| **TOTAL[4]:** | | 534,592 | 43.65 | 34,758 | 2.88 | | |

^We consider the bin 2 estimates as an upper bound of bin 3 & 4 exposures.

**# acres in species range:** 1,226,760 acres
**% of range in California (i.e., where CalPUR data is available):** 0%

[3] Mosquito control has the potential to overlap with other uses. It is not included in the Sub-TOTALs.
[4] TOTAL includes usage on all use sites with effects, including mosquito control.

**Range overlap with Federal lands:** 212,692 acres, 17.338%

**Overall Usage:** ☐ **High** ☐ **Medium** ☒ **Low**

***CONSERVATION MEASURES***

**Rain restriction:** Given the relatively short half-life of malathion and rapid degradation via hydrolysis and other processes, persistence of malathion in storm run-off into most aquatic habitats is not anticipated to last longer than 48 hours under typical pH values, (i.e., 6.5-8.5) and water temperatures corresponding to growing season. Restricting malathion application to periods where rain is not forecasted for at least 48 hours or when the soil is not saturated will provide time for the pesticide to degrade before runoff into aquatic habitats can occur, decreasing exposure and risk.

**Aquatic habitat buffers:** Application buffers, which specify on the label a distance from water bodies where pesticides are not to be applied, are designed to reduce spray drift from entering sensitive non-target areas, thereby providing protection to aquatic species. While the exact amount of spray drift reduction depends on the physical traits of the aquatic ecosystem (e.g., flow rate, volume, etc.) as well as the application method, we can expect (based on AgDRIFT modeling) spray drift reductions ranging from 40 to 91%, with low flow and low volume aquatic habitats receiving the most reduction in spray drift deposition. In many cases, these buffers substantially reduce exposure to aquatic organisms and subsequent risk of direct and indirect effects.

**Residential use label changes:** New restrictions to the method and frequency of application for residential use of malathion are expected to substantially reduce exposure to species that overlap with developed and open space developed areas. Label changes will ensure that residential use is limited to spot treatments only (rendering spray drift offsite unlikely) and reducing the extent of area which can be treated in the developed and open space developed areas by as much as 75% or more from modeled values. In addition, we expect the frequency of exposure to decrease as the number of allowable applications is reduced from “repeat as necessary” to a maximum of 2–4 applications per year (depending on the specific residential use). Retreatment intervals of 7-10 days between any repeated applications are expected to reduce environmental concentrations by allowing any initial residues to degrade prior to the next application. In addition, exposure to aquatic organisms is reduced due to buffers from waterways, which specify on the label a distance from water bodies where pesticides are not to be applied, and restrictions to application during periods where rain is not forecasted within 24 hours or when the soil is not saturated.

**Reduced application number and rate:** New restrictions on corn, cotton, orchards and vineyards, pasture, other crops, and vegetables and ground fruit lower the maximum allowable number of applications to 2-4 per year (depending on the specific crop; previous allowable numbers of applications ranged from 3 to 13 applications per year). This will help reduce the amount of malathion used and decrease potential exposure to the species, thus decreasing the risk of both indirect and direct effects to the species.

***CONCLUSION***

After reviewing the current status of the species, the environmental baseline for the action area, the effects of the proposed registration of malathion, and the cumulative effects, it is the Service's biological opinion that the registration of malathion, as proposed, with the implementation of the general conservation measures described above, is not likely to jeopardize the continued existence of the interrupted rocksnail. As discussed below, the vulnerability is high for this species, the risk and likelihood of exposure to malathion is low, and the implementation of the general conservation measures described above is expected to further reduce the likelihood of exposure.

The interrupted rocksnail has a high vulnerability based on its status, distribution, and trends, as described above. This species is endemic to the Coosa River drainage of the Mobile River Basin in Alabama and Georgia and has disappeared from 90 percent or more of its historical range, primarily due to impoundment of riverine habitats (FWS 2014). A single population of interrupted rocksnail is known to survive in the Oostanaula River, Georgia (FWS 2014). This species requires flowing water, stable stream channels with minimal sediment and algae growth, and adequate water quality. Interrupted rocksnails are currently found in shoal habitats with sand-boulder substrate, at water depths less than 50 centimeters (cm) (20 in), and in water currents less than 40 cm/second (sec) (16 in/sec) (Johnson 2004 *in* USFWS, 2014).

The risk to the species from labeled uses across the range is expected to be low as we do not anticipate any measurable effects from malathion exposure to individuals, including mortality or sublethal effects to growth, reproduction, or behavior. There may be potential effects to the species' food base (e.g., algae, plants, detritus), however these effects are expected to be small and will not likely result in adverse effects to snails.

About 17% of the species range is on Federal lands where we expect any adverse effects would be minimal, considering the small scale and low levels of past malathion usage on Federal lands, and in light of Federal agency programs that are designed to understand, avoid, and minimize the effects to listed species (see the Approach to Usage section of the Opinion). We anticipate malathion usage within the range is anticipated to be low (2.88%, expected on the non-Federal portion), based primarily on standard usage data we acquired, as described in the Opinion and summarized for this species above. Additionally, conservation measures, such as rain restrictions, aquatic habitat buffers, changes to residential use labels, and reductions in the allowable number of applications and application rates, are expected to further reduce the likelihood of exposure.

Due to the lack of measurable effects to individuals, including mortality and sublethal effects, the lack of appreciable effects to its food base and habitat, the low level of expected usage, and the incorporation of conservation measures that would further reduce the risk of exposure, we anticipate minimal, if any, adverse effects (i.e., not enough to result in take) will occur throughout the duration of the action. Therefore, we do not anticipate that the proposed action would appreciably reduce survival and recovery of the interrupted rocksnail.

**Conclusion:** Not likely to jeopardize

***ADDITIONAL REFERENCES***

U.S. Fish and Wildlife Service. 2020. Interrupted Rocksnail (*Leptoxis foremani*) 5-Year Review: Summary and Evaluation. Alabama Ecological Services Field Office, Daphne, Alabama. 24 pp.

**Integration and Synthesis Summary: Snails *(Aquatic)***

| Scientific Name: | Common Name: | Entity ID: |
|---|---|---|
| *Pleurocera foremani* | Rough hornsnail | 3364 |

***VULNERABILITY***
***(Summary of status, environmental baseline and cumulative effects)***

**Status:** Endangered
**Distribution:** Small, endemic, constrained, and/or isolated population(s)
**Number of Populations:** Single population
**Species Trends:** Declining population(s) – one or more populations declining
**Pesticides noted** ☐

**Environmental Baseline/Cumulative Effects (EB/CE) Summary:**
Rough hornsnails are primarily found on gravel, cobble, bedrock, and mud in moderate currents. They have been collected at depths of 1 m (3.3 ft) to 3 m (9.8 ft) (Hartfield 2004). The species appears to be very tolerant of silt deposition. Little is known regarding the life history characteristics of this species. Snails in the genus Pleurocera generally lay their eggs in a spiral arrangement on smooth surfaces (Sides 2005), whereas Elimia snails generally lay eggs in short strings (P. Johnson pers. comm. 2006). Although some attempts to induce rough hornsnails to lay eggs in captivity have been unsuccessful (Sides 2005), others have observed females laying eggs individually or in short "strips" (3-10 eggs) during late April into July (Johnson in litt. 2009) (Figure 7). Cultured rough hornsnails have become reproductively active in their 2nd year (Johnson in litt. 2009). Some adult individuals collected from the wild have survived in captivity for 3 years, suggesting a life span of 4 to 5 years in the wild (Garner in litt. 2009, Johnson in litt. 2009). The rough hornsnail was federally listed as endangered on November 2, 2010 (75 FR 67512). It is endemic to the Coosa River drainage of the Mobile River Basin in Alabama and Georgia but has disappeared from 90 percent or more of its historical range, primarily due to impoundment of riverine habitats. Only two localized populations of rough hornsnail, one in Yellowleaf Creek, Alabama, and the other in lower Coosa River, Alabama, are currently known. According to the 2006 Alabama Wildlife Action Plan, the rough hornsnail is considered a Priority 1 species. This species requires flowing water, stable stream channels with minimal sediment and algae growth, and adequate water quality. Primary threats to the species include extreme curtailment of habitat and range, small population sizes, and their resulting vulnerability to natural or human induced catastrophic events (e.g., droughts, pollution spills, etc.). Surviving populations are threatened by water quality and habitat deterioration. The 2019 Recovery Plan Amendment clarified recovery criteria.

**EB/CE Source:** U.S. Fish and Wildlife Service. 2014. Recovery Plan for the Georgia pigtoe mussel, Interrupted rocksnail, and Rough hornsnail. Atlanta, Georgia. 55 pp.

**Overall Vulnerability:** ☒ **High** ☐ **Medium** ☐ **Low**

***RISK***
***(Risk is based on species exposure and response from labeled uses across the range)***

**Risk to individuals if exposed:** We do not anticipate effects to the species from exposure to malathion at labeled use rates.

**Risk to the species from labeled uses across the range:**
The table below summarizes the risk to the species from labeled uses across the range based on range overlaps with use sites and anticipated effects associated with the particular uses.

| ALL USES except mosquito control | |
|---|---|
| Mortality | no effects expected |
| MOSQUITO CONTROL | |
| Mortality | no effects expected |

**Risk modifiers:**

*Allowable uses driving effects/other considerations:* Rough hornsnails are primarily found on gravel, cobble, bedrock, and mud in moderate currents. They have been collected at depths of 1 m (3.3 ft) to 3 m (9.8 ft) (Hartfield 2004). The species appears to be very tolerant of silt deposition (FWS, 2014).

As described in the "Approach to the Effects Analysis" section of the main body of the Opinion, we made specific considerations for species that occur in bins 3 and 4 as they were modeled in such a way that likely resulted in overestimation of estimated environmental concentrations, thus overestimating potential exposure. Further investigation by EPA into bins 3 and 4 estimated environmental concentrations indicates that the flow rates in these aquatic habitats are sufficient to dilute malathion concentrations to a level that will not cause toxic effects to the species.

**Overall Risk: ☐ High ☐ Medium ☒ Low**

***USAGE***
***(Anticipated usage within the range based on past usage data)***

| Use type | Risk to species[1] | Use overlap with range | | Estimated usage in range[2] | | Bins associated with use type^ | Effect associated with bin (H, M, L) |
|---|---|---|---|---|---|---|---|
| | | Acres | % | Acres | % | | |
| Mosquito Control | D | 389,838 | 37.6 | 18,167 | 1.75 | 3 | 3L |
| Developed | D | 25,998 | 2.51 | 1,300 | 0.13 | 3 | 3L |

[1] Direct effects (D), Indirect effects (I), No effects expected (N), Use site not utilized by the species (*)
[2] Estimated usage in the range is based on information about annual past usage.----------‘

| Use type | Risk to species[1] | Use overlap with range | | Estimated usage in range[2] | | Bins associated with use type^ | Effect associated with bin (H, M, L) |
|---|---|---|---|---|---|---|---|
| | | Acres | % | Acres | % | | |
| Cotton | D | 13,075 | 1.26 | 9,720 | 0.94 | 3 | 3L |
| Other Crops | D | 7,574 | 0.73 | 68 | < 0.01 | 3 | 3L |
| Corn | D | 4,570 | 0.44 | 585 | 0.06 | 3 | 3L |
| Nurseries | D | 386 | 0.04 | 386 | 0.04 | 3 | 3L |
| Wheat | D | 263 | 0.03 | 154 | 0.01 | 3 | 3L |
| Other Grains | D | 254 | 0.02 | 353 | 0.03 | 3 | 3L |
| Vegetables & Ground Fruit | D | 165 | 0.02 | 137 | 0.01 | 3 | 3L |
| Orchards & Vineyards | D | 153 | 0.01 | 128 | 0.01 | 3 | 3L |
| Other Row Crops | D | 108 | 0.01 | 106 | 0.01 | 3 | 3L |
| Pasture | D | 9 | <0.01 | 9 | <0.01 | 3 | 3L |
| **Sub-TOTAL (D):** *Other uses with direct effects*[3] | | 52,555 | 5.08 | 12,946 | 1.26 | | |
| **Sub-TOTAL (I):** *Other uses with indirect effects*[3] | | 0 | 0 | 0 | 0 | | |
| **TOTAL[4]:** | | 442,393 | 42.68 | 31,113 | 3.01 | | |

^Species only occurs in bin 3.

**# acres in species range:** 1,036,180 acres
**% of range in California (i.e., where CalPUR data is available):** 0%
**Range overlap with Federal lands:** 1,690 acres, 0.163%

**Overall Usage:** ☐ **High** ☐ **Medium** ☒ **Low**

## *CONSERVATION MEASURES*

**Rain restriction:** Given the relatively short half-life of malathion and rapid degradation via hydrolysis and other processes, persistence of malathion in storm run-off into most aquatic habitats is not anticipated to last longer than 48 hours under typical pH values, (i.e., 6.5-8.5) and water temperatures corresponding to growing season. Restricting malathion application to periods where rain is not forecasted for at least 48 hours or when the soil is not saturated will provide time for the pesticide to degrade before runoff into aquatic habitats can occur, decreasing exposure and risk.

**Aquatic habitat buffers:** Application buffers, which specify on the label a distance from water bodies where pesticides are not to be applied, are designed to reduce spray drift from entering sensitive non-target areas, thereby providing protection to aquatic species. While the exact amount of spray drift reduction depends on the physical traits of the aquatic ecosystem

[3] Mosquito control has the potential to overlap with other uses. It is not included in the Sub-TOTALs.
[4] TOTAL includes usage on all use sites with effects, including mosquito control.

(e.g., flow rate, volume, etc.) as well as the application method, we can expect (based on AgDRIFT modeling) spray drift reductions ranging from 40 to 91%, with low flow and low volume aquatic habitats receiving the most reduction in spray drift deposition. In many cases, these buffers substantially reduce exposure to aquatic organisms and subsequent risk of direct and indirect effects.

**Residential use label changes:** New restrictions to the method and frequency of application for residential use of malathion are expected to substantially reduce exposure to species that overlap with developed and open space developed areas. Label changes will ensure that residential use is limited to spot treatments only (rendering spray drift offsite unlikely) and reducing the extent of area which can be treated in the developed and open space developed areas by as much as 75% or more from modeled values. In addition, we expect the frequency of exposure to decrease as the number of allowable applications is reduced from "repeat as necessary" to a maximum of 2–4 applications per year (depending on the specific residential use). Retreatment intervals of 7-10 days between any repeated applications are expected to reduce environmental concentrations by allowing any initial residues to degrade prior to the next application. In addition, exposure to aquatic organisms is reduced due to buffers from waterways, which specify on the label a distance from water bodies where pesticides are not to be applied, and restrictions to application during periods where rain is not forecasted within 24 hours or when the soil is not saturated.

**Reduced application number and rate:** New restrictions on corn, cotton, orchards and vineyards, pasture, other crops, and vegetables and ground fruit lower the maximum allowable number of applications to 2-4 per year (depending on the specific crop; previous allowable numbers of applications ranged from 3 to 13 applications per year). This will help reduce the amount of malathion used and decrease potential exposure to the species, thus decreasing the risk of both indirect and direct effects to the species.

---

***CONCLUSION***

After reviewing the current status of the species, the environmental baseline for the action area, the effects of the proposed registration of malathion, and the cumulative effects, it is the Service's biological opinion that the registration of malathion, as proposed, with the implementation of the general conservation measures described above, is not likely to jeopardize the continued existence of the Rough hornsnail. As discussed below, the vulnerability is high for this species, the risk and likelihood of exposure to malathion is low, and the implementation of the general conservation measures described above is expected to further reduce the likelihood of exposure.

The Rough hornsnail has a high vulnerability based on its status, distribution, and trends, as described above. This species is endemic to the Coosa River drainage of the Mobile River Basin in Alabama and Georgia and has disappeared from 90 percent or more of its historical range, primarily due to impoundment of riverine habitats (USFWS 2014). Only two localized populations of rough hornsnail are currently known (USFWS 2014). This species requires flowing water, stable stream channels with minimal sediment and algae growth, and adequate

water quality. They are primarily found on gravel, cobble, bedrock, and mud in moderate currents and have been collected at depths of 1 m (3.3 ft) to 3 m (9.8 ft) (Hartfield 2004 *in* USFWS 2014). The surviving populations are threatened by water quality and habitat deterioration. We anticipate that the risk to the species posed by labeled uses across the range will be high, as described above.

The risk to the species from labeled uses across the range is expected to be low as we do not anticipate any measurable effects from malathion exposure to individuals, including mortality or sublethal effects to growth, reproduction, or behavior. There may be potential effects to the species' food base (e.g., algae, plants, detritus), however these effects are expected to be small and will not likely result in adverse effects to snails.

We anticipate malathion usage within the range will be low (3.01%, expected on the non-Federal portion), based primarily on standard usage data we acquired, as described in the Opinion and summarized for this species above. Additionally, conservation measures, such as rain restrictions, aquatic habitat buffers, changes to residential use labels, and reductions in the allowable number of applications and application rates, are expected to substantially reduce the environmental concentrations of malathion within the species' range. These measures would further reduce the likelihood of exposure.

Due to the lack of measurable effects to individuals, including mortality and sublethal effects, the lack of appreciable effects to its food base and habitat, the low level of expected usage, and the incorporation of conservation measures that would further reduce the risk of exposure, we anticipate minimal, if any, adverse effects (i.e., not enough to result in take) will occur throughout the duration of the action. Therefore, we do not anticipate that the proposed action would appreciably reduce survival and recovery of the Rough hornsnail.

**Conclusion:** Not likely to jeopardize

***ADDITIONAL REFERENCES***

U.S. Fish and Wildlife Service. 2014. Recovery Plan for the Georgia pigtoe mussel, Interrupted rocksnail, and Rough hornsnail. Atlanta, Georgia. 55 pp.

**Integration and Synthesis Summary: Snails *(Aquatic)***

| Scientific Name: | Common Name: | Entity ID: |
|---|---|---|
| *Pyrgulopsis chupaderae* | Chupadera springsnail | 4162 |

***VULNERABILITY***
***(Summary of status, environmental baseline and cumulative effects)***

**Status:** Endangered
**Distribution:** Small, endemic, constrained, and/or isolated population(s)
**Number of Populations:** Single population
**Species Trends:** Unknown population trends
**Pesticides noted** ☐

**Environmental Baseline/Cumulative Effects (EB/CE) Summary:**
The Chupadera springsnail (*Pyrgulopsis chupaderae*) is a tiny (1.6 to 3.0 mm (0.06 to 0.12 in) tall) freshwater snail (Taylor 1987) in the family Hydrobiidae. Springsnails are strictly aquatic, and respiration occurs through an internal gill. Hydrobiid snails feed primarily on periphyton, and have a life span of 9 to 15 months (Pennak 1989). Hydrobiid snails are sensitive to water quality, and each species is usually found within relatively narrow habitat parameters (Sada 2008). Many springsnail species exhibit decreased abundance farther away from spring vents, presumably due to their need for stable water chemistry (Hershler 1994; Hershler 1998; Hershler and Sada 2002; Martinez and Thome 2006). The Chupadera springsnail is endemic to Willow Spring and an unnamed spring of similar size 0.5 km (0.3 mi) north of Willow Spring at the southeast end of the Chupadera Mountains in Socorro County, New Mexico (Taylor 1987; Mehlhop 1993; Lang 1998). The two springs where the Chupadera springsnail has been documented are on hillsides where groundwater discharges flow through volcanic gravels containing sand, mud, and aquatic plants (Taylor 1987). Water temperatures in areas of the springbrook currently occupied by the springsnail range from 15 to 25 degrees Celsius (59 to 77 degrees Fahrenheit) over all seasons (as measured in 1997 to 1998). The current status of the population at Willow Spring is unknown because access to private lands has not been permitted since 1999 to monitor the springsnail (Carman 2004; 2005; NMDGF 2007). Prior surveys show the springsnail population to be locally abundant and stable at this location through 1999 (Lang 1998; Lang 1999), with average densities in 1997–1998 of 23,803 ± 17,431 per $m^2$ (2,211 ± 1,619 per $ft^2$) (NMDGF 2011). The landowner recently provided qualitative information in response to the 2011 proposed rule (76 FR 46218) that a springsnail, presumed to be the Chupadera springsnail, continues to occur at the springhead, although not in high numbers, and is abundant in the springbrook (Highland Springs Ranch, LLC 2011). At the unnamed spring, the species was originally discovered in 1986 (Stefferud 1986) and reported from this location again in 1993 (Melhop 1993). However, repeated sampling between 1995 and 1997 yielded no snails, and the habitat at that spring has been significantly degraded (devoid of riparian vegetation due to trampling by cattle, and the benthic habitat was covered with manure) (Lang 1998; Lang

1999). Therefore, the species is likely extirpated from this unnamed spring (NMDGF 1996; Lang 1999).

Continued use of the springs by livestock, if it is occurring at Willow Spring or the unnamed spring designated as critical habitat in the rule, presents a substantial threat to the Chupadera springsnail. Springsnail dispersal is primarily limited to aquatic habitat connections (Hershler et al. 2005). Once extirpated from a spring, natural recolonization of that spring or other nearby springs is very rare. Groundwater depletion due to new wells from nearby subdivision developments, in addition to droughts, is likely resulting in reduced flow at the spring that supports the species. Livestock grazing has likely resulted in the extirpation of the species from habitat alteration and contamination at one of these springs and may continue in the future. Finally, springhead and springbrook modification have affected Chupadera springsnail habitat at Willow Spring, and further modification may have occurred since the last visit to this site in 1999. The loss of one of two known populations, the ongoing threat of modification of the habitat at the only known remaining site (Willow Spring) from grazing and spring modification, and the imminent threat of groundwater depletion posed by subdivision development adjacent to the spring places this species at great risk of extinction. The existing threats are exacerbated by the effects of ongoing and future climate change, namely intensified droughts.

**EB/CE Sources:** U.S. Fish and Wildlife Service. 2012. Determination of Endangered Status for the Chupadera Springsnail and Designation of Critical Habitat: Final Rule. 77 FR 41088-41106.

U.S. Fish and Wildlife Service. 2019. Chupadera springsnail (*Pyrgulopsis chupaderae*) 5-Year Review: Summary and Evaluation. New Mexico Ecological Services Field Office, Albuquerque, New Mexico. 23 pp.

**Overall Vulnerability:** ☒ **High** ☐ **Medium** ☐ **Low**

***RISK***
***(Risk is based on species exposure and response from labeled uses across the range)***

**Risk to individuals if exposed:** We do not anticipate effects to the species from exposure to malathion at labeled use rates.

**Risk to the species from labeled uses across the range:**
The table below summarizes the risk to the species from labeled uses across the range based on range overlaps with use sites and anticipated effects associated with the particular uses.

| ALL USES except mosquito control | |
|---|---|
| Mortality | no effects expected |
| MOSQUITO CONTROL | |
| Mortality | no effects expected |

**Risk modifiers:** This species is a resident of a cienega system with multiple source springs (22 degrees Celsius). Most of the sources have been impounded. The species survives in an outflow. *Pyrgulopsis* is a rheocrene spring snail, or a spring emerging from the ground as a free-flowing stream. *Pyrgulopsis* snails are rarely found on or in soft sediment. Aquatic vegetation within these habitats includes watercress (Nasturtium spp.), Ranunculus, and filamentous green algae. Springsnails are commonly found among watercress. Other associated mollusks include *Anodonta californiensis, Valvata humeralis, Physa gyrina, Radix auricularia, Gyraulus parvus, Pisidium casertanum, P. compressum,* and *P. variab*ile (USFWS, 2003). High ecological integrity of the community and site fidelity as well as low tolerance ranges are based on the species-specific habitat requirements and the low number of known populations.

**Overall Risk:** ☐ **High** ☐ **Medium** ☒ **Low**

***USAGE***
***(Anticipated usage within the range based on past usage data)***

| Use type | Risk to species [133] | Use overlap with range | | Estimated usage in range[134] | | Bins associated with use type^ | Effect associated with bin (H, M, L) |
|---|---|---|---|---|---|---|---|
| | | Acres | % | Acres | % | | |
| Mosquito Control | D | 2,393,192 | 43.8 | 0 | 0 | 2 | 2L |
| Pasture | D | 7,030 | 0.13 | 5,016 | 0.09 | 2 | 2L |
| Developed | D | 5,647 | 0.1 | 282 | < 0.01 | 2 | 2L |
| Orchards & Vineyards | D | 488 | < 0.01 | 488 | < 0.01 | 2 | 2L |
| Vegetables & Ground Fruit | D | 201 | < 0.01 | 196 | < 0.01 | 2 | 2L |
| Other Crops | D | 126 | < 0.01 | 0 | 0 | 2 | 2L |
| Corn | D | 111 | < 0.01 | 111 | < 0.01 | 2 | 2L |
| Wheat | D | 109 | < 0.01 | 62 | < 0.01 | 2 | 2L |
| Other Grains | D | 105 | < 0.01 | 105 | < 0.01 | 2 | 2L |
| Cotton | D | 11 | < 0.01 | 4 | < 0.01 | 2 | 2L |
| Nurseries | D | 2 | < 0.01 | 2 | < 0.01 | 2 | 2L |
| **Sub-TOTAL (D):** *Other uses with direct effects*[135] | | 13,831 | 0.31 | 6,266 | 0.18 | | |
| **Sub-TOTAL (I):** *Other uses with indirect effects*[3] | | 0 | 0 | 0 | 0 | | |
| **TOTAL**[136]**:** | | 2,407,023 | 44.11 | 6,453.66 | 0.18 | | |

^Species only occurs in bin 2.

[133] Direct effects (D), Indirect effects (I), No effects expected (N), Use site not utilized by the species (*)
[134] Estimated usage in the range is based on information about annual past usage.
[135] Mosquito control has the potential to overlap with other uses. It is not included in the Sub-TOTALs.
[136] TOTAL includes usage on all use sites with effects, including mosquito control.

**# acres in species range:** 5,466,545 acres
**% of range in California (i.e., where CalPUR data is available):** 0%
**Range overlap with Federal lands:** 2,715,543 acres, 49.676%

**Overall Usage:** ☐ **High** ☐ **Medium** ☒ **Low**

***CONSERVATION MEASURES***

**Rain restriction:** Given the relatively short half-life of malathion and rapid degradation via hydrolysis and other processes, persistence of malathion in storm run-off into most aquatic habitats is not anticipated to last longer than 48 hours under typical pH values, (i.e., 6.5-8.5) and water temperatures corresponding to growing season. Restricting malathion application to periods where rain is not forecasted for at least 48 hours or when the soil is not saturated will provide time for the pesticide to degrade before runoff into aquatic habitats can occur, decreasing exposure and risk.

**Aquatic habitat buffers:** Application buffers, which specify on the label a distance from water bodies where pesticides are not to be applied, are designed to reduce spray drift from entering sensitive non-target areas, thereby providing protection to aquatic species. While the exact amount of spray drift reduction depends on the physical traits of the aquatic ecosystem (e.g., flow rate, volume, etc.) as well as the application method, we can expect (based on AgDRIFT modeling) spray drift reductions ranging from 40 to 91%, with low flow and low volume aquatic habitats receiving the most reduction in spray drift deposition. In many cases, these buffers substantially reduce exposure to aquatic organisms and subsequent risk of direct and indirect effects.

***CONCLUSION***

After reviewing the current status of the species, the environmental baseline for the action area, the effects of the proposed registration of malathion, and the cumulative effects, it is the Service's biological opinion that the registration of malathion, as proposed, with the implementation of the general conservation measures described above, is not likely to jeopardize the continued existence of the Chupadera springsnail. As discussed below, the vulnerability is high for this species, the risk and likelihood of exposure to malathion is low, and the implementation of the general conservation measures described above is expected to further reduce the likelihood of exposure.

The Chupadera springsnail has a high vulnerability based on its status, distribution, and trends, as described above. The Chupadera springsnail is endemic to Willow Spring and an unnamed spring of similar size 0.5 kilometers (0.3 miles) north of Willow Spring at the southeast end of the Chupadera Mountains in Socorro County, New Mexico (Taylor 1987; Mehlhop 1993; Lang 1998). However, the species is likely extirpated from this unnamed spring (NMDGF 1996; Lang

1999). The two springs where the Chupadera springsnail has been documented are on two hillsides where groundwater discharges flow through volcanic gravels containing sand, mud, and aquatic plants (Taylor 1987). This species survives in the outflow of springs. Groundwater depletion due to new wells from nearby subdivision developments, in addition to droughts, is likely resulting in reduced flow at the spring that currently supports the species.

The risk to the species from labeled uses across the range is expected to be low as we do not anticipate any measurable effects from malathion exposure to individuals, including mortality or sublethal effects to growth, reproduction, or behavior. There may be potential effects to the species' food base (e.g., algae, plants, detritus), however these effects are expected to be small and will not likely result in adverse effects to snails.

About 50% of the species range is on Federal lands where we expect any adverse effects would be minimal, considering the small scale and low levels of past malathion usage on Federal lands, and in light of Federal agency programs that are designed to understand, avoid, and minimize the effects to listed species (see the Approach to Usage section of the Opinion). We anticipate malathion usage within the range will be low (0.18%, expected on the non-Federal portion), based primarily on standard usage data we acquired, as described in the Opinion and summarized for this species above. Additionally, conservation measures, such as rain restrictions and aquatic habitat buffers, are expected to substantially reduce the environmental concentrations of malathion within the species' range, reducing the likelihood of exposure.

Due to the lack of measurable effects to individuals, including mortality and sublethal effects, the lack of appreciable effects to its food base and habitat, the low level of expected usage, and the incorporation of conservation measures that would further reduce the risk of exposure, we anticipate minimal, if any, adverse effects (i.e., not enough to result in take) will occur throughout the duration of the action. Therefore, we do not anticipate that the proposed action would appreciably reduce survival and recovery of the Chupadera springsnail.

**Conclusion:** Not likely to jeopardize

***ADDITIONAL REFERENCES***

U.S. Fish and Wildlife Service. 2012. Determination of Endangered Status for the Chupadera Springsnail and Designation of Critical Habitat: Final Rule. 77 FR 41088-41106.

**Integration and Synthesis Summary: Snails *(Aquatic)***

| Scientific Name: | Common Name: | Entity ID: |
|---|---|---|
| *Pseudotryonia adamantina* | Diamond tryonia (formerly Diamond Y Spring Snail) | 4437 |

***VULNERABILITY***
***(Summary of status, environmental baseline and cumulative effects)***

**Status:** Endangered
**Distribution:** Small, endemic, constrained, and/or isolated population(s)
**Number of Populations:** Multiple populations (few)
**Species Trends:** Unknown population trends
**Pesticides noted** ☐

**Environmental Baseline/Cumulative Effects (EB/CE) Summary:**
Diamond tryonia is a small aquatic snail found in two springs of the Diamond Y spring system and is completely dependent upon spring outflows. In 1968, the Diamond tryonia was considered abundant in the outflow of Diamond Y Spring in the upper watercourse for about 1.6 km (1 mi) downstream of the spring head pool, but by 1984 the species was present in only areas along stream margins (near the banks) (Taylor 1985). Average density estimates in 1984 at 12 of 14 sampled sites in the upper watercourse ranged from 500 to 93,700 individuals per sq m (50 to 8,700 per sq ft), with very low densities in the upstream areas near the headspring (Taylor 1985). However, the Diamond tryonia was largely absent from the headspring and main spring flow channel where it was abundant in 1968 surveys (Taylor 1985). Instead, it was most common in small numbers along the outflow stream margins and lateral springs (Taylor 1985). Over time, the distribution of the Diamond tryonia in the upper watercourse has continued to recede so that it is no longer found in the outflow channel at all but may be restricted to small lateral spring seeps disconnected from the main spring flow channel (Landye 2000; Echelle et al. 2001). Surveys by Lang (2011) in 2001 and 2003 found only 2 and 7 individuals, respectively, in the outflow channel of Diamond Y Spring. Additional surveys in 2009 and 2010 (Ladd 2010; Lang 2011) did not find Diamond tryonia in the upper watercourse. The Diamond tryonia was not previously reported from the lower watercourse until first detected there in 2001 at the outflow of Euphrasia Spring (Lang 2011). Ladd (2010) roughly estimated the total number of Diamond tryonia in the lower watercourse to be about 35,000 individuals with the highest density reported as 2,500 individuals per sq m (230 per sq ft). Lang (2011) estimated densities of Diamond tryonia in 2009 at 16,695 per sq m (1,552 per sq ft; ±18,212 per sq m, ±1,694 per sq ft) in Euphrasia Spring outflow, which suggests a much larger population than that estimated by Ladd (2010). This species is very rare in the upper watercourse and limited to small side seeps (and may be extirpated), and it occurs in the lower watercourse in the outflow of Euphrasia Spring. Systematic surveys or monitoring efforts for the Diamond tryonia have not been conducted since 2010 (Ladd 2010, p. 18).

The primary threat to the continued existence of the Diamond tryonia is the degradation and potential future loss of aquatic habitat (flowing water from the spring outlets) due to the decline of groundwater levels in the aquifers that support spring surface flows. Spring flows in the Diamond Y Spring system appear to have declined in flow rate over time, and as spring flows decline, available aquatic habitat is reduced and altered. Substantial scientific uncertainty exists regarding the aquifer sources that provide the source water to the Diamond Y Springs. The aquifers that support flow of the Diamond Y Spring system are under increasing pressure from groundwater pumping in Pecos and Reeves counties. As stated in the 2019 5-Year Review, the Rustler Aquifer experienced historically unprecedented groundwater withdrawals over the previous 19 years. Withdrawals from the Edwards-Plateau (Trinity) Plateau Aquifer increased over the last 10 years, reaching pumped volumes comparable to the 1980s. The majority of pumped groundwater from both aquifers is for irrigation. Grazing dominates human land use (86%) in Pecos County followed by a small amount of cropland (Texas Land Trends 2019). As of 2017, there were 309 farms in Pecos County with an average farm size of 3,766 ha (9,281 ac) [U.S. Department of Agriculture 2017, p. 1)]. Irrigated cropland has declined since the mid-1960s from 48,284 ha (119,313 ac) in 1964 to 11,113 ha (27,460 ac) in 2000 (Texas Water Development Board 2001, p. 61; Texas Water Development Board 2019). Oil and natural gas activity is likewise significant and projected to increase into the near-future furthering demands for groundwater withdrawals. Anthropogenic climate change is projected to lead to warmer and more arid conditions across western Texas, conditions that could precipitate increased demands for groundwater from use-sectors.

**EB/CE Sources:** U.S. Fish and Wildlife Service. 2013. Determination of Endangered Species Status for Six West Texas Aquatic Invertebrates. Final Rule. 78 FR 41227-41258.

U.S. Fish and Wildlife Service. 2019. Diamond Tryonia (Pseudotryonia adamantina) 5-Year Review: Summary and Evaluation. Austin Ecological Services Field Office, Austin, Texas. 80 pp.

**Overall Vulnerability:** ☒ **High** ☐ **Medium** ☐ **Low**

***RISK***
***(Risk is based on species exposure and response from labeled uses across the range)***

**Risk to individuals if exposed:** We do not anticipate effects to the species from exposure to malathion at labeled use rates.

**Risk to the species from labeled uses across the range:**
The table below summarizes the risk to the species from labeled uses across the range based on range overlaps with use sites and anticipated effects associated with the particular uses.

| ALL USES except mosquito control | |
|---|---|
| Mortality | no effects expected |
| MOSQUITO CONTROL | |
| Mortality | no effects expected |

**Risk modifiers:** Habitat for this species is mud substrates on the margins of small springs, seeps, and marshes in flowing water associated with cattail and sedge wetlands (but not marshy pools) (Taylor, 1987). The species occurs in the same system with *Tryonia circumstriata* (= *Tryonia stocktonensis*), but they are mutually exclusive; and co-occurs with *Assiminea pecos*, *Physa mexicana*, *Stagnicola caperata*, *Ferrissia californica* (= *Ferrissia rivularis*), *Laevapex fuscus*, and *Pisidium casertanum* (Taylor, 1987; USFWS, 2003). High ecological integrity of the population and site fidelity as well as low tolerance ranges are inferred based on species extremely restricted range and habitat requirements.

**Overall Risk: ☐ High ☐ Medium ☒ Low**

***USAGE***
***(Anticipated usage within the range based on past usage data)***

| Use type | Risk to species[1] | Use overlap with range | | Estimated usage in range[2] | | Bins associated with use type^ | Effect associated with bin (H, M, L) |
|---|---|---|---|---|---|---|---|
| | | Acres | % | Acres | % | | |
| Mosquito Control | N | 0 | 0 | 0 | 0 | | |
| Other Crops | D | 20,295 | 0.49 | 0 | 0 | 2,5 | 2L<br>5L |
| Developed | D | 9,875 | 0.24 | 494 | 0.01 | 2,5 | 2L<br>5L |
| Cotton | D | 5,571 | 0.13 | 5,571 | 0.13 | 2,5 | 2L<br>5L |
| Wheat | D | 4,530 | 0.11 | 3,572 | 0.09 | 2,5 | 2L<br>5L |
| Pasture | D | 4,196 | 0.1 | 2,356 | 0.06 | 2,5 | 2L<br>5L |
| Orchards & Vineyards | D | 1,252 | 0.03 | 1,252 | 0.03 | 2,5 | 2L<br>5L |
| Other Grains | D | 1,093 | 0.03 | 1,093 | 0.03 | 2,5 | 2L |

[1] Direct effects (D), Indirect effects (I), No effects expected (N), Use site not utilized by the species (*)
[2] Estimated usage in the range is based on information about annual past usage.

| Use type | Risk to species[1] | Use overlap with range | | Estimated usage in range[2] | | Bins associated with use type^ | Effect associated with bin (H, M, L) |
|---|---|---|---|---|---|---|---|
| | | Acres | % | Acres | % | | |
| | | | | | | | 5L |
| Vegetables & Ground Fruit | D | 327 | < 0.01 | 324 | < 0.01 | 2,5 | 2L<br>5L |
| Corn | D | 186 | < 0.01 | <1 | <0.01 | 2,5 | 2L<br>5L |
| Other Row Crops | D | 150 | < 0.01 | 144 | < 0.01 | 2,5 | 2L<br>5L |
| Nurseries | D | 6 | < 0.01 | 6 | < 0.01 | 2,5 | 2L<br>5L |
| **Sub-TOTAL (D):** *Other uses with direct effects*[3] | | 47,484 | 1.17 | 14,812 | 0.39 | | |
| **Sub-TOTAL (I):** *Other uses with indirect effects*[3] | | 0 | 0 | 0 | 0 | | |
| **TOTAL[4]:** | | 47,484 | 1.17 | 14,813 | 0.39 | | |

^Species only occurs in bins 2 and 5.

**# acres in species range:** 4,128,556 acres
**% of range in California (i.e., where CalPUR data is available):** 0%
**Range overlap with Federal lands:** 4 acres, 0.000%

**Overall Usage:** ☐ **High** ☐ **Medium** ☒ **Low**

## *CONSERVATION MEASURES*

**Rain restriction:** Given the relatively short half-life of malathion and rapid degradation via hydrolysis and other processes, persistence of malathion in storm run-off into most aquatic habitats is not anticipated to last longer than 48 hours under typical pH values, (i.e., 6.5-8.5) and water temperatures corresponding to growing season. Restricting malathion application to periods where rain is not forecasted for at least 48 hours or when the soil is not saturated will provide time for the pesticide to degrade before runoff into aquatic habitats can occur, decreasing exposure and risk.

**Aquatic habitat buffers:** Application buffers, which specify on the label a distance from water bodies where pesticides are not to be applied, are designed to reduce spray drift from entering sensitive non-target areas, thereby providing protection to aquatic species. While the exact amount of spray drift reduction depends on the physical traits of the aquatic ecosystem (e.g., flow rate, volume, etc.) as well as the application method, we can expect (based on

[3] Mosquito control has the potential to overlap with other uses. It is not included in the Sub-TOTALs.
[4] TOTAL includes usage on all use sites with effects, including mosquito control.

AgDRIFT modeling) spray drift reductions ranging from 40 to 91%, with low flow and low volume aquatic habitats receiving the most reduction in spray drift deposition. In many cases, these buffers substantially reduce exposure to aquatic organisms and subsequent risk of direct and indirect effects.

***CONCLUSION***

After reviewing the current status of the species, the environmental baseline for the action area, the effects of the proposed registration of malathion, and the cumulative effects, it is the Service's biological opinion that the registration of malathion, as proposed, with the implementation of the general conservation measures described above, is not likely to jeopardize the continued existence of the Diamond tryonia. As discussed below, the vulnerability is high for this species, the risk and likelihood of exposure to malathion is low, and the implementation of the general conservation measures described above is expected to further reduce the likelihood of exposure.

The Diamond tryonia has a high vulnerability based on its status, distribution, and trends, as described above. The Diamond tryonia is very rare and occurs within a relatively small areas of the Chihuahuan Desert of the Pecos River drainage basin of west Texas (FWS 2013). The species inhabits soft substrates on the margins of small springs, seeps, and marshes in shallow flowing water associated with emergent bulrush (*Scirpus americanus*) and saltgrass (*Distichlis spicata*) (FWS 2013).

The risk to the species from labeled uses across the range is expected to be low as we do not anticipate any measurable effects from malathion exposure to individuals, including mortality or sublethal effects to growth, reproduction, or behavior. There may be potential effects to the species' food base (e.g., algae, plants, detritus), however these effects are expected to be small and will not likely result in adverse effects to snails.

We anticipate usage within the species range will be low (0.39%), based primarily on the standard usage data we acquired, as described in the Opinion and summarized for this species above. Conservation measures, such as rain restrictions and aquatic habitat buffers, are expected to substantially reduce environmental concentrations of malathion within the species' range, reducing the likelihood of exposure.

Due to the lack of measurable effects to individuals, including mortality and sublethal effects, the lack of appreciable effects to its food base and habitat, the low level of expected usage, and the incorporation of conservation measures that would further reduce the risk of exposure, we anticipate minimal, if any, adverse effects (i.e., not enough to result in take) will occur throughout the duration of the action. Therefore, we do not anticipate that the proposed action would appreciably reduce survival and recovery of the Diamond tryonia in the wild.

**Conclusion:** Not likely to jeopardize

**Integration and Synthesis Summary: Snails (Aquatic)**

| Scientific Name: | Common Name: | Entity ID: |
|---|---|---|
| *Pyrgulopsis texana* | Phantom Springsnail (formerly Phantom Cave Snail) | 4479 |

***VULNERABILITY***
***(Summary of status, environmental baseline and cumulative effects)***

**Status:** Endangered
**Distribution:** Small, endemic, constrained, and/or isolated population(s)
**Number of Populations:** Multiple populations (few)
**Species Trends:** Unknown population trends
**Pesticides noted** ☐

**Environmental Baseline/Cumulative Effects (EB/CE) Summary:**
The Phantom springsnail occurs only in the four remaining desert spring outflow channels associated with the San Solomon Spring system (i.e., San Solomon, Phantom, Giffin, and East Sandia springs). Hershler et al. (2010) did not include Giffin Spring in this species distribution, but unpublished data from Lang (2011) confirms that the species is also found in Giffin Spring outflows as well as the other three springs in the San Solomon Spring system. The geographic extent of the historic range for the Phantom springsnail was likely not larger than the present range, but the species may have occurred in additional small springs contained within the current range of the San Solomon Spring system, such as Saragosa and Toyah Springs. It likely also had a larger distribution within Phantom Lake Spring and San Solomon Spring before the habitat there was modified and reduced in conversion of spring outflow channels into irrigation ditches. Within its current, limited range, Phantom springsnails can exist in very high densities. Dundee and Dundee (1969) described the abundance of the Phantom springsnails at Phantom Lake Spring in 1968 as persisting "in such tremendous numbers that the bottom and sides of the canal appear black from the cover of snails." Today the snails are limited to the small pool at the mouth of Phantom Cave and cannot be found in the irrigation canal downstream. At San Solomon Spring, Taylor (1987) reported the Phantom springsnail was abundant and generally distributed in the canals from 1965 to 1981. Density data and simple population size estimates based on underwater observations indicate there may be over 3.8 million individuals of this species at San Solomon Spring (Bradstreet 2011). Lang (2011) also reported very high densities (not total population estimates) of Phantom springsnails (with ± standard deviations): San Solomon Spring from 2009 sampling in the main canal, 71,740 per sq m (6,672 per sq ft; ±47,229 per sq m, ±4,393 per sq ft); Giffin Spring at road crossing in 2001, 4,518 per sq m (420 per sq ft; ±4,157 per sq m, ±387 per sq ft); East Sandia Spring in 2009, 41,215 per sq m (3,832 per sq ft; ±30,587 per sq m, ±2,845 per sq ft); and Phantom Lake Spring in 2009, 1,378 per sq m (128 per sq ft; ±626 per sq m, ±58 per sq ft). From these data, it is evident that when conditions are favorable, Phantom springsnails can reach tremendous population sizes in very small areas. Phantom springsnails are found concentrated near the spring source (Hershler et al. 2010) and

can occur as far as a few hundred meters downstream of a large spring outlet like San Solomon Spring. Bradstreet (2011) found the highest abundances of Phantom springsnails at San Solomon Spring outflows in the high-velocity areas in the irrigation canals and the lowest abundances in the San Solomon Cie´nega.

**EB/CE Source:** U.S. Fish and Wildlife Service. 2013. Determination of Endangered Species Status for Six West Texas Aquatic Invertebrates. Final Rule. 78 FR 41227-41258.

**Overall Vulnerability: ☒ High ☐ Medium ☐ Low**

***RISK***
***(Risk is based on species exposure and response from labeled uses across the range)***

**Risk to individuals if exposed:** We do not anticipate effects to the species from exposure to malathion at labeled use rates.

**Risk to the species from labeled uses across the range:**
The table below summarizes the risk to the species from labeled uses across the range based on range overlaps with use sites and anticipated effects associated with the particular uses.

| ALL USES except mosquito control | |
|---|---|
| Mortality | no effects expected |
| MOSQUITO CONTROL | |
| Mortality | no effects expected |

**Risk modifiers:** This species inhabits an artesian spring, localized around the area where the stream issues from the cave and for about 100 feet downstream. The stream contains much debris over which alga has grown. The water temperature runs in the 70's F, varying with high flow and low flow and has a high mineral content (Dundee, 1969). The lacustrine shallow water habitat where this species was once found has now dried up. This species is concentrated near the sources of the springs and are typically found on hard substrates where it is often extremely abundant (Hershler et al., 2010).

As described in the “Approach to the Effects Analysis” section of the main body of the Opinion, we made specific considerations for species that occur in bins 3 and 4 as they were modeled in such a way that likely resulted in overestimation of estimated environmental concentrations, thus overestimating potential exposure. While the Phantom Springsnail does occupy other aquatic habitats that contain higher concentrations of malathion (e.g., bins 2 and 5), individuals of the species that occupy habitats with higher flow rates (e.g., bins 3 and 4) will experience lower exposure than those occupying low flow areas, reducing the risk of effects across the species in general.

**Overall Risk: ☐ High ☐ Medium ☒ Low**

***USAGE***
***(Anticipated usage within the range based on past usage data)***

| Use type | Risk to species[1] | Use overlap with range | | Estimated usage in range[2] | | Bins associated with use type^ | Effect associated with bin (H, M, L) |
|---|---|---|---|---|---|---|---|
| | | Acres | % | Acres | % | | |
| Mosquito Control | D | 3,319 | 0.08 | 0 | 0 | 2,3,5,6 | 2L<br>3L<br>5L<br>6L |
| Other Crops | D | 115,114 | 2.66 | 31 | < 0.01 | 2,3,5,6 | 2L<br>3L<br>5L<br>6L |
| Developed | D | 10,686 | 0.25 | 534 | 0.01 | 2,3,5,6 | 2L<br>3L<br>5L<br>6L |
| Cotton | D | 10,211 | 0.24 | 9,753 | 0.23 | 2,3,5,6 | 2L<br>3L<br>5L<br>6L |
| Pasture | D | 7,758 | 0.18 | 2,356 | 0.05 | 2,3,5,6 | 2L<br>3L<br>5L<br>6L |
| Wheat | D | 2,365 | 0.05 | 2,121 | 0.05 | 2,3,5,6 | 2L<br>3L<br>5L<br>6L |
| Other Grains | D | 1,528 | 0.04 | 1,528 | 0.04 | 2,3,5,6 | 2L<br>3L<br>5L<br>6L |
| Orchards & Vineyards | D | 427 | < 0.01 | 312 | < 0.01 | 2,3,5,6 | 2L<br>3L<br>5L<br>6L |
| Other Row Crops | D | 171 | < 0.01 | 171 | < 0.01 | 2,3,5,6 | 2L<br>3L<br>5L |

[1] Direct effects (D), Indirect effects (I), No effects expected (N), Use site not utilized by the species (*)
[2] Estimated usage in the range is based on information about annual past usage.

| Use type | Risk to species[1] | Use overlap with range | | Estimated usage in range[2] | | Bins associated with use type^ | Effect associated with bin (H, M, L) |
|---|---|---|---|---|---|---|---|
| | | Acres | % | Acres | % | | |
| | | | | | | | 6L |
| Vegetables & Ground Fruit | D | 141 | < 0.01 | 141 | < 0.01 | 2,3,5,6 | 2L<br>3L<br>5L<br>6L |
| Corn | D | 24 | < 0.01 | <1 | <0.01 | 2,3,5,6 | 2L<br>3L<br>5L<br>6L |
| **Sub-TOTAL (D):** *Other uses with direct effects*[3] | | 148,423 | 3.46 | 16,947 | 0.41 | | |
| **Sub-TOTAL (I):** *Other uses with indirect effects*[3] | | 0 | 0 | 0 | 0 | | |
| **TOTAL[4]:** | | 151,744 | 3.54 | 17,118 | 0.41 | | |

^We consider the bin 2 estimates as an upper bound of bin 3 & 4 exposures.

**# acres in species range:** 4,331,681 acres
**% of range in California (i.e., where CalPUR data is available):** 0%
**Range overlap with Federal lands:** 10,352 acres, 0.239%

**Overall Usage:** ☐ **High** ☐ **Medium** ☒ **Low**

***CONSERVATION MEASURES***

**Rain restriction:** Given the relatively short half-life of malathion and rapid degradation via hydrolysis and other processes, persistence of malathion in storm run-off into most aquatic habitats is not anticipated to last longer than 48 hours under typical pH values, (i.e., 6.5-8.5) and water temperatures corresponding to growing season. Restricting malathion application to periods where rain is not forecasted for at least 48 hours or when the soil is not saturated will provide time for the pesticide to degrade before runoff into aquatic habitats can occur, decreasing exposure and risk.

**Aquatic habitat buffers:** Application buffers, which specify on the label a distance from water bodies where pesticides are not to be applied, are designed to reduce spray drift from entering sensitive non-target areas, thereby providing protection to aquatic species. While the exact amount of spray drift reduction depends on the physical traits of the aquatic ecosystem (e.g., flow rate, volume, etc.) as well as the application method, we can expect (based on

[3] Mosquito control has the potential to overlap with other uses. It is not included in the Sub-TOTALs.
[4] TOTAL includes usage on all use sites with effects, including mosquito control.

AgDRIFT modeling) spray drift reductions ranging from 40 to 91%, with low flow and low volume aquatic habitats receiving the most reduction in spray drift deposition. In many cases, these buffers substantially reduce exposure to aquatic organisms and subsequent risk of direct and indirect effects.

**Reduced application number and rate:** New restrictions on corn, cotton, orchards and vineyards, pasture, other crops, and vegetables and ground fruit lower the maximum allowable number of applications to 2-4 per year (depending on the specific crop; previous allowable numbers of applications ranged from 3 to 13 applications per year). This will help reduce the amount of malathion used and decrease potential exposure to the species, thus decreasing the risk of both indirect and direct effects to the species.

---

***CONCLUSION***

After reviewing the current status of the species, the environmental baseline for the action area, the effects of the proposed registration of malathion, and the cumulative effects, it is the Service's biological opinion that the registration of malathion, as proposed, with the implementation of the general conservation measures described above, is not likely to jeopardize the continued existence of the Phantom Springsnail. As discussed below, the vulnerability is high for this species, the risk and likelihood of exposure to malathion is low, and the implementation of the general conservation measures described above is expected to further reduce the likelihood of exposure.

The Phantom Springsnail has a high vulnerability based on its status, distribution, and trends, as described above. The Phantom springsnail only occurs in the four remaining desert spring outflow channels associated with the San Solomon Spring system (i.e., San Solomon, Phantom, Giffin, and East Sandia springs). Phantom springsnails are found concentrated on hard substrates near the spring source (Hershler et al. 2010) and can occur a few hundred meters downstream. When conditions are favorable, Phantom springsnails can reach large population sizes in very small areas.

The risk to the species from labeled uses across the range is expected to be low as we do not anticipate any measurable effects from malathion exposure to individuals, including mortality or sublethal effects to growth, reproduction, or behavior. There may be potential effects to the species' food base (e.g., algae, plants, detritus), however these effects are expected to be small and will not likely result in adverse effects to snails.

Furthermore, we anticipate usage within the species range will be low (0.41%), based primarily on the standard usage data we acquired, as described in the Opinion and summarized for this species above. Conservation measures, such as rain restrictions, aquatic habitat buffers, and reductions to the allowable number of applications and application rates for certain crops, are expected to substantially reduce environmental concentrations of malathion, further reducing the likelihood of exposure.

Due to the lack of measurable effects to individuals, including mortality and sublethal effects, the lack of appreciable effects to its food base and habitat, the low level of expected usage, and the incorporation of conservation measures that would further reduce the risk of exposure, we anticipate minimal, if any, adverse effects (i.e., not enough to result in take) will occur throughout the duration of the action. Therefore, we do not anticipate that the proposed action would appreciably reduce survival and recovery of the Phantom Springsnail in the wild.

**Conclusion:** Not likely to jeopardize

**Integration and Synthesis Summary: Snails *(Aquatic)***

| Scientific Name: | Common Name: | Entity ID: |
|---|---|---|
| *Pyrgulopsis trivialis* | Three Forks springsnail | 4766 |

***VULNERABILITY***
***(Summary of status, environmental baseline and cumulative effects)***

**Status:** Endangered
**Distribution:** Small, endemic, constrained, and/or isolated population(s)
**Number of Populations:** Multiple populations (few)
**Species Trends:** Unknown population trends
**Pesticides noted** ☐

**Environmental Baseline/Cumulative Effects (EB/CE) Summary:**
Historically, the Three Forks springsnail is known to have occurred in numerous springs and seeps in Apache County, Arizona. In recent years, the species' range has been reduced to the point that it has only been found at two spring complexes. Because the species is so limited in range, the magnitude of threats that are occurring now are high, and those that may impact the species in the foreseeable future are high as well. A recent high-intensity fire that burned around the only remaining populations of the Three Forks springsnail has caused the habitat of the species to be currently threatened with destruction, modification, and curtailment due to soil erosion and sedimentation during storm events. Also, predation by nonnative crayfish is currently threatening the Three Forks springsnail across its entire range. In addition to the current threats, the Three Forks springsnail is also at a high risk of extinction due to threats that could affect the species in the foreseeable future, such as the use of fire retardant chemicals during future wildfires, the potential spread and competition with New Zealand springsnails, and the potential for climate change and drought to dry its springhead habitat. Due to its endemic nature, the Three Forks springsnail may be more vulnerable to extinction from both present and future threats. The Three Forks springsnail was historically abundant within all spring ecosystems where found, though with patchy micro-distribution. Nelson et al. (2002) reported Three Forks springsnail densities of approximately 72 snails per square yard (60 snails per square meter) at Three Forks Springs, and approximately 945 per square yard (790 snails per square meter) at Boneyard Bog Springs. The highest number recorded at a single springbrook occurred in a 254-square yards (213-square meters) area at Three Forks Springs in 2002, where tens of thousands of individual snails were estimated (Martinez 2009). Unfortunately, the Three Forks springsnail was last documented at Three Forks Springs in 2003. The AGFD has been conducting annual surveys since 2001 (Nelson et al. 2002), and they have been reporting very low numbers of the springsnails at Three Forks Springs since 2005 (Cox 2007; Bailey 2008; Grosch 2010). However, no voucher specimens (specimens collected to verify species identification) were actually collected until 2011, when it was discovered that the small snails from Three Forks Springs were not Three Forks springsnails (Sorensen 2011a), but rather air-breathing, land snails belonging to the family Pupillidae. Based on this new information, the species is not currently

considered to be extant at Three Forks Springs. However, the species continues to be abundant at Boneyard Bog Springs and Boneyard Creek Springs.

**EB/CE Source:** U.S. Fish and Wildlife Service. 2012. Determination of Endangered Status for Three Forks Springsnail and Threatened Status for San Bernardino Springsnail Throughout Their Ranges and Designation of Critical Habitat for Both Species. Final Rule. 77 FR 23060-23092.

**Overall Vulnerability:** ☒ **High** ☐ **Medium** ☐ **Low**

***RISK***
***(Risk is based on species exposure and response from labeled uses across the range)***

**Risk to individuals if exposed:** We do not anticipate effects to the species from exposure to malathion at labeled use rates.

**Risk to the species from labeled uses across the range:**
The table below summarizes the risk to the species from labeled uses across the range based on range overlaps with use sites and anticipated effects associated with the particular uses.

| ALL USES except mosquito control | |
|---|---|
| Mortality | no effects expected |
| MOSQUITO CONTROL | |
| Mortality | no effects expected |

**Risk modifiers:** Three Forks springsnails are found in creeks or ponds, at elevations of about 3,000 m (8,200 ft.) and at temperatures of 15 to 17°C (59 to 63°F). Three Forks springsnail are clumped in freshwater rheocrene (emerging from the ground as a flowing stream) springs, seeps, spring pools, outflows, and diverse flowing waters associated with gravel, pebble, and cobble substrates, and are rarely found in mud or soft sediments. Three Forks springsnails have a narrow environmental specificity and occur in close proximity to springheads where water emerges from the ground. Springheads play a key role in the life history of springsnails. Dissolved salts such as calcium carbonate are also important factors for the Three Forks springsnail, because they are essential for shell formation (77 FR 23060; NatureServe 2015; USFWS 2012a).

As described in the "Approach to the Effects Analysis" section of the main body of the Opinion, we made specific considerations for species that occur in bins 3 and 4 as they were modeled in such a way that likely resulted in overestimation of estimated environmental concentrations, thus overestimating potential exposure. While the Three Forks Springsnail does occupy other aquatic habitats that contain higher concentrations of malathion (e.g., bins 2 and 5), individuals of the species that occupy habitats with higher flow rates (e.g., bin 3) will experience lower exposure than those occupying low flow areas, reducing the risk of effects across the species in general.

**Overall Risk:** ☐ **High** ☐ **Medium** ☒ **Low**

***USAGE***
***(Anticipated usage within the range based on past usage data)***

| Use type | Risk to species[1] | Use overlap with range | | Estimated usage in range[2] | | Bins associated with use type^ | Effect associated with bin (H, M, L) |
|---|---|---|---|---|---|---|---|
| | | Acres | % | Acres | % | | |
| Mosquito Control | N | 0 | 0 | 0 | 0 | | |
| Developed | D | 72 | 0.02 | 4 | < 0.01 | 2,3,5,6 | 2L<br>3L<br>5L<br>6L |
| **Sub-TOTAL (D):** *Other uses with direct effects*[3] | | 72 | 0.02 | 4 | < 0.01 | 2,3,5,6 | |
| **Sub-TOTAL (I):** *Other uses with indirect effects*[3] | | 0 | 0 | 0 | 0 | 2,3,5,6 | |
| **TOTAL[4]:** | | 72 | 0.02 | 4 | < 0.01 | 2,3,5,6 | |

^We consider the bin 2 estimates as an upper bound of bin 3 & 4 exposures.

**# acres in species range:** 315,529 acres
**% of range in California (i.e., where CalPUR data is available):** 0%
**Range overlap with Federal lands:** 313,725 acres, 99.428%

**Overall Usage:** ☐ **High** ☐ **Medium** ☒ **Low**

***CONSERVATION MEASURES***

**Rain restriction:** Given the relatively short half-life of malathion and rapid degradation via hydrolysis and other processes, persistence of malathion in storm run-off into most aquatic habitats is not anticipated to last longer than 48 hours under typical pH values, (i.e., 6.5-8.5) and water temperatures corresponding to growing season. Restricting malathion application to periods where rain is not forecasted for at least 48 hours or when the soil is not saturated will provide time for the pesticide to degrade before runoff into aquatic habitats can occur, decreasing exposure and risk.

**Aquatic habitat buffers:** Application buffers, which specify on the label a distance from water bodies where pesticides are not to be applied, are designed to reduce spray drift from entering sensitive non-target areas, thereby providing protection to aquatic species. While the exact amount of spray drift reduction depends on the physical traits of the aquatic ecosystem

[1] Direct effects (D), Indirect effects (I), No effects expected (N), Use site not utilized by the species (*)
[2] Estimated usage in the range is based on information about annual past usage.
[3] Mosquito control has the potential to overlap with other uses. It is not included in the Sub-TOTALs.
[4] TOTAL includes usage on all use sites with effects, including mosquito control.

(e.g., flow rate, volume, etc.) as well as the application method, we can expect (based on AgDRIFT modeling) spray drift reductions ranging from 40 to 91%, with low flow and low volume aquatic habitats receiving the most reduction in spray drift deposition. In many cases, these buffers substantially reduce exposure to aquatic organisms and subsequent risk of direct and indirect effects.

***CONCLUSION***

After reviewing the current status of the species, the environmental baseline for the action area, the effects of the proposed registration of malathion, and the cumulative effects, it is the Service's biological opinion that the registration of malathion, as proposed, with the implementation of the general conservation measures described above, is not likely to jeopardize the continued existence of the Three Forks springsnail. As discussed below, the vulnerability is high for this species, the risk and likelihood of exposure to malathion is low, and the implementation of the general conservation measures described above is expected to further reduce the likelihood of exposure.

The Three Forks springsnail has a high vulnerability based on its status, distribution, and trends, as described above. Historically, the species occurred in numerous springs and seeps in Apache County, Arizona. In recent years, the species' range has been reduced to the point that it has only been found at two spring complexes. Three Forks springsnails have a narrow environmental specificity and occur in close proximity to springheads where water emerges from the ground (FWS 2012).

The risk to the species from labeled uses across the range is expected to be low as we do not anticipate any measurable effects from malathion exposure to individuals, including mortality or sublethal effects to growth, reproduction, or behavior. There may be potential effects to the species' food base (e.g., algae, plants, detritus), however these effects are expected to be small and will not likely result in adverse effects to snails.

About 99% of the species range is on Federal lands where we expect any adverse effects would be minimal, considering the small scale and low levels of past malathion usage on Federal lands, and in light of Federal agency programs that are designed to understand, avoid, and minimize the effects to listed species (see the Approach to Usage section of the Opinion). We anticipate usage within the species range will be very low (<0.01%, expected to occur on the non-Federal portion), based primarily on the standard usage data we acquired, as described in the Opinion and summarized for this species above. Additionally, conservation measures, such as rain restrictions and aquatic habitat buffers, are expected to substantially reduce environmental concentrations of malathion within the species' range, further decreasing the likelihood of exposure.

Due to the lack of measurable effects to individuals, including mortality and sublethal effects, the lack of appreciable effects to its food base and habitat, the low level of expected usage, and the incorporation of conservation measures that would further reduce the risk of exposure, we anticipate minimal, if any, adverse effects (i.e., not enough to result in take) will occur throughout the duration of the action. Therefore, we do not expect species-level effects and we do not anticipate that the proposed action would appreciably reduce survival and recovery of the Three Forks springsnail in the wild.

**Conclusion:** Not likely to jeopardize

**Integration and Synthesis Summary: Snails *(Aquatic)***

| Scientific Name: | Common Name: | Entity ID: |
|---|---|---|
| *Tryonia circumstriata* | Gonzales tryonia (formerly Gonzales springsnail) | 5362 |

***VULNERABILITY***
***(Summary of status, environmental baseline and cumulative effects)***

**Status:** Endangered
**Distribution:** Small, endemic, constrained, and/or isolated population(s)
**Number of Populations:** Single population
**Species Trends:** Unknown population trends
**Pesticides noted** ☐

**Environmental Baseline/Cumulative Effects (EB/CE) Summary:**
The Gonzales tryonia inhabits the Diamond Y Spring system, a complex of isolated, desert freshwater springs, seeps, and associated ciénegas (i.e., desert wetland), in the Chihuahuan Basin and Playas ecoregion of western Texas. Gonzales tryonia is a small aquatic snail found in two springs of the Diamond Y spring system and is completely dependent upon spring outflows. Spring flows in the Diamond Y Spring system appear to have declined in flow rate over time, and as spring flows decline, available aquatic habitat is reduced and altered. Substantial scientific uncertainty exists regarding the aquifer sources that provide the source water to the Diamond Y Springs. The snail from Diamond Y Spring area was first described as *Tryonia stocktonensis* by Taylor (1987). It is a small snail, measuring 3.0 to 3.7 mm (0.11 to 0.14 in) long. Systematic studies later changed the name to *Tryonia circumstriata*, integrating it with the fossilized snails from the Pecos River (Hershler 2001), and confirming the species as a ‘‘true *Tryonia*,’’ in other words, it is appropriately classified in the genus *Tryonia* (Hershler et al. 2011). Taylor (1985; 1987) found Gonzales tryonia only in the first 27 m (90 ft) of the outflow from Euphrasia Spring. The species has been consistently found in this short stretch of spring outflow channel since then (Echelle et al. 2001; Lang 2011). Gonzales tryonia was first reported in the upper watercourse in 1991 during collections from one site in the Diamond Y Spring outflow and one small side seep near the spring head (Fullington and Goodloe 1991). The species has since been collected from this area (Lang 2011), and Echelle et al. (2001) found it to be the most abundant snail for the first 430 m (1,400 ft) downstream from the spring head. Ladd (2010) also found Gonzales tryonia in the outflow of Diamond Y Spring, but only from 125 to 422 m (410 to 1,384 ft) downstream of the spring head (Ladd 2011, pers. comm.). The Gonzales tryonia appears to have replaced the Diamond tryonia in some of the habitat in the upper watercourse (Brown 2008) since 1991. Taylor (1985) calculated densities for Gonzales tryonia in the outflow of Euphrasia Spring in the range of 50,480 to 85,360 individuals per sq m (4,690 to 7,930 individuals per sq ft) and estimated the population size in that 27- m (90-ft) stretch to be at least 162,000 individuals and estimated the total population of over one million individuals as a reasonable estimate. Lang (2011) estimated the density of Gonzales tryonia in the Euphrasia Spring outflow to be 3,086

individuals per sq m (287 per sq ft; ±5,061 per sq m, ±471per sq ft). Ladd (2010) estimated the population of Gonzales tryonia in the upper watercourse to be only about 11,000 individuals. Systematic surveys or monitoring efforts for the Gonzales tryonia have not been conducted since 2010 (Ladd 2010, p. 18).

The primary threat to the continued existence of the Gonzales tryonia is the degradation and potential future loss of aquatic habitat (flowing water from the spring outlets) due to the decline of groundwater levels in the aquifers that support spring surface flows. Spring flows in the Diamond Y Spring system appear to have declined in flow rate over time, and as spring flows decline, available aquatic habitat is reduced and altered. Substantial scientific uncertainty exists regarding the aquifer sources that provide the source water to the Diamond Y Springs. The aquifers that support flow of the Diamond Y Spring system are under increasing pressure from groundwater pumping in Pecos and Reeves counties. As stated in the 2019 5-Year Review, the Rustler Aquifer experienced historically unprecedented groundwater pumping since the early 2000s. Withdrawals from the Edwards-Plateau (Trinity) Plateau Aquifer increased over the last 10 years, reaching pumped volumes comparable to the 1980s. The majority of pumped groundwater from both aquifers is for irrigation. Grazing dominates human land use (86%) in Pecos County followed by a small amount of cropland (Texas Land Trends 2019). As of 2017, there were 309 farms in Pecos County with an average farm size of 3,766 ha (9,281 ac) [U.S. Department of Agriculture 2017, p. 1)]. Irrigated cropland has declined since the mid-1960s from 48,284 ha (119,313 ac) in 1964 to 11,113 ha (27,460 ac) in 2000 (Texas Water Development Board 2001, p. 61; Texas Water Development Board 2019). Oil and natural gas activity is significant and projected to increase into the near-future furthering demands for groundwater withdrawals. Anthropogenic climate change is projected to lead to warmer and more arid conditions across western Texas, conditions that could precipitate increased demands for groundwater from use-sectors.

**EB/CE Sources:** U.S. Fish and Wildlife Service. 2013. Determination of Endangered Species Status for Six West Texas Aquatic Invertebrates. Final Rule. 78 FR 41227-41258.

U.S. Fish and Wildlife Service. 2019. Gonzales Tryonia (*Tryonia circumstriata*) 5-Year Review: Summary and Evaluation. Austin Ecological Services Field Office, Austin, Texas. 82 pp.

**Overall Vulnerability: ☒ High ☐ Medium ☐ Low**

***RISK***
***(Risk is based on species exposure and response from labeled uses across the range)***

**Risk to individuals if exposed:** We do not anticipate effects to the species from exposure to malathion at labeled use rates.

**Risk to the species from labeled uses across the range:**
The table below summarizes the risk to the species from labeled uses across the range based on range overlaps with use sites and anticipated effects associated with the particular uses.

| ALL USES except mosquito control | |
|---|---|
| Mortality | no effects expected |
| MOSQUITO CONTROL | |
| Mortality | no effects expected |

**Risk modifiers:** Habitat of the species is mud substrates on the margins of small springs, seeps, and marshes in flowing water associated with sedges and cattails (Taylor, 1987). Other habitat factors, however, are limiting as this species has not expanded beyond the immediate vicinity of the Diamond Y Spring system (first in the lower watercourse, then extirpated there but found in the upper watercourse) in over 40 years since its original description (FWS 2003). The only other associated mollusk species is *Physella mexicana* (Taylor, 1987). High ecological integrity of the population and site fidelity as well as low tolerance ranges are inferred based on species extremely restricted range and habitat requirements.

As described in the "Approach to the Effects Analysis" section of the main body of the Opinion, we made specific considerations for species that occur in bins 3 and 4 as they were modeled in such a way that likely resulted in overestimation of estimated environmental concentrations, thus overestimating potential exposure. While the Gonzales tryonia does occupy other aquatic habitats that contain higher concentrations of malathion (e.g., bin 2), individuals of the species that occupy habitats with higher flow rates (e.g., bin 3) will experience lower exposure than those occupying low flow areas, reducing the risk of effects across the species in general.

**Overall Risk:** ☐ **High** ☐ **Medium** ☒ **Low**

***USAGE***
***(Anticipated usage within the range based on past usage data)***

| Use type | Risk to species[1] | Use overlap with range | | Estimated usage in range[2] | | Bins associated with use type^ | Effect associated with bin (H, M, L) |
|---|---|---|---|---|---|---|---|
| | | Acres | % | Acres | % | | |
| Mosquito Control | N | 0 | 0 | 0 | 0 | - | - |
| Other Crops | D | 20,295 | 0.49 | 0 | 0 | 2,3 | 2L<br>3L |
| Developed | D | 9,875 | 0.24 | 494 | 0.01 | 2,3 | 2L<br>3L |
| Cotton | D | 5,571 | 0.13 | 5,571 | 0.13 | 2,3 | 2L |

[1] Direct effects (D), Indirect effects (I), No effects expected (N), Use site not utilized by the species (*)
[2] Estimated usage in the range is based on information about annual past usage.

| Use type | Risk to species[1] | Use overlap with range | | Estimated usage in range[2] | | Bins associated with use type^ | Effect associated with bin (H, M, L) |
|---|---|---|---|---|---|---|---|
| | | Acres | % | Acres | % | | |
| | | | | | | | 3L |
| Wheat | D | 4,530 | 0.11 | 3,572 | 0.09 | 2,3 | 2L<br>3L |
| Pasture | D | 4,196 | 0.1 | 2,356 | 0.06 | 2,3 | 2L<br>3L |
| Orchards & Vineyards | D | 1,252 | 0.03 | 1,252 | 0.03 | 2,3 | 2L<br>3L |
| Other Grains | D | 1,093 | 0.03 | 1,093 | 0.03 | 2,3 | 2L<br>3L |
| Vegetables & Ground Fruit | D | 327 | < 0.01 | 324 | < 0.01 | 2,3 | 2L<br>3L |
| Corn | D | 186 | < 0.01 | <1 | <0.01 | 2,3 | 2L<br>3L |
| Other Row Crops | D | 150 | < 0.01 | 144 | < 0.01 | 2,3 | 2L<br>3L |
| Nurseries | D | 6 | < 0.01 | 6 | < 0.01 | 2,3 | 2L<br>3L |
| **Sub-TOTAL (D):** *Other uses with direct effects*[3] | | 47,483 | 1.17 | 14,812 | 0.39 | | |
| **Sub-TOTAL (I):** *Other uses with indirect effects*[3] | | 0 | 0 | 0 | 0 | | |
| **TOTAL[4]:** | | 47,483 | 1.17 | 14,812 | 0.39 | | |

^We consider the bin 2 estimates as an upper bound of bin 3 & 4 exposures.

**# acres in species range:** 4,128,556 acres
**% of range in California (i.e., where CalPUR data is available):** 0%
**Range overlap with Federal lands:** 4 acres, 0.000%

**Overall Usage:** ☐ **High** ☐ **Medium** ☒ **Low**

***CONSERVATION MEASURES***

**Rain restriction:** Given the relatively short half-life of malathion and rapid degradation via hydrolysis and other processes, persistence of malathion in storm run-off into most aquatic habitats is not anticipated to last longer than 48 hours under typical pH values, (i.e., 6.5-8.5) and water temperatures corresponding to growing season. Restricting malathion application to periods where rain is not forecasted for at least 48 hours or when the soil is not saturated will

[3] Mosquito control has the potential to overlap with other uses. It is not included in the Sub-TOTALs.
[4] TOTAL includes usage on all use sites with effects, including mosquito control.

provide time for the pesticide to degrade before runoff into aquatic habitats can occur, decreasing exposure and risk.

**Aquatic habitat buffers:** Application buffers, which specify on the label a distance from water bodies where pesticides are not to be applied, are designed to reduce spray drift from entering sensitive non-target areas, thereby providing protection to aquatic species. While the exact amount of spray drift reduction depends on the physical traits of the aquatic ecosystem (e.g., flow rate, volume, etc.) as well as the application method, we can expect (based on AgDRIFT modeling) spray drift reductions ranging from 40 to 91%, with low flow and low volume aquatic habitats receiving the most reduction in spray drift deposition. In many cases, these buffers substantially reduce exposure to aquatic organisms and subsequent risk of direct and indirect effects.

---

***CONCLUSION***

After reviewing the current status of the species, the environmental baseline for the action area, the effects of the proposed registration of malathion, and the cumulative effects, it is the Service's biological opinion that the registration of malathion, as proposed, with the implementation of the general conservation measures described above, is not likely to jeopardize the continued existence of the Gonzales tryonia. As discussed below, the vulnerability is high for this species, the risk and likelihood of exposure to malathion is low, and the implementation of the general conservation measures described above is expected to further reduce the likelihood of exposure.

The Gonzales tryonia has a high vulnerability based on its status, distribution, and trends, as described above. Gonzales tryonia is a small aquatic snail found within the Diamond Y spring system and is completely dependent upon spring outflows. The species habitat is mud substrates on the margins of small springs, seeps, and marshes in flowing water associated with sedges and cattails (Taylor, 1987). However, other habitat factors are limiting as this species has not expanded beyond the immediate vicinity of the Diamond Y Spring system (first in the lower watercourse, then extirpated there but found in the upper watercourse) in over 40 years since its original description (FWS 2003).

The risk to the species from labeled uses across the range is expected to be low as we do not anticipate any measurable effects from malathion exposure to individuals, including mortality or sublethal effects to growth, reproduction, or behavior. There may be potential effects to the species' food base (e.g., algae, plants, detritus), however these effects are expected to be small and will not likely result in adverse effects to snails.

We anticipate usage within the species range will be low (0.39%), based primarily on the standard usage data we acquired, as described in the Opinion and summarized for this species above. We did not quantitatively evaluate use or usage on Federal lands that overlap with the species range, but range overlap on Federal lands is minimal (<0.001%) and we assume only low

levels of usage for this species, per the rationale related to usage on Federal lands as described in the Opinion. Additionally, conservation measures, such as rain restrictions and aquatic habitat buffers, are expected to substantially reduce environmental concentrations of malathion within the species' range, further reducing the likelihood of exposure.

Due to the lack of measurable effects to individuals, including mortality and sublethal effects, the lack of appreciable effects to its food base and habitat, the low level of expected usage, and the incorporation of conservation measures that would further reduce the risk of exposure, we anticipate minimal, if any, adverse effects (i.e., not enough to result in take) will occur throughout the duration of the action. Therefore, we do not anticipate that the proposed action would appreciably reduce survival and recovery of the Gonzales tryonia in the wild.

**Conclusion:** Not likely to jeopardize

**Integration and Synthesis Summary: Snails *(Aquatic)***

| Scientific Name: | Common Name: | Entity ID: |
|---|---|---|
| *Tryonia cheatumi* | Phantom tyronia (formerly Phantom Springsnail (=Tryonia)) | 6138 |

***VULNERABILITY***
***(Summary of status, environmental baseline and cumulative effects)***

**Status:** Endangered
**Distribution:** Small, endemic, constrained, and/or isolated population(s)
**Number of Populations:** Multiple populations (few)
**Species Trends:** Unknown population trends
**Pesticides noted** ☐

**Environmental Baseline/Cumulative Effects (EB/CE) Summary:**
The Phantom tyronia is found in the San Solomon Spring system and is threatened by past and future destruction of its habitat and reduction in range. Groundwater pumping for irrigated agriculture has had a measurable effect on groundwater levels in the areas that likely support the spring flows at the San Solomon Spring system. The Phantom tryonia occurs only in the four remaining desert spring outflow channels associated with the San Solomon Spring system (i.e., San Solomon, Phantom, Giffin, and East Sandia springs) (Taylor 1987; Allan 2011; Lang 2011). The historic range for the Phantom tryonia was likely not larger than present, but the species may have occurred in other springs within the San Solomon Spring system, such as Saragosa and Toyah Springs. Within its current, limited range, Phantom tryonia can have moderate densities of abundance, but have never been recorded as high as the Phantom springsnail. In the 1980s, Taylor (1987) described Phantom tryonia as abundant in the outflow ditch several hundred meters downstream of Phantom Lake Spring. The snails are now limited to low densities in the small pool at the mouth of Phantom Cave and cannot be found in the irrigation canal downstream as it does not have water (Allan 2009). Density data and simple population size estimates based on underwater observations indicate that more than 460,000 individuals of this species may be at San Solomon Spring (Bradstreet 2011). Lang (2011) reports the following densities (not population estimates) of Phantom tryonia (with ± standard deviations): San Solomon Spring from 2009 sampling in the main canal, 11,681 per sq m (1,086 per sq ft; ±11,925 per sq m, ±1,109 per sq ft); Giffin Spring at road crossing in 2001, 3,857 per sq m (358 per sq ft; ±6,110 per sq m, ±568 per sq ft); East Sandia Spring in 2009, 65,845 per sq m (6,123 per sq ft; ±60,962 per sq m, ±5,669 per sq ft); and Phantom Lake Spring in 2009, 31,462 per sq m (2,926 per sq ft; ±20,251 per sq m, ±1,883 per sq ft). Phantom tryonia are usually found concentrated near the spring source but once occurred as far as a few hundred meters downstream when Phantom Lake Spring was a large flowing spring (Dundee and Dundee 1969; Taylor 1987). The species is most abundant in the swimming pool at Balmorhea State Park, but has not been found in either of the constructed cinegas at the Park in 2010 and 2011 (Allan 2011; Bradstreet 2011). The exposure of the spring habitats to pollutants is limited because most of the nearby agricultural activity mainly

occurs in downstream areas where herbicide or pesticide use would not likely come into contact with the species or their habitat in upstream spring outlets. To ensure these pollutants do not affect these spring outflow habitats, their use has been limited in an informal protected area in the outflows of San Solomon and Giffin Springs (Service 2004) that was developed in cooperation with the US EPA and the Texas Department of Agriculture and has little agricultural activities. While more agricultural activities occur far upstream in the aquifer source area, available information does not lead to concern about contaminants from those sources. There are no oil and gas operations in the area around the San Solomon Spring system.

**EB/CE Source:** U.S. Fish and Wildlife Service. 2013. Determination of Endangered Species Status for Six West Texas Aquatic Invertebrates. Final Rule. 78 FR 41227-41258.

**Overall Vulnerability:** ☒ **High** ☐ **Medium** ☐ **Low**

***RISK***
***(Risk is based on species exposure and response from labeled uses across the range)***

**Risk to individuals if exposed:** We do not anticipate effects to the species from exposure to malathion at labeled use rates.

**Risk to the species from labeled uses across the range:**
The table below summarizes the risk to the species from labeled uses across the range based on range overlaps with use sites and anticipated effects associated with the particular uses.

| ALL USES except mosquito control | |
|---|---|
| Mortality | no effects expected |
| MOSQUITO CONTROL | |
| Mortality | no effects expected |

**Risk modifiers:** This species is currently only found in modified waters on the margins of spring flows. It is abundant on firm substrate and in soft mud downstream from the source before modification. Outflow from Phantom Lake Spring is led through a cement-lined irrigation canal with lateral ditches at intervals. The vertical cement walls have a gravelly bottom with mud overlay as well as gates on either side of the weir on the canal with muddy embayments. This area is where *Tryonia cheatumi* are present. Associated species in Phantom Lake Spring are *Cochliopa texana*, *Tryonia brunei*, *Physella mexicana*, and *Melanoides tuberculatus*. This species, before site modification, was likely found in large creeks, and in a wider range of habitats than its other associates (Taylor, 1987; USFWS, 2003).

As described in the "Approach to the Effects Analysis" section of the main body of the Opinion, we made specific considerations for species that occur in bins 3 and 4 as they were modeled in such a way that likely resulted in overestimation of estimated environmental concentrations, thus overestimating potential exposure. While the Phantom Tryonia does occupy other aquatic habitats that contain higher concentrations of malathion (e.g., bins 2 and 5), individuals of the

species that occupy habitats with higher flow rates (e.g., bin 3) will experience lower exposure than those occupying low flow areas, reducing the risk of effects across the species in general.

**Overall Risk:** ☐ **High** ☐ **Medium** ☒ **Low**

***USAGE***
***(Anticipated usage within the range based on past usage data)***

| Use type | Risk to species[1] | Use overlap with range | | Estimated usage in range[2] | | Bins associated with use type^ | Effect associated with bin (H, M, L) |
|---|---|---|---|---|---|---|---|
| | | Acres | % | Acres | % | | |
| Mosquito Control | D | 3,319.00 | 0.08 | 0 | 0 | 2,3,5,6,7 | 2L<br>3L<br>5L<br>6L<br>7L |
| Other Crops | D | 115,114 | 2.66 | 31 | < 0.01 | 2,3,5,6,7 | 2L<br>3L<br>5L<br>6L<br>7L |
| Developed | D | 10,686 | 0.25 | 534 | 0.01 | 2,3,5,6,7 | 2L<br>3L<br>5L<br>6L<br>7L |
| Cotton | D | 10,211 | 0.24 | 9,753 | 0.23 | 2,3,5,6,7 | 2L<br>3L<br>5L<br>6L<br>7L |
| Pasture | D | 7,758 | 0.18 | 2,356 | 0.05 | 2,3,5,6,7 | 2L<br>3L<br>5L<br>6L<br>7L |
| Wheat | D | 2,365 | 0.05 | 2,121 | 0.05 | 2,3,5,6,7 | 2L<br>3L<br>5L<br>6L |

[1] Direct effects (D), Indirect effects (I), No effects expected (N), Use site not utilized by the species (*)
[2] Estimated usage in the range is based on information about annual past usage.

| Use type | Risk to species[1] | Use overlap with range | | Estimated usage in range[2] | | Bins associated with use type^ | Effect associated with bin (H, M, L) |
|---|---|---|---|---|---|---|---|
| | | Acres | % | Acres | % | | |
| | | | | | | | 7L |
| Other Grains | D | 1,528 | 0.04 | 1,528 | 0.04 | 2,3,5,6,7 | 2L<br>3L<br>5L<br>6L<br>7L |
| Orchards & Vineyards | D | 427 | < 0.01 | 312 | < 0.01 | 2,3,5,6,7 | 2L<br>3L<br>5L<br>6L<br>7L |
| Other Row Crops | D | 172 | < 0.01 | 171 | < 0.01 | 2,3,5,6,7 | 2L<br>3L<br>5L<br>6L<br>7L |
| Vegetables & Ground Fruit | D | 141 | < 0.01 | 141 | < 0.01 | 2,3,5,6,7 | 2L<br>3L<br>5L<br>6L<br>7L |
| Corn | D | 24 | < 0.01 | <1 | <0.01 | 2,3,5,6,7 | 2L<br>3L<br>5L<br>6L<br>7L |
| **Sub-TOTAL (D):** *Other uses with direct effects*[3] | | 148,426 | 3.46 | 16,947 | 0.41 | | |
| **Sub-TOTAL (I):** *Other uses with indirect effects*[3] | | 0 | 0 | 0 | 0 | | |
| **TOTAL[4]:** | | 151,744.55 | 3.54 | 16,947 | 0.41 | | |

^We consider the bin 2 estimates as an upper bound of bin 3 & 4 exposures.

**# acres in species range:** 4,331,681 acres
**% of range in California (i.e., where CalPUR data is available):** 0%
**Range overlap with Federal lands:** 10,352 acres, 0.239%

[3] Mosquito control has the potential to overlap with other uses. It is not included in the Sub-TOTALs.
[4] TOTAL includes usage on all use sites with effects, including mosquito control.

**Overall Usage:** ☐ **High** ☐ **Medium** ☒ **Low**

***CONSERVATION MEASURES***

**Rain restriction:** Given the relatively short half-life of malathion and rapid degradation via hydrolysis and other processes, persistence of malathion in storm run-off into most aquatic habitats is not anticipated to last longer than 48 hours under typical pH values, (i.e., 6.5-8.5) and water temperatures corresponding to growing season. Restricting malathion application to periods where rain is not forecasted for at least 48 hours or when the soil is not saturated will provide time for the pesticide to degrade before runoff into aquatic habitats can occur, decreasing exposure and risk.

**Aquatic habitat buffers:** Application buffers, which specify on the label a distance from water bodies where pesticides are not to be applied, are designed to reduce spray drift from entering sensitive non-target areas, thereby providing protection to aquatic species. While the exact amount of spray drift reduction depends on the physical traits of the aquatic ecosystem (e.g., flow rate, volume, etc.) as well as the application method, we can expect (based on AgDRIFT modeling) spray drift reductions ranging from 40 to 91%, with low flow and low volume aquatic habitats receiving the most reduction in spray drift deposition. In many cases, these buffers substantially reduce exposure to aquatic organisms and subsequent risk of direct and indirect effects.

**Reduced application number and rate:** New restrictions on corn, cotton, orchards and vineyards, pasture, other crops, and vegetables and ground fruit lower the maximum allowable number of applications to 2-4 per year (depending on the specific crop; previous allowable numbers of applications ranged from 3 to 13 applications per year). This will help reduce the amount of malathion used and decrease potential exposure to the species, thus decreasing the risk of both indirect and direct effects to the species.

***CONCLUSION***

After reviewing the current status of the species, the environmental baseline for the action area, the effects of the proposed registration of malathion, and the cumulative effects, it is the Service's biological opinion that the registration of malathion, as proposed, with the implementation of the general conservation measures described above, is not likely to jeopardize the continued existence of the Phantom tyronia. As discussed below, the vulnerability is high for this species, the risk and likelihood of exposure to malathion is low, and the implementation of the general conservation measures described above is expected to further reduce the likelihood of exposure.

The Phantom tyronia has a high vulnerability based on its status, distribution, and trends, as described above. The Phantom tyronia only occurs in the four remaining desert spring outflow channels associated with the San Solomon Spring system (i.e., San Solomon, Phantom, Giffin, and East Sandia springs). This species is found in modified waters on the margins of spring

flows. It is abundant on firm substrate and in soft mud downstream from the source before modification.

The risk to the species from labeled uses across the range is expected to be low as we do not anticipate any measurable effects from malathion exposure to individuals, including mortality or sublethal effects to growth, reproduction, or behavior. There may be potential effects to the species' food base (e.g., algae, plants, detritus), however these effects are expected to be small and will not likely result in adverse effects to snails.

We anticipate usage within the species range will be low (0.41%), based primarily on the standard usage data we acquired, as described in the Opinion and summarized for this species above. We did not quantitatively evaluate use or usage on Federal lands that overlap with the species range, but range overlap on Federal lands is minimal (0.239%) and we assume only low levels of usage for this species, per the rationale related to usage on Federal lands as described in the Opinion. Furthermore, the exposure of the spring habitats to pollutants is limited because most of the nearby agricultural activity mainly occurs in downstream areas where pesticide use would not likely come into contact with the species or their habitat in upstream spring outlets. To ensure these pollutants do not affect these spring outflow habitats, their use has been limited in an informal protected area in the outflows of San Solomon and Giffin Springs (FWS 2004) that was developed in cooperation with the EPA and the Texas Department of Agriculture. Additionally, conservation measures, such as rain restrictions, aquatic habitat buffers, and reducing the allowable number of applications and application rates for certain crops, are expected to substantially decrease environmental concentrations of malathion within the species' range, further decreasing the likelihood of exposure.

Due to the lack of measurable effects to individuals, including mortality and sublethal effects, the lack of appreciable effects to its food base and habitat, the low level of expected usage, and the incorporation of conservation measures that would further reduce the risk of exposure, we anticipate minimal, if any, adverse effects (i.e., not enough to result in take) will occur throughout the duration of the action. Therefore, we do not anticipate that the proposed action would appreciably reduce survival and recovery of the Phantom tyronia in the wild.

**Conclusion:** Not likely to jeopardize