

Integration and Synthesis Summary: Bivalves

We conducted an analysis for each bivalve species; our results, conclusions, and supporting rationales for each species are in the following pages. This section of the appendix is divided into two subsections. The first subsection includes an expanded version of the analysis for a large subset of species, with the organization of the analysis similar to that found in most of the other animal taxa groups in Appendix K. For this subset, the account for each species in the set includes multiple tables of information that detail the analysis of vulnerability, risk, and usage related to anticipated overlap and usage. The second subset of species, while still relying on the same types of data and considerations, addresses the remaining species, all with low anticipated usage. Subset 2 is presented in a more summarized format, which serves as a more streamlined, abbreviated account for those species.

We found that this approach provides context for the reader by providing numerous examples that offer an in-depth explanation of our analysis and the factors that were taken into account for each bivalve species considered in the Opinion, while also providing a more efficient presentation of the material (i.e., in subset 2) where similar types of assumptions are relevant for all the species in the subset. Additional information on the analyses is provided in each subsection.

Subset 1. Detailed Presentation of Analysis

The following section includes a detailed presentation of our analysis of risk related to overlap and usage. In addition to the species vulnerability assessments and summarized Environmental Baseline and Cumulative Effects information relevant to the analysis, we present results from the R-Plot analysis (see Appendix M for R-Plots), use and usage data, and our determination as to whether the proposed action is likely to jeopardize the continued existence of the listed entity in question.

As described in greater detail in the Approach to the Effects Analysis (Chapter 2), EPA accounted for estimated environmental concentrations (EECs) for the “open space developed” use category within the “developed” category. Therefore, this use site appears separately in the usage tables below. Overlap with open space developed use sites are included within totals presented in the risk tables, causing these numbers to sometimes be higher than the sum total of overlap described in the usage table for the same species.

Summary of changes to Risk Analysis for Aquatic Species Inhabiting Bins 3 and 4 since Draft Biological Opinion

Between the 2021 draft Biological Opinion (Opinion) and the final Opinion, the Service reconsidered some of our assumptions and methods related to flowing waterbodies¹ based on additional information from EPA and the registrants. Previous methods used by EPA in their biological evaluation (BE) for malathion to model bin 3 and 4 EECs greatly over-estimated the concentrations anticipated to be in these larger, and therefore we did not rely on the numbers generated for aquatic EECs for these bins. As an interim approach for the draft Opinion we used the modeled EECs EPA had already provided in their BE, in an effort to avoid underestimating the EECs. Using this approach, which had been previously agreed upon by EPA and the Service, we used bin 2 modeled EECs (i.e., for small, flowing waterbodies) to estimate bin 3 and 4 EECs (for medium and larger flowing waterbodies), with the understanding that using such a value would likely overestimate concentrations found in these larger volume streams and rivers. Thus, we used bin 2 as an upper bound estimate of EECs for bins 3 and 4 in our analysis for the draft Opinion; for species found in bin 3 and 4 habitats, this method usually resulted in a risk ranking of “high” in that document.

After we issued the draft Opinion, we had additional conversations with EPA and reconsidered our approach to this issue. We determined the approach we took in the draft Opinion was overly conservative. In general, we expect that bin 3 and 4 EECs are up to an order of magnitude lower than bin 2 EECs, and the EECs in these habitats would not be expected to cause toxic effects to listed species.

Therefore, in order to more accurately reflect the level of risk from exposure in our analysis from EECs in bins 3 and 4, we adjusted the level of risk for listed species (and other species and habitat features on which they depended) in flowing waterbodies in this Opinion as follows:

- If the aquatic species inhabits only large water bodies, including larger rivers and streams assigned to bins 3 and 4, but not bin 2 (small flowing waterbodies), we changed the risk level in the final Biological Opinion to ‘low.’ This is based on our assumption that the new EEC levels are below the level where we would expect toxic effects to the species, if exposed. This same approach applies if the species inhabits larger static water bodies (i.e., bins 6 and 7) in addition to larger flowing water bodies, provided the species does not occur in smaller flowing or static waterbodies (i.e., bin 2 or bin 5).
- If the aquatic species inhabits bin 3 and 4 waterbodies, and also smaller flowing or static waterbodies assigned to bin 2 or 5 (which have higher EECs), respectively, we adjusted

¹ This issue was only applicable to flowing water bodies (bins 2, 3, and 4). No such concerns were warranted for ponds, lakes, or other static water bodies (i.e., bins 5, 6, and 7) or other aquatic habitat bins.

the risk level from either 'high' to 'medium' or 'medium' to 'low' in this final Opinion. We no longer anticipate toxic effects to the species based on exposure to malathion in bins 3 and 4, however, exposure to malathion in bin 2 or 5 habitats would be at levels where we anticipate toxic effects to the listed species or other species on which it depends.

Integration and Synthesis Summary: Bivalves

| Scientific Name: | Common Name: | Entity ID: |
|-------------------------|--------------------------------|-------------------|
| <i>Villosa trabalis</i> | Cumberland bean (pearlymussel) | 317 |

Family: Unionidae

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:

When listed in 1976 (41 FR 24062) and last reviewed in 2010, the Cumberland bean, *Villosa trabalis*, was reported to occur in both the Tennessee and Cumberland River systems as a white nacre mussel. Its close relative, the Purple bean (*Villosa purpurpurea*) was limited to the Tennessee River system and recognized as a mussel with a purple nacre. However, recent genetic assessments of these two species support recognizing of the Cumberland River populations of

Villosa trabalis as the Cumberland bean, while combining the Tennessee River populations of *V. trabalis* and *V. perpurpurea* and recognizing them as a separate species, the Tennessee bean, *Venustaconcha trabalis* (Kuenhl 2009; Lane et al. 2016 & 2019).

Currently, the Cumberland bean is known to occur only in the upper reaches of the Cumberland River, with populations restricted to Buck Creek, Rockcastle River (including the Sinking Creek tributary), and Big South Fork Cumberland River. Currently, the Rockcastle River population (together with the Sinking Creek population) is the best remaining population of Cumberland Bean in the upper Cumberland River system (McGregor 2018, pers. comm.). The three remaining populations are separated by large distances due to the creation of Lake Cumberland and are thought to be genetically isolated from one another.

The recovery plan lists impoundments, siltation, and pollution as major causes for the decline of this species; however, it also indicates the reasons for declines are not completely understood. The population is considered to be vulnerable to decline in the Big South Fork due primarily to legacy coal mining activities in the headwaters (New River system). Acid mine wastes and resulting impacts to water quality are either known and/or suspected causes in streams like the Little South Fork, Big South Fork, and Rockcastle River systems. The Little South Fork population is now considered extirpated due to coal-related activities in the 1980s.

Other natural or manmade factors may affect this mussel, including changes in land use that accelerate pollutant (e.g., sediment) delivery. Other potential threats include contaminant spills, resource extraction (e.g. coal, oil, gas, and gravel), siltation from land use practices, and stream impoundments. A portion of the headwaters of Sinking Creek is impacted by development and other urban activities in London, Kentucky, and from historical surface coal mining. To help address these issues, a portion of the upper section of Sinking Creek was purchased by The Nature Conservancy in order to restore this upstream segment of Sinking Creek and improve water quality conditions downstream where known populations of the Cumberland Bean occur. Once restored, this segment of Sinking Creek may be suitable for introduction of the species and/or its fish hosts.

The majority of the remaining Cumberland bean populations are generally small and

geographically isolated, making natural repopulation of extirpated populations unlikely. Furthermore, many of the remaining populations are likely below the effective population size, making future extirpations more likely.

This species is most often found associated with clean, fast-flowing water in stable substrate, which contains relatively firm rubble, gravel, and sand swept-free from siltation. Typically, the Cumberland Bean is found buried in shallow riffle and shoal areas and is often located under large rocks that must be removed by hand to inspect the habitat underneath. The banded culpin (*Cottus carolinae*), striped darter (*Etheostoma virgatum*), fantail darter (*E. flabellare*), greenside darter (*E. blennioides*) and redline darter (*E. rufilineatum*) can all serve as hosts for this species (Guyot 2005). There is concern that the number of host fishes may not be adequate in the Big South Fork and Buck Creek to promote successful recruitment. Recent fish community surveys demonstrate significant recovery of the fish community as compared to historical conditions. Of the documented hosts listed by Guyot (2005), only greenside darter occurs in the mainstem of the Big South Fork Cumberland River.

Until recently, propagation success has been limited to a relatively small number of cultured Cumberland bean. That changed in 2018 when Kentucky Department of Fish and Wildlife Resources was able to propagate and culture approximately 6,000 juveniles from gravid females collected from Sinking Creek. These 6,000 individuals will likely be released at multiple sites in the Rockcastle River and Sinking Creek in the future once release sites have been determined.

EB/CE Source: U.S. Fish and Wildlife Service (FWS). 2020. Cumberland bean (*Villosa trabalis*) 5-Year Review: Summary and Evaluation. Kentucky Ecological Services Field Office. Frankfort, Kentucky. 29 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 expect the Cumberland bean will experience direct mortality or sublethal effects from any malathion uses at the maximum rates for all bins (2, 3, 4, 6, 7). However, risk of mortality to the host fish for bin 2 is high for all use sites except developed, where it is medium. Risk of mortality to individuals in bin 7 is medium for all uses except for developed and mosquito control, which are low. Risk of mortality to individuals in bin 6 is high for all other uses except medium for mosquito control and low for developed.

We do not expect mussel species to be directly impacted by exposure from malathion. However their lifecycle is such that when glochidia (larval stage) are released into the water, within a few days, they must attach to an appropriate species of fish, which they parasitize for a short time while they develop into juvenile mussels in order to complete their lifecycle; they cannot complete their lifecycle without a fish host.

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.

| | |
|--|--|
| DIRECT (all uses except mosquito control) | |
| Use areas – mortality | No effects expected |
| Sublethal – growth (G), reproduction (R) and behavior (B) enzyme (E) | No effects expected |
| INDIRECT (all uses except mosquito control) | |
| Use areas - Prey item mortality | If plankton: H, except for developed is L If detritus: NA |
| Use areas – Fish Host | Total overlap: 4.39%, H M for most uses L for developed |
| MOSQUITO CONTROL | |
| Direct (mortality) | No effects expected |
| Sublethal | No effects expected |
| Indirect | Total overlap: 0%, |

Risk modifiers:

This species is most often found associated with clean, fast flowing water in stable substrate, which contains relatively firm rubble, gravel, and sand swept-free from siltation. Typically, *V. trabalis* is found buried in shallow riffle and shoal areas, often located under large rocks that must be removed by hand to inspect the habitat underneath. Ideal habitat conditions are difficult to find; much of the historical habitat for the species has likely been degraded and may be incapable of currently harboring the species.

In the “Approach to the Effects Analysis” section of the main body of the Opinion, we stated that specific considerations were made 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. Further investigation by EPA into Bin 3 and 4 estimated environmental concentrations indicate 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. While the Cumberland bean also occupies other aquatic habitats that may be exposed to potentially high levels of malathion due to lower volume in those habitats (Bin 2), their potential exposure risk is at least partially lowered based on their reliance upon larger flowing and static aquatic habitats (Bins 3, 4, 6, and 7), reducing the overall risk to the species as a whole.

Mussels depend on a host fish to accomplish their reproductive lifecycle. Glochidia that do not attach to a host fish will not survive. Where sufficient numbers of suitable host fish are not available, we anticipate reproduction of mussels would be reduced. Mussels can be categorized into different categories that reflect the type of mussel-host relationships, including host fish generalists, host fish specialists, and those for which the host fish are unknown. The recently described Buck darter, *Etheostoma nebra* (formerly *E. virgatum*) is apparently endemic to the Buck Creek system and is a known host for the Cumberland bean. Near and Thomas (2015) indicate that *E. nebra* has also undergone a significant range reduction in the Buck Creek system where it is now only known from Flat Lick Creek, a tributary to Buck Creek. It has also been determined that the banded sculpin (*Cottus carolinae*), striped darter (*Etheostoma virgatum*), fantail darter (*E. flabellare*), greenside darter (*E. blennioides*) and redline darter (*Nothonotus rufilineatus*) could all serve as hosts for this species (Guyot 2005). While the sculpin and the darters, except for the Buck darter, are all relatively common and do not have widespread conservation concerns, we do not have high resolution data on their relative abundances in the range of the Cumberland bean or their relative proportion or selection in serving as the host fish. Therefore, this relatively specialized fish host requirement suggests that the Cumberland bean may be less resilient to possible changes in the fish host community and make it more susceptible to indirect effects of malathion where fish hosts are limited. Thus, the risk is determined to be higher for the Cumberland bean.

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 to Host Fish associated with bin (H, M, L) |
|---------------------------|------------------------------|------------------------|--------|---------------------------------------|--------|--|---|
| | | Acres | % | Acres | % | | |
| Mosquito Control | I | 0 | 0 | 0 | 0 | 2,3,4,5,6,7 | NA |
| Developed | I | 13,704.9 | 1.51 | 685.2 | 0.076 | 2,3,4,6,7 | 2M 3 4 6L 7L |
| Other Row Crops | I | 74.5 | 0.008 | 74.5 | 0.008 | 2,3,4,6,7 | 2H 3 4 6H 7M |
| Open Space Developed | I | 23379.8 | 2.58 | 1,169 | 0.129 | 2,3,4,6,7 | 2M 3 4 6L 7L |
| Corn | I | 5,434.8 | 0.60 | 2,717.3 | 0.30 | 2,3,4,6,7 | 2H 3 4 6H 7M |
| Wheat | I | 503 | 0.027 | 238.4 | 0.026 | 2,3,4,6,7 | 2H 3 4 6H 7M |
| Pasture | I | 572.3 | 0.063 | 400.1 | 0.044 | 2,3,4,6,7 | 2H 3 4 6H 7M |
| Vegetables & Ground Fruit | I | 7 | 0.0008 | 7 | 0.0008 | 2,3,4,6,7 | 2H 3 |

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. Although mosquito adulticide was identified as an anticipated usage category in the draft biological opinion, our subsequent rerun of the usage overlap with the species' refined range indicated this usage was no longer relevant to the analysis.

| Use type | Risk to species ¹ | Use overlap with range | | Estimated usage in range ² | | Bins associated with use type [^] | Effect to Host Fish associated with bin (H, M, L) |
|--|------------------------------|------------------------|----------|---------------------------------------|-----------|--|---|
| | | Acres | % | Acres | % | | |
| | | | | | | | 4 6H 7M |
| Other Grains | I | 12.3 | 0.001 | 12.3 | 0.001 | 2,3,4,6,7 | 2H 3 4 6H 7M |
| Other Crops | I | 24.2 | 0.003 | 0 | 0 | 2,3,4,6,7 | 2H 3 4 6H 7M |
| Nurseries | I | 32.7 | 0.003 | 32.7 | 0.004 | 2,3,4,6,7 | 2H 3 4 6H 7M |
| Orchards & Vineyards | I | 0.33 | 0.000368 | 0.33 | 0.0000368 | 2,3,4,6,7 | 2H 3 4 6H 7M |
| Sub-TOTAL (I): <i>Other uses with indirect effects³</i> | | 43,745 | 4.39 | 5,337 | 0.59 | | |
| TOTAL³: | | 43,745 | 4.39 | 5,337 | 0.59 | | |

[^]We consider the Bin 2 estimates as a surrogate for Bins 3 & 4 exposures, as described in the *Effects of the Action* section of this Opinion. The estimated environmental concentrations for a Bin 2 water are an order of magnitude greater than Bins 3 and 4; therefore, concentrations in Bins 3 and 4 can be reduced by a correction factor of 10.

Exposure Modifiers:

A reassessment of our crop use data layers shows that within the “Other Row Crops” layer shows that usage in this category may be overestimated. This UDL is composed of sunflower,

³ TOTAL includes usage on all use sites with effects, including mosquito control if applicable.

peanuts, tobacco, sugar beets, and hops, of which, only hops is a registered use site on malathion labels and is thus the only crop in this layer that is relevant in our analysis. USDA data shows that 96% of hops are grown in the Pacific Northwest region (in Idaho, Oregon, and Washington), with some small farms in Florida reporting occasional hop production. Given the highly specific regions that hops are grown in, we can assume that potential exposure to malathion from “other row crops” use sites is 0 outside of these areas, and is thus not relevant to the Cumberland bean.

acres in species range: 906,170.1 acres

% of range in California (i.e., where CalPUR data is available): 0%

Range overlap with Federal lands: 473,413 acres, 52.24%

Overall Usage: ☐ High ☐ Medium ☒ Low

CONSERVATION MEASURES

- 1) **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.
- 2) **Aquatic habitat buffers:** Application buffers 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 significantly reduce exposure to aquatic organisms and subsequent risk of direct and indirect effects.
- 3) **Residential use label changes:** New restrictions to the method and frequency of application for residential use of malathion are expected to significantly 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 initial residues to degrade prior to the next application. In addition, exposure to aquatic organisms is reduced due to buffers from waterways 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 Cumberland bean (pearly mussel). As discussed below, even though the species vulnerability is high and risk to the species host fish is high, we anticipate the likelihood of exposure of host fish to malathion is low, and the implementation of the general conservation measures described above is expected to further reduce the likelihood of exposure. In addition, although mosquito adulticide was identified as an anticipated usage category in our February 2021 draft biological opinion, our subsequent reexamination of the usage overlap with the species' refined range indicated this usage was no longer relevant to the analysis. Thus, for this species, based upon a refinement of the range and mosquito adulticide usage information, we conclude that mosquito adulticide is not a driver for malathion effects and that effects to host fish are not anticipated from this use.

The Cumberland bean (pearly mussel) has a high vulnerability based on its status, distribution, and trends. Mortality and sublethal effects to the species are not anticipated. The risk to the species host fish posed by labeled uses across the range is high, and where individual host fish are exposed, we anticipate high to medium levels of mortality, depending on water body size and use type. Mussels depend on host fish to accomplish their reproductive lifecycle. Glochidia (larval stage) are released into the water and within a few days they must attach to an appropriate species of fish, which they parasitize for a short time while they develop into juvenile mussels. Glochidia that do not attach to a host fish will not survive. Where sufficient numbers of suitable host fish are not available, we anticipate reproduction of mussels would be reduced.

We anticipate usage within the non-Federal portion of the species' range will be low (0.59%), based primarily on the 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 Biological Opinion.

According to the 2020 5-year Review, populations of this species remain in small segments of Buck Creek, Big South Fork Cumberland River, and the Rockcastle River system, including Sinking Creek. The best population of this species is in the mainstem of the Rockcastle River (i.e., about a 40 mile reach), including lower Sinking Creek, but the species only occurs at sporadic locations. All streams show limited evidence of reproduction and recruitment. In populations in Buck Creek and Big South Fork Cumberland River, recruitment is likely very low and may be undetectable by standard survey techniques, if recruitment is occurring at all. In Buck Creek, the species is observed in about a four-mile reach and in the Big South Fork Cumberland River in only a few shoals. Limited host fish is a concern in Big South Fork Cumberland River and Buck Creek, as numbers may not be adequate to promote successful recruitment of the Cumberland bean (pearly mussel) (Monte McGregor, personal communication). This may be the case in other rivers where recruitment is low.

The recently described Buck darter, *Etheostoma nebra* (formerly *E. virgatum*) is apparently endemic to the Buck Creek system and is a known host for the Cumberland bean. Near and Thomas (2015) indicate that *E. nebra* has also undergone a significant range reduction in the Buck Creek system where it is now only known from Flat Lick Creek, a tributary to Buck Creek. It has also been determined that the banded sculpin, striped darter, fantail darter, greenside darter, and redline darter could all serve as hosts for this species. While the sculpin and the darters, except for the Buck darter, are all relatively common and do not have widespread conservation concerns, we do not have high resolution data on their relative abundances in the range of the Cumberland bean or their relative proportion or selection in serving as the host fish. As stated in the Environmental Baseline section above, of the two populations currently considered the best for this species, one is in the Cumberland River drainage (Sinking Creek), and one is in the Tennessee River drainage (Hiwassee River). Both of these populations are considered viable with evidence of reproduction and recruitment. Two additional populations, both in the Cumberland River drainage (Big South Fork Cumberland River and Buck Creek), show recent evidence of reproduction; however, recruitment and the overall population numbers for both streams are considered low, with these populations remaining vulnerable to further decline. Based on this information, we anticipate that locally diminished host fish(es) numbers are an important factor in reducing recruitment and survival of the Cumberland bean in its few remaining populations.

Low levels of malathion usage (0.59%) within this species range could reduce plankton and the availability of host fish where this species occurs. However, any reductions in plankton would likely replenish relatively quickly from upstream sources. Reductions in host fish would be localized to areas of application and likely be replenished from other areas within the watershed. Although the species has a narrow patchy distribution, we anticipate that the conservation measures above, including rain restrictions, aquatic habitat buffers, and residential use label changes, will minimize the risk of exposure to plankton and the mussels' host fish.

As stated previously, conservation measures are aimed at reducing the amount of malathion runoff and spray drift that enter into sensitive habitats (e.g., species habitat, aquatic environments). For example, by placing a 48-hour rain restriction on agricultural applications, malathion has the ability to degrade after application (e.g., by hydrolysis, other processes) prior to any rain/runoff events, thus minimizing malathion runoff into aquatic habitats and decreasing exposure to listed species. Increasing application buffers reduces the amount of malathion that drifts off target and subsequently into non-target environments. In addition, changes to residential labels limits applications to spot treatments and reduces the number of applications per year (2-4), significantly decreasing the overall amounts of malathion used in residential areas and resulting amounts of runoff and drift. Additional reductions in the number of applications and rates allowed for certain crops (e.g., corn, vegetables and ground fruit) further reduces the amount of malathion used in agricultural settings, thereby decreasing potential exposure to the species. Combined, these conservation measures substantially reduce exposure to the Cumberland bean and therefore minimize overall risk and adverse effects to the species. Most significantly however, are the reductions in the anticipated usage for both mosquito adulticide and Other row crops UDL, as described above. Both use categories were anticipated to be drivers for effects in our February 2021 draft Opinion, but have subsequently been revised based upon improved overlap information and an improved understanding of the USDA data, effectively nullifying both usage categories and significantly reducing the likelihood of adverse effects to

the species host fish. Thus, while we anticipate small numbers of individual host fish would be lost over the duration of the action, resulting in very small reductions in reproductive success, we do not anticipate species-level effects to this mussel species.

Therefore, we do not anticipate that the proposed action would appreciably reduce survival and recovery of the Cumberland bean (pearlymussel) in the wild.

Conclusion: Is not likely to jeopardize.

ADDITIONAL REFERENCES

U.S. Fish and Wildlife Service (FWS). 2020. Cumberland bean (*Villosa trabalis*) 5-Year Review: Summary and Evaluation. Kentucky Ecological Services Field Office. Frankfort, Kentucky. 29 pp.

Integration and Synthesis Summary: Bivalves

| Scientific Name: | Common Name: | Entity ID: |
|--|--------------------------------|-------------------|
| <i>Epioblasma obliquata perobliqua</i> | White cat's paw (pearlymussel) | 324 |

Family: Unionidae

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:

As reported in the 2021 5-Year Review, the white cat's paw pearly mussel is currently known to exist in only a 3-mile portion of Fish Creek in Williams County in northwest Ohio. Museum records indicate that the white cat's paw pearly mussel historically occurred in Indiana in the Wabash, White, Tippecanoe, Maumee, and St. Joseph Rivers, and Ohio in the Maumee and St. Joseph Rivers and Fish Creek. The last observation of a live white cat's paw pearly mussel occurred in 1999. Fish Creek was surveyed, system-wide, in 1975, 1988, 1996, 1999, 2004, 2005, and 2012. No mussel surveys of Fish Creek have been conducted since 2012.

. . Museum records indicate that the white cat's paw pearly mussel historically occurred in Indiana in the Wabash, White, Tippecanoe, Maumee, and St. Joseph rivers, and Ohio in the Maumee and St. Joseph Rivers and Fish Creek. It may have also occurred in the Ohio River though the museum record is questionable since this subspecies is usually restricted to smaller streams (USFWS 1990¹). The biology of the white cat's paw pearly mussel is similar to other bivalved mollusks belonging to the family Unionidae. However, due in large part to its rarity, relatively little is known about its specific life history requirements. Fish Creek was surveyed, system-wide, in 1975, 1988, 1996, 1999, 2004, 2005, and 2012. Clark (1977) reported finding one live female and one freshly dead female in 1975. Hoggarth (1993) reported finding a freshly dead specimen in 1985. According to Watters (1988), a live individual was observed by a private collector in 1985. Watters (1988) found one live individual and one freshly dead specimen in 1988 and one live individual in 1993. The last observation of a live white cat's paw pearly

¹ This and other references in this paragraph as cited in USFWS 2013.

mussel occurred in 1999 (Watters 2000). In 1993, a pipeline ruptured, discharging an estimated 30,000 gallons of #2 diesel fuel into a crop field in DeKalb County, Indiana. The diesel fuel made its way into a small drainage ditch that discharges to Fish Creek. This oil entered Fish Creek and spread downstream, crossing into Williams County, Ohio, exposing the lower 7 miles of the creek to the diesel fuel contamination. The spill occurred where the only remaining population of white cat's paw pearly mussel is known to occur. The magnitude of the impact on the white cat's paw pearly mussel is not known, though it has been determined that there were acute and likely sublethal impacts to freshwater mussels from the spill (USFWS 1997). A \$2.5 million Natural Resource Damage Assessment settlement was reached in 1995. After the settlement, the Ohio and Indiana trustees worked jointly on projects to restore, protect and preserve the land along the creek. More than 1,500 acres of the Fish Creek watershed has been protected through acquisitions, conservation easements, reforestation, stream bank stabilization and wetlands restoration. Educational and research projects included mussel surveys, stream flow analysis and promotion of best management projects to local landowners.

Channelization for flood control and other forms of substrate disturbance (e.g., gravel dredging operations, channel maintenance dredging, instream construction, and the removal of logs and other obstructions to flow) and siltation due to poor agricultural practices and deforestation are probably the leading factors in the decline of the white cat's paw pearly mussel (USFWS 1990, as cited in USFWS 2013).

EB/CE Source:

U.S. Fish and Wildlife Service (FWS). 2021. White Cat's Paw Pearly Mussel (*Epioblasma obliquata perobliqua*) 5-Year Review: Summary and Evaluation. Ohio Ecological Services Field Office. Columbus, Ohio. 2 pp.

U.S. Fish and Wildlife Service (FWS). 2013. White Cat's Paw Pearly Mussel (*Epioblasma obliquata perobliqua*) 5-Year Review: Summary and Evaluation. Ohio Ecological Services Field Office. Columbus, Ohio. 14 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 expect the white cat's paw will experience direct mortality or sublethal effects from any malathion uses at the maximum rates for all bins (2,3).

We do not expect mussel species to be directly impacted by exposure from malathion. However their lifecycle is such that when glochidia (larval stage) are released into the water, within a few days, they must attach to an appropriate species of fish, which they parasitize for a short time while they develop into juvenile mussels in order to complete their lifecycle; they cannot complete their lifecycle without a fish host.

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

| | |
|--|--|
| DIRECT (all uses except mosquito control) | |
| Use areas – mortality | No effects expected |
| Sublethal – growth (G), reproduction (R) and behavior (B) enzyme (E) | No effects expected |
| INDIRECT (all uses except mosquito control) | |
| Use areas - Prey item mortality | If plankton: H for all bins If detritus: NA |
| Use areas – Fish Host | Total overlap: 18%, Bins 2,3H for all uses except developed and M for Bin 3 corn and pasture |
| MOSQUITO CONTROL | |
| Direct (mortality) | No effects expected |
| Sublethal | No effects expected |
| Indirect | Total overlap: 0%, |

Risk modifiers: *Species occurs in Bins 2 and 3. See Risk Assumptions (above) for risk to individuals and species.*

Species host (unknown) occurs in Bins 2 and 3. See Risk Assumptions (above) for risk to host species.

Mussels depend on a host fish to accomplish their reproductive lifecycle. Glochidia that do not attach to a host fish will not survive. We anticipate reproduction of mussels would be reduced in areas with insufficient fish hosts available. The mussel glochidia fish host relationship can be categorized into several different categories that capture the breadth of the type of mussel-host relationships such as generalists, specialists, or unknown fish host species. We anticipate that variable numbers of individual host fish may be affected over the duration of the proposed action, some of which would result in local extirpations of these mussel species in their highly isolated and fragmented populations, and we would expect species-level effects to these mussels to occur in the absence of mitigating factors. There is no information currently available regarding which fish species the white cat's paw relies on for glochidia attachment, however laboratory studies using other species of the same genus have successfully transformed glochidia on riffle dwelling species like darters and sculpins. Given the lack of information we have regarding the age, size at maturity, or appropriate host fish species, we anticipate a medium risk is warranted.

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 that they were modeled in such a way that likely resulted in overestimation of estimated environmental concentrations, thus overestimating potential exposure. While the white cat's paw also occupies other aquatic habitats that may be exposed to potentially high levels of malathion due to lower volume in those habitats (Bin 2), their potential exposure risk is at least partially lowered based on their reliance upon a larger flowing aquatic habitat (Bin 3), reducing the overall risk to the species as a whole.

Overall Risk: ☐ High ☒ Medium ☐ Low

USAGE

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

| Use type | Risk to species ² | Use overlap with range | | Estimated usage in range ³ | | Bins associated with use type [^] | Effect to Host Fish associated with bin (H, M, L) |
|--|------------------------------|------------------------|-------|---------------------------------------|-------|--|---|
| | | Acres | % | Acres | % | | |
| Developed | I | 4.8 | 4.6 | 0.24 | 0.23 | 2,3 | 2L 3L |
| Open Space Developed | I | 12.3 | 11.8 | 0.62 | 0.60 | 2,3 | 2H 3L |
| Corn | I | 1.93 | 1.84 | 1.93 | 1.84 | 2,3 | 2H 3M |
| Pasture | I | 0.04 | 0.035 | 0.04 | 0.035 | 2,3 | 2H 3M |
| Sub-TOTAL (I): <i>Other uses with indirect effects³</i> | | 19 | 18.3 | 2.83 | 2.7 | | |
| TOTAL⁴: | | 19 | 18.3 | 2.83 | 2.7 | | |

[^]We consider the Bin 2 estimates as an upper bound of Bin 3 & 4 exposures. The estimated environmental concentrations for a Bin 2 water are an order of magnitude greater than Bins 3 and 4; therefore concentrations in Bins 3 and 4 can be reduced by a correction factor of 10.

Exposure Modifiers:

A reassessment of crop UDL showed that usage data in the “Other Row Crops” may be overestimated. This UDL is composed of sunflower, peanuts, tobacco, sugar beets, and hops, of which, only hops is a registered use site on malathion labels and is thus the only crop in this layer that is relevant in our analysis. USDA data shows that 96% of hops are grown in the Pacific

² Direct effects (D), Indirect effects (I), No effects expected (N), Use site not utilized by the species (*)

³ Estimated usage in the range is based on information about annual past usage.

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

Northwest region (Idaho, Oregon, and Washington), with some small farms in Florida reporting occasional hop production. Given the highly specific regions that hops are grown in, we can assume that the potential exposure to malathion from “other row crops” use sites is 0 outside the areas indicated above, and thus does not apply to this species.

acres in species range: 104 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

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 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 significantly 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 significantly 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 initial residues to degrade prior to the next application. In addition, exposure to aquatic organisms is reduced due to buffers from waterways 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 groundfruit lower the maximum allowable

number of applications to 2-4 per year (depending on the specific crop). 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.

Species specific measures: In addition to the general label changes that would apply to all uses specified on the label, which would be protective of a wide range of species, the registrants have also agreed to additional conservation measures, such as additional application buffers. The following species-specific measures are now part of the Action and will be included in *BulletinsLive! Two*:

The following has been specified for agricultural uses within the range of the white cat's paw:

Do not apply aerially within 100ft (or 50ft if a full swath displacement is used) of low flow habitats (as defined with input from FWS Field Office staff) for wheat, corn, and pasture applications.

Application buffers are designed to reduce spray drift from entering sensitive non-target areas, thereby providing protection to species. While the exact amount of spray drift reduction will vary depending on traits of the ecosystem (e.g. flow rate, volume, etc.) as well as the application method, based on AgDRIFT modeling we can expect spray drift reductions ranging from 82 to 90%.

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 white cat's paw (pearlymussel). As discussed below, even though the species vulnerability is high and risk to the species host fish is medium, we anticipate the likelihood of exposure of host fish to malathion is low, and the implementation of the general conservation measures and species-specific conservation measures described above is expected to further reduce the likelihood of exposure.

The white cat's paw (pearlymussel) has a high vulnerability based on its status, distribution, and trends. Mortality and sublethal effects to the species are not anticipated. The risk to the species host fish posed by labeled uses across the range is medium, and where individual host fish are exposed, we anticipate medium levels of mortality. Mussels depend on host fish to accomplish their reproductive lifecycle. Glochidia (larval stage) are released into the water and within a few days they must attach to an appropriate species of fish, which they parasitize for a short time while they develop into juvenile mussels. Glochidia that do not attach to a host fish will not survive.

We anticipate usage within the non-Federal portion of the species' range will be low (2.7%), based primarily on the 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 Biological Opinion. Where sufficient numbers of suitable host fish are not available, we anticipate reproduction of mussels would be reduced.

Low levels of malathion usage within this species range could reduce plankton and the availability of host fish within the 3-mile section where this fish occurs. However, any reductions in plankton would likely replenish relatively quickly from upstream sources. Reductions in host fish would be localized to areas of application and likely be replenished from other areas of the stream. Although the species range is very small, we anticipate that the conservation measures above, including rain restrictions, aquatic habitat buffers, residential use label changes, and reduced number of applications and rates on certain use sites, will minimize the risk of exposure to plankton and the mussels' host fish.

As stated previously, conservation measures are aimed at reducing the amount of malathion runoff and spray drift that enter into sensitive habitats (e.g., species habitat, aquatic environments). For example, by placing a 48-hour rain restriction on agricultural applications, malathion has the ability to degrade after application (e.g., by hydrolysis, other processes) prior to any rain/runoff events, thus minimizing malathion runoff into aquatic habitats and decreasing exposure to listed mussels and their host fish. Increasing application buffers reduces the amount of malathion that drifts off target and subsequently into non-target environments. In addition, changes to residential labels limits applications to spot treatments and reduces the number of applications per year (2-4), significantly decreasing the overall amounts of malathion used in residential areas and resulting amounts of runoff and drift. Additional reductions in the number of applications and rates allowed for certain crops (e.g., corn, vegetables and ground fruit) further reduces the amount of malathion used in agricultural settings, thereby decreasing potential exposure to the species and their host fish. In addition, the following application restriction for agricultural uses will be applied within this species' range: *Do not apply aerially within 100ft (or 50ft if a full swath displacement is used) of low flow habitats (as defined with input from FWS Field Office staff) for wheat, corn, and pasture applications.* Combined, these conservation measures substantially reduce exposure to the white cat's paw (pearlymussel) and their host fish and therefore minimize overall risk and adverse effects to the species. Thus, while we anticipate small numbers of individual host fish would be lost over the duration of the action, resulting in very small reductions in reproductive success, we do not anticipate species-level effects to this mussel species.

Therefore, we anticipate that the proposed action would not appreciably reduce survival and recovery of the white cat's paw (pearlymussel) in the wild.

Conclusion: Is not likely to jeopardize.

Integration and Synthesis Summary: Bivalves

| Scientific Name: | Common Name: | Entity ID: |
|----------------------------|----------------------------|------------|
| <i>Lampsilis higginsii</i> | Higgins eye (pearlymussel) | 325 |

Family: Unionidae

VULNERABILITY

(Summary of status, environmental baseline and cumulative effects)

Status: Endangered

Distribution: Species/Populations widespread or wide-ranging

Number of Populations: Multiple populations (numerous)

Species Trends: Declining population(s) – one or more populations declining

Pesticides noted ☒

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

There is some uncertainty regarding the historical distribution of Higgins eye but it is believed to have been distributed widely, inhabiting the Upper Mississippi River main stem from just north of St. Louis, Missouri, to Minneapolis-St. Paul, Minnesota (Coker 1919). It also was found in several Upper Mississippi River tributaries including the Ohio, Illinois, Sangamon, Iowa, Cedar, Wapsipinicon, Rock, Wisconsin, Black, Minnesota, St. Croix Rivers (USFWS 2004), and the Chippewa River in Wisconsin (USFWS 2018). The range of Higgins eye has been reduced from its historical distribution and now includes the Upper Mississippi River upstream of Lock and Dam 22 near Hannibal, Missouri, the lower St. Croix River between Wisconsin and Minnesota, 59 the lower Wisconsin River, Wisconsin, and the lower Rock River in Illinois (USFWS 2004). The species has been recently reintroduced to two locations on the Chippewa River in Wisconsin (Smith 2018, p. 1), although it is too soon to determine whether these efforts have resulted in the successful reestablishment of the species in those areas.

The primary threats to Higgins eye are habitat changes (chiefly in the form of impoundments), water quality problems, and non-native species, both as predators (carp) and competitors (zebra mussels and Asian clams). Toxic chemical spills have killed mussels and fish throughout the range of Higgins eye, particularly in the Mississippi River where officials have documented several spills. Various alien or nonnative species of aquatic organisms are established firmly in the range of Higgins eye. The alien species that poses the most significant stressor to the Higgins eye is the zebra mussel, although the Asian clam, non-native carp, and round goby all continue to impact Higgins eye and other freshwater mussels. Since listing, almost all of the extant sites have had encroachment of zebra mussels. Only the Chippewa River and Interstate populations have not experienced zebra mussel encroachment.

Conservation work has been an active area for Higgins eye since the last review in 2006. Major activities that have taken place include: monitoring, captive propagation and release, outreach, and funding acquisition.

EB/CE Source: U.S. Fish and Wildlife Service (FWS). 2020. Higgins eye (*Lampsilis higginsii*) 5-Year Review: Summary and Evaluation. Minnesota-Wisconsin Field Office. Bloomington, MN. 28 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 expect the Higgin's eye (pearly mussel) will experience direct mortality or sublethal effects from any malathion uses at the maximum rates for all bins (2,3,4,5,6,7). However, risk of mortality to the host fish for bin 2 is high for all use sites except developed, where it is medium. Risk of mortality to the host fish for bin 5 is low for developed, all high for all other uses. Risk of mortality to host fish in bin 6 is low for developed, medium for mosquito control, corn, other crops, wheat, and other grains, and high for all other uses. Risk of mortality to the host fish in bin 7 is low for corn, mosquito control, other crops, developed, wheat, other grains, medium for nurseries, other row crops, and Christmas trees.

We do not expect mussel species to be directly impacted by exposure from malathion. However their lifecycle is such that when glochidia (larval stage) are released into the water, within a few days they must attach to an appropriate species of fish, which they parasitize for a short time while they develop into juvenile mussels in order to complete their lifecycle; they cannot complete their lifecycle without a fish host.

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.

| | |
|--|---|
| DIRECT (all uses except mosquito control) | |
| Use areas – mortality | No effects expected |
| Sublethal – growth (G), reproduction (R) and behavior (B) enzyme (E) | No effects expected |
| INDIRECT (all uses except mosquito control) | |
| Use areas - Prey item mortality | If plankton: H If detritus: NA |
| Use areas – Fish Host | Total overlap: 6.18%, H, M, L all bins |
| MOSQUITO CONTROL | |
| Direct (mortality) | No effects expected |
| Sublethal | No effects expected |

| | |
|----------|--|
| Indirect | Total overlap: 3.17%, H M L depending on the bin |
|----------|--|

Risk modifiers:

Lampsilis higginsii is characterized as a large river species occupying stable substrates that vary from sand to boulders, but not firmly packed clay, flocculent silt, organic material, bedrock, concrete or unstable sand. Water velocities should be less than 1 m/second during periods of low discharge. They are usually found in mussel beds that contain at least 15 other species at densities greater than .01 individual/m².

In the “Approach to the Effects Analysis” section of the main body of the Opinion, we stated that specific considerations were made 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. Further investigation by EPA into Bin 3 and 4 estimated environmental concentrations indicate 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. While the Higgins eye (pearly mussel) also occupies other aquatic habitats that may be exposed to potentially high levels of malathion due to lower volume in those habitats (Bin 2), their potential exposure risk is at least partially lowered based on their reliance upon larger flowing and static aquatic habitats (Bins 2, 3, 4, 5, 6, and 7), reducing the overall risk to the species as a whole.

The Higgins eye (pearly mussel) is considered a fish host generalist whose glochidia can metamorphose on a wide variety of fishes from multiple families. While we anticipate some species of the host fish community will exhibit temporary reductions in abundance due to malathion exposure, the species’ flexible host requirement will allow the species to be more resilient to temporary losses of host fish, reducing the anticipated indirect effects to the species.

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 to Host Fish associated with bin (H, M, L) |
|------------------|------------------------------|------------------------|------|---------------------------------------|------|--|---|
| | | Acres | % | | | | |
| Mosquito Control | I | 118,531 | 3.17 | 0 | 0 | 2,3,4,5,6,7 | 2H 3 4 5H 6M 7L |
| Corn | I | 156,036 | 4.17 | 22,305 | 0.6 | 2,3,4,5,6,7 | 2H 3 4 5H 6M 7L |
| Developed | I | 50,554 | 1.35 | 2,528 | 0.07 | 2,3,4,5,6,7 | 2M 3 4 5L 6L 7L |
| Pasture | I | 16,555 | 0.44 | 15,963 | 0.43 | 2,3,4,5,6,7 | 2H 3 4 5H 6H 7M |
| Other Crops | I | 2,316 | 0.06 | 0 | 0 | 2,3,4,5,6,7 | 2H 3 4 5H 6M 7L |
| Wheat | I | 1,872 | 0.05 | 1,840 | 0.05 | 2,3,4,5,6,7 | 2H 3 4 5H 6M |

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 to Host Fish associated with bin (H, M, L) |
|--|------------------------------|------------------------|--------|---------------------------------------|--------|--|---|
| | | Acres | % | | | | |
| | | | | | | | 7L |
| Other Grains | I | 1,605 | 0.04 | 1,605 | 0.04 | 2,3,4,5,6,7 | 2H 3 4 5H 6M 7L |
| Vegetables & Ground Fruit | I | 1,103 | 0.03 | 707 | 0.02 | 2,3,4,5,6,7 | 2H 3 4 5H 6H 7M |
| Nurseries | I | 189 | < 0.01 | 189 | < 0.01 | 2,3,4,5,6,7 | 2H 3 4 5H 6H 7M |
| Orchards and vineyards | I | 30 | < 0.01 | 22 | < 0.01 | 2,3,4,5,6,7 | 2H 3 4 5H 6H 7H |
| Christmas trees | I | 6 | < 0.01 | 5 | < 0.01 | 2,3,4,5,6,7 | 2H 3 4 5H 6H 7M |
| Other Row Crops | I | 9 | < 0.01 | 6 | < 0.01 | 2,3,4,5,6,7 | 2H 3 4 5H 6H 7M |
| Sub-TOTAL (I): <i>Other uses with indirect effects³</i> | | 230,275 | 6.18 | 45,172 | 1.26 | | |

| Use type | Risk to species ¹ | Use overlap with range | | Estimated usage in range ² | | Bins associated with use type [^] | Effect to Host Fish associated with bin (H, M, L) |
|----------------------|------------------------------|------------------------|------|---------------------------------------|------|--|---|
| | | Acres | % | | | | |
| TOTAL ³ : | | 348,806 | 9.35 | 45,202 | 1.26 | | |

[^] We consider the Bin 2 estimates as an upper bound of Bin 3 & 4 exposures. The estimated environmental concentrations for a Bin 2 water are an order of magnitude greater than Bins 3 and 4; therefore concentrations in Bins 3 and 4 can be reduced by a correction factor of 10.

Exposure Modifiers:

A reassessment of our crop use data layers shows that within the “Other Row Crops” layer shows that usage in this category may be overestimated. This UDL is composed of sunflower, peanuts, tobacco, sugar beets, and hops, of which, only hops is a registered use site on malathion labels and is thus the only crop in this layer that is relevant in our analysis. USDA data shows that 96% of hops are grown in the Pacific Northwest region (in Idaho, Oregon, and Washington), with some small farms in Florida reporting occasional hop production. Given the highly specific regions that hops are grown in, we can assume that potential exposure to malathion from “other row crops” use sites is 0 outside of these areas, and thus does not apply to this species.

acres in species range: 3,740,965 acres

% of range in California (i.e., where CalPUR data is available): 0%

Range overlap with Federal lands: 329,355 acres, 8.804%

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.

³ 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 groundfruit lower the maximum allowable number of applications to 2-4 per year (depending on the specific crop). 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 Higgins eye (pearly mussel). As discussed below, even though the species vulnerability is high and risk to the species host fish is medium, we anticipate the likelihood of exposure of host fish to malathion is low, and the implementation of the general conservation measures described above is expected to further reduce the likelihood of exposure.

The Higgin’s eye (pearly mussel) has a high vulnerability based on its status, distribution, and trends. Mortality and sublethal effects to the species are not anticipated. The risk to the species host fish posed by labeled uses across the range is high, and where individual host fish are exposed, we anticipate high to medium levels of mortality, depending on water body size and use type. Mussels depend on host fish to accomplish their reproductive lifecycle. Glochidia (larval

stage) are released into the water, within a few days they must attach to an appropriate species of fish, which they parasitize for a short time while they develop into juvenile mussels. Glochidia that do not attach to a host fish will not survive. Where sufficient numbers of suitable host fish are not available, we anticipate reproduction of mussels would be reduced.

We anticipate usage within the non-Federal portion of the species' range will be low (1.26%), based primarily on the 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 Biological Opinion.

The species range, and thus this species host fish range, is very large (>3.7 million acres) and we do not anticipate that host fish would necessarily be found in the affected areas of the waterbodies near application sites when malathion is applied, although small numbers of host fish may occur in these areas and be exposed over the duration of the proposed action. Reductions in plankton could be high in localized areas, however, we anticipate additional food resources from upstream sources would quickly recolonize after an application event. In addition, we anticipate that the conservation measures above, including rain restrictions, aquatic habitat buffers, residential use label changes, and reduced number of applications and rates on certain use sites, will minimize the risk of exposure to plankton and the mussels' host fish.

As stated previously, conservation measures are aimed at reducing the amount of malathion runoff and spray drift that enter into sensitive habitats (e.g., species habitat, aquatic environments). For example, by placing a 48-hour rain restriction on agricultural applications, malathion has the ability to degrade after application (e.g., by hydrolysis, other processes) prior to any rain/runoff events, thus minimizing malathion runoff into aquatic habitats and decreasing exposure to listed mussels and their host fish. Increasing application buffers reduces the amount of malathion that drifts off target and subsequently into non-target environments. In addition, changes to residential labels limits applications to spot treatments and reduces the number of applications per year (2-4), significantly decreasing the overall amounts of malathion used in residential areas and resulting amounts of runoff and drift. Additional reductions in the number of applications and rates allowed for certain crops (e.g., corn, vegetables and ground fruit) further reduces the amount of malathion used in agricultural settings, thereby decreasing potential exposure the species and their host fish. Combined, these conservation measures substantially reduce exposure to the Higgins eye (pearly mussel) and their host fish and therefore minimizes overall risk and adverse effects to the species. Thus, while we anticipate small numbers of individual host fish would be lost over the duration of the action, resulting in very small reductions in reproductive success, we do not anticipate species-level effects to this mussel species.

Therefore, we do not anticipate that the proposed action would appreciably reduce survival and recovery of the Higgins eye (pearly mussel) in the wild.

Conclusion: Is not likely to jeopardize.

Integration and Synthesis Summary: Bivalves

| Scientific Name: | Common Name: | Entity ID: |
|-------------------------|-----------------------|-------------------|
| <i>Lemiox rimosus</i> | Birdwing pearlymussel | 332 |

Family: Unionidae

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 birdwing pearlymussel is endemic to the Tennessee River drainage in Virginia, Tennessee, and Alabama. Based on modern and archeological records, the species occurred from the main channel Tennessee River in Perry and Decatur counties, Tennessee, upstream to Knoxville and in the following tributary rivers: Duck, Sequatchie and Elk Rivers (Tennessee) and the Paint Rock River (Alabama). In the upper Tennessee River drainage, the species was reported from the main channel Holston River upstream to the confluence of North and South Fork Holston rivers, the lower North Fork Holston River (Tennessee and Virginia), and the Clinch and Powell Rivers (Tennessee and Virginia). In the French Broad drainage, it was reported from the Little Pigeon and Nolichucky Rivers (Tennessee). Across its range, it historically occurred in approximately 1,414 river miles, but the species is now restricted to approximately 171 river miles, a reduction of approximately 88%. It currently occurs in 40 miles of the Duck River, 103 miles of the Clinch River, and 28 miles of the Powell River. The population in the Duck and Clinch Rivers appear to be stable, but the populations in the Powell River is declining. Since 1983, the range of the birdwing pearlymussel in the Powell River has declined 54%.

Over the last several years, the birdwing pearlymussel stock from the Duck River has been translocated or propagated for reintroduction into the Nolichucky River. In addition, propagated birdwing pearlymussels have been released in several sites in the Virginia portion of the Clinch River. These population reintroduction and augmentation efforts have been moderately successful, as evidenced by persisting individuals at these sites; however, it is not known if these individuals are reproducing.

Habitat degradation in the Powell River continues to threaten the birdwing pearlymussel, and while the species still occurs in this river, its abundance is very low. Coal mining continues to degrade habitat and water quality in the system, and these effects are pervasive and will be long lasting, decades into the future (Zipper et al. 2016; Jones pers. comm. 2020).

Disease may be an emerging threat for the birdwing pearlymussel. A large number of freshwater mussels in the Clinch River near the Tennessee/Virginia border died over a relatively short period of time in fall 2016, 2017, and 2019. Among the several thousand dead mussels found in 2016 and 2017 were 87 and 18 dead birdwing pearlymussels, respectively. It is not known if dead birdwing pearlymussels were found in the 2019 die-off (Dinkins, unpublished data, 2019). The cause(s) of the die-offs is still not clear, but viral pathogens may have played a roll. Whatever caused these sudden and dramatic die-offs has the potential to be a limiting factor for the long-term viability of the birdwing pearlymussel in the Clinch River.

EB/CE Source: U.S. Fish and Wildlife Service. 2020. Birdwing pearlymussel (*Lemiox rimosus*) 5-Year Review: Summary and Evaluation. Tennessee Ecological Services Field Office, Cookeville, Tennessee.

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 expect the Birdwing pearlymussel will experience direct mortality or sublethal effects from any malathion uses at the maximum rates for all bins (2, 3, 4, 5, 6, 7). However, risk of mortality to the host fish for bin 2 is high for all use sites except developed. Risk of mortality to the host fish in bin 7 is low for mosquito control, developed, medium for cotton, nurseries, other crops, other grains, pasture, vegetables and groundfruit, other row crops, wheat, and Christmas trees, and high for corn and orchards and vineyards. For bin 6, risk of mortality to the host fish is low for developed. Risk of mortality is medium for mosquito control, and high for all other uses not already discussed. For bin 5, risk of mortality to the host fish is high for all uses except developed which is low.

We do not expect mussel species to be directly impacted by exposure from malathion. However their lifecycle is such that when glochidia (larvae) are released into the water, within a few days they must attach to the appropriate species of fish, which they parasitize for a short time while they develop into juvenile mussels in order to complete their lifecycle; they cannot complete their lifecycle without a fish host.

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.

| | |
|--|---------------------|
| DIRECT (all uses except mosquito control) | |
| Use areas – mortality | No effects expected |
| Sublethal – growth (G), reproduction (R) and behavior (B) enzyme (E) | No effects expected |
| INDIRECT (all uses except mosquito control) | |

| | |
|---------------------------------|--|
| Use areas - Prey item mortality | If plankton: High If detritus: NA |
| Use Areas – Fish host mortality | Total overlap: 4.84%, H M L for all bins |
| MOSQUITO CONTROL | |
| Direct (mortality) | No effects expected |
| Sublethal | No effects expected |
| Indirect | Total overlap 7.74%, H |

Risk modifiers:

The environmental specificity of this species is narrow as it is a strict riffle dwelling species sensitive to changes in water quality and disturbance. This species is almost always found in riffle areas with stable, sand and gravel substrates in moderate to fast currents in small to medium sized rivers (Bogan and Parmalee, 1983; USFWS, 1983). Separation barriers within standing water bodies are based solely on separation distance. Separation barriers between standing water bodies and within flowing water systems include lack of lotic connections, natural barriers such as upland habitat, absence of appropriate species specific fish hosts, water depth greater than 10 meters (Cvancara, 1972; Moyle and Bacon, 1969) or anthropogenic barriers to water flow such as dams or other impoundments and high waterfalls (NatureServe 2015).

In the “Approach to the Effects Analysis” section of the main body of the Opinion, we stated that specific considerations were made 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. Further investigation by EPA into Bin 3 and 4 estimated environmental concentrations indicate 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. While the birdwing pearl mussel also occupies other aquatic habitats that may be exposed to potentially high levels of malathion due to lower volume in those habitats (Bin 2), their potential exposure risk is at least partially lowered based on their reliance upon larger flowing and static aquatic habitats (Bins 3, 4, 5, 6, and 7), reducing the overall risk to the species as a whole.

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 [^] | Mortality to Fish Host Effect associated with bin (H, M, L) |
|------------------|------------------------------|------------------------|------|---------------------------------------|--------|--|---|
| | | Acres | % | Acres | % | | |
| Mosquito Control | I | 453,450 | 7.74 | 36,300 | 0.62 | 2,3,4,5,6,7 | 2H 3 4 5H 6M 7L |
| Developed | I | 222,245 | 3.79 | 11,112 | 0.19 | 2,3,4,5,6,7 | 2L 3 4 5L 6L 7L |
| Corn | I | 48,665 | 0.83 | 3,204 | 0.05 | 2,3,4,5,6,7 | 2H 3 4 5H 6H 7H |
| Cotton | I | 5,483 | 0.09 | 4,364 | 0.07 | 2,3,4,5,6,7 | 2H 3 4 5H 6H 7M |
| Wheat | I | 2,151 | 0.04 | 450 | < 0.01 | 2,3,4,5,6,7 | 2H 3 4 5H 6H 7M |
| Nurseries | I | 957 | 0.02 | 957 | 0.02 | 2,3,4,5,6,7 | 2H 3 4 |

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 [^] | Mortality to Fish Host Effect associated with bin (H, M, L) |
|-----------------------------|------------------------------|------------------------|--------|---------------------------------------|--------|--|---|
| | | Acres | % | Acres | % | | |
| | | | | | | | 5H 6H 7M |
| Other Grains | I | 743 | 0.02 | 632 | < 0.01 | 2,3,4,5,6,7 | 2H 3 4 5H 6H 7M |
| Other Crops | I | 947 | 0.01 | <1 | <0.01 | 2,3,4,5,6,7 | 2H 3 4 5H 6H 7M |
| Pasture | I | 629 | 0.01 | 502 | < 0.01 | 2,3,4,5,6,7 | 2H 3 4 5H 6H 7M |
| Vegetables and Ground Fruit | I | 611 | 0.01 | 219 | < 0.01 | 2,3,4,5,6,7 | 2H 3 4 5H 6H 7M |
| Orchards and Vineyards | I | 33 | < 0.01 | 24 | < 0.01 | 2,3,4,5,6,7 | 2H 3 4 5H 6H 7H |
| Christmas Trees | I | 17 | < 0.01 | 16 | < 0.01 | 2,3,4,5,6,7 | 2H 3 4 5H 6H 7M |
| Other Row Crops | I | 233 | < 0.01 | 182 | < 0.01 | 2,3,4,5,6,7 | 2H 3 |

| Use type | Risk to species ¹ | Use overlap with range | | Estimated usage in range ² | | Bins associated with use type [^] | Mortality to Fish Host Effect associated with bin (H, M, L) |
|--|------------------------------|------------------------|------|---------------------------------------|------|--|---|
| | | Acres | % | Acres | % | | |
| | | | | | | | 4 5H 6H 7M |
| Sub-TOTAL (I): <i>Other uses with indirect effects³</i> | | 282,714 | 4.84 | 21,663 | 0.41 | | |
| TOTAL³: | | 736,164 | 12.6 | 57,963 | 1.03 | | |

[^]We consider the Bin 2 estimates as an upper bound of Bin 3 & 4 exposures. The estimated environmental concentrations for a Bin 2 water are an order of magnitude greater than Bins 3 and 4; therefore concentrations in Bins 3 and 4 can be reduced by a correction factor of 10.

Exposure Modifiers:

A reassessment of our crop use data layers shows that within the “Other Row Crops” layer shows that usage in this category may be overestimated. This UDL is composed of sunflower, peanuts, tobacco, sugar beets, and hops, of which, only hops is a registered use site on malathion labels and is thus the only crop in this layer that is relevant in our analysis. USDA data shows that 96% of hops are grown in the Pacific Northwest region (in Idaho, Oregon, and Washington), with some small farms in Florida reporting occasional hop production. Given the highly specific regions that hops are grown in, we can assume that potential exposure to malathion from “other row crops” use sites is 0 outside of these areas, and thus does not apply to this species.

acres in species range: 5,858,887 acres

% of range in California (i.e., where CalPUR data is available): 0%

Range overlap with Federal lands: 485,364 acres, 8.284%

Overall Usage: ☐ High ☐ Medium ☒ Low

CONSERVATION MEASURES

³ TOTAL includes usage on all use sites with effects, including mosquito control.

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, is not likely to jeopardize the continued existence of the birdwing pearlymussel. As discussed below, even though the species vulnerability is high and risk to the species host fish is high, we anticipate the likelihood of exposure of host fish to malathion is low, and the implementation of the general conservation measures described above is expected to further reduce the likelihood of exposure.

The birdwing pearlymussel has a high vulnerability based on its status, distribution, and trends. Mortality and sublethal effects to the species are not anticipated. The risk to the species host fish posed by labeled uses across the range is high, and where individual host fish are exposed, we

anticipate high to variable levels of mortality, depending on water body size and use type. Mussels depend on host fish to accomplish their reproductive lifecycle. Glochidia (larval stage) are released into the water and within a few days they must attach to an appropriate species of fish, which they parasitize for a short time while they develop into juvenile mussels. Glochidia that do not attach to a host fish will not survive. Where sufficient numbers of suitable host fish are not available, we anticipate reproduction of mussels would be reduced.

We anticipate usage within the non-Federal portion of the species' range will be low (1.03%), based primarily on the 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 Biological Opinion.

According to the 2020 5-Year Review, the birdwing pearl mussel historically occupied approximately 1,414 miles of river in the Tennessee River drainage of Virginia, Tennessee, and Alabama. It has been extirpated from the main channel Tennessee River, Sequatchie River, Paint Rock River, Holston River, North Fork Holston River, Little Pigeon River, and North Fork Clinch River. It has not been observed live in the Elk River since 1980, and individuals transplanted there in 2017 have not been found in subsequent surveys. In the Duck River, Tennessee, the distribution and abundance of the birdwing pearl mussel had diminished significantly between publication of the Recovery Plan in 1983 and a survey conducted by Tennessee Valley Authority in 1988 (Service 1984, Jenkinson 1988). By 2003, the Duck River population had made a remarkable recovery in distribution and abundance because numerous point source discharges to the river had been eliminated. Improvements have been made in the wastewater de-chlorination process at the Shelbyville sewage treatment plant and increased minimum flow improvements had been made to water being released from Normandy Dam (Ahlstedt et al. 2017). Currently, the birdwing pearl mussel occupies approximately 45 river miles between the Old Columbia Dam and Lillard's Mill. In contrast, the species' range in the Clinch and Powell rivers has decreased over this same general time span.

The species range, and thus this species host fish range, is very large (>5.8 million acres) and we do not anticipate that host fish would necessarily be found in the affected areas of the waterbodies near application sites when malathion is applied, although small numbers of host fish may occur in these areas and be exposed over the duration of the proposed action. Reductions in plankton could be high in localized areas, however, we anticipate additional food resources from upstream sources would quickly recolonize after an application event. In addition, we anticipate that the conservation measures above, including rain restrictions, aquatic habitat buffers, and residential use label changes, will further reduce the risk of exposure to the mussels' host fish.

As stated previously, conservation measures are aimed at reducing the amount of malathion runoff and spray drift that enter into sensitive habitats (e.g., species habitat, aquatic environments). For example, by placing a 48-hour rain restriction on agricultural applications, malathion has the ability to degrade after application (e.g., by hydrolysis, other processes) prior to any rain/runoff events, thus minimizing malathion runoff into aquatic habitats and decreasing exposure to listed mussels and their host fish. Increasing application buffers reduces the amount of malathion that drifts off target and subsequently into non-target environments. In addition,

changes to residential labels limits applications to spot treatments and reduces the number of applications per year (2-4), significantly decreasing the overall amounts of malathion used in residential areas and resulting amounts of runoff and drift. Combined, these conservation measures substantially reduce exposure to the birdwing pearlymussel and their host fish and therefore minimizes overall risk and adverse effects to the species. Thus, while we anticipate small numbers of individual host fish would be lost over the duration of the action, resulting in very small reductions in reproductive success, we do not anticipate species-level effects to this mussel species.

Therefore, we anticipate that the proposed action would not appreciably reduce survival and recovery of the birdwing pearlymussel in the wild.

Conclusion: Is not likely to jeopardize.

ADDITIONAL REFERENCES

U.S. Fish and Wildlife Service. 2020. Birdwing pearlymussel (*Lemiox rimosus*) 5-Year Review: Summary and Evaluation. Tennessee Ecological Services Field Office, Cookeville, Tennessee.

Integration and Synthesis Summary: Bivalves

| Scientific Name: | Common Name: | Entity ID: |
|---------------------------------------|----------------------|-------------------|
| <i>Epioblasma florentina curtisii</i> | Curtis' pearlymussel | 333 |

Family: Unionidae

VULNERABILITY

(Summary of status, environmental baseline and cumulative effects)

Status: Endangered

Distribution: Declining population(s) – one or more populations declining

Number of Populations: Population size/location(s) unknown

Species Trends: Population size/location unknown

Pesticides noted ☒

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

The Curtis' pearlymussel has a small historical range within the Ozark Highlands and is known from the Black, St. Francis, and White river drainages in Southeast Missouri and Northeast Arkansas (USFWS 2010). At the time of the last status review in 2010, a living population could not be located. It had last been seen alive in 1993 when living specimens were observed from the Mudpuppy Conservation Area on the Little Black River (LBR) in Missouri (USFWS 2010). Since that time, only one mussel survey has been conducted within its historical range. In 2017, Schrum and Rosenburger (2018) surveyed 18 sites on the LBR in Missouri. The following LBR tributaries were also included in the survey: the South Prong Little Black River (2 sites), North Prong Little Black River (3 sites), Beaverdam Creek (2 sites), Logan Creek (2 sites), and Harris Creek (1 site). No evidence of the species was found during these efforts. Overall, they found low mussel abundance and species richness compared to previous surveys indicating that the mussel community in this stream has not yet recovered from the rapid mussel decline observed in the late 1980's and early 1990's (USFWS 2010). The Little Black River remains the last place the Curtis' pearlymussel has been seen alive. No other information is available on the status of the species within its known range in Missouri and Arkansas. Therefore, it is still unknown whether an extant population exists.

The existence of an unknown population of the Curtis' pearlymussel is plausible where it has not been documented previously. Some streams within the White and Black river basins appear to provide suitable habitat and are in close proximity to historical streams. Further, mussel survey data is lacking for many areas. Results from several recent mussel surveys are available for some of these streams. In Missouri, the USFWS conducted mussel surveys on the Current River and Big Barren Fork Creek, which are a part of the Black River watershed (Finley et al. 2017, Drews et al. 2019). Surveys have been conducted in Arkansas within the White River Basin including the Strawberry River (Gonzalez 2018, Bouldin et al. 2013) and War Eagle (Bouldin et al. 2013), the North Fork Sylamore, Richland, and Falling Water creeks (Bouldin et al. 2015). While

mussel communities were documented in these streams, no evidence of the Curtis' pearlymussel was found in any of these surveys.

Habitat alteration has been the principal threat to the Curtis' pearlymussel throughout its historical range (USFWS 1986). Flowing water and a stable substrate are two important basic habitat requirements of the species. Stream impoundments, gravel dredging, and channelization have completely eliminated these basic habitat components in several streams including the White, Castor, and Black, rivers. The largest population in the White River was eliminated by

the construction of reservoirs including Lake Tanycomo and Table Rock, Bull Shoals, and Beaver reservoirs (USFWS 1986). The Castor River was channelized and diverted into the Mississippi River in 1913 (Norman 1994). This eliminated most of this stream entirely and cut it off from the St. Francis River Basin. The Black River populations have been affected by gravel dredging and are currently greatly affected by the operation of Clearwater Reservoir upstream (USFWS 1986). If there was a population in the St. Francis River (listed by Johnson 1986), it is now the location of Lake Wappapello. Today, no major impoundments or channelization projects are proposed within the historical range of the Curtis' pearlymussel, but gravel dredging is an ongoing activity.

Other threats to the Curtis' pearlymussel have been described that are generally caused by poor land use. These include water quality degradation, sedimentation, and increased nutrient loading (USFWS 1986, Bruenderman *et al.* 2001). These threats are still ongoing today throughout the range of the species. The cause of the decline of the last known population in the Little Black River remains unknown, but water quality degradation and head-cutting (channel degradation) were suspected as the main cause (Bruenderman *et al.* 2001).

Recently a new threat has been identified for freshwater mussels related to water quality. Recent studies indicate that mussels are among the most sensitive organisms to ammonia (Augsburger *et al.* 2003, Wang *et al.* 2007a, Wang *et al.* 2007b), which is a common pollutant. Ammonia is a degradation product of nitrogenous organic matter and is associated with municipal wastewater treatment plants, industrial wastes, and run off from agricultural areas including animal wastes and nitrogenous fertilizers (Goudreau *et al.* 1993). These sources are nearly ubiquitous throughout the historical range of the Curtis' pearlymussel in Missouri and Arkansas.

EB/CE Source: U.S. Fish and Wildlife Service (FWS). 2021. The Curtis' Pearlymussel (*Epioblasma florentina curtisii*) 5-Year Review: Summary and Evaluation. Missouri Ecological Services Field Office. Columbia, Missouri. 28 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 expect risk of adverse effects from malathion for the Curtis' pearlymussel to be low for all bins (2 and 3) for all uses at maximum rates. However, risk of mortality to the host fish for bin 2 is high for all use sites except developed where it is medium.

We do not expect mussel species to be directly impacted by exposure from malathion. However their lifecycle is such that when glochidia (larval stage) are released into the water, within a few days they must attach to an appropriate species of fish, which they parasitize for a short time while they develop into juvenile mussels in order to complete their lifecycle; they cannot complete their lifecycle without a fish host.

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.

| | |
|--|--|
| DIRECT (all uses except mosquito control) | |
| Use areas – mortality | No effects expected |
| Sublethal – growth (G), reproduction (R) and behavior (B) enzyme (E) | No effects expected |
| INDIRECT (all uses except mosquito control) | |
| Use areas - Prey item mortality | High if plankton, NA if detritus |
| Use areas – Fish Host | Total overlap: 4.4%, H for all uses for 2 bin except M for developed |
| MOSQUITO CONTROL | |
| Direct (mortality) | No effects expected |
| Sublethal | No effects expected |
| Indirect | Total overlap: 14.5%, H |

Risk modifiers: The Curtis' pearlymussel requires good water quality and occurs in shallow stable riffles and runs. The species is limited to stream segments that are transitional between headwater and lowland streams reaches (USFWS 1986). In the White, Black, St. Francis, and Castor rivers, these transitional stream reaches either have been inundated by major reservoirs, affected by altered flows from reservoir releases, or destroyed by channelization (USFWS 1986). The recent population declines, and continued lack of mussels found during recent surveys indicate that habitat conditions in the Little Black River are not currently conducive to freshwater mussels (Bruenderman et al. 2001).

In the "Approach to the Effects Analysis" section of the main body of the Opinion, we stated that 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. Further investigation by EPA into Bin 3 and 4 estimated environmental concentrations indicate 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. While the Curtis' pearlymussel also occupies other aquatic habitats that may be exposed to potentially high levels of malathion due to lower volume in those habitats (Bin 2), their potential exposure

risk is at least partially lowered based on their reliance upon a larger flowing aquatic habitat (Bin 3), reducing the overall risk to the species as a whole.

The Curtis pearlymussel is a considered a fish host generalist whose glochidia can metamorphose on a wide variety of fishes from multiple families. While we anticipate some species of the host fish community will exhibit temporary reductions in abundance due to malathion exposure, the species' flexible host requirement will allow the species to be more resilient to temporary losses of host fish, reducing the anticipated indirect effects to the species.

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 to Host Fish associated with bin (H, M, L) |
|------------------|------------------------------|------------------------|-------|---------------------------------------|------|--|---|
| | | Acres | % | Acres | % | | |
| Mosquito Control | I | 463,648 | 14.54 | 108,900 | 3.41 | 2,3 | 2H 3H |
| Corn | I | 60,955 | 1.91 | 7,866 | 0.25 | 2,3 | 2H 3H |
| Other Crops | I | 37,888 | 1.19 | 0 | 0 | 2,3 | 2H 3H |
| Developed | I | 24,108 | 0.76 | 1,205 | 0.04 | 2,3 | 2M 3M |
| Other Grains | I | 5,408 | 0.17 | 3,789 | 0.12 | 2,3 | 2H 3H |
| Other Row Crops | I | 3,347 | 0.1 | 356 | 0.01 | 2,3 | 2H 3H |
| Wheat | I | 2,665 | 0.08 | 2,600 | 0.08 | 2,3 | 2H |

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 to Host Fish associated with bin (H, M, L) |
|--|------------------------------|------------------------|--------|---------------------------------------|--------|--|---|
| | | Acres | % | Acres | % | | |
| | | | | | | | 3H |
| Cotton | I | 2,525 | 0.08 | 2,525 | 0.08 | 2,3 | 2H 3H |
| Vegetables & Ground Fruit | I | 258 | < 0.01 | 247 | < 0.01 | 2,3 | 2H 3H |
| Pasture | I | 140 | < 0.01 | 140 | < 0.01 | 2,3 | 2H 3H |
| Nurseries | I | 68 | < 0.01 | 68 | < 0.01 | 2,3 | 2H 3H |
| Orchards & Vineyards | I | 35 | < 0.01 | 34 | < 0.01 | 2,3 | 2H 3H |
| Christmas trees | I | <1 | < 0.01 | <1 | < 0.01 | 2,3 | 2H 3H |
| Sub-TOTAL (I): <i>Other uses with indirect effects³</i> | | 134,051 | 4.4 | 18,831 | 0.63 | | |
| TOTAL³: | | 597,699 | 18.9 | 127,731 | 4.04 | | |

[^]We consider the Bin 2 estimates as an upper bound of Bin 3 & 4 exposures. The estimated environmental concentrations for a Bin 2 water are an order of magnitude greater than Bins 3 and 4; therefore concentrations in Bins 3 and 4 can be reduced by a correction factor of 10.

Exposure Modifiers:

A reassessment of our crop use data layers shows that within the “Other Row Crops” layer shows that usage in this category may be overestimated. This UDL is composed of sunflower, peanuts, tobacco, sugar beets, and hops, of which, only hops is a registered use site on malathion labels and is thus the only crop in this layer that is relevant in our analysis. USDA data shows that 96% of hops are grown in the Pacific Northwest region (in Idaho, Oregon, and Washington), with some small farms in Florida reporting occasional hop production. Given the highly specific regions that hops are grown in, we can assume that potential exposure to malathion from “other row crops” use sites is 0 outside of these areas, and thus does not apply to this species.

acres in species range: 3,189,423 acres

% of range in California (i.e., where CalPUR data is available): 0%

³ TOTAL includes usage on all use sites with effects, including mosquito control.

Range overlap with Federal lands: 467,193 acres, 14.648%

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 groundfruit lower the maximum allowable number of applications to 2-4 per year (depending on the specific crop). 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 Curtis' pearlymussel. As discussed below, even though the species vulnerability is high and risk to the species host fish is high, we anticipate the likelihood of exposure of host fish to malathion is low, and the implementation of the general conservation measures described above is expected to further reduce the likelihood of exposure.

The Curtis' pearlymussel has a high vulnerability based on its status, distribution, and trends. Mortality and sublethal effects to the species are not anticipated. The risk to the species host fish posed by labeled uses across the range is high, and where individual host fish are exposed, we generally anticipate high levels of mortality, depending on water body size and use type. Mussels depend on host fish to accomplish their reproductive lifecycle. Glochidia (larval stage) are released into the water and within a few days they must attach to an appropriate species of fish, which they parasitize for a short time while they develop into juvenile mussels. Glochidia that do not attach to a host fish will not survive. Where sufficient numbers of suitable host fish are not available, we anticipate reproduction of mussels would be reduced.

We anticipate usage within the non-Federal portion of the species' range will be low (4.04%), based primarily on the 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 Biological Opinion.

The species range, and thus this species host fish range, is very large (>3.1 million acres) and we do not anticipate that host fish would necessarily be found in the affected areas of the waterbodies near application sites when malathion is applied, although small numbers of host fish may occur in these areas and be exposed over the duration of the proposed action. Reductions in plankton could be high in localized areas, however, we anticipate additional food resources from upstream sources would quickly recolonize after an application event. In addition, we anticipate that the conservation measures above, including rain restrictions, aquatic habitat buffers, residential use label changes, and reduced number of applications and rates on certain use sites, will further reduce the risk of exposure to the mussels' host fish.

As stated previously, conservation measures are aimed at reducing the amount of malathion runoff and spray drift that enter into sensitive habitats (e.g., species habitat, aquatic environments). For example, by placing a 48-hour rain restriction on agricultural applications, malathion has the ability to degrade after application (e.g., by hydrolysis, other processes) prior to any rain/runoff events, thus minimizing malathion runoff into aquatic habitats and decreasing exposure to listed mussels and their host fish. Increasing application buffers reduces the amount of malathion that drifts off target and subsequently into non-target environments. In addition, changes to residential labels limits applications to spot treatments and reduces the number of applications per year (2-4), significantly decreasing the overall amounts of malathion used in residential areas and resulting amounts of runoff and drift. Additional reductions in the number of applications and rates allowed for certain crops (e.g., corn, vegetables and ground fruit)

further reduces the amount of malathion used in agricultural settings, thereby decreasing potential exposure to the species and their host fish. Combined, these conservation measures substantially reduce exposure to the Curtis' pearlymussel and their host fish and therefore minimizes overall risk and adverse effects to the species. Thus, while we anticipate small numbers of individual host fish would be lost over the duration of the action, resulting in very small reductions in reproductive success, we do not anticipate species-level effects to this mussel species.

Therefore, we anticipate that the proposed action would not appreciably reduce survival and recovery of the Curtis' pearlymussel in the wild.

Conclusion: Is not likely to jeopardize.

Integration and Synthesis Summary: Bivalves

| Scientific Name: | Common Name: | Entity ID: |
|---------------------------------|--------------------------------|-------------------|
| <i>Plethobasus cicatricosus</i> | White wartyback (pearlymussel) | 336 |

Family: Unionidae

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 species range once included major rivers in Alabama, Illinois, Indiana, Kentucky, Ohio, Tennessee, and West Virginia. These include the Tennessee River (Tennessee, Alabama, Kentucky), Holston River (Tennessee), Cumberland River (Tennessee, Kentucky), Ohio River (Ohio, Illinois, Indiana, Kentucky, West Virginia), Wabash River (Indiana, Illinois), and Kanawha River (West Virginia)). Despite decades of surveys by numerous federal agencies, state agencies, and partners individuals of this species have not been found in these systems in contemporary times (Williams et al., 2008; Garner, 2013).

The only known extant members of this species are presently confined to a small population, comprised of individuals at low densities in the Tennessee River downstream of Wilson Dam between Tennessee River mile (TRM) 245 to TRM 256 in Lauderdale and Colbert counties, Alabama (Bogan and Parmalee, 1983; Garner and McGregor 2001; Williams et al., 2008).

The white wartyback is threatened by habitat destruction and modification resulting from impoundment, sand and gravel dredging/mining, navigation activities, operation of water control facilities, and construction and operation of barge loading and fleeting facilities on the Ohio River and lower Tennessee River. A combination of these stressors may have contributed to the extirpation of this species from much of its former range in the Tennessee River (Tennessee, Alabama, Kentucky), Holston River (Tennessee), Cumberland River (Tennessee, Kentucky), Ohio River (Ohio, Illinois, Indiana, Kentucky, West Virginia), Wabash River (Indiana, Illinois), and Kanawha River (West Virginia).

Though they have not been observed outside of the Tennessee River since 1885, cold water releases from Wolf Creek Dam (Cumberland River, Kentucky), Dale Hollow Dam (Obey River, Tennessee), and Center Hill Dam (Caney Fork River, Tennessee) could still adversely affect rare, undetected white wartybacks among resident mussel populations in the middle reach of the Cumberland River (between Old Hickory Dam and Cordell Hull Dam). These releases have

adversely affected other listed and non-listed mussels by inhibiting reproduction (Layzer et al., 1993). However, increased water temperatures of three to seven degrees Fahrenheit during drawdowns for dam repairs on some dams and through cooperative agreements at others have enabled non-listed mussels in that reach of the river to spawn (i.e., gravid females are being collected) (Layzer and Madison, 1995). It is possible that if white wartyback persist undetected at low density in these waterways they too might be benefiting from the change in temperature below these dams."

EB/CE Source: U.S. Fish and Wildlife Service (FWS). 2016. White wartyback (*Plethobasus cicatricosus*) 5-Year Review: Summary and Evaluation. 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 expect the white wartyback mussel will experience direct mortality or sublethal effects from any malathion uses at the maximum rates for all bins (4, 7). However, risk of mortality to the host fish for bin 4 and bin 7 is moderate for most uses except for developed where risk of mortality is low for bin 7 and bin 4.

We do not expect mussel species to be directly impacted by exposure from malathion. However their lifecycle is such that when glochidia (larval stage) are released into the water, within a few days, they must attach to an appropriate species of fish, which they parasitize for a short time while they develop into juvenile mussels in order to complete their lifecycle; they cannot complete their lifecycle without a fish host.

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.

M

| | |
|---|--|
| DIRECT (all uses except mosquito control) | |
| Use areas – mortality | No effects expected |
| Sublethal – growth (G), reproduction (R) and behavior (B), enzyme (E) | No effects expected |
| INDIRECT (all uses except mosquito control) | |
| Use areas - Prey item mortality | If plankton: H for Bin 4 for all uses, except L for Bin 7 developed If detritus: NA |

| | |
|-------------------------|--|
| Use areas – Fish Host | Total overlap: 12.4 % M for most uses in both Bins 4 and 7 except H for Bin 4 in pasture, cotton, other crops, nurseries, orchards & vineyards |
| MOSQUITO CONTROL | |
| Direct (mortality) | No effects expected |
| Sublethal | No effects expected |
| Indirect | Total overlap: 11.5 % M for Bins 4 and 7 |

Risk modifiers: *Species occurs in Bins 4 and 7. See Risk Assumptions (above) for risk to individuals and species.*

Species host (unknown) occurs in Bins 4 and 7. See Risk Assumptions (above) for risk to host species.

Mussels depend on a host fish to accomplish their reproductive lifecycle. Glochidia that do not attach to a host fish will not survive. We anticipate reproduction of mussels would be reduced in areas with insufficient fish hosts available. The mussel glochidia fish host relationship can be categorized into several different categories that capture the breadth of the type of mussel-host relationships such as generalists, specialists, or unknown fish host species. We anticipate that variable numbers of individual host fish may be affected over the duration of the proposed action, some of which would result in local extirpations of these mussel species in their highly isolated and fragmented populations, and we would expect species-level effects to these mussels to occur in the absence of mitigating factors. There is no information currently available regarding which fish species the White wartyback relies on for glochidia attachment. Given the lack of information we have regarding the age, size at maturity, or appropriate host fish species, we anticipate a high risk is warranted.

The white wartyback is primarily found in riffles and shoals in large rivers, which was characterized as Bin 4. Within the “Approach to the Effects Analysis” section of the main body of the Opinion, we stated that specific considerations were made for species that occur in Bins 3 and 4 and that they were modeled in such a way that likely resulted in overestimation of EECs, thus overestimating potential exposure. Further investigation by EPA into Bin 3 and 4 estimated environmental concentrations indicate 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. The white wartyback potential exposure risk is also partially lowered based on their reliance upon a larger static aquatic habitat (Bin 7), reducing the overall risk to the species as a whole.

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 to Host Fish associated with bin (H, M, L) |
|--|------------------------------|------------------------|--------|---------------------------------------|---------|--|---|
| | | Acres | % | Acres | % | | |
| Mosquito Control | | 464,540 | 11.5 | 21,898 | 0.54 | 4,7 | 4M 7M |
| Developed | I | 169,320 | 4.19 | 8,466 | 0.21 | 4,7 | 4M 7M |
| Open Space Developed | I | 258,827 | 6.40 | 12,941 | 0.32 | 4,7 | 4M 7M |
| Corn | I | 47,225 | 1.17 | 2,929 | 0.07 | 4,7 | 4M 7M |
| Pasture | I | 137 | 0.03 | 137 | 0.003 | 4,7 | 4H 7M |
| Wheat | I | 1,059 | 0.025 | 1,059 | 0.03 | 4,7 | 4M 7M |
| Vegetables and Groundfruit | I | 66 | 0.002 | 66 | 0.002 | 4,7 | 4M 7M |
| Cotton | I | 15,121 | 0.37 | 11,493 | 0.28 | 4,7 | 4H 7M |
| Nurseries | I | 774 | 0.019 | 774 | 0.019 | 4,7 | 4H 7M |
| Orchards & Vineyards | I | 5 | 0.0001 | 3.8 | 0.00009 | 4,7 | 4H 7M |
| Other Crops | I | 1,907 | 0.047 | 0 | 0 | 4,7 | 4H 7M |
| Other Grains | I | 1,724 | 0.043 | 631 | 0.016 | 4,7 | 4M 7M |
| Sub-TOTAL (I): <i>Other uses with indirect effects³</i> | | 498,474 | 12.4 | 38,757 | 0.96 | | |
| TOTAL³: | | 963,014 | 23.9 | 60,655 | 1.50 | | |

Exposure Modifiers:

A reassessment of crop UDL showed that usage data in the “Other Row Crops” may be overestimated. This UDL is composed of sunflower, peanuts, tobacco, sugar beets, and hops, of which, only hops is a registered use site on malathion labels and is thus the only crop in this layer that is relevant in our analysis. USDA data shows that 96% of hops are grown in the Pacific Northwest region (Idaho, Oregon, and Washington), with some small farms in Florida reporting occasional hop production. Given the highly specific regions that hops are grown in, we can assume that the potential exposure to malathion from “other row crops” use sites is 0 outside the areas indicated above, and thus does not apply to this species.

acres in species range: 4,044,294 acres

% of range in California (i.e., where CalPUR data is available): 0%

Range overlap with Federal lands: 142,501 acres, 3.523%

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 groundfruit lower the maximum allowable number of applications to 2-4 per year (depending on the specific crop). 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 white wartyback (pearlymussel). As discussed below, even though the species vulnerability is high and risk to the species host fish is high, we anticipate the likelihood of exposure of host fish to malathion is low, and the implementation of the general conservation measures described above is expected to further reduce the likelihood of exposure.

The white wartyback (pearlymussel) has a high vulnerability based on its status, distribution, and trends. Mortality and sublethal effects to the species are not anticipated. The risk to the species host fish posed by labeled uses across the range is high, and where individual host fish are exposed, we generally anticipate high levels of mortality, depending on water body size and use type. Mussels depend on host fish to accomplish their reproductive lifecycle. Glochidia (larval stage) are released into the water and within a few days they must attach to an appropriate species of fish, which they parasitize for a short time while they develop into juvenile mussels. Glochidia that do not attach to a host fish will not survive. Where sufficient numbers of suitable host fish are not available, we anticipate reproduction of mussels would be reduced.

We anticipate usage within the non-Federal portion of the species' range will be low (1.5%), based primarily on the 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 Biological Opinion.

The species range, and thus this species host fish range, is very large (>4 million acres) and we do not anticipate that host fish would necessarily be found in the affected areas of the waterbodies near application sites when malathion is applied, although small numbers of host fish may occur in these areas and be exposed over the duration of the proposed action. Reductions in plankton could be high in localized areas, however, we anticipate additional food resources from upstream sources would quickly recolonize after an application event. In

addition, we anticipate that the conservation measures above, including rain restrictions, aquatic habitat buffers, residential use label changes, and reduced number of applications and rates on certain use sites, will further reduce the risk of exposure to the mussels' host fish.

As stated previously, conservation measures are aimed at reducing the amount of malathion runoff and spray drift that enter into sensitive habitats (e.g., species habitat, aquatic environments). For example, by placing a 48-hour rain restriction on agricultural applications, malathion has the ability to degrade after application (e.g., by hydrolysis, other processes) prior to any rain/runoff events, thus minimizing malathion runoff into aquatic habitats and decreasing exposure to listed mussels and their host fish. Increasing application buffers reduces the amount of malathion that drifts off target and subsequently into non-target environments. In addition, changes to residential labels limits applications to spot treatments and reduces the number of applications per year (2-4), significantly decreasing the overall amounts of malathion used in residential areas and resulting amounts of runoff and drift. Additional reductions in the number of applications and rates allowed for certain crops (e.g., corn, vegetables and ground fruit) further reduces the amount of malathion used in agricultural settings, thereby decreasing potential exposure to the species and their host fish. Combined, these conservation measures substantially reduce exposure to the white wartyback (pearly mussel) and their host fish and therefore minimizes overall risk and adverse effects to the species in the larger waterbodies in which they occur. Thus, we anticipate small numbers of individual host fish will experience low levels of adverse effects either from exposure to malathion or via a loss of prey resources, and very small numbers of mussels will experience low levels of adverse effects due to small reductions of prey items (plankton/zooplankton) over the duration of the action. However, we do not anticipate that these adverse effects would have population- or species-level effects. .

Therefore, we anticipate that the proposed action would not appreciably reduce survival and recovery of the white wartyback (pearly mussel) in the wild.

Conclusion: Is not likely to jeopardize.

Integration and Synthesis Summary: Bivalves

| Scientific Name: | Common Name: | Entity ID: |
|--------------------------------|--------------------------------------|-------------------|
| <i>Plethobasus cooperianus</i> | Orangefoot pimpleback (pearlymussel) | 340 |

Family: Unionidae

VULNERABILITY

(Summary of status, environmental baseline and cumulative effects)

Status: Endangered

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 only known remaining populations of the orangefoot pimpleback are located in the Tennessee River in Tennessee and Kentucky and the Ohio River in Kentucky and Illinois.

The life history details of the orangefoot pimpleback mussel are thought to be similar to other unionid mussel species (Parmalee and Bogan, 1998). The host fish for this species is still unknown; however, Dr. Monte McGregor, malacologist with the Kentucky Department of Fish and Wildlife Resources, has had success transforming this species using an in-vitro process. The knowledge that the species can be propagated using in-vitro techniques has significant potential for future recovery work because it does not require the use of a host fish.

Little is known about the abundance, population trends, demographic features, or demographic trends of the orangefoot pimpleback. Within the mainstem Ohio River, recent records (i.e., last 50 plus years) of live orangefoot pimpleback mussels are available from an approximate 34-mile reach downstream of the confluence with the Tennessee River. The orangefoot pimpleback is irregularly encountered during routine mussel sampling in the Tennessee River downstream of Pickwick Landing Dam (river mile 206.7 in Hardin County) to the mouth of Cedar Creek (river mile 141.5 in Perry County), a distance of approximately 65 miles (Hubbs 2017b). Individuals that are considered young (e.g., less than 15 years old) comprise part of the known population, indicating that there has been some recent recruitment (Hubbs 2015). The orangefoot pimpleback is considered extremely rare in the riverine portion of the Tennessee River, located downstream of Kentucky Lock and Dam, with only occasional records indicating that a population still exists. Historically, the orangefoot pimpleback was likely a regular member of the mussel fauna in the mainstem Cumberland River (Haag and Cicerello 2016). By the 1970's, this population was considered small and non-reproducing (Parmalee 1980). One very old live specimen was observed in 2011-2012 surveys; therefore, it is possible that a small population remains in the Cumberland River.

Ongoing threats to the orangefoot pimpleback include water quality degradation from point and non-point sources, particularly in tributaries that have limited capability to dilute and assimilate sewage, agricultural runoff, and other pollutants. In addition, this species is affected by hydrologic and water quality alterations resulting from the operation of impoundments. A variety of instream activities (e.g., sand and gravel dredging, navigation, fleeting, etc.) continue to threaten orangefoot pimpleback populations. Other potential threats include land-based development including residential and agricultural activities near streams that often results in loss of riparian habitat, increased storm water runoff due to increased impervious surfaces, increased sedimentation due to loss of streamside vegetation, and subsequent degradation of stream banks.

EB/CE Source: U.S. Fish and Wildlife Service (FWS). 2018. Orangefoot Pimpleback (*Plethobasus cooperianus*) 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service, Kentucky Field Office. Frankfort, Kentucky. 18 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 expect the orangefoot pimpleback will experience direct mortality or sublethal effects from any malathion uses at the maximum rates for all bins (3, 4, 7). However, risk of loss (mortality) of the host fish is medium for all use sites and bins except developed and mosquito control which is low for all bins.

We do not expect mussel species to be directly impacted by exposure from malathion. However their lifecycle is such that when glochidia (larval stage) are released into the water, within a few days they must attach to the appropriate species of fish, which they parasitize for a short time while they develop into juvenile mussels in order to complete their lifecycle; they cannot complete their lifecycle without a fish host.

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.

| | |
|--|---------------------|
| DIRECT (all uses except mosquito control) | |
| Use areas – mortality | No effects expected |
| Sublethal – growth (G), reproduction (R) and behavior (B) enzyme (E) | No effects expected |
| INDIRECT (all uses except mosquito control) | |
| Use areas – Fish host mortality | Total overlap: 9.5% |
| MOSQUITO CONTROL | |
| Direct (mortality) | No effects expected |

| | |
|-----------|----------------------|
| Sublethal | No effects expected |
| Indirect | Total overlap: 11.7% |

Risk modifiers:

Allowable uses driving effects/other considerations: The reproductive cycle of the orangefoot pimpleback is likely similar to that of other native freshwater mussels. The mussel glochidia are released into the water, and within a few days they must attach to the appropriate species of fish, which they parasitize for a short time while they develop into juvenile mussels. The orangefoot pimpleback is likely a short-term brooder with spawning occurring in the spring and release of glochidia during summer months (USFWS 1984). The orangefoot pimpleback is found in medium to large rivers with sand and gravel substrates (USFWS 1984).

In the “Approach to the Effects Analysis” section of the main body of the Opinion, we stated that specific considerations were made 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. Further investigation by EPA into Bin 3 and 4 estimated environmental concentrations indicate 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. The orangefoot pimpleback potential exposure risk is also partially lowered based on their reliance upon a larger static aquatic habitat (Bin 7) in addition to Bins 3 and 4, reducing the overall risk to the species as a whole.

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 [^] | Mortality to Fish Host Effect associated with bin (H, M, L) |
|---------------------------|------------------------------|------------------------|--------|---------------------------------------|--------|--|---|
| | | Acres | % | Acres | % | | |
| Mosquito Control | I | 1,910,680 | 11.7 | 90,767 | 0.56 | 3,4,7 | 3L 4L 7L |
| Developed | I | 698,087 | 4.27 | 34,904 | 0.21 | 3,4,7 | 3L 4L 7L |
| Corn | I | 657,899 | 4.03 | 42,944 | 0.26 | 3,4,7 | 3M 4M 7M |
| Cotton | I | 16,333 | 0.1 | 13,986 | 0.09 | 3,4,7 | 3M 4M 7M |
| Pasture | I | 13,108 | 0.08 | 1,511 | < 0.01 | 3,4,7 | 3M 4M 7M |
| Other Crops | I | 11,205 | 0.07 | 0 | 0 | 3,4,7 | 3M 4M 7M |
| Wheat | I | 6,776 | 0.04 | 1,129 | < 0.01 | 3,4,7 | 3M 4M 7M |
| Other Grains | I | 6,258 | 0.04 | 1,840 | <0.01 | 3,4,7 | 3M 4M 7M |
| Nurseries | I | 2,750 | 0.02 | 2,750 | 0.02 | 3,4,7 | 3M 4M 7M |
| Vegetables & Ground Fruit | I | 449 | < 0.01 | 411 | < 0.01 | 3,4,7 | 3M 4M 7M |
| Orchards & Vineyards | I | 61 | < 0.01 | 45 | < 0.01 | 3,4,7 | 3M 4M |

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 [^] | Mortality to Fish Host Effect associated with bin (H, M, L) |
|--|------------------------------|------------------------|--------|---------------------------------------|--------|--|---|
| | | Acres | % | Acres | % | | |
| | | | | | | | 7M |
| Christmas Trees | I | 1 | < 0.01 | 1 | < 0.01 | 3,4,7 | 3M 4M 7M |
| Rice | I | 227 | < 0.01 | 32 | < 0.01 | 3,4,7 | 3M 4M 7M |
| Other Row Crops | I | 7,707 | 0.05 | 642 | < 0.01 | 3,4,7 | 3M 4M 7M |
| Sub-TOTAL (I): <i>Other uses with indirect effects³</i> | | 1,420,861 | 9.5 | 100,195 | 1.11 | | |
| TOTAL³: | | 3,331,541 | 21.2 | 190,962 | 1.67 | | |

[^]We consider the Bin 2 estimates as an upper bound of Bin 3 & 4 exposures. The estimated environmental concentrations for a Bin 2 water are an order of magnitude greater than Bins 3 and 4; therefore concentrations in Bins 3 and 4 can be reduced by a correction factor of 10.

Exposure Modifiers: A reassessment of our crop use data layers shows that within the “Other Row Crops” layer shows that usage in this category may be overestimated. This UDL is composed of sunflower, peanuts, tobacco, sugar beets, and hops, of which, only hops is a registered use site on malathion labels and is thus the only crop in this layer that is relevant in our analysis. USDA data shows that 96% of hops are grown in the Pacific Northwest region (in Idaho, Oregon, and Washington), with some small farms in Florida reporting occasional hop production. Given the highly specific regions that hops are grown in, we can assume that potential exposure to malathion from “other row crops” use sites is 0 outside of these areas, and thus does not apply to this species.

acres in species range: 16,340,978 acres

% of range in California (i.e., where CalPUR data is available): 0%

³ TOTAL includes usage on all use sites with effects, including mosquito control.

Range overlap with Federal lands: 753,414 acres, 4.611%

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 groundfruit lower the maximum allowable number of applications to 2-4 per year (depending on the specific crop). 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 orangefoot pimpleback (pearlymussel). As discussed below, even though the species vulnerability is high and risk to the species host fish is medium, we anticipate the likelihood of exposure of host fish to malathion is low, and the implementation of the general conservation measures described above is expected to further reduce the likelihood of exposure.

The orangefoot pimpleback (pearlymussel) has a high vulnerability based on its status, distribution, and trends. Mortality and sublethal effects to the species are not anticipated. The risk to the species host fish posed by labeled uses across the range is medium, and where individual host fish are exposed, we anticipate medium levels of mortality. Mussels depend on host fish to accomplish their reproductive lifecycle. Glochidia (larval stage) are released into the water and within a few days they must attach to an appropriate species of fish, which they parasitize for a short time while they develop into juvenile mussels. Glochidia that do not attach to a host fish will not survive.

We anticipate usage within the non-Federal portion of the species' range will be low (1.67%), based primarily on the 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 Biological Opinion. Where sufficient numbers of suitable host fish are not available, we anticipate reproduction of mussels would be reduced.

The species range, and thus this species host fish range, is very large (>16.3 million acres) and we do not anticipate that host fish would necessarily be found in the affected areas of the waterbodies near application sites when malathion is applied, although small numbers of host fish may occur in these areas and be exposed over the duration of the proposed action. Reductions in plankton could be high in localized areas, however, we anticipate additional food resources from upstream sources would quickly recolonize after an application event. In addition, we anticipate that the conservation measures above, including rain restrictions, aquatic habitat buffers, residential use label changes, and reduced number of applications and rates on certain use sites, will further reduce the risk of exposure to the mussels' host fish.

As stated previously, conservation measures are aimed at reducing the amount of malathion runoff and spray drift that enter into sensitive habitats (e.g., species habitat, aquatic environments). For example, by placing a 48-hour rain restriction on agricultural applications, malathion has the ability to degrade after application (e.g., by hydrolysis, other processes) prior to any rain/runoff events, thus minimizing malathion runoff into aquatic habitats and decreasing exposure to listed mussels and their host fish. Increasing application buffers reduces the amount of malathion that drifts off target and subsequently into non-target environments. In addition, changes to residential labels limits applications to spot treatments and reduces the number of applications per year (2-4), significantly decreasing the overall amounts of malathion used in

residential areas and resulting amounts of runoff and drift. Additional reductions in the number of applications and rates allowed for certain crops (e.g., corn, vegetables and ground fruit) further reduces the amount of malathion used in agricultural settings, thereby decreasing potential exposure to the species and their host fish. Combined, these conservation measures substantially reduce exposure to the orangefoot pimpleback (pearlymussel) and their host fish and therefore minimizes overall risk and adverse effects to the species in the larger waterbodies in which they occur. Thus, we anticipate small numbers of individual host fish will experience low levels of adverse effects either from exposure to malathion or via a loss of prey resources, and very small numbers of mussels will experience low levels of adverse effects due to small reductions of prey items (plankton/zooplankton) over the duration of the action. However, we do not anticipate that these adverse effects would have population- or species-level effects

.

Therefore, we anticipate that the proposed action would not appreciably reduce survival and recovery of the orangefoot pimpleback (pearlymussel) in the wild.

Conclusion: Is not likely to jeopardize.

Integration and Synthesis Summary: Bivalves

| Scientific Name: | Common Name: | Entity ID: |
|-------------------------|---------------------|-------------------|
| <i>Potamilus capax</i> | Fat pocketbook | 342 |

Family: Unionidae

VULNERABILITY

(Summary of status, environmental baseline and cumulative effects)

Status: Endangered, Five-Year Review Recommendation: delisting recommended, 3 of 3 recovery criteria met

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

Number of Populations: Multiple populations (few)

Species Trends: Increasing population(s)

Pesticides noted ☐

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

Current data demonstrate increasing fat pocketbook population trends over the past three decades in the St. Francis, Ohio, and Mississippi river drainages, primarily through the discovery of new site locations. In the Ohio and Wabash rivers, the species populations have increased from locally rare in 1989, to locally common. Persistence and recruitment have been documented within multiple river and stream reaches in all three drainages. A comparison of the past and recent collection history of the fat pocketbook indicates that the fat pocketbook is recruiting and increasing in abundance in the St. Francis, Ohio, and Lower Mississippi rivers and some of their tributaries.

The fat pocketbook was historically distributed in the Mississippi River drainage from the confluence of the Minnesota and St. Croix rivers downstream to the White River System. Collection records from the St. Francis River drainage since listing show a significant expansion in spatial distribution of fat pocketbook in the St. Francis River drainage, from a historical range of less than 100 km (60 mi) to a current range of about 480 km (300 mi) of river and stream reaches. At the time of listing the fat pocketbook was believed to be extirpated from the Ohio River drainage. Over the past three decades, however, the species has been reported from scattered locations along 260 km (150 mi) of the Wabash River, and from the lower reaches of other major tributaries (Saline, Tennessee, White, Cumberland, Clarks, and Green Rivers), Kentucky, Illinois, and Indiana. While the fat pocketbook appears to remain extirpated from the upper Mississippi River, it has expanded its range in the lower Mississippi River. Overall, the fat pocketbook is now known to occupy approximately 1,000 channel miles in three distinct drainages and 33 river or stream reaches.

The primary threats identified for the fat pocketbook have included the destruction, modification, and curtailment of its historical habitat and range due to navigation and flood control activities (e.g., impoundment, channel maintenance, dredging) on the rivers where it was once found (U.S.

Fish and Wildlife Service 1989). Construction of impoundments for flood control and navigation in some of the river basins in which fat pocketbook historically occurred (e.g., upper Mississippi River, Ohio River, White River) inundated habitats, changed flow distributions, and are likely to have contributed to local extirpations of fat pocketbook populations. The 2012 5-year review identified on-going threats to habitat and range as impoundment, hydropower and hydrokinetic power development, channel dredging, and illegal discharges and spills (Service 2012). Potential stressors to the species included sedimentation and non-point source pollution (Service 2012). Since the 2012 5-year review, impoundment and hydropower projects with potentially adverse effects on the fat pocketbook have been completed with minimal impact to the species, while hydrokinetic development on the Lower Mississippi River has been abandoned. Potential threats have been further reduced by development and implementation of U.S. Army Corps of Engineers programs protective of the species and its habitats in the St. Francis, Mississippi, and Ohio River drainages. The species' increase in abundance and range, including within channelized ditches highly affected by agricultural runoff and in navigable river channels subject to dredging, shows resiliency to non-point source pollution and channel maintenance activities.

According to the 2019 5-year review summary and evaluation, the best available information indicates that the fat pocketbook mussel no longer meets the definition of an endangered or threatened species under the ESA and should be proposed for delisting.

EB/CE Source: U.S. Fish and Wildlife Service (FWS). 2019. Fat Pocketbook Pearly Mussel (*Potamilus capax*) 5-Year Review: Summary and Evaluation. Mississippi Ecological Services Field Office. Jackson, Mississippi. 32 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 expect the fat pocketbook will experience direct mortality or sublethal effects from any malathion uses at the maximum rates for all bins (2, 3, 4, 5, 6, 7). However, risk of mortality to the host fish for bin 2 is high for all use sites except developed where it is medium. Risk of mortality to the host fish in bin 7 is low for mosquito control, developed, corn, other crops, other grains, pasture, and wheat and medium for cotton, orchards and vineyards, nurseries, other row crops, and Christmas trees, and high for vegetables and ground fruit. For bin 6, risk of mortality to the host fish is low for developed and mosquito control. Risk of mortality is medium for bin 6 corn, other crops, other grains, and wheat, and high for all other uses not already discussed. For bin 5, risk of mortality to the host fish is high for all uses except developed which is low.

We do not expect mussel species to be directly impacted by exposure from malathion. However their lifecycle is such that when glochidia (larval stage) are released into the water, within a few

days they must attach to the appropriate species of fish, which they parasitize for a short time while they develop into juvenile mussels in order to complete their lifecycle; they cannot complete their lifecycle without a fish host.

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.

| | |
|--|---|
| DIRECT (all uses except mosquito control) | |
| Use areas – mortality | No effects expected |
| Sublethal – growth (G), reproduction (R) and behavior (B) enzyme (E) | No effects expected |
| INDIRECT (all uses except mosquito control) | |
| Use areas - Prey item mortality | High if plankton, NA of detritus |
| Use areas – Fish Host | 18.7% H, M, L, depending on bin and use |
| MOSQUITO CONTROL | |
| Direct (mortality) | No effects expected |
| Sublethal | No effects expected |
| Indirect | Total overlap: 28.2%, H for some bins, L for others |

Risk modifiers:

This species is found in sand, mud, and fine gravel substrates and flowing water (Dennis, 1985). It is also found in large rivers in slow-flowing water (often near the bank) in mud or sand (Cummings et al., 1990). Recently, it has been found to be tolerant of depositional areas that are usually unfavorable to other mussel species and is in fact, not a lotic species as indicated in the Recovery Plan (USFWS, 1989) that is negatively affected by high sedimentation rates. In fact, man-made ditches and existing bayous, sloughs, and streams in the St. Francis watershed provide suitable habitat (Miller and Payne, 2005). Recently, this species was found to be tolerant of depositional areas that are usually unfavorable to other mussel species and is in fact, not a lotic species as indicated in the Recovery Plan (USFWS, 1989) that is negatively affected by high sedimentation rates. Separation barriers between standing water bodies and within flowing water systems include lack of lotic connections, natural barriers such as upland habitat, absence of appropriate species specific fish hosts, water depth greater than 10 meters (Cvancara, 1972; Moyle and Bacon, 1969) or anthropogenic barriers to water flow such as dams or other impoundments and high waterfalls (NatureServe, 2015).

In the “Approach to the Effects Analysis” section of the main body of the Opinion, we stated that 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. Further investigation by EPA into Bin 3 and 4 estimated environmental concentrations indicate 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. While the fat pocketbook also occupies other aquatic habitats that may be exposed to potentially high

levels of malathion due to lower volume in those habitats (Bin 2), their potential exposure risk is at least partially lowered based on their reliance upon larger flowing and static aquatic habitats (Bins 3, 4, 5, 6, and 7), reducing the overall risk to the species as a whole.

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 to Fish Host associated with bin (H, M, L) |
|------------------|------------------------------|------------------------|-------|---------------------------------------|-------|-------------------------------|---|
| | | Acres | % | Acres | % | | |
| Mosquito Control | I | 6,749,349 | 28.2 | 203,350 | 0.85 | 2,3,4,5,6,7 | 2H 3 4 5H 6L 7L |
| Corn | I | 2,647,922 | 11.08 | 58,217 | 0.24 | 2,3,4,5,6,7 | 2H 3 4 5H 6M 7L |
| Other Crops | I | 553,735 | 2.32 | 235 | <0.01 | 2,3,4,5,6,7 | 2H 3 4 5H 6M 7L |
| Cotton | I | 545,268 | 2.28 | 75,567 | 0.32 | 2,3,4,5,6,7 | 2H 3 |

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 to Fish Host associated with bin (H, M, L) |
|---------------------------|------------------------------|------------------------|------|---------------------------------------|-------|-------------------------------|---|
| | | Acres | % | Acres | % | | |
| | | | | | | | 4 5H 6H 7M |
| Developed | I | 442,374 | 1.85 | 22,119 | 0.09 | 2,3,4,5,6,7 | 2M 3 4 5L 6L 7L |
| Other Grains | I | 148,407 | 0.62 | 20,891 | 0.09 | 2,3,4,5,6,7 | 2H 3 4 5H 6M 7L |
| Wheat | I | 66,430 | 0.28 | 10,924 | 0.05 | 2,3,4,5,6,7 | 2H 3 4 5H 6M 7L |
| Orchards & Vineyards | I | 18,287 | 0.08 | 6,280 | 0.03 | 2,3,4,5,6,7 | 2H 3 4 5H 6H 7M |
| Vegetables & Ground Fruit | I | 15,910 | 0.07 | 6,624 | 0.03 | 2,3,4,5,6,7 | 2H 3 4 5H 6H 7H |
| Pasture | I | 8,693 | 0.04 | 4,779 | 0.02 | 2,3,4,5,6,7 | 2H 3 4 6H 7L |
| Other Row Crops | I | 14,082 | 0.06 | 1,452 | 0.006 | 2,3,4,5,6,7 | 2H 3 4 6H 7L |

| Use type | Risk to species ¹ | Use overlap with range | | Estimated usage in range ² | | Bins associated with use type | Effect to Fish Host associated with bin (H, M, L) |
|--|------------------------------|------------------------|--------|---------------------------------------|--------|-------------------------------|---|
| | | Acres | % | Acres | % | | |
| Nurseries | I | 1,536 | < 0.01 | 1536 | < 0.01 | 2,3,4,5,6,7 | 2H 3 4 5H 6H 7M |
| Christmas Trees | I | 1 | < 0.01 | 1 | <0.01 | 2,3,4,5,6,7 | 2H 3 4 5H 6H 7M |
| Sub-TOTAL (I): <i>Other uses with indirect effects³</i> | | 4,462,645 | 18.7 | 208,625 | 1.72 | | |
| TOTAL³: | | 11,211,995 | 46.9 | 411,975 | 2.57 | | |

^We consider the Bin 2 estimates as an upper bound of Bin 3 & 4 exposures. The estimated environmental concentrations for a Bin 2 water are an order of magnitude greater than Bins 3 and 4; therefore concentrations in Bins 3 and 4 can be reduced by a correction factor of 10.

Exposure Modifiers:

A reassessment of our crop use data layers shows that within the “Other Row Crops” layer shows that usage in this category may be overestimated. This UDL is composed of sunflower, peanuts, tobacco, sugar beets, and hops, of which, only hops is a registered use site on malathion labels and is thus the only crop in this layer that is relevant in our analysis. USDA data shows that 96% of hops are grown in the Pacific Northwest region (in Idaho, Oregon, and Washington), with some small farms in Florida reporting occasional hop production. Given the highly specific regions that hops are grown in, we can assume that potential exposure to malathion from “other row crops” use sites is 0 outside of these areas, and thus does not apply to this species.

acres in species range: 23,903,816 acres

% of range in California (i.e., where CalPUR data is available): 0%

Range overlap with Federal lands: 1,143,026 acres, 4.782%

³ 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 groundfruit lower the maximum allowable number of applications to 2-4 per year (depending on the specific crop). 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 fat pocketbook. As discussed below, even though the species vulnerability is low and risk to the species host fish is high, we anticipate the likelihood of exposure of host fish to malathion is low, and the implementation of the general conservation measures described above is expected to further reduce the likelihood of exposure.

The fat pocketbook has a low vulnerability based on its status, distribution, and trends. Mortality and sublethal effects to the species are not anticipated. The risk to the species host fish posed by labeled uses across the range is medium, and where individual host fish are exposed, we anticipate variable levels of mortality, depending on water body size and use type. Mussels depend on host fish to accomplish their reproductive lifecycle. Glochidia (larval stage) are released into the water and within a few days they must attach to an appropriate species of fish, which they parasitize for a short time while they develop into juvenile mussels. Glochidia that do not attach to a host fish will not survive. Where sufficient numbers of suitable host fish are not available, we anticipate reproduction of mussels would be reduced.

We anticipate usage within the non-Federal portion of the species' range will be low (2.57%), based primarily on the 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 Biological Opinion.

According to the 2019 5-Year review, three of the three recovery criteria have been met; all three drainage populations (Ohio, Mississippi, and St. Francis Rivers) are displaying an increasing trend, evidenced by natural recruitment and presence of multiple age classes; fat pocketbook have been documented at a minimum of 12 sites along a 200 km stretch of each of the drainages; and active U.S. Army Corps of Engineers' management programs are in place and are assured to continue into the future leading to maintenance and improvement of the fat pocketbook habitat and population expansion.

The species range, and thus this species host fish range, is very large (>23.9 million acres) and we do not anticipate that host fish would necessarily be found in the affected areas of the waterbodies near application sites when malathion is applied, although small numbers of host fish may occur in these areas and be exposed over the duration of the proposed action. Reductions in plankton could be high in localized areas, however, we anticipate additional food resources from upstream sources would quickly recolonize after an application event. In addition, we anticipate that the conservation measures above, including rain restrictions, aquatic habitat buffers, residential use label changes, and reduced number of applications and rates on certain use sites, will further reduce the risk of exposure to the mussels' host fish.

As stated previously, conservation measures are aimed at reducing the amount of malathion runoff and spray drift that enter into sensitive habitats (e.g., species habitat, aquatic environments). For example, by placing a 48-hour rain restriction on agricultural applications,

malathion has the ability to degrade after application (e.g., by hydrolysis, other processes) prior to any rain/runoff events, thus minimizing malathion runoff into aquatic habitats and decreasing exposure to listed mussels and their host fish. Increasing application buffers reduces the amount of malathion that drifts off target and subsequently into non-target environments. In addition, changes to residential labels limits applications to spot treatments and reduces the number of applications per year (2-4), significantly decreasing the overall amounts of malathion used in residential areas and resulting amounts of runoff and drift. Additional reductions in the number of applications and rates allowed for certain crops (e.g., corn, vegetables and ground fruit) further reduces the amount of malathion used in agricultural settings, thereby decreasing potential exposure to the species and their host fish. Combined, these conservation measures substantially reduce exposure to the fat pocketbook and their host fish and therefore minimizes overall risk and adverse effects to the species. Thus, while we anticipate small numbers of individual host fish would be lost over the duration of the action, resulting in very small reductions in reproductive success, we do not anticipate species-level effects to this mussel species.

Therefore, we anticipate that the proposed action would not appreciably reduce survival and recovery of the fat pocketbook in the wild.

Conclusion: Is not likely to jeopardize.

ADDITIONAL REFERENCES

U.S. Fish and Wildlife Service (FWS). 2019. Fat Pocketbook Pearly Mussel (*Potamilus capax*) 5-Year Review: Summary and Evaluation. Mississippi Ecological Services Field Office. Jackson, Mississippi. 32 pp.

Integration and Synthesis Summary: Bivalves

| Scientific Name: | Common Name: | Entity ID: |
|--------------------------|--------------------------|-------------------|
| <i>Arkansia wheeleri</i> | Ouachita rock pocketbook | 343 |

Family: Unionidae

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:

Since the Ouachita rock pocketbook was listed as an endangered species in 1991, living or fresh dead specimens have been found within the three principal inhabited drainages (the Kiamichi, Little, and Ouachita rivers), but with reduced frequency and at a reduced number of localities. A single individual observed in the Ouachita River in 1995 is the only evidence of the species' persistence in that river over the past 30 years. In the Kiamichi River, the species has declined in abundance and in numbers of inhabited localities. A new population of the Ouachita rock pocketbook was discovered in the lower Little River, downstream of Millwood Reservoir, in 2002. Although exhibiting a fair concentration of individuals, the lower Little River population remains incompletely evaluated, appears subject to ongoing threats, may be restricted by available habitat, and appears isolated from other populations. The Ouachita rock pocketbook persists in a middle segment of the Little River, but remains rare there.

The decline of the Ouachita rock pocketbook is primarily the result of habitat loss and degradation (USFWS 2004). Chief among the causes of decline, but in no particular ranking order, are impoundments, channelization, flow modifications, water quality degradation, and gravel excavation. These stressors have had profound adverse effects on Ouachita rock pocketbook populations, its habitat, and fish hosts. Many past habitat alterations are large, not easily alleviated, and continue to affect the species adversely. In addition, new instances of habitat degradation have been reported from throughout the species' range, and proposed actions threaten to produce further impacts. Little information is known about specific sensitivities of mussels to various pollutants, but the Ouachita rock pocketbook continues to decline due to the effects of poor water quality, contaminants, and other factors.

The majority of the remaining Ouachita rock pocketbook populations are generally small and geographically isolated. The patchy distributional pattern of populations in short river reaches makes them more susceptible to extirpation from single catastrophic events, such as toxic

chemical spills (Watters and Dunn 1995). Furthermore, this level of isolation makes recolonization of extirpated populations virtually impossible without human intervention.

Various nonnative species of aquatic organisms are either established already in the range of the Ouachita rock pocketbook or are spreading toward the range. The nonnative species that poses the most significant threat to the Ouachita rock pocketbook is the zebra mussel, which has expanded into the Red River system but has not yet been reported from waters inhabited by the Ouachita rock pocketbook. Human-caused climate change has become recognized as a significant threat, and may produce similar (additive) effects with natural droughts, inadequately planned reservoir operations, and water diversions. Although there are ongoing attempts to alleviate some threats at some locations, there appear to be no populations of the species without significant threats.

Farris *et al.* (2003) and Seagraves (2006) performed fish infection trials and identified 11 of 30 tested species as suitable fish hosts for the Ouachita rock pocketbook. The fish reported as successful hosts included bleeding shiner (*Luxilus zonatus*), emerald shiner (*Notropis atherinoides*), river carpsucker (*Carpionodes carpio*), green sunfish (*Lepomis cyanellus*), warmouth (*L. gulosus*), bluegill (*L. macrochirus*), longear sunfish (*L. megalotis*), smallmouth bass (*Micropterus dolomieu*), largemouth bass (*M. salmoides*), white crappie (*Pomoxis annularis*), and black crappie (*P. nigromaculatus*). Barnhart (2009) identified three of eight tested species as suitable fish hosts for the Ouachita rock pocketbook: dusky stripe shiner (*Luxilus pilsbryi*), golden shiner (*Notemigonus crysoleucas*), and freshwater drum (*Aplodinotus grunniens*).

EB/CE Source: U.S. Fish and Wildlife Service. 2018. Ouachita Rock Pocketbook (Arkansas wheeleri Ortmann and Walker, 1912) 5-Year Review: Summary and Evaluation. Oklahoma Ecological Services Field Office. Tulsa, Oklahoma. 60 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 expect the Ouachite rock pocketbook will experience direct mortality or sublethal effects from any malathion uses at the maximum rates for all bins (2, 3, 4, 6, 7). However, risk of mortality to the host fish for bin 2 is high for all use sites except developed. Risk of mortality to the host fish in bin 7 is low for mosquito control, developed, corn, wheat, other crops and medium for cotton, orchards and vineyards, other grains, pasture, nurseries, vegetables and ground fruit, and other row crops. For bin 6, risk of mortality to the host fish is low for developed. Risk of mortality is medium for mosquito control, corn, wheat, other crops, vegetables and groundfruit, and other grains but high for cotton, orchards and vineyards, pasture, nurseries and other row crops.

We do not expect mussel species to be directly impacted by exposure from malathion. However their lifecycle is such that when glochidia (larvae) are released into the water, within a few days

they must attach to the appropriate species of fish, which they parasitize for a short time while they develop into juvenile mussels in order to complete their lifecycle; they cannot complete their lifecycle without a fish host.

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.

| | |
|--|--|
| DIRECT (all uses except mosquito control) | |
| Use areas – mortality | No effects expected |
| Sublethal – growth (G), reproduction (R) and behavior (B) enzyme (E) | No effects expected |
| INDIRECT (all uses except mosquito control) | |
| Use areas - Prey item mortality | If plankton: High If detritus: NA |
| Use areas – Fish Host | Total overlap: 2.22% High |
| MOSQUITO CONTROL | |
| Direct (mortality) | No effects expected |
| Sublethal | No effects expected |
| Indirect | Total overlap: 3.33%, H M and L depending on bin |

Risk modifiers: The Ouachita rock pocketbook's life cycle is unknown; however, it is most likely similar to that of other unionid mussels. Reproductive anatomy is likely similar to other members of the subfamily Anodontinae, as discussed by Ortmann (1912).

The Ouachita rock pocketbook inhabits pools, backwaters, and side channels of rivers and large creeks in or near the southern slope of the Ouachita Uplift. This species occupies stable substrates containing gravel, sand, and other materials. The Ouachita rock pocketbook always occurs within large mussel beds containing a diversity of mussel species (Ouachita Rock Pocketbook Recovery Plan March 2004).

In the "Approach to the Effects Analysis" section of the main body of the Opinion, we stated that specific considerations were made 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. Further investigation by EPA into Bin 3 and 4 estimated environmental concentrations indicate 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. While the Ouachita rock pocketbook also occupies other aquatic habitats that may be exposed to potentially high levels of malathion due to lower volume in those habitats (Bin 2), their potential exposure risk is at least partially lowered based on their reliance upon larger flowing and static aquatic habitats (Bins 3, 4, 6, and 7), reducing the overall risk to the species as a whole.

The Ouachita rock pocketbook is a considered a fish host generalist whose glochidia can metamorphosize on a wide variety of fishes from multiple families. While we anticipate some species of the host fish community will exhibit temporary reductions in abundance due to malathion exposure, the species' flexible host requirement will allow the species to be more resilient to temporary losses of host fish, reducing the anticipated indirect 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 [^] | Mortality to Fish Host Effect associated with bin (H, M, L) |
|------------------|------------------------------|------------------------|-------|---------------------------------------|--------|--|---|
| | | Acres | % | Acres | % | | |
| Mosquito Control | I | 257,857 | 3.33 | 120,133 | 1.55 | 2,3,4,6,7 | 2H 3 4 6M 7L |
| Other Crops | I | 9,259 | 0.12 | 0 | 0 | 2,3,4,6,7 | 2H 3 4 6M 7L |
| Other Grains | I | 737 | <0.01 | 737 | <0.01 | 2,3,4,6,7 | 2H 3 4 6M 7M |
| Other Row Crops | I | 2 | <0.01 | 2 | < 0.01 | 2,3,4,6,7 | 2H 3 4 |

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 [^] | Mortality to Fish Host Effect associated with bin (H, M, L) |
|---------------------------|------------------------------|------------------------|--------|---------------------------------------|--------|--|---|
| | | Acres | % | Acres | % | | |
| | | | | | | | 6H 7M |
| Corn | I | 22,541 | 0.29 | 6,468 | 0.08 | 2,3,4,6,7 | 2H 3 4 6M 7L |
| Cotton | I | 1,787 | 0.02 | 106 | < 0.01 | 2,3,4,6,7 | 2H 3 4 6H 7M |
| Developed | I | 114,022 | 1.47 | 5,701 | 0.07 | 2,3,4,6,7 | 2L 3 4 6L 7L |
| Nurseries | I | 108 | < 0.01 | 108 | < 0.01 | 2,3,4,6,7 | 2H 3 4 6H 7M |
| Wheat | I | 19,248 | 0.25 | 10,121 | 0.13 | 2,3,4,6,7 | 2H 3 4 6M 7L |
| Vegetables & Ground Fruit | I | 59 | < 0.01 | 56 | < 0.01 | 2,3,4,6,7 | 2H 3 4 6M 7M |
| Orchards & Vineyards | I | 1,589 | 0.02 | 1,190 | 0.02 | 2,3,4,6,7 | 2H 3 4 6H 7M |
| Pasture | I | 597 | < 0.01 | 597 | < 0.01 | 2,3,4,6,7 | 2H 3 4 6H |

| Use type | Risk to species ¹ | Use overlap with range | | Estimated usage in range ² | | Bins associated with use type [^] | Mortality to Fish Host Effect associated with bin (H, M, L) |
|--|------------------------------|------------------------|------|---------------------------------------|------|--|---|
| | | Acres | % | Acres | % | | |
| | | | | | | | 7M |
| Sub-TOTAL (I): <i>Other uses with indirect effects³</i> | | 169,839 | 2.22 | 25,084 | 0.35 | | |
| TOTAL³: | | 427,696 | 5.54 | 145,217 | 1.90 | | |

[^]We consider the Bin 2 estimates as an upper bound of Bin 3 & 4 exposures. The estimated environmental concentrations for a Bin 2 water are an order of magnitude greater than Bins 3 and 4; therefore concentrations in Bins 3 and 4 can be reduced by a correction factor of 10.

Exposure Modifiers:

A reassessment of our crop use data layers shows that within the “Other Row Crops” layer shows that usage in this category may be overestimated. This UDL is composed of sunflower, peanuts, tobacco, sugar beets, and hops, of which, only hops is a registered use site on malathion labels and is thus the only crop in this layer that is relevant in our analysis. USDA data shows that 96% of hops are grown in the Pacific Northwest region (in Idaho, Oregon, and Washington), with some small farms in Florida reporting occasional hop production. Given the highly specific regions that hops are grown in, we can assume that potential exposure to malathion from “other row crops” use sites is 0 outside of these areas, and thus does not apply to this species.

acres in species range: 7,745,690 acres

% of range in California (i.e., where CalPUR data is available): 0%

Range overlap with Federal lands: 465,896 acres, 6.015%

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 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.

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, is not likely to jeopardize the continued existence of the Ouachita rock pocketbook. As discussed below, even though the species vulnerability is high and risk to the species host fish is medium, we anticipate the likelihood of exposure of host fish to malathion is low, and the implementation of the general conservation measures described above is expected to further reduce the likelihood of exposure.

The Ouachita rock pocketbook has a high vulnerability based on its status, distribution, and trends. Mortality and sublethal effects to the species are not anticipated. The risk to the species host fish posed by labeled uses across the range is medium, and where individual host fish are exposed, we anticipate variable levels of mortality, depending on water body size and use type. Mussels depend on host fish to accomplish their reproductive lifecycle. Glochidia (larval stage) are released into the water and within a few days they must attach to an appropriate species of

fish, which they parasitize for a short time while they develop into juvenile mussels. Glochidia that do not attach to a host fish will not survive. Where sufficient numbers of suitable host fish are not available, we anticipate reproduction of mussels would be reduced.

We anticipate usage within the non-Federal portion of the species' range will be low (1.90%), based primarily on the 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 Biological Opinion.

According to the 5-Year Review, there are still several recovery criteria that have not yet been fully met: work is still needed to: (1) address the existing population in the Kiamichi River to be protected from further decline and degradation of its habitat, (2) have at least two viable populations successfully reestablished (or found) and protected in two additional stream systems within the natural range of the Ouachita rock pocketbook, (3) ensure viable populations are successfully reestablished (or found) and protected in four major stream systems naturally inhabited by the Ouachita rock pocketbook, including the Ouachita River, Kiamichi River, Little River, and one or more additional tributaries of the Red River basin. Efforts described above address this criterion. However work is being performed to protect the population through existing conservation programs, and sections 7(a)(1) and 7(a)(2) of the ESA to address known and potential impacts to the species' habitats associated with multiple federal actions in the Kiamichi River watershed and the lower Little River watershed.

The species range, and thus this species host fish range, is very large (>7.7 million acres) and we do not anticipate that host fish would necessarily be found in the affected areas of the waterbodies near application sites when malathion is applied, although small numbers of host fish may occur in these areas and be exposed over the duration of the proposed action. Reductions in plankton could be high in localized areas, however, we anticipate additional food resources from upstream sources would quickly recolonize after an application event. In addition, we anticipate that the conservation measures above, including rain restrictions, aquatic habitat buffers, and residential use label changes, will further reduce the risk of exposure to the mussels' host fish.

As stated previously, conservation measures are aimed at reducing the amount of malathion runoff and spray drift that enter into sensitive habitats (e.g., species habitat, aquatic environments). For example, by placing a 48-hour rain restriction on agricultural applications, malathion has the ability to degrade after application (e.g., by hydrolysis, other processes) prior to any rain/runoff events, thus minimizing malathion runoff into aquatic habitats and decreasing exposure to listed mussels and their host fish. Increasing application buffers reduces the amount of malathion that drifts off target and subsequently into non-target environments. In addition, changes to residential labels limits applications to spot treatments and reduces the number of applications per year (2-4), significantly decreasing the overall amounts of malathion used in residential areas and resulting amounts of runoff and drift. Combined, these conservation measures substantially reduce exposure to the Ouachita rock pocketbook and their host fish and therefore minimizes overall risk and adverse effects to the species. Thus, while we anticipate small numbers of individual host fish would be lost over the duration of the action, resulting in

very small reductions in reproductive success, we do not anticipate species-level effects to this mussel species.

Therefore, we anticipate that the proposed action would not appreciably reduce survival and recovery of the Ouachita rock pocketbook in the wild.

Conclusion: Is not likely to jeopardize.

ADDITIONAL REFERENCES

U.S. Fish and Wildlife Service. 2018. Ouachita Rock Pocketbook (*Arkansia wheeleri* Ortmann and Walker, 1912) 5-Year Review: Summary and Evaluation. Oklahoma Ecological Services Field Office. Tulsa, Oklahoma. 60 pp.

Integration and Synthesis Summary: Bivalves

| Scientific Name: | Common Name: | Entity ID: |
|--------------------------|-----------------|------------|
| <i>Pleurobema curtum</i> | Black clubshell | 347 |

Family: Unionidae

VULNERABILITY

(Summary of status, environmental baseline and cumulative effects)

Status: Endangered

Distribution: Population size/location unknown

Number of Populations: Single population

Species Trends: Unknown population trends

Pesticides noted ☐

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

From the 2021 5-Year Review: Live black clubshells have not been observed since the construction of the Tennessee-Tombigbee Waterway, and fresh dead shells of the species were last collected in 1997 from a single shoal on the East Fork Tombigbee River, Itawamba County, MS. The East Fork Tombigbee River was last searched for the species in 2011 (Hamstead et al., 2020). No live or fresh dead black clubshells were located. Conditions at the historical collection site had degraded to such an extent that few mussels of any species were found there. However, other portions of the river appear to be stabilizing (Gangloff and Hamstead 2012), and the potential of survival persists. No new surveys have been completed since the 2015 5-year review, and there is no new information regarding survival of the black clubshell at this location; however, mussel habitats within the East Fork Tombigbee River continue to support a diverse although altered mussel community (Service 2015; Hamstead et al., 2020). FWS (1987) page 11166 – “Habitat alteration from a flowing riverine system to an impounded system. This limited distribution continues to be threatened by habitat modification. Impoundment of the Tombigbee River has altered water flows and increased siltation on the gravel bars. This alteration suffocated mussels with silt and may have modified habitat so as to eliminate the fish host, if the host is a riverine species that is intolerant of impoundments. The COE has a channel improvement project for 84.5 miles of the Sipsey River that includes 32 miles of clearing and snagging [U.S. Army Corps of Engineers 1981]. Channel modifications adversely impact clams by alteration of the substrate, increased siltations, altered water flows, and direct mortality of mussels from dredging and snagging activities.

FWS (1987) page 11167... "All five species are affected by runoff not proposed for these species for reasons given in the next section. Critical Habitat of fertilizers and pesticides. Runoff of fertilizers into small streams can exceed the assimilation ability of the stream and result in algal blooms and excess of other aquatic vegetation. This condition can produce stream eutrophication and result in the death of the native fauna. Herbicides, insecticides, fungicides, and other

pesticides are easily washed from fields into streams, along with silt particles to which these substances adhere. While being transported downstream, these particles may be ingested by filter feeders, which include these native clams. Pesticide laden silt particles eventually settle to and become a part of the substrate. This increases the concentrations of pesticides in the clams habitat. All five species may also be adversely affected by loss of their fish hosts. Although the host fish for these particular species have not been identified., the hosts of clams from riffle habitats tend to be riffle-dwelling species [Fuller 1974) and are likely to decline or become extirpated as this habitat is modified."

EB/CE Source:

U.S. Fish and Wildlife Service. 2021. Black Clubshell (*Pleurobema curtum*), Heavy Pigtoe (*Pleurobema taitianum*), and Southern Combshell (*Epioblasma penita*) 5-Year Review: Summary and Evaluation. Jackson Ecological Services Field Office. Jackson, Mississippi. 13 pp.

U.S. Fish and Wildlife Service (FWS). 1987. Endangered and Threatened Wildlife and Plants; Endangered Status for Marshall's Mussel (*Pleurobema marshalli*), Curtus' Mussel (*Pleurobema curtum*), Judge fait's Mussel (*Pleurobema taitianum*), the Stirrup Shell (*Quadrual stapes*), and the Penitent Mussel (*Epioblasma* (= *Dysnomia*) *penita*). Federal Register. 52(66): 11162-11169.

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 expect the black clubshell will experience direct mortality or sublethal effects from any malathion uses at the maximum rates for Bin 4. However, risk of mortality to the host fish is high for all use sites except developed where it is medium.

We do not expect mussel species to be directly impacted by exposure from malathion. However, their lifecycle is such that when glochidia (larval stage) are released into the water, within a few days they must attach to an appropriate species of fish, which they parasitize for a short

while they develop into juvenile mussels in order to complete their lifecycle; they cannot complete their lifecycle without a fish host.

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.

| DIRECT (all uses except mosquito control) | |
|---|---------------------|
| Use areas – mortality | No effects expected |
| Sublethal – growth (G), reproduction (R) and behavior (B)) enzyme (E) | No effects expected |

| | |
|--|---|
| INDIRECT (all uses except mosquito control) | |
| Use areas - Prey item mortality | If plankton: H If detritus: NA |
| Use areas – Fish Host | Total overlap: 8.6%, H for all uses except, M for developed and wheat |
| MOSQUITO CONTROL | |
| Direct (mortality) | No effects expected |
| Sublethal | No effects expected |
| Indirect | Total overlap: 16.1%, M |

Risk Modifiers:

Species occurs in Bin 4. See Risk Assumptions (above) for risk to individuals and species.

Species host (unknown) occurs in Bin 4. See Risk Assumptions (above) for risk to host species.

Mussels depend on a host fish to accomplish their reproductive lifecycle. Glochidia that do not attach to a host fish will not survive. Where sufficient numbers of suitable host fish are not available, we anticipate reproduction of mussels would be reduced. Mussels can be categorized into several different categories that capture the breadth of the type of mussel-host relationships, including host fish generalists, host fish specialists, and those for which the host fish are unknown. Because fish species exhibit a range of sensitivities to malathion, exposure is expected to have varying effects upon these different fish species, thus malathion would have variable impacts to the mussels that parasitize the fish.

For the black clubshell, fish host species required for successful reproduction are unknown. Therefore we anticipate the risk to the black clubshell will be greater due to the fact that there is no specific information on age, size of maturity, or host fish use for the black clubshell. This suggests that the black clubshell may be less resilient to possible changes in the fish host community and make it more susceptible to indirect effects of malathion. Thus, the risk is determined to be high for the black clubshell.

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 that 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 Bin 3 and 4 estimated environmental concentrations indicate 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 to Host Fish associated with bin (H, M, L) |
|--|------------------------------|------------------------|---------|---------------------------------------|---------|--|---|
| | | Acres | % | Acres | % | | |
| Mosquito Control | I | 275,352 | 16.1 | 274,718 | 1.76 | 4 | M |
| Developed | I | 27,300 | 1.60 | 1,365 | 0.08 | 4 | M |
| Corn | I | 18,620 | 1.09 | 2,384 | 0.14 | 4 | H |
| Wheat | I | 868 | 0.05 | 868 | 0.05 | 4 | M |
| Pasture | I | 1.7 | 0.0001 | 0.67 | 0.00004 | 4 | H |
| Nurseries | I | 72 | 0.004 | 72 | 0.004 | 4 | H |
| Other Crops | I | 6,360 | 0.4 | 0 | 0 | 4 | H |
| Other Grains | I | 303 | 0.02 | 303 | 0.018 | 4 | H |
| Vegetables & Ground Fruit | I | 51 | 0.003 | 51 | 0.003 | 4 | H |
| Open Space Developed | I | 73,154 | 4.3 | 3,658 | 0.21 | 4 | M |
| Orchards & Vineyards | I | 93 | 0.005 | 93 | 0.005 | 4 | H |
| Other Row Crops | I | 2,395 | 0.14 | 875 | 0.05 | 4 | H |
| Cotton | I | 16,550 | 0.97 | 8,481 | 0.50 | 4 | H |
| Rice | I | 1.3 | 0.00008 | 0 | 0 | 4 | |
| Sub-TOTAL (I): <i>Other uses with indirect effects³</i> | | 145,769 | 8.6 | 18,151 | 1 | | |
| TOTAL³: | | 421,121 | 24.7 | 292,869 | 2.76 | | |

Exposure Modifiers:

A reassessment of crop UDL showed that usage data in the “Other Row Crops” may be overestimated. This UDL is composed of sunflower, peanuts, tobacco, sugar beets, and hops, of

which, only hops is a registered use site on malathion labels and is thus the only crop in this layer that is relevant in our analysis. USDA data shows that 96% of hops are grown in the Pacific Northwest region (Idaho, Oregon, and Washington), with some small farms in Florida reporting occasional hop production. Given the highly specific regions that hops are grown in, we can assume that the potential exposure to malathion from “other row crops” use sites is 0 outside the areas indicated above, and is thus not relevant to this species.

Since the overlap analysis for the black clubshell was completed, a new range map was developed for this species. One of two counties that had usage data for mosquito adulticide (a county that had significant use of malathion) no longer occurs in the overlap and the new estimated usage for mosquito adulticide within the range of the black clubshell is anticipated to be 1.76%, rather than 16%.

acres in species range: 1,705,650 acres

% of range in California (i.e., where CalPUR data is available): 0%

Range overlap with Federal lands: 5,932 acres, 0.35%

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 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 significantly 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 significantly 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 initial residues to degrade prior to the next application. In addition, exposure to aquatic organisms is reduced due to buffers from waterways 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 groundfruit lower the maximum allowable number of applications to 2-4 per year (depending on the specific crop). 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 black clubshell. As discussed below, even though the species vulnerability is high and the risk to the species host fish is high, we anticipate the likelihood of exposure of host fish to malathion is low, and the implementation of the general conservation measures described above is expected to further reduce the likelihood of exposure. In addition, although mosquito adulticide was identified as a significant driver in our February 2021 draft Opinion, our subsequent examination of the usage overlap with the species' refined range indicated this usage is greatly reduced. Thus, for this species, based upon a refinement of the range and mosquito adulticide usage information, we anticipate that mosquito adulticide is only a minor driver for malathion effects and that no more than minor effects to host fish are anticipated from this use. Lastly, since our draft Opinion in February 2021, EPA provided additional information regarding EECs in aquatic Bins 3 and 4. The black clubshell prefers swift moving streams represented by Bin 4 and we anticipate that exposure to malathion was likely previously overestimated. Thus, although risk to this species' host fish(es) is high and, for this species, remains unknown, we anticipate the likelihood of exposure to malathion is low and further mitigated through the conservation measures detailed above.

This species has a high vulnerability based on its status, distribution, and trends. The black clubshell is only known, or thought to still occur, within the East Fork of the Tombigbee River. Mortality and sublethal effects to the species are not anticipated. The risk to the species host fish posed by labeled uses across the range is high, and where individual host fish are exposed, we anticipate high to medium levels of mortality, depending on water body size and use type. Mussels depend on host fish to accomplish their reproductive lifecycle. Glochidia (larval stage) are released into the water, within a few days they must attach to an appropriate species of fish, which they parasitize for a short time while they develop into juvenile mussels. Glochidia that do not attach to a host fish will not survive. Where sufficient numbers of suitable host fish are not available, we anticipate reproduction of mussels would be reduced.

We anticipate usage within the non-Federal portion of the species' range will be low (2.76%), based primarily on the 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 Biological Opinion.

Low levels of malathion usage (2.76%) within this species' range could reduce plankton and the availability of host fish where this species occurs. However, any reductions in plankton would likely replenish relatively quickly from upstream sources. Reductions in host fish would be localized to areas of application and likely be replenished from other areas within the watershed. Although the species has a limited distribution, we anticipate that the conservation measures above, including rain restrictions, aquatic habitat buffers, and residential use label changes, will minimize the risk of exposure to plankton and the mussels' host fish.

As stated previously, conservation measures are aimed at reducing the amount of malathion runoff and spray drift that enter into sensitive habitats (e.g., species habitat, aquatic environments). For example, by placing a 48-hour rain restriction on agricultural applications, malathion has the ability to degrade after application (e.g., by hydrolysis, other processes) prior to any rain/runoff events, thus minimizing malathion runoff into aquatic habitats and decreasing exposure to listed mussels and their host fish. Increasing application buffers reduces the amount of malathion that drifts off target and subsequently into non-target environments. In addition, changes to residential labels limits applications to spot treatments and reduces the number of applications per year (2-4), significantly decreasing the overall amounts of malathion used in residential areas and resulting amounts of runoff and drift. Additional reductions in the number of applications and rates allowed for certain crops (e.g., corn, vegetables and ground fruit) further reduces the amount of malathion used in agricultural settings, thereby decreasing potential exposure to the species and their host fish. Combined, these conservation measures substantially reduce exposure to the black clubshell and their host fish and therefore minimizes overall risk and adverse effects to the species in the larger waterbodies in which they occur. Thus, we anticipate small numbers of individual host fish will experience low levels of adverse effects either from exposure to malathion or via a loss of prey resources, and very small numbers of mussels will experience low levels of adverse effects due to small reductions of prey items (plankton/zooplankton) over the duration of the action. However, we do not anticipate that these adverse effects would have population- or species-level effects

Therefore, we do not anticipate that the proposed action would appreciably reduce survival and recovery of the black clubshell in the wild.

Conclusion: Is not likely to jeopardize.

Integration and Synthesis Summary: Bivalves

| Scientific Name: | Common Name: | Entity ID: |
|--------------------------|--------------------|------------|
| <i>Epioblasma penita</i> | Southern combshell | 348 |

Family: Unionidae

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), relatively large numbers of individuals

Species Trends: All populations at least stable, and one or more increasing populations

Pesticides noted ☒

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

According to the 2015 5-Year review for the species, the southern combshell persists only in the Buttahatchee River of Mississippi. Channel erosion due to headcutting negatively affected the species in the lower Buttahatchee during the late 1980's through the 1990's; however, the system now appears to be stabilizing and the species is reoccupying some areas in the degraded lower reaches. A survey in the 2015 5-Year review (Gangloff et al. 2015) indicates expanding range and abundance in the system. Conservation measures are being implemented throughout the drainage to reduce the effects of nonpoint source pollution. Although range in the Buttahatchee is expanding, the single population remains vulnerable to natural or human-induced random catastrophic events. Conservation strategies include artificial propagation to re-establish the species into historically occupied drainages where conditions have improved.

The southern combshell is known to have persisted since listing in an approximately 12 kilometer (km) reach of the Buttahatchee River in Lowndes/Monroe Counties, Mississippi, as evidenced by spot collections of small adult and subadult southern combshells (P. Johnson in litt. 2014). Gangloff et al. (2015) recently conducted the first intensive mussel survey of the Buttahatchee River in Mississippi, since 1989-1990 (Hartfield and Jones 1990, Jones 1991), documenting an increase in mussel density, and locating 53 live southern combshell from 18 sites, over more than a 50 km river reach. The Buttahatchee River Restoration Project (BRRP) was initiated by Mississippi Fish and Wildlife Foundation (MFWF) in 2003, as part of a larger effort with the Mississippi Department of Environmental Quality (MDEQ) and other partners to secure conservation easements along key water resources in the state. In 2005, MFWF partnered with the Mississippi Department of Transportation, U.S. Army Corps of Engineers, the USFWS and others to protect over 5,000 acres of bottomland hardwoods located along the Buttahatchee River in Mississippi. Since then, the MFWF has purchased an additional 3,000 acres in Mississippi and Alabama, and now manages and protects 8,000 acres of land bordering approximately 43 km of frontage along the Buttahatchee River in Mississippi and Alabama. This

protected reach includes approximately 50 percent of the habitat currently known to be occupied by the southern combshell.

The Southern combshell habitat has been limited by altered habitat from a flowing riverine system to an impounded system. This limited distribution continues to be threatened by habitat modification. The listing document for this species indicates the species is affected by runoff of fertilizers and pesticides. Runoff of fertilizers into small streams can exceed the assimilation ability of the stream and result in algal blooms and excess of other aquatic vegetation. This condition can produce stream eutrophication and result in the death of the native fauna. Herbicides, insecticides, fungicides, and other pesticides are easily washed from fields into streams, along with silt particles to which these substances adhere. While being transported downstream, these particles may be ingested by filter feeders, which include these native clams. Pesticide laden silt particles eventually settle to and become a part of the substrate. This increases the concentrations of pesticides in the clams' habitat. All five species may also be adversely affected by loss of their fish hosts. Although the host fish for these particular species have not been identified, the hosts of clams from riffle habitats tend to be riffle-dwelling species (Fuller 1974) and are likely to decline or become extirpated as this habitat is modified.

According to the 2019 Recovery Plan amendment, the species' habitats in the Buttahatchee River demonstrated continued improvement, and surveys there documented an increase in the southern combshell range to a 50 km reach of the River (as described in the 2015 5-Year review). Propagation technology and science at the Alabama Aquatic Biodiversity Center (AABC) had also improved to the extent that juvenile combshells were produced in sufficient numbers that they could be released into a reach of the Cahaba River, Alabama, in 2012 and 2015, with releases planned for the East Fork Tombigbee drainage, Mississippi, in 2016. Recent monitoring of these reaches show survival and persistence of the reintroduced combshells. Although there has been no evidence of recruitment as of yet, follow up monitoring in the Cahaba River has detected gravid female southern combshells on multiple occasions (P. Johnson (AABC), pers. comm.) 2018.

EB/CE Source: U.S. Fish and Wildlife Service (FWS). 1987. Endangered and Threatened Wildlife and Plants; Endangered Status for Marshall's Mussel (*Pleurobema marshalli*), Curtus' Mussel (*Pleurobema curtum*), Judge Tait's Mussel (*Pleurobema taitianum*), the Stirrup Shell (*Quadrula stapes*), and the Penitent Mussel (*Epioblasma* (= *Dysnomia*) *penita*). Federal Register. 52(66): 11162 11169.

U.S. Fish and Wildlife Service (FWS). 2015. Black Clubshell (Curtus' Pearly Mussel) (*Pleurobema curtum*), Flat Pigtoe (Marshall's Pearly Mussel) (*Pleurobema marshalli*), Heavy Pigtoe (Judge Tait's Mussel) (*Pleurobema taitianum*), Southern Combshell (Penitent Mussel) (*Epioblasma penita*), Stirrupshell (*Quadrula stapes*), 5-Year Review: Summary and Evaluation. Jackson Ecological Services Field Office. Jackson, Mississippi. 16 pp.

U.S. Fish and Wildlife Service. 2019. Recovery Plan Amendment for Southern Combshell Mussel (*Epioblasma penita*) and Black Clubshell Mussel (*Pleurobema curtum*). Southeast Regional Office, Atlanta, Georgia. 7 pp.

(https://ecos.fws.gov/docs/recovery_plan/Southern%20Combshell%20Mussel%20and%20Black%20Clubshell%20Mussel%20Recovery%20Plan%20Amendment.pdf)

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 expect the southern combshell will experience direct mortality or sublethal effects from any malathion uses at the maximum rates for all bins (2, 3, 4, 7). However, risk of mortality to the host fish for bin 2 is high for all use sites except developed where it is medium. Risk of mortality to individuals in bin 7 is low for developed and mosquito control but medium for all other uses.

We do not expect mussel species to be directly impacted by exposure from malathion. However their lifecycle is such that when glochidia (larval stage) are released into the water, within a few days they must attach to an appropriate species of fish, which they parasitize for a short time while they develop into juvenile mussels in order to complete their lifecycle; they cannot complete their lifecycle without a fish host.

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.

| | |
|--|---|
| DIRECT (all uses except mosquito control) | |
| Use areas – mortality | No effects expected |
| Sublethal – growth (G), reproduction (R) and behavior (B) enzyme (E) | No effects expected |
| INDIRECT (all uses except mosquito control) | |
| Use areas - Prey item mortality | If plankton: H except for developed, L If detritus: NA |
| Use areas – Fish Host | Total overlap: 6.35%, H for bin 2, M for bin 7, developed L and M |
| MOSQUITO CONTROL | |
| Direct (mortality) | No effects expected |
| Sublethal | No effects expected |
| Indirect | Total overlap: 12.03%, H and L |

Risk modifiers:

From NatureServe (2015): This species is restricted to riffles or shoals of medium sized rivers with sandy gravel to gravel-cobble substrates in moderate to swift current (USFWS, 2000).

Within the “Approach to the Effects Analysis” section of the main body of the Opinion, we stated that specific considerations were made for species that occur in Bins 3 and 4 and that 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 Bin 3 and 4 estimated environmental concentrations indicate 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. While the Southern combshell also occupies other aquatic habitats that may be exposed to potentially high levels of malathion due to lower volume in those habitats (Bin 2), their potential exposure risk and that of their host fish is at least partially lowered based on their reliance upon larger flowing and static aquatic habitats (Bins 3, 4, and 7), reducing the overall risk to the species as a whole.

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 to Host Fish associated with bin (H, M, L) |
|------------------|------------------------------|------------------------|-------|---------------------------------------|------|--|---|
| | | Acres | % | | | | |
| Mosquito Control | I | 278,716 | 12.03 | 277,963 | 12 | 2,3,4,7 | 2H 3 4 7L |
| Corn | I | 45,288 | 1.95 | 2,384 | 0.1 | 2,3,4,7 | 2H 3 4 7M |
| Developed | I | 38,757 | 1.67 | 1,938 | 0.08 | 2,3,4,7 | 2M 3 4 |

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 to Host Fish associated with bin (H, M, L) |
|--|------------------------------|------------------------|--------|---------------------------------------|--------|--|---|
| | | Acres | % | | | | |
| | | | | | | | 7L |
| Open Space Developed | I | 102,522 | 4.42 | 5,126 | 0.22 | 2,3,4,7 | 2M 3 4 7L |
| Cotton | I | 33,408 | 1.44 | 12,166 | 0.53 | 2,3,4,7 | 2H 3 4 7M |
| Other Crops | I | 25,098 | 1.08 | 0 | 0 | 2,3,4,7 | 2H 3 4 7M |
| Other Grains | I | 381 | 0.02 | 381 | 0.02 | 2,3,4,7 | 2H 3 4 7M |
| Wheat | I | 998 | 0.04 | 706 | 0.03 | 2,3,4,7 | 2H 3 4 7 |
| Orchards & Vineyards | I | 122 | < 0.01 | 106 | < 0.01 | 2,3,4,7 | 2H 3 4 7M |
| Nurseries | I | 86 | < 0.01 | 86 | < 0.01 | 2,3,4,7 | 2H 3 4 7M |
| Other Row Crops | I | 2,501 | 0.11 | 1,017 | 0.04 | 2,3,4 | 2H 3 4 7M |
| Vegetables & Ground Fruit | I | 66 | < 0.01 | 43 | < 0.01 | 2,3,4,7 | 2H 3 4 7M |
| Pasture | I | 2 | < 0.01 | 2 | < 0.01 | 2,3,4,7 | 2H 3 4 7M |
| Sub-TOTAL (I): <i>Other uses with indirect effects³</i> | | 248,848 | 10.8 | 23,955 | 1.03 | | |

| Use type | Risk to species ¹ | Use overlap with range | | Estimated usage in range ² | | Bins associated with use type [^] | Effect to Host Fish associated with bin (H, M, L) |
|----------------------|------------------------------|------------------------|------|---------------------------------------|-------|--|---|
| | | Acres | % | | | | |
| TOTAL ³ : | | 527,564 | 22.8 | 301,918 | 12.03 | | |

[^]We consider the Bin 2 estimates as an upper bound of Bin 3 & 4 exposures. The estimated environmental concentrations for a Bin 2 water are an order of magnitude greater than Bins 3 and 4; therefore concentrations in Bins 3 and 4 can be reduced by a correction factor of 10.

Exposure Modifiers:

A reassessment of our crop use data layers shows that within the “Other Row Crops” layer shows that usage in this category may be overestimated. This UDL is composed of sunflower, peanuts, tobacco, sugar beets, and hops, of which, only hops is a registered use site on malathion labels and is thus the only crop in this layer that is relevant in our analysis. USDA data shows that 96% of hops are grown in the Pacific Northwest region (in Idaho, Oregon, and Washington), with some small farms in Florida reporting occasional hop production. Given the highly specific regions that hops are grown in, we can assume that potential exposure to malathion from “other row crops” use sites is 0 outside of these areas, and is thus not relevant to this species.

acres in species range: 2,317,045 acres

% of range in California (i.e., where CalPUR data is available): 0%

Range overlap with Federal lands: 6,999 acres, 0.302%

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.

³ 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 groundfruit lower the maximum allowable number of applications to 2-4 per year (depending on the specific crop). 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 southern combshell. As discussed below, even though the species vulnerability is high and risk to the species host fish is medium, we anticipate the likelihood of exposure of host fish to malathion is low. Since our draft Opinion in February 2021, EPA provided additional information regarding EECs in aquatic Bins 3 and 4. The Southern combshell prefers a variety of habitats, including larger and faster moving streams represented by Bins 3, 4, and 7 and we anticipate that exposure to malathion was likely previously overestimated for Bins 3 and 4. Thus, while risk to this species’ host fish(es) is medium, we anticipate the likelihood of exposure to malathion is low, due to dilution in Bins 3 and 4, and further mitigated through the implementation of the general conservation measures described above.

The southern combshell has a high vulnerability based on its status, distribution, and trends. Mortality and sublethal effects to the species are not anticipated. The risk to the species host fish posed by labeled uses across the range is medium, and where individual host fish are exposed, we anticipate variable levels of mortality, depending on water body size and use type. Mussels depend on host fish to accomplish their reproductive lifecycle. Glochidia (larval stage) are released into the water and within a few days they must attach to an appropriate species of fish, which they parasitize for a short time while they develop into juvenile mussels. Glochidia that do not attach to a host fish will not survive. Where sufficient numbers of suitable host fish are not available, we anticipate reproduction of mussels would be reduced.

We anticipate usage within the non-Federal portion of the species' range will be high (12.8%), based primarily on the usage data we acquired, as described in the Opinion and summarized for this species above. We did not quantitatively evaluate use or usage on the small amount of Federal lands that overlap with the species range (<1% of the 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.

According to the 2019 amended Recovery Plan, the main recovery criteria address the altered habitat and flow regimes caused by multiple dams and large expanses of impoundments contributing to the mussels fragmented distribution. This limited distribution continues to be threatened by habitat modification, although conservation efforts have also been implemented. Due to basin-wide fragmentation and habitat loss, the Service developed in partnership, the Mobile Basin Aquatic Ecosystem Recovery Plan as well as the Plan for the population restoration and conservation of the freshwater mollusks of the Mobile River Drainage through a process of controlled propagation, reintroduction, and augmentation. These plans continue to be implemented but recovery criteria have not yet been met.

Both the Mobile basin logperch (*Percina kathae*) and the blackbanded darter (*Percina nigrofasciata*) have been identified as successful host species for captive propagated Southern combshell. While the logperch and the darter are both relatively common and do not have widespread conservation concerns, we do not have high resolution data on their relative abundances in the range of the Southern combshell or their relative proportion or selection in serving as host fishes. In general, we anticipate that locally diminished host fish(es) numbers are an important factor in reducing recruitment and survival of the Southern combshell in its few remaining populations.

We expect that the introduction of malathion at high levels via mosquito adulticide applications and urban and agricultural runoff or drift would reduce the survival and availability of this species' host fish(es). However, as described above in the Environmental Baseline, a recent survey indicates expanding range and abundance of mussels in the system. Conservation measures are also being implemented throughout the drainage to reduce the effects of nonpoint source pollution. Conservation strategies include artificial propagation to re-establish the species into historically occupied drainages where conditions have improved. Conservation for the Southern combshell includes protection of approximately 43 km of frontage along the Buttahatchee River in Mississippi and Alabama, including approximately 50 percent of the habitat currently known to be occupied by the species. Given these ongoing conservation efforts we do not anticipate that host fish would be exposed at high levels in these conserved recovery

sites, although variable numbers of host fish may occur in other areas where exposure is more likely to occur and over the duration of the proposed action. In addition, we anticipate that the conservation measures above, including rain restrictions, aquatic habitat buffers, residential use label changes, and reduced number of applications and rates on certain use sites, will further reduce the risk of exposure to the mussels' host fish across the species range.

As stated previously, conservation measures are aimed at reducing the amount of malathion runoff and spray drift that enter into sensitive habitats (e.g., species habitat, aquatic environments). For example, by placing a 48-hour rain restriction on agricultural applications, malathion has the ability to degrade after application (e.g., by hydrolysis, other processes) prior to any rain/runoff events, thus minimizing malathion runoff into aquatic habitats and decreasing exposure to listed mussels and their host fish. Increasing application buffers reduces the amount of malathion that drifts off target and subsequently into non-target environments. In addition, changes to residential labels limits applications to spot treatments and reduces the number of applications per year (2-4), significantly decreasing the overall amounts of malathion used in residential areas and resulting amounts of runoff and drift. Additional reductions in the number of applications and rates allowed for certain crops (e.g., corn, vegetables and ground fruit) further reduces the amount of malathion used in agricultural settings, thereby decreasing potential exposure to the species and their host fish. Combined, these conservation measures substantially reduce exposure to the southern clubshell and their host fish and therefore minimizes overall risk and adverse effects to the species. Thus, while we anticipate that small numbers of host fish may be lost over the duration of the action, which subsequently results in a reduction in mussel recruitment; with the ongoing and future conservation efforts within the species range and the continuing expansion of the abundance and distribution of the species, we do not anticipate that incremental losses in host fish abundance from malathion exposure will lead to species-level effects.

Therefore, we anticipate that the proposed action would not appreciably reduce survival and recovery of the southern combshell in the wild.

Conclusion: Is not likely to jeopardize.

ADDITIONAL REFERENCES

U.S. Fish and Wildlife Service. 2019. Recovery Plan Amendment for Southern Combshell Mussel (*Epioblasma penita*) and Black Clubshell Mussel (*Pleurobema curtum*). Southeast Regional Office, Atlanta, Georgia. 7 pp.

(https://ecos.fws.gov/docs/recovery_plan/Southern%20Combshell%20Mussel%20and%20Black%20Clubshell%20Mussel%20Recovery%20Plan%20Amendment.pdf)

Integration and Synthesis Summary: Bivalves

| Scientific Name: | Common Name: | Entity ID: |
|-----------------------------|--------------|------------|
| <i>Pleurobema taitianum</i> | Heavy pigtoe | 350 |

Family: Unionidae

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:

2012 5-Year Review: A single surviving population of heavy pigtoe is known from the Alabama River, Dallas County, Alabama (Hartfield and Garner 1998, Garner and Buntin 2011). The area of habitat supporting mussels at this site has been quantified (6,250 square meters (m²)); based upon quantitative sampling the surviving heavy pigtoe population within this bed was estimated at 81 animals (Garner and Buntin 2011; Service 2015). No evidence of recruitment of heavy pigtoe within this bed has been found since its discovery. Propagation attempts with captive adults have been unsuccessful (Service 2015). There have been no surveys or monitoring of this population since 2011 as cited in the 2015 review.

FWS (1987) page 11166 ... Habitat alteration from a flowing riverine system to an impounded system. This limited distribution continues to be threatened by habitat modification. Impoundment of the Tombigbee River has altered water flows and increased siltation on the gravel bars. This alteration suffocated mussels with silt and may have modified habitat so as to eliminate the fish host, if the host is a riverine species that is intolerant of impoundments. The COE has a channel improvement project for 84.5 miles of the Sipsey River that includes 32 miles of clearing and snagging [U.S. Army Corps of Engineers 1981]. Channel modifications adversely impact clams by alteration of the substrate. increased siltations, altered water flows, and direct mortality of mussels from dredging and snagging activities.

FWS (1987) page 11167..."All five species are affected by runoff of fertilizers and pesticides. Runoff of fertilizers into small streams can exceed the assimilation ability of the stream and result in algal blooms and excess of other aquatic vegetation. This condition can produce stream eutrophication and result in the death of the native fauna. Herbicides, insecticides, fungicides, and other pesticides are easily washed from fields into streams, along with silt particles to which these substances adhere. While being transported downstream, these particles may be ingested by filter feeders, which include these native clams. Pesticide laden silt particles eventually settle to

and become a part of the substrate. This increases the concentrations of pesticides in the clams habitat. All five species may also be adversely affected by loss of their fish hosts. Although the host fish for these particular species have not been identified, the hosts of clams from riffle habitats tend to be riffle-dwelling species (Fuller 1974) and are likely to decline or become extirpated as this habitat is modified."

EB/CE Source:

U.S. Fish and Wildlife Service. 2021. Black Clubshell (*Pleurobema curtum*), Heavy Pigtoe (*Pleurobema taitianum*), and Southern Combshell (*Epioblasma penita*) 5-Year Review: Summary and Evaluation. Jackson Ecological Services Field Office. Jackson, Mississippi. 13 pp.

U.S. Fish and Wildlife Service (FWS). 1987. Endangered and Threatened Wildlife and Plants; Endangered Status for Marshall's Mussel (*Pleurobema marshalli*), Curtus' Mussel (*Pleurobema curtum*), Judge fait's Mussel (*Pleurobema taitianum*), the Stirrup Shell (*Quadrual stapes*), and the Penitent Mussel (*Epioblasma* (= *Dysnomia*) *penita*). Federal Register. 52(66): 11162-11169.

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 expect the heavy pigtoe will experience direct mortality or sublethal effects from any malathion uses at the maximum rates for all bins (2, 3, 4). However, risk of mortality to the host fish for bin 2 is high for all uses except for developed where risk of mortality is medium. Risk of mortality to the host fish for bins 3 and 4 is medium for all uses.

We do not expect mussel species to be directly impacted by exposure from malathion. However their lifecycle is such that when glochidia (larval stage) are released into the water, within a few days, they must attach to an appropriate species of fish, which they parasitize for a short time while they develop into juvenile mussels in order to complete their lifecycle; they cannot complete their lifecycle without a fish host.

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.

| | |
|--|---------------------|
| DIRECT (all uses except mosquito control) | |
| Use areas – mortality | No effects expected |
| Sublethal – growth (G), reproduction (R) and behavior (B) enzyme (E) | No effects expected |
| INDIRECT (all uses except mosquito control) | |

| | |
|---------------------------------|---|
| Use areas - Prey item mortality | If plankton: H for all uses and Bins If detritus: NA |
| Use areas – Fish Host | Total overlap: 10% M for Bins 2,3 for developed, wheat and other crops; H for all Bins for all other uses |
| MOSQUITO CONTROL | |
| Direct (mortality) | No effects expected |
| Sublethal | No effects expected |
| Indirect | Total overlap: 22% M for Bins 3 and 4, H for Bin 2 |

Risk modifiers: *Species occurs in Bins 2, 3 and 4. See Risk Assumptions (above) for risk to individuals and species.*

The heavy pigtoe is primarily found in sandy gravel and gravel-cobble substrates in small to large rivers with moderate to fast currents, which was characterized as bins 3/4. As described in the section “Approach to the Effects Analysis” from 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 EECs, thus overestimating potential exposure. Further investigation by EPA into Bin 3 and 4 estimated environmental concentrations indicate 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. While the heavy pigtoe also occupies other aquatic habitats that may be exposed to potentially high levels of malathion due to lower volume in those habitats (Bin 2), their potential exposure risk is at least partially lowered based on their reliance upon the larger flowing aquatic habitats (Bin 3 and 4), reducing the overall risk to the species as a whole.

Species host (unknown) occurs in Bins 3 and 4. See Risk Assumptions (above) for risk to host species.

Mussels depend on a host fish to accomplish their reproductive lifecycle. Glochidia that do not attach to a host fish will not survive. We anticipate reproduction of mussels would be reduced in areas with insufficient fish hosts available. The mussel glochidia fish host relationship can be categorized into several different categories that capture the breadth of the type of mussel-host relationships such as generalists, specialists, or unknown fish host species. We anticipate that variable numbers of individual host fish may be affected over the duration of the proposed action, some of which would result in local extirpations of these mussel species in their highly isolated and fragmented populations, and we would expect species-level effects to these mussels to occur in the absence of mitigating factors. There is no information currently available regarding which fish species the heavy pigtoe relies on for glochidia attachment. Given the lack of information we have regarding the age, size at maturity, or appropriate host fish species, we anticipate a high risk is warranted.

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 to Host Fish associated with bin (H, M, L) |
|----------------------------|------------------------------|------------------------|--------------|---------------------------------------|--------------|--|---|
| | | Acres | % | Acres | % | | |
| Mosquito Control | | 755,459 | 22 | 38,381 | 1.12 | 2,3,4 | 2H 3M 4M |
| Developed | I | 41,283 | 1.20 | 2,064 | 0.06 | 2,3,4 | 2M 3M 4M |
| Open Space Developed | I | 143,137 | 4.16 | 7,157 | 0.21 | 2,3,4 | 2H 3H 4H |
| Corn | I | 34,450 | 1 | 2,384 | 0.07 | 2,3,4 | 2H 3H 4H |
| Pasture | I | 2.37 | 0.000 069 | 1.3 | 0.000 038 | 2,3,4 | 2H 3H 4H |
| Wheat | I | 1,751 | 0.051 | 1,833 | 0.05 | 2,3,4 | 2H 3M 4M |
| Vegetables and Groundfruit | I | 171 | 0.005 | 153 | 0.004 | 2,3,4 | 2H 3H 4H |
| Cotton | I | 38,854 | 1.13 | 16,030 | 0.47 | 2,3,4 | 2H 3H 4H |
| Nurseries | I | 183 | 0.005 | 183 | 0.005 | 2,3,4 | 2H 3H |

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 to Host Fish associated with bin (H, M, L) |
|--|------------------------------|------------------------|-----------|---------------------------------------|-------|--|---|
| | | Acres | % | Acres | % | | |
| | | | | | | | 4H |
| Orchards & Vineyards | I | 762 | 0.022 | 295 | 0.009 | 2,3,4 | 2H 3H 4H |
| Other Crops | I | 81,214 | 2.36 | 184 | 0.005 | 2,3,4 | 2H 3M 4M |
| Other Grains | I | 707 | 0.02 | 707 | 0.02 | 2,3,4 | 2H 3H 4H |
| Other Row Crops | I | 3,460 | 0.10 | 1,819 | 0.05 | 2,3,4 | 3H 4H |
| Rice | I | 1.27 | 0.000 037 | 0 | 0 | 2,3,4 | |
| Sub-TOTAL (I): <i>Other uses with indirect effects³</i> | | 345,976 | 10 | 32,810 | 0.95 | | |
| TOTAL³: | | 1,101,435 | 32 | 71,191 | 2.07 | | |

[^]We consider the Bin 2 estimates as an upper bound of Bin 3 & 4 exposures. The estimated environmental concentrations for a Bin 2 water are an order of magnitude greater than Bins 3 and 4; therefore concentrations in Bins 3 and 4 can be reduced by a correction factor of 10.

Exposure Modifiers:

A reassessment of crop UDL showed that usage data in the “Other Row Crops” may be overestimated. This UDL is composed of sunflower, peanuts, tobacco, sugar beets, and hops, of which, only hops is a registered use site on malathion labels and is thus the only crop in this layer that is relevant in our analysis. USDA data shows that 96% of hops are grown in the Pacific Northwest region (Idaho, Oregon, and Washington), with some small farms in Florida reporting occasional hop production. Given the highly specific regions that hops are grown in, we can assume that the potential exposure to malathion from “other row crops” use sites is 0 outside the areas indicated above, and is thus not relevant to this species.

³ TOTAL includes usage on all use sites with effects, including mosquito control.

acres in species range: 3,440,488 acres

% of range in California (i.e., where CalPUR data is available): 0%

Range overlap with Federal lands: 6,025 acres, 0.175%

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 groundfruit lower the maximum allowable number of applications to 2-4 per year (depending on the specific crop). 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.

Species specific measures: In addition to the general label changes that would apply to all uses specified on the label, which would be protective of a wide range of species, the registrants have also agreed to additional conservation measures, such as additional application buffers. The following species-specific measures are now part of the Action and will be included in *BulletinsLive! Two*:

The following has been specified for agricultural uses within the range of the heavy pigtoe:

Do not apply aerially within 100ft (or 50ft if a full swath displacement is used) of low flow habitats (as defined with input from FWS Field Office staff) for cotton application.

The following has been specified for mosquito control measures within the range of the heavy pigtoe:

Where feasible, avoid application. If avoidance is not feasible or impairs the ability of the mosquito control district or agency to protect the public's health and welfare, coordinate with the local FWS Ecological Services field office to determine appropriate measures to minimize exposure and to ensure the proposed application is likely to have no more than minor effects on the species (FWS points of contact and maps of designated critical habitat are available through the Information, Planning, and Consultation (IPaC) website <https://ecos.fws.gov/ipac/>). The applicator must retain documentation of the technical assistance and the agreed upon species-specific measures that were implemented.

Application buffers, which specify on the label a distance from use limitation areas where pesticides are not to be applied, are designed to reduce spray drift from entering sensitive non-target areas, thereby providing protection to species. While the exact amount of spray drift reduction will vary depending on traits of the ecosystem (e.g. flow rate, volume, etc.) as well as the application method, based on AgDRIFT modeling we can expect spray drift reductions ranging from 82 to 90%.

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 heavy pigtoe. As discussed below, even though the species vulnerability is high and risk to the species host fish is medium, we anticipate the likelihood of exposure of host fish to malathion is low, and the implementation of the general conservation measures and species-specific measures described above is expected to further reduce the likelihood of exposure. Additionally, since our draft Opinion in February 2021, EPA provided additional information regarding EECs in aquatic Bins 3 and 4. The heavy pigtoe prefers swift moving streams represented by Bin 4 and we anticipate that exposure to malathion was likely previously overestimated. Thus, risk to this species' host fish(es) is medium and for this species, remains unknown, we anticipate the likelihood of exposure to malathion is low in

these habitats, due to dilution in Bins 3 and 4, and further mitigated through the conservation measures detailed above.

The heavy pigtoe has a high vulnerability based on its status, distribution, and trends. Mortality and sublethal effects to the species are not anticipated. The risk to the species host fish posed by labeled uses across the range is medium to high, and where individual host fish are exposed, we anticipate medium to high levels of mortality, though we anticipate a reduced likelihood of exposure, as described above. Mussels depend on host fish to accomplish their reproductive lifecycle. Glochidia (larval stage) are released into the water and within a few days they must attach to an appropriate species of fish, which they parasitize for a short time while they develop into juvenile mussels. Glochidia that do not attach to a host fish will not survive.

We anticipate usage within the non-Federal portion of the species' range will be low (2.07%), based primarily on the 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 Biological Opinion. Where sufficient numbers of suitable host fish are not available, we anticipate reproduction of mussels would be reduced.

The species range, and thus this species host fish range, is very large (>3.4 million acres) and we do not anticipate that host fish would necessarily be found in the affected areas of the waterbodies near application sites when malathion is applied, although small numbers of host fish may occur in these areas and be exposed over the duration of the proposed action. The mosquito adulticide usage within the range is very low (1.12%). Reductions in plankton could be high in localized areas, however, we anticipate additional food resources from upstream sources would quickly recolonize after an application event. In addition, we anticipate that the conservation measures above, including rain restrictions, aquatic habitat buffers, residential use label changes, reduced number of applications and rates on certain use sites, and species-specific measures, will further reduce the risk of exposure to the mussels' host fish.

As stated previously, conservation measures are expected to reduce the amount of malathion runoff and spray drift that enter into sensitive habitats (e.g., species habitat, aquatic environments). For example, by placing a 48-hour rain restriction on agricultural applications, malathion has the ability to degrade after application (e.g., by hydrolysis, other processes) prior to any rain/runoff events, thus minimizing malathion runoff into aquatic habitats and decreasing exposure to listed mussels and their host fish. Increasing application buffers reduces the amount of malathion that drifts off target and subsequently into non-target environments. In addition, changes to residential labels limits applications to spot treatments and reduces the number of applications per year (2-4), significantly decreasing the overall amounts of malathion used in residential areas and resulting amounts of runoff and drift. Additional reductions in the number of applications and rates allowed for certain crops (e.g., corn, vegetables and ground fruit) further reduces the amount of malathion used in agricultural settings, thereby decreasing potential exposure to the species and their host fish. Species-specific measures for agricultural uses (application buffer on low-flow habitats) and mosquito adulticide applications (avoid applications within low flow areas; or implement other conservation measures with collaboration with FWS) will further reduce malathion exposure to this species.

The main use driver for this species is mosquito control. As a result, to reduce anticipated exposure and resultant mortality from mosquito uses, a conservation measure will be implemented that restricts this use within the range of the mussel. More specifically, use will be prohibited within the low flow areas where malathion concentrations are expected to be highest. If applications are needed to control mosquitos in these areas, such as due to a public health threat, the applicator must contact the local FWS field office to determine alternative measures to minimize exposure and ensure the proposed application is likely to have no more than minor effects on the species. Discussions at the local level may allow for greater flexibility and less restrictive measures based on site- or species-specific considerations, such as specific timing, species life history, and geographic or habitat factors. Coordination with FWS on measures to minimize exposure to listed species, including avoidance, is a recognized practice by mosquito control professionals. In its 2021 Best Practices for Integrated Mosquito Management, the American Mosquito Control Association (AMCA) instructs applicators with listed species in their treatment area to coordinate with FWS prior to application and maintain records of interactions. Discussions with the AMCA and anecdotal reports from FWS field offices indicate that this type of coordination is presently occurring to varying degrees for mosquito control applications in general. Applicators subject to this conservation measure will be required to maintain records of their interactions with FWS offices, allowing EPA to better track this coordination and its outcomes moving forward.

Combined, we expect that these conservation measures will substantially reduce exposure to the heavy pigtoe and their host fish. Thus, while we anticipate small numbers of individual host fish will be lost over the duration of the action, resulting in very small reductions in reproductive success, we do not anticipate species-level effects to this mussel species.

Therefore, we anticipate that the proposed action would not appreciably reduce survival and recovery of the heavy pigtoe in the wild.

Conclusion: Is not likely to jeopardize.

Integration and Synthesis Summary: Bivalves

| Scientific Name: | Common Name: | Entity ID: |
|-------------------------------|-----------------------|-------------------|
| <i>Elliptio steinstansana</i> | Tar River spinymussel | 351 |

Family: Unionidae

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:

Current available information indicates the species is endemic to both the Tar River and Neuse River systems in North Carolina (North Carolina Wildlife Resources Commission's (NCWRC) 1999; NCWRC freshwater mussel survey data base (NCWRC database 2014); Sarah McRae, North Carolina Natural Heritage Program (NCNHP) personal communication, 2010). In the Tar River system, the species has been documented only from the mainstem of the Tar River and a few of its tributaries, Shocco Creek, Fishing Creek, Little Fishing Creek, Swift Creek, and Sandy Creek – Sandy Creek is a headwater stream forming Swift Creek (NCWRC data base 2014). In the Neuse River system, the species has been documented from the mainstem of the Little River

(NCWRC database 2014; McRae personal communication, 2010), as well as the mainstem of the Neuse River (J Smith, NC Museum of Natural Sciences, pers. comm., 2014).

Monitoring and other surveys for the Tar River spinymussel have documented a continued decline in nearly all of the surviving populations of the species (NCWRC database 2014). Based on the most recent survey data from the NCWRC's database, the species may be extirpated from the mainstem of the Tar River (last observation was two live individuals in 2001; no live or shells were found during surveys in 2002, 2007, or 2013) and Shocco Creek (last and only record was a shell found in 1993, many surveys since have not located the species) (NCWRC database 2014). Surveys in Swift Creek from 1987-2002 found a total of 353 spinymussels (61 live (some likely duplicative records of the same individual found on multiple surveys, as individuals were not tagged) and 292 shells), yet only one individual was found during surveys in Swift Creek in 2005 and none during surveys since (covering 2006-2014) (NCWRC database 2014; C Eads, pers. comm., 2014); in addition, none have been recorded from Sandy Creek since 1988 (NCWRC database 2014). A total of 67 individuals have been observed in Little Fishing Creek, during surveys from 1993-2014 (some potential duplicative records; NCWRC database 2014; C Eads, pers. comm., 2014); only a total of 7 individuals in Fishing Creek during surveys from 1999-2014 (NCWRC database 2014, C Eads, pers. comm., 2014). A total of only 4 individuals

have ever been recorded from the Little River (Neuse River basin) – one each in 1998, 2005, 2010, and 2011; repeated surveys since have not recorded any additional specimens (NCRWC database 2014; T Savidge, pers. comm., 2010). Only two unusually large specimens have been documented from the mainstem of the Neuse River (R Nichols and J Smith, pers. comm., 2014).

Additional surveys are needed to determine the status of the Tar River spiny mussel in the mainstem of the Tar River, Shocco Creek, and the mainstem of the Neuse River; however, based on all available information there is no evidence of reproduction and recruitment within these populations and all three populations may now be extirpated. More intensive survey efforts are needed in the Sandy/Swift Creek basin to determine if the species continues to persist. Although limited levels of reproduction and recruitment may be occurring within the Little Fishing Creek/Fishing Creek and the Little River populations, the amount of recruitment occurring does not appear to be at levels high enough to maintain these populations. All of these populations appear to be at extremely low levels. Because there are so few individuals, the proximity of males and females may be limiting their reproductive success.

We have evidence that all of the surviving populations continue to be threatened by many of the same factors identified in Service's revised recovery plan for the species as leading to the loss and decline of the species throughout significant portions of its historic range and threats to surviving populations, including habitat fragmentation, loss, and alteration resulting from impoundments, wastewater discharges, loss of forested lands and riparian buffers, and the runoff of silt and other pollutants from ground disturbance activities. For example, despite repeated surveys, no live individuals of the species have been observed in the Sandy/Swift Creek watershed since 2005. This can be attributed to the cumulative effects of multiple threats - the pesticide-induced die off, drought, and large scale clearing of timber within the watershed. The Neuse River basin population(s) will likely face development-related pressures as several Wake County municipalities (e.g., Raleigh, Rolesville, Zebulon and Wendell) expand and grow. If the water supply reservoir and wastewater discharge on the Little River in Wake County are pursued, the population in the Little River will be under imminent threat from decreased flows and chemical contaminants from discharged effluent. Water quality continues to be an issue affecting habitat quality, as freshwater mussels are some of the most sensitive forms of aquatic life to toxicity of common pollutants in surface waters, such as ammonia, chlorine, chloride, copper, nickel, lead, potassium, sulfate, and zinc (Augspurger et al. 2003; Wang et al. 2007a, 2007b, 2010). Recent studies indicate that Tar River spiny mussels are sensitive to contaminants (T. Augspurger, pers. comm. 2014), thus pollutants are important to consider in managing Tar River spiny mussel populations."

EB/CE Source: U.S. Fish and Wildlife Service (FWS). 2020. Tar River Spiny mussel (*Elliptio steinstansana*) 5-Year Review: Summary and Evaluation. Raleigh Ecological Services Field Office. Raleigh, North Carolina. 44 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 expect the Tar River spiny mussel will experience direct mortality or sublethal effects from any malathion uses at the maximum rates for all bins (2, 3, 4). However, risk of mortality to the host fish for bin 2 is high for all use sites except developed where it is medium.

We do not expect mussel species to be directly impacted by exposure from malathion. However their lifecycle is such that when glochidia (larval stage) are released into the water, within a few days they must attach to an appropriate species of fish, which they parasitize for a short time while they develop into juvenile mussels in order to complete their lifecycle; they cannot complete their lifecycle without a fish host.

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.

| | |
|--|---|
| DIRECT (all uses except mosquito control) | |
| Use areas – mortality | No effects expected |
| Sublethal – growth (G), reproduction (R) and behavior (B) enzyme (E) | No effects expected |
| INDIRECT (all uses except mosquito control) | |
| Use areas - Prey item mortality | If plankton: H If detritus: NA |
| Use areas – Fish Host | Total overlap: 14.04%, H for most uses, M for developed |
| MOSQUITO CONTROL | |
| Direct (mortality) | No effects expected |
| Sublethal | No effects expected |
| Indirect | Total overlap: 46.75%, H |

Risk modifiers:

From USFWS (2014): This species continues to have a very fragmented, relict distribution. Suitable habitat for the Tar River spiny mussel appears to be extremely limited throughout the species' range. From USFWS (1993): The preferred habitat of *E. steinstansana* in Swift Creek was described by Alderman (1989) as relatively fast-flowing, well-oxygenated, circumneutral pH water in sites prone to significant swings in water velocity, with a substrate comprised of relatively silt-free, uncompacted gravel and/or coarse sand.

Within the "Approach to the Effects Analysis" section of the main body of the Opinion, we stated that specific considerations were made for species that occur in Bins 3 and 4 and that 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 Bin 3

and 4 estimated environmental concentrations indicate 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. While the Tar River spiny mussel also occupies other aquatic habitats that may be exposed to potentially high levels of malathion due to lower volume in those habitats (Bin 2), their potential exposure risk is at least partially lowered based on their reliance upon the larger flowing aquatic habitats (Bin 3 and 4), reducing the overall risk to the species as a whole.

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 to Host Fish associated with bin (H, M, L) |
|---------------------------|------------------------------|------------------------|-------|---------------------------------------|------|--|---|
| | | Acres | % | | | | |
| Mosquito Control | I | 1485666 | 46.75 | 0 | 0 | 2,3,4 | 2H 3 4 |
| Cotton | I | 113953 | 3.59 | 8304 | 0.26 | 2,3,4 | 2H 3 4 |
| Developed | I | 88910 | 2.8 | 4445 | 0.14 | 2,3,4 | 2M 3 4 |
| Corn | I | 84130 | 2.65 | 2267 | 0.07 | 2,3,4 | 2H 3 4 |
| Other Crops | I | 56857 | 1.79 | 0 | 0 | 2,3,4 | 2H 3 4 |
| Vegetables & Ground Fruit | I | 23626 | 0.74 | 4062 | 0.13 | 2,3,4 | 2H 3 4 |
| Wheat | I | 9146 | 0.29 | 1336 | 0.04 | 2,3,4 | 2H |

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 to Host Fish associated with bin (H, M, L) |
|--|------------------------------|------------------------|--------|---------------------------------------|--------|--|---|
| | | Acres | % | | | | |
| | | | | | | | 3 4 |
| Other grains | I | 6460 | 0.2 | 1517 | 0.05 | 2,3,4 | 2H 3 4 |
| Nurseries | I | 858 | 0.03 | 858 | 0.03 | 2,3,4 | 2H 3 4 |
| Other Row Crops | I | 55128 | 1.73 | 4331 | 0.14 | 2,3,4 | 2H 3 4 |
| Orchards and Vineyards | I | 620 | 0.02 | 67 | 0.01 | 2,3,4 | 2H 3 4 |
| Pasture | I | 50 | < 0.01 | 34 | < 0.01 | 2,3,4 | 2H 3 4 |
| Christmas trees | I | <1 | < 0.01 | <1 | < 0.01 | 2,3,4 | 2H 3 4 |
| Sub-TOTAL (I): <i>Other uses with indirect effects³</i> | | 439,739 | 14.04 | 27,222 | 0.89 | | |
| TOTAL³: | | 1,925,405 | 60.8 | 27,222 | 0.89 | | |

[^]We consider the Bin 2 estimates as an upper bound of Bin 3 & 4 exposures. The estimated environmental concentrations for a Bin 2 water are an order of magnitude greater than Bins 3 and 4; therefore concentrations in Bins 3 and 4 can be reduced by a correction factor of 10.

Exposure Modifiers:

A reassessment of our crop use data layers shows that within the “Other Row Crops” layer shows that usage in this category may be overestimated. This UDL is composed of sunflower, peanuts, tobacco, sugar beets, and hops, of which, only hops is a registered use site on malathion labels and is thus the only crop in this layer that is relevant in our analysis. USDA data shows that 96% of hops are grown in the Pacific Northwest region (in Idaho, Oregon, and Washington), with

³ TOTAL includes usage on all use sites with effects, including mosquito control.

some small farms in Florida reporting occasional hop production. Given the highly specific regions that hops are grown in, we can assume that potential exposure to malathion from “other row crops” use sites is 0 outside of these areas, and is thus not relevant to this species.

acres in species range: 3,177,860 acres

% of range in California (i.e., where CalPUR data is available): 0%

Range overlap with Federal lands: 3,244 acres, 0.102%

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 groundfruit lower the maximum allowable number of applications to 2-4 per year (depending on the specific crop). 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 Tar River spiny mussel. As discussed below, even though the species vulnerability is high and risk to the species host fish is high, we anticipate the likelihood of exposure of host fish to malathion is low, and the implementation of the general conservation measures described above is expected to further reduce the likelihood of exposure.

The Tar River spiny mussel has a high vulnerability based on its status, distribution, and trends. Mortality and sublethal effects to the species are not anticipated. The risk to the species host fish posed by labeled uses across the range is high, and where individual host fish are exposed, we anticipate high to medium levels of mortality, depending on water body size and use type. Mussels depend on host fish to accomplish their reproductive lifecycle. Glochidia (larval stage) are released into the water and within a few days they must attach to an appropriate species of fish, which they parasitize for a short time while they develop into juvenile mussels. Glochidia that do not attach to a host fish will not survive. Where sufficient numbers of suitable host fish are not available, we anticipate reproduction of mussels would be reduced.

We anticipate usage within the non-Federal portion of the species' range will be low (0.89%), based primarily on the 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 Biological Opinion.

The species range, and thus this species host fish range, is very large (>3.17 million acres) and we do not anticipate that host fish would necessarily be found in the affected areas of the waterbodies near application sites when malathion is applied, although small numbers of host fish may occur in these areas and be exposed over the duration of the proposed action. Reductions in plankton could be high in localized areas, however, we anticipate additional food resources from upstream sources would quickly recolonize after an application event. In addition, we anticipate that the conservation measures above, including rain restrictions, aquatic habitat buffers, residential use label changes, and reduced number of applications and rates on certain use sites, will further reduce the risk of exposure to plankton and the mussels' host fish.

As stated previously, conservation measures are aimed at reducing the amount of malathion runoff and spray drift that enter into sensitive habitats (e.g., species habitat, aquatic environments). For example, by placing a 48-hour rain restriction on agricultural applications,

malathion has the ability to degrade after application (e.g., by hydrolysis, other processes) prior to any rain/runoff events, thus minimizing malathion runoff into aquatic habitats and decreasing exposure to listed mussels and their host fish. Increasing application buffers reduces the amount of malathion that drifts off target and subsequently into non-target environments. In addition, changes to residential labels limits applications to spot treatments and reduces the number of applications per year (2-4), significantly decreasing the overall amounts of malathion used in residential areas and resulting amounts of runoff and drift. Additional reductions in the number of applications and rates allowed for certain crops (e.g., corn, vegetables and ground fruit) further reduces the amount of malathion used in agricultural settings, thereby decreasing potential exposure to the species and their host fish. Combined, these conservation measures substantially reduce exposure to the Tar River spiny mussel and their host fish and therefore minimizes overall risk and adverse effects to the species. Thus, while we anticipate small numbers of individual host fish would be lost over the duration of the action, resulting in very small reductions in reproductive success, we do not anticipate species-level effects to this mussel species.

Therefore, we anticipate that the proposed action would not appreciably reduce survival and recovery of the Tar River spiny mussel in the wild.

Conclusion: Is not likely to jeopardize.

Integration and Synthesis Summary: Bivalves

| Scientific Name: | Common Name: | Entity ID: |
|-------------------------|---------------------|-------------------|
| <i>Pleurobema clava</i> | Clubshell | 352 |

Family: Unionidae

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 clubshell was listed as endangered in 1993. Historical and/or current clubshell records are known from Alabama, Illinois, Indiana, Kentucky, Michigan, New York, Ohio, Pennsylvania, Tennessee and West Virginia. In addition to its presence in the streams detailed in the Recovery Plan, the clubshell has also been observed in Cassadaga Creek, New York, and Muddy Creek and Tionesta Creek, Pennsylvania.

At the time of listing, the clubshell was thought to be extant in 12 streams: the Tippecanoe River, Kosciusko, Fulton, Pulaskia, and Tippecanoe Counties, Indiana; Fish Creek of the St. Josephs River, Williams County, Ohio, and DeKalb County, Indiana; West Branch of the St. Josephs River, Williams County, Ohio, and Hillsdale County, Michigan; Walhonding River, Coshocton County, Ohio; East Fork of the West Branch of the St. Josephs River, Hillsdale County, Michigan; Little Darby Creek, Madison County, Ohio; Allegheny River, Warren and Forest Counties, Pennsylvania; French Creek, Crawford, Venango, and Mercer Counties, Pennsylvania; Conneauttee Creek of French Creek, Crawford County, Pennsylvania; LeBoeuf Creek, Erie County, Pennsylvania; Elk River, Braxton and Clay Counties, West Virginia; and Green River, Edmonson and Hart Counties, Kentucky.

Currently, clubshells appear to be restricted to 13 populations in the Ohio River and Lake Erie Basins. Portions of 21 streams support, or might still support, the species. Evidence of recent successful recruitment has been reported in 10 streams: the Allegheny River, French Creek, LeBoeuf Creek, Muddy Creek, Tippecanoe River, Middle Branch of the North Fork Vermilion River, Green River, Elk River, Little Darby Creek, and Shenango River. In several streams, clubshell populations appear to comprise only older adults, and the populations are in decline and possibly extirpated: East Fork of the West Branch St. Joseph River, Fish Creek, Hackers Creek, Walhonding River, Cassadaga Creek, Pymatuning Creek, Conneaut Outlet, and Conneauttee Creek.

Clubshells have been moved from the Allegheny River to several streams (including in New York, Pennsylvania, West Virginia, Ohio, Kentucky, Indiana, and Illinois) in the historical range of the species to augment existing populations or reintroduce the species to increase redundancy and species recovery. These relocations occurred from 2014 to 2018, and no evidence of successful recruitment has been documented; however, juvenile clubshells take several years to reach a size that is likely to be detected.

Ongoing threats to the clubshell include water quality degradation from point and non-point sources, particularly in small tributaries that have limited capability to dilute and assimilate sewage, agricultural runoff, and other pollutants. In addition, the species is affected by hydrologic and water quality alterations resulting from the operation of impoundments such as Union City Reservoir on French Creek, Green River Reservoir on the Green River, Pymatuning Reservoir on the Shenango River, Kinzua Dam on the Allegheny River, and Sutton Dam on the Elk River. The presence of impoundments may have ameliorated the effects of downstream siltation on clubshell, but these structures also control river discharges (and the many environmental parameters influenced by discharge), which may profoundly affect the ability of these populations to occupy or successfully reproduce in downstream habitats.

A variety of instream activities continues to threaten clubshell populations, including sand and gravel dredging, gravel bar removal, bridge construction, and pipeline construction. Protecting clubshell populations from the direct physical disturbance of these activities depends on accurately identifying the location of the populations, which is difficult with a cryptic species such as clubshell. The indirect effects of altering the streambed configuration following instream disturbance can result in long-lasting alteration of streamflow patterns that may result in head-cutting and channel reconfiguration, thereby eliminating previously suitable habitat some distance from the disturbance.

Coal, oil, and natural gas resources are present in a number of the watersheds that are known to support clubshell, including the Allegheny River, Hackers Creek, Meathouse Fork, and the Elk River. Exploration and extraction of these energy resources can result in increased siltation, a changed hydrograph, and altered water quality even at a distance from the mine or well field. Clubshell populations in smaller streams are more vulnerable to these resource extraction activities, which can account for a much larger percentage of a small watershed. However, clubshell habitat in larger streams can also be threatened by the cumulative effects of a large number of mines and well fields.

Land-based development near streams of occurrence, including residential development and agriculture, often results in loss of riparian habitat, increased storm water runoff due to increased impervious surfaces, increased sedimentation due to loss of streamside vegetation, and subsequent degradation of streambanks. Because clubshells often live below the gravel surface, this species may be exceptionally sensitive to the increased siltation that these activities generate. The clubshell in Little Darby Creek on the western side of the City of Columbus is an example of a population threatened by development, while Hackers Creek, Pymatuning Creek, and Meathouse Fork appear to be strongly influenced by agriculture.

Development has also resulted in an increased number of sewage treatment plants in drainages that support clubshell as well as an increase in the amount of sewage discharged from existing

plants. Mounting evidence indicates that freshwater mussels are more sensitive to several components of treated sewage effluent (e.g., ammonia, chlorine and copper) than are the typical organisms used to establish criteria protective of aquatic life. Small streams, such as Conneaut Outlet, are particularly vulnerable to sewage effluent, which can comprise a significant portion of the total stream flow.

This species, like many mussels, is susceptible to permanent, temporary, and intermittent forms of environmental degradation. Reduced populations may take several decades to recover, even if no further degradation occurs."

EB/CE Source: U.S. Fish and Wildlife Service (FWS). 2019. Clubshell (*Pleurobema clava*) 5-Year Review: Summary and Evaluation. Pennsylvania Ecological Services Field Office. State College, Pennsylvania. 34 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 expect the Clubshell will experience direct mortality or sublethal effects from any malathion uses at the maximum rates for all bins (2, 3, 4, 6, 7). . However, risk of mortality to the host fish for bin 2 is high for all use sites except developed where it is medium. Risk of mortality to individuals in bin 7 is medium for all uses except for corn, developed, wheat, and mosquito control which are low. Risk of mortality to individuals in bin 6 is low for developed, medium for mosquito control, corn, and wheat, other crops, other grains, and high for the remaining uses.

We do not expect mussel species to be directly impacted by exposure from malathion. However their lifecycle is such that when glochidia (larval stage) are released into the water, within a few days they must attach to an appropriate species of fish, which they parasitize for a short time while they develop into juvenile mussels in order to complete their lifecycle; they cannot complete their lifecycle without a fish host.

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.

| | |
|--|---------------------|
| DIRECT (all uses except mosquito control) | |
| Use areas – mortality | No effects expected |
| Sublethal – growth (G), reproduction (R) and behavior (B) enzyme (E) | No effects expected |
| INDIRECT (all uses except mosquito control) | |

| | |
|---------------------------------|--|
| Use areas - Prey item mortality | If plankton: M, H, depending on the bin If detritus: NA |
| Use areas – Fish Host | Total overlap: 15%, H M for most uses L for developed |
| MOSQUITO CONTROL | |
| Direct (mortality) | No effects expected |
| Sublethal | No effects expected |
| Indirect | Total overlap: 13.8%, H M L depending on the bin |

Risk modifiers: It is found mostly in sand and fine gravel, and is deeply buried. Hoggarth (pers. comm.) and Watters (unpublished) have found live individuals completely buried with the posterior shell margin facing up in sand/gravel substrate in riffle/run situations in less than 1.5 feet of water. This seems to be the habitat of choice. This species is generally found in clean, coarse sand and gravel in runs, often just downstream of a riffle, and cannot tolerate mud or slackwater conditions (USFWS, 1994). The environmental specificity is moderate (generalist or community with some key requirements scarce). Separation barriers between standing water bodies and within flowing water systems include lack of lotic connections, natural barriers such as upland habitat, absence of appropriate species specific fish hosts, water depth greater than 10 meters (Cvancara, 1972; Moyle and Bacon, 1969) or anthropogenic barriers to water flow such as dams or other impoundments and high waterfalls (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. Further investigation by EPA into Bin 3 and 4 estimated environmental concentrations indicate 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. While the clubshell also occupies other aquatic habitats that may be exposed to potentially high levels of malathion due to lower volume in those habitats (Bin 2), their potential exposure risk is at least partially lowered based on their reliance upon larger flowing and static aquatic habitats (Bins 3, 4, 6, and 7), reducing the overall risk to the species as a whole.

The Clubshell is considered a fish host generalist whose glochidia can metamorphosize on a wide variety of fishes from multiple families. While we anticipate some species of the host fish community will exhibit temporary reductions in abundance due to malathion exposure, the species’ flexible host requirement will allow the species to be more resilient to temporary losses of host fish, reducing the anticipated indirect 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 to Host Fish associated with bin (H, M, L) |
|---------------------------|------------------------------|------------------------|-------|---------------------------------------|------|--|---|
| | | Acres | % | Acres | % | | |
| Mosquito Control | I | 5,071,419 | 13.8 | 130,245 | 0.35 | 2,3,4,6,7 | 2H 3 4 6M 7L |
| Corn | I | 3,777,589 | 10.28 | 57,698 | 0.16 | 2,3,4,6,7 | 2H 3 4 6M 7L |
| Developed | I | 1,191,731 | 3.24 | 59,587 | 0.16 | 2,3,4,6,7 | 2M 3 4 6L 7L |
| Wheat | I | 219,192 | 0.6 | 40,486 | 0.11 | 2,3,4,6,7 | 2H 3 4 6M 7L |
| Pasture | I | 170,518 | 0.46 | 58,582 | 0.16 | 2,3,4,6,7 | 2H 3 4 6H 7M |
| Other Crops | I | 71,758 | 0.2 | 0 | 0 | 2,3,4,6,7 | 2H 3 4 6M 7M |
| Vegetables & Ground Fruit | I | 16,283 | 0.04 | 4,989 | 0.01 | 2,3,4,6,7 | 2H 3 4 6H 7M |

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 to Host Fish associated with bin (H, M, L) |
|--|------------------------------|------------------------|--------|---------------------------------------|--------|--|---|
| | | Acres | % | Acres | % | | |
| Orchards & Vineyards | I | 16,207 | 0.04 | 1,352 | < 0.01 | 2,3,4,6,7 | 2H 3 4 6H 7M |
| Other grains | I | 15,355 | 0.04 | 6,905 | 0.02 | 2,3,4,6,7 | 2H 3 4 6M 7M |
| Other Row Crops | I | 13,943 | 0.04 | 656 | < 0.01 | 2,3,4,6,7 | 2H 3 4 6H 7M |
| Cotton | I | 3813 | 0.01 | 3611 | <0.01 | 2,3,4,6,7 | 2H 3 4 6H 7M |
| Nurseries | I | 6303 | 0.02 | 6303 | 0.02 | 2,3,4,6,7 | 2H 3 4 6H 7M |
| Christmas Trees | I | 179 | < 0.01 | 163 | < 0.01 | 2,3,4,6,7 | 2H 3 4 6H 7M |
| Sub-TOTAL (I): <i>Other uses with indirect effects³</i> | | 436,942 | 15 | 240,332 | 0.68 | | |
| TOTAL³: | | 5,508,361 | 28.8 | 370,577 | 1.03 | | |

³ TOTAL includes usage on all use sites with effects, including mosquito control.

^We consider the Bin 2 estimates as an upper bound of Bin 3 & 4 exposures. The estimated environmental concentrations for a Bin 2 water are an order of magnitude greater than Bins 3 and 4, therefore concentrations in Bins 3 and 4 can be reduced by a correction factor of 10.

Exposure Modifiers:

A reassessment of our crop use data layers shows that within the “Other Row Crops” layer shows that usage in this category may be overestimated. This UDL is composed of sunflower, peanuts, tobacco, sugar beets, and hops, of which, only hops is a registered use site on malathion labels and is thus the only crop in this layer that is relevant in our analysis. USDA data shows that 96% of hops are grown in the Pacific Northwest region (in Idaho, Oregon, and Washington), with some small farms in Florida reporting occasional hop production. Given the highly specific regions that hops are grown in, we can assume that potential exposure to malathion from “other row crops” use sites is 0 outside of these areas, and thus is not relevant to this species.

acres in species range: 36,753,579 acres

% of range in California (i.e., where CalPUR data is available): 0%

Range overlap with Federal lands: 1,065,580 acres, 2.899%

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 groundfruit lower the maximum allowable number of applications to 2-4 per year (depending on the specific crop). 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 clubshell. As discussed below, even though the species vulnerability is high and risk to the species host fish is high, we anticipate the likelihood of exposure of host fish to malathion is low, and the implementation of the general conservation measures described above is expected to further reduce the likelihood of exposure.

The clubshell has a high vulnerability based on its status, distribution, and trends. Mortality and sublethal effects to the species are not anticipated. The risk to the species host fish posed by labeled uses across the range is medium, and where individual host fish are exposed, we anticipate variable levels of mortality, depending on water body size and use type. Mussels depend on host fish to accomplish their reproductive lifecycle. Glochidia (larval stage) are released into the water and within a few days they must attach to an appropriate species of fish, which they parasitize for a short time while they develop into juvenile mussels. Glochidia that do not attach to a host fish will not survive. Where sufficient numbers of suitable host fish are not available, we anticipate reproduction of mussels would be reduced.

We anticipate usage within the non-Federal portion of the species’ range will be low (1.03%), based primarily on the 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 Biological Opinion.

The species range, and thus this species host fish range, is very large (>36 million acres) and we do not anticipate that host fish would necessarily be found in the affected areas of the waterbodies near application sites when malathion is applied, although small numbers of host

fish may occur in these areas and be exposed over the duration of the proposed action. Reductions in plankton could be high in localized areas, however, we anticipate additional food resources from upstream sources would quickly recolonize after an application event. In addition, we anticipate that the conservation measures above, including rain restrictions, aquatic habitat buffers, residential use label changes, and reduced number of applications and rates on certain use sites, will further reduce the risk of exposure to plankton and the mussels' host fish.

As stated previously, conservation measures are aimed at reducing the amount of malathion runoff and spray drift that enter into sensitive habitats (e.g., species habitat, aquatic environments). For example, by placing a 48-hour rain restriction on agricultural applications, malathion has the ability to degrade after application (e.g., by hydrolysis, other processes) prior to any rain/runoff events, thus minimizing malathion runoff into aquatic habitats and decreasing exposure to listed mussels and their host fish. Increasing application buffers reduces the amount of malathion that drifts off target and subsequently into non-target environments. In addition, changes to residential labels limits applications to spot treatments and reduces the number of applications per year (2-4), significantly decreasing the overall amounts of malathion used in residential areas and resulting amounts of runoff and drift. Additional reductions in the number of applications and rates allowed for certain crops (e.g., corn, vegetables and ground fruit) further reduces the amount of malathion used in agricultural settings, thereby decreasing potential exposure to the species and their host fish. Combined, these conservation measures substantially reduce exposure to the clubshell and their host fish and therefore minimizes overall risk and adverse effects to the species. Thus, while we anticipate small numbers of individual host fish would be lost over the duration of the action, resulting in very small reductions in reproductive success, we do not anticipate species-level effects to this mussel species.

Therefore, we anticipate that the proposed action would not appreciably reduce survival and recovery of the clubshell in the wild.

Conclusion: Is not likely to jeopardize.

Integration and Synthesis Summary: Bivalves

| Scientific Name: | Common Name: | Entity ID: |
|---------------------------------|---------------------|-------------------|
| <i>Alasmidonta atropurpurea</i> | Cumberland elktoe | 355 |

Family: Unionidae

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 Cumberland elktoe is limited in distribution to the upper Cumberland River system in southeast Kentucky and north-central Tennessee, occupying streams both above and below Cumberland Falls. This species appears to have occurred only in the mainstem of the Cumberland River and primarily its southern tributaries upstream from Cumberland Falls near Burnside, Pulaski County, Kentucky.

Based on information from the Recovery Plan (2004), populations of the Cumberland elktoe persist in 12 tributaries: Laurel Fork, Claiborne County, Tennessee and Whitley County, Kentucky; Marsh Creek, McCreary County, Kentucky; Sinking Creek, Laurel County, Kentucky; Big South Fork, Scott County, Tennessee and McCreary County, Kentucky; Rock Creek, McCreary County, Kentucky; North White Oak Creek, Fentress County, Tennessee; Clear Fork, Fentress, Morgan and Scott Counties, Tennessee; North Prong Clear Fork, Fentress County, Tennessee; Crooked Creek, Fentress County, Tennessee; White Oak Creek, Scott County, Tennessee; Bone Camp Creek, Morgan County, Tennessee; and New River, Scott County, Tennessee. The latter nine streams, which comprise the Big South Fork system, may represent a single, viable metapopulation of the Cumberland elktoe. In 2005, a fresh dead specimen was found in Jellico Creek in Kentucky (Cicerello, pers. comm., 2006) which is a new occurrence for this creek.

Marsh Creek harbors the largest population known in Kentucky (Cicerello, pers. comm., 2006). The population in Rock Creek is also sizable (Cicerello, pers. comm., 2006). The largest populations in Tennessee are in the Big South Fork system in the headwaters of Clear Fork. Good recruitment occurs within the Marsh Creek, Rock Creek, and Big South Fork system populations. The Laurel Fork and Sinking Creek populations are much smaller and it is harder to find individuals to determine recruitment levels.

Oil, gas, and coal exploration and development are on the increase in the New River watershed (Steve Bakaletz, National Park Service biologist, pers. comm., 2006). The New River is a major tributary to the Big South Fork that influences the quality of the Cumberland elk toe habitat. The potential negative impacts to mussels and their habitat will have to be monitored closely as exploration and development increase. We have an ongoing project that is looking at the sediment toxicity in the Big South Fork system. The results of this study are not available yet.

There are no known additional habitat threats to the Cumberland elktote populations in Rock, Sinking, Marsh and Laurel Fork Creeks beyond the ones listed in the Recovery Plan." "The Recovery Plan listed the presence or potential introduction of alien species (especially zebra mussels and black carp), insufficient densities of host fish species, inbreeding depression and other genetic considerations, and possible weak links in the species' life cycles. We have no new information on any of these issues."

EB/CE Source: U.S. Fish and Wildlife Service (FWS). 2015. Cumberland Elktote (*Alasmidonta atropurpurea*, Rafinesque, 1831) 5-Year Review: Summary and Evaluation. Cookeville Ecological Services Field Office. Cookeville, Tennessee. 15 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 expect the Cumberland elktote will experience direct mortality or sublethal effects from any malathion uses at the maximum rates for all bins (2, 3, 4, 6, 7). However, risk of mortality to the host fish for bin 2 is high for all use sites except developed where it is medium. Risk of mortality to individuals in bin 7 is medium for all uses except for developed and mosquito control which are low. Risk of mortality to individuals in bin 6 is high for all other uses except medium for mosquito control, wheat, and corn, and low for developed.

We do not expect mussel species to be directly impacted by exposure from malathion. However their lifecycle is such that when glochidia (larval stage) are released into the water, within a few days they must attach to an appropriate species of fish, which they parasitize for a short time while they develop into juvenile mussels in order to complete their lifecycle; they cannot complete their lifecycle without a fish host.

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.

| DIRECT (all uses except mosquito control) | |
|---|---------------------|
| Use areas – mortality | No effects expected |

| | |
|--|---|
| Sublethal – growth (G), reproduction (R) and behavior (B) enzyme (E) | No effects expected |
| INDIRECT (all uses except mosquito control) | |
| Use areas - Prey item mortality | If plankton: H, except for developed is LMH depending on the bin If detritus: NA |
| Use areas – Fish Host | Total overlap: 3.02%, H M for most uses L for developed |
| MOSQUITO CONTROL | |
| Direct (mortality) | No effects expected |
| Sublethal | No effects expected |
| Indirect | Total overlap: 4.20%, H M L depending on the bin |

Risk modifiers:

The Cumberland elktoe is reliant on the following species as fish hosts: northern hogsucker (*Hypentelium nigricans*), banded sculpin (*Cottus carolinae*), redline darter (*Etheostoma rufilineatum*), and fantail darter (*Etheostoma flabellare*).

Adult mussels are ideally found in localized patches (beds) in streams, almost completely burrowed in the substrate with only the area around the siphons exposed (Balfour and Smock 1995). The composition and abundance of mussels are directly linked to bed sediment distributions (Vannote and Minshall 1982, Neves and Widlak 1987, Leff et al. 1990, Strayer 1997). Physical qualities of the sediment (e.g., texture, particle size) may be important in allowing the mussels to firmly burrow in the substrate (Lewis and Riebel 1984). The Cumberland elktoe inhabits medium-sized rivers and may extend into headwater streams where it is often the only mussel present (Gordon and Layzer 1989, Gordon 1991). Gordon and Layzer (1989) reported that the species appears to be most abundant in flats, which were described by Gordon (1991) as shallow pool areas lacking the bottom contour development of typical pools, with sand and scattered cobble/boulder material, relatively shallow depths, and slow (almost imperceptible) currents. They also report the species from swifter currents and in areas with mud, sand, and gravel substrates.

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. Further investigation by EPA into Bin 3 and 4 estimated environmental concentrations indicate 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. While Cumberland elktoe also occupies other aquatic habitats that may be exposed to potentially high levels of malathion due to lower volume in those habitats (Bin 2), their potential exposure risk is at least partially lowered based on their reliance upon larger flowing and static aquatic habitats (Bins 3, 4, 6, and 7), reducing the overall risk to the species as a whole.

The Cumberland elktoe is considered a fish host generalist whose glochidia can metamorphosize on a wide variety of fishes from multiple families. While we anticipate some species of the host fish community will exhibit temporary reductions in abundance due to malathion exposure, the species' flexible host requirement will allow the species to be more resilient to temporary losses of host fish, reducing the anticipated indirect 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 to Host Fish associated with bin (H, M, L) |
|------------------|------------------------------|------------------------|------|---------------------------------------|------|--|---|
| | | Acres | % | | | | |
| Mosquito Control | I | 172,057 | 4.2 | 0 | 0 | 2,3,4,6,7 | 2H 3 4 6M 7L |
| Developed | I | 92,737 | 2.26 | 4,637 | 0.11 | 2,3,4,6,7 | 2M 3 4 6L 7L |
| Corn | I | 25,597 | 0.62 | 4,298 | 0.1 | 2,3,4,6,7 | 2H 3 4 6M 7M |
| Wheat | I | 1,287 | 0.03 | 561 | 0.01 | 2,3,4,6,7 | 2H 3 4 6M 7M |

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 to Host Fish associated with bin (H, M, L) |
|---|------------------------------|------------------------|--------|---------------------------------------|--------|--|---|
| | | Acres | % | | | | |
| Pasture | I | 1,189 | 0.03 | 799 | 0.02 | 2,3,4,6,7 | 2H 3 4 6H 7M |
| Nurseries | I | 647 | 0.02 | 647 | 0.02 | 2,3,4,6,7 | 2H 3 4 6H 7M |
| Other Crops | I | 566 | 0.01 | 0 | <0.01 | 2,3,4,6,7 | 2H 3 4 6H 7M |
| Other Row Crops | I | 298 | < 0.01 | 298 | < 0.01 | 2,3,4,6,7 | 2H 3 4 6H 7M |
| Vegetables & Ground Fruit | I | 188 | < 0.01 | 164 | < 0.01 | 2,3,4,6,7 | 2H 3 4 6H 7M |
| Other Grains | I | 112 | < 0.01 | 112 | < 0.01 | 2,3,4,6,7 | 2H 3 4 6H 7M |
| Cotton | I | 4 | < 0.01 | 0 | 0 | 2,3,4,6,7 | 2H 3 4 6H 7M |
| Orchards & Vineyards | I | 1 | < 0.01 | 1 | < 0.01 | 2,3,4,6,7 | 2H 3 4 6H 7M |
| Sub-TOTAL (I): <i>Other uses with indirect effects</i> ³ | | 122,626 | 3.02 | 11,518 | 0.32 | | |

| Use type | Risk to species ¹ | Use overlap with range | | Estimated usage in range ² | | Bins associated with use type [^] | Effect to Host Fish associated with bin (H, M, L) |
|----------------------|------------------------------|------------------------|------|---------------------------------------|------|--|---|
| | | Acres | % | | | | |
| TOTAL ³ : | | 294,683 | 7.22 | 11,518 | 0.32 | | |

[^]We consider the Bin 2 estimates as an upper bound of Bin 3 & 4 exposures. The estimated environmental concentrations for a Bin 2 water are an order of magnitude greater than Bins 3 and 4; therefore concentrations in Bins 3 and 4 can be reduced by a correction factor of 10.

Exposure Modifiers:

A reassessment of our crop use data layers shows that within the “Other Row Crops” layer shows that usage in this category may be overestimated. This UDL is composed of sunflower, peanuts, tobacco, sugar beets, and hops, of which, only hops is a registered use site on malathion labels and is thus the only crop in this layer that is relevant in our analysis. USDA data shows that 96% of hops are grown in the Pacific Northwest region (in Idaho, Oregon, and Washington), with some small farms in Florida reporting occasional hop production. Given the highly specific regions that hops are grown in, we can assume that potential exposure to malathion from “other row crops” use sites is 0 outside of these areas, and thus is not relevant to this species.

acres in species range: 4,098,636 acres

% of range in California (i.e., where CalPUR data is available): 0%

Range overlap with Federal lands: 1,063,666 acres, 25.952%

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 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.

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, is not likely to jeopardize the continued existence of the Cumberland elktoe. As discussed below, even though the species vulnerability is high and risk to the species host fish is medium, we anticipate the likelihood of exposure of host fish to malathion is low, and the implementation of the general conservation measures described above is expected to further reduce the likelihood of exposure.

The Cumberland elktoe has a high vulnerability based on its status, distribution, and trends. Mortality and sublethal effects to the species are not anticipated. The risk to the species host fish posed by labeled uses across the range is medium and where individual host fish are exposed, we anticipate variable levels of mortality, depending on water body size and use type. Mussels depend on host fish to accomplish their reproductive lifecycle. Glochidia (larval stage) are released into the water and within a few days they must attach to an appropriate species of fish, which they parasitize for a short time while they develop into juvenile mussels. Glochidia that do

not attach to a host fish will not survive. Where sufficient numbers of suitable host fish are not available, we anticipate reproduction of mussels would be reduced.

We anticipate usage within the non-Federal portion of the species' range will be low (0.32%), based primarily on the 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 Biological Opinion.

The species range, and thus this species host fish range, is very large (>4.1 million acres) and we do not anticipate that host fish would necessarily be found in the affected areas of the waterbodies near application sites when malathion is applied, although small numbers of host fish may occur in these areas and be exposed over the duration of the proposed action. Reductions in plankton could be high in localized areas, however, we anticipate additional food resources from upstream sources would quickly recolonize after an application event. In addition, we anticipate that the conservation measures above, including rain restrictions, aquatic habitat buffers, and residential use label changes, will further reduce the risk of exposure to plankton and the mussels' host fish.

As stated previously, conservation measures are aimed at reducing the amount of malathion runoff and spray drift that enter into sensitive habitats (e.g., species habitat, aquatic environments). For example, by placing a 48-hour rain restriction on agricultural applications, malathion has the ability to degrade after application (e.g., by hydrolysis, other processes) prior to any rain/runoff events, thus minimizing malathion runoff into aquatic habitats and decreasing exposure to listed mussels and their host fish. Increasing application buffers reduces the amount of malathion that drifts off target and subsequently into non-target environments. In addition, changes to residential labels limits applications to spot treatments and reduces the number of applications per year (2-4), significantly decreasing the overall amounts of malathion used in residential areas and resulting amounts of runoff and drift. Additional reductions in the number of applications and rates allowed for certain crops (e.g., corn, vegetables and ground fruit) further reduces the amount of malathion used in agricultural settings, thereby decreasing potential exposure to the species and their host fish. Combined, these conservation measures substantially reduce exposure to the Cumberland elktoe and their host fish and therefore minimizes overall risk and adverse effects to the species. Thus, while we anticipate small numbers of individual host fish would be lost over the duration of the action, resulting in very small reductions in reproductive success, we do not anticipate species-level effects to this mussel species.

Therefore, we anticipate that the proposed action would not appreciably reduce survival and recovery of the Cumberland elktoe in the wild.

Conclusion: Is not likely to jeopardize.

Integration and Synthesis Summary: Bivalves

| Scientific Name: | Common Name: | Entity ID: |
|-----------------------|-----------------------|------------|
| <i>Hemistena lata</i> | Cracking pearlymussel | 359 |

Family: Unionidae

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:

From the 2019 5-Year Review: The Cracking Pearlymussel historically occurred in much of the Ohio River system, including the mainstem and major tributaries in Alabama, Illinois, Indiana, Kentucky, Ohio, Pennsylvania, Tennessee, and Virginia (Watters et al. 2009, Williams et al. 2008, Parmalee and Bogan 1998). It has been extirpated from nearly all of its historical range; most extirpations occurred decades ago (Watters et al. 2009, Haag and Cicerello 2016). The population in the Powell River, listed as extant in the 1991 Recovery Plan, is now considered extirpated (Jones 2019, pers. comm.). The species is currently believed to be extant only in the Tennessee River basin in a short reach of the Elk River near the Alabama and Tennessee state line and a short reach of the Clinch River near the Tennessee and Virginia state line (Jones et al. 2018, Haag and Cicerello 2016, Williams et al. 2008).

Successful propagation is necessary to augment existing populations and reestablish the species in other streams within its historical range. However, species propagation has had limited success to date. Propagation techniques and understanding of the reproductive biology must be in response to mussel losses from a chemical spill in 1998, the Virginia Department of Game and Inland Fisheries' Aquatic Wildlife Conservation Center and the Virginia Polytechnic Institute and State University's Freshwater Mollusk Conservation Center propagated the species and produced juvenile mussels of 34 freshwater mussel species to release into the Clinch and Powell Rivers (Hyde and Jones -2019). None of the 148 individual Cracking Pearlymussels produced from 2010-2018 survived to six months. The facility is currently in the middle of a two-year propagation study and has had some preliminary success (Lane 2019, pers. comm.). The Tennessee Wildlife Resources Agency's Cumberland River Aquatic Center successfully propagated Cracking Pearly mussel in 2019; 18 of 278 individuals had survived 4 to 5 months at the time of this review (Hua 2019, pers. comm.). Additional research is needed to refine propagation techniques to support recovery actions.

Propagation work has established that Cracking Pearlymussel is a short-term brooder and can have multiple broods (Lane 2019, pers. comm.). When the larvae are developed, the females release white, flattened conglutinates (gelatinous or mucous masses containing glochidia) (Lane 2019, pers. comm.). Some progress has been made in identifying the species' fish hosts. Laboratory host fish trials by researchers at Virginia Polytechnic Institute and State University documented marginal success with Banded Sculpin (*Cottus carolinae*), Central Stoneroller (*Campostoma anomalum*), Whitetail Shiner (*Cyprinella galactura*), Streamline Chub (*Erimystax dissimilis*), and Fantail Darter (*Etheostoma flabellare*) (Jones et al. 2003). Other species tested in those trials did not successfully transform juvenile Cracking Pearlymussels. The Tennessee Wildlife Resources Agency's Cumberland River Aquatic Center successfully propagated Cracking Pearlymussel in 2019 using Logperch (*Percina caprodes*) and Greenside Darter as hosts (Hua 2019, pers. comm.). The Virginia Department of Game and Inland Fisheries' Aquatic Wildlife Conservation Center is currently in the middle of a two-year study to further investigate fish host suitability for the species and has had some preliminary success (Lane 2019, pers. comm.).

FWS (2011) page 20-21 ... "Over the past five years, biologists working in the Clinch River upstream from Norris Lake in Tennessee have reported the presence of increasing amounts of coal fines in the river. There have been no obvious adverse effects to the mussels in the Tennessee reach of the river to date, but malacologists report declines in overall mussel numbers, including the birdwing, dromedary, and cracking pearlymussels, in the Virginia reach. Impacts from increased mining activity in the upper Clinch River drainage could eventually have adverse effects on the best known populations of the dromedary pearlymussel and cracking pearlymussel. The population of the birdwing pearlymussel in the Clinch River will also be affected. The final listing rule for the cracking pearlymussel indicates that Factor A (present or threatened destruction, modification, or curtailment of its habitat or range) is a major factor in the endangered status of the species." FWS (2011) page 24 ... "The cracking pearlymussel populations in the Powell River and Clinch River are likely declining due to sedimentation (i.e., coal fines). The population in the mainstem Tennessee River is declining due to development, reservoir operations, and pollution. Although the population in the Elk River is apparently reproducing, it is being affected by agricultural operations and reservoir operations."

EB/CE Source: U.S. Fish and Wildlife Service (FWS). 2011. Birdwing pearlymussel (*Conradilla caelata* [= *Lemiox rimosus*]), Dromedary pearlymussel (*Dromus dromas*), Cracking pearlymussel (*Hemistena lata*) 5-Year Review: Summary and Evaluation. Cookeville Ecological Services Field Office.

U.S. Fish and Wildlife Service. 2019. Cracking pearlymussel (*Hemistena lata*) 5-Year Review: Summary and Evaluation. Tennessee Ecological Services Field Office, Cookeville, Tennessee. 28 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 expect the cracking pearly mussel will experience direct mortality or sublethal effects from any malathion uses at the maximum rates for all bins (3, 4). We use Bin 2 as an upper bound estimate for Bins 3 and 4 and risk of mortality to the host fish for bin 2 is high for all use sites except developed where it is medium.

We do not expect mussel species to be directly impacted by exposure from malathion. However their lifecycle is such that when glochidia (larval stage) are released into the water, within a few days they must attach to an appropriate species of fish, which they parasitize for a short time while they develop into juvenile mussels in order to complete their lifecycle; they cannot complete their lifecycle without a fish host.

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.

| | |
|--|--|
| DIRECT (all uses except mosquito control) | |
| Use areas – mortality | No effects expected |
| Sublethal – growth (G), reproduction (R) and behavior (B) enzyme (E) | No effects expected |
| INDIRECT (all uses except mosquito control) | |
| Use areas - Prey item mortality | If plankton: H If detritus: NA |
| Use areas – Fish Host | Total overlap: 4.38%, H, M for developed |
| MOSQUITO CONTROL | |
| Direct (mortality) | No effects expected |
| Sublethal | No effects expected |
| Indirect | Total overlap: 7.34%, H |

Risk modifiers:

This species inhabits cobble, gravel, sand, and sometimes mud substrate in medium to large rivers of the Ohio River basin (USFWS 2011). Separation barriers between standing water bodies and within flowing water systems include lack of lotic connections, natural barriers such as upland habitat, absence of appropriate species-specific fish hosts, water depth greater than 10 meters (Cvancara, 1972; Moyle and Bacon, 1969) or anthropogenic barriers to water flow such as dams or other impoundments and high waterfalls (NatureServe 2015).

In the “Approach to the Effects Analysis” section of the main body of the Opinion, we stated that specific considerations were made for species that occur in Bins 3 and 4 and that 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 Bin 3

and 4 estimated environmental concentrations indicate 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.

Mussels depend on a host fish to accomplish their reproductive lifecycle. Glochidia that do not attach to a host fish will not survive. We anticipate reproduction of mussels would be reduced in areas where there are insufficient host fish available. Mussels can be categorized into several different categories that capture the breadth of the type of mussel-host relationships, including host fish generalists, host fish specialists, and those for which the host fish are unknown. While the fish hosts for the cracking pearlymussel in the wild are still unknown, laboratory host fish trials have shown marginal success with transforming glochidia into larval mussels with a number of host fish species, including the banded sculpin (*Cottus carolinae*), central stoneroller (*Campostoma anomalum*), whitetail shiner (*Cyprinella galactura*), streamline chub (*Erimystax dissimilis*), fantail darter (*Etheostoma flabellare*), logperch (*Percina caprodes*), and greenside darters (Jones et al. 2003; Hua 2019, pers. comm), suggesting that the cracking pearlymussel might be a host fish generalist. Because fish species exhibit a range of sensitivities to malathion, exposure is expected to have varying effects upon these different fish species, thus malathion would have variable impacts to the mussels that parasitize the fish. Data on the sensitivities of these specific fish host species to malathion is not available, however toxicity data from other fish species suggests that some species may be more tolerant to malathion exposure than others. Therefore, exposure is expected to reduce the abundance of host fish, but not completely eliminate the range of species to which glochidia can attach. Any reductions in fish hosts from malathion exposure are likely to be temporary and would be a function of application frequency, with community recovery over a short period of time. Thus, we anticipate malathion to pose a medium risk to the cracking pearlymussel.

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 to Host Fish associated with bin (H, M, L) |
|------------------|------------------------------|------------------------|--------|---------------------------------------|--------|--|---|
| | | Acres | % | | | | |
| Mosquito Control | I | 441,937 | 7.34 | 290,400 | 4.82 | 2,3,4 | 2H 3 4 |
| Developed | I | 147,428 | 2.45 | 7,371 | 0.12 | 2,3,4 | 2M 3 4 |
| Corn | I | 88,560 | 1.47 | 3,256 | 0.05 | 2,3,4 | 2H 3 4 |
| Cotton | I | 19,112 | 0.32 | 14,025 | 0.23 | 2,3,4 | 2H 3 4 |
| Other Crops | I | 2,799 | 0.05 | 0 | 0 | 2,3,4 | 2H 3 4 |
| Other Grains | I | 1,999 | 0.03 | 1,227 | 0.02 | 2,3,4 | 2H 3 4 |
| Wheat | I | 1,948 | 0.03 | 512 | < 0.01 | 2,3,4 | 2H 3 4 |
| Other Row Crops | I | 155 | 0.003 | 150 | 0.002 | 2,3,4 | 2H 3 4 |
| Nurseries | I | 708 | 0.01 | 708 | 0.01 | 2,3,4 | 2H 3 4 |
| Pasture | I | 256 | < 0.01 | 256 | < 0.01 | 2,3,4 | 2H 3 |

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 to Host Fish associated with bin (H, M, L) |
|--|------------------------------|------------------------|--------|---------------------------------------|--------|--|---|
| | | Acres | % | | | | |
| | | | | | | | 4 |
| Vegetables & Ground Fruit | I | 167 | < 0.01 | 157 | < 0.01 | 2,3,4 | 2H 3 4 |
| Orchards & Vineyards | I | 22 | < 0.01 | 22 | < 0.01 | 2,3,4 | 2H 3 4 |
| Christmas trees | I | 1 | < 0.01 | 1 | < 0.01 | 2,3,4 | 2H 3 4 |
| Sub-TOTAL (I): <i>Other uses with indirect effects³</i> | | 263,155 | 4.38 | 27,685 | 0.48 | | |
| TOTAL³: | | 705,092 | 11.7 | 318,085 | 5.3 | | |

[^]We consider the Bin 2 estimates as an upper bound of Bin 3 & 4 exposures. The estimated environmental concentrations for a Bin 2 water are an order of magnitude greater than Bins 3 and 4; therefore concentrations in Bins 3 and 4 can be reduced by a correction factor of 10.

Exposure modifiers:

A reassessment of our crop use data layers shows that within the “Other Row Crops” layer shows that usage in this category may be overestimated. This UDL is composed of sunflower, peanuts, tobacco, sugar beets, and hops, of which, only hops is a registered use site on malathion labels and is thus the only crop in this layer that is relevant in our analysis. USDA data shows that 96% of hops are grown in the Pacific Northwest region (in Idaho, Oregon, and Washington), with some small farms in Florida reporting occasional hop production. Given the highly specific regions that hops are grown in, we can assume that potential exposure to malathion from “other row crops” use sites is 0 outside of these areas, and thus is not relevant to this species.

acres in species range: 6,022,717 acres

% of range in California (i.e., where CalPUR data is available): 0%

Range overlap with Federal lands: 425,534 acres, 7.065%

Overall Usage: ☐ High ☒ Medium ☐ Low

³ TOTAL includes usage on all use sites with effects, including mosquito control.

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 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 significantly 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 significantly 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 initial residues to degrade prior to the next application. In addition, exposure to aquatic organisms is reduced due to buffers from waterways 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 groundfruit lower the maximum allowable number of applications to 2-4 per year (depending on the specific crop). 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 cracking pearlymussel. As discussed below, even though the species vulnerability is high and risk to the species host fish is medium, we anticipate the likelihood of exposure of host fish to malathion is low. Since our draft Opinion in February 2021, EPA provided additional information regarding EECs in aquatic Bins 3 and 4. The cracking pearlymussel prefers a variety of habitats, including larger and faster moving streams represented by Bins 3 and 4 and we anticipate that exposure to malathion was likely previously overestimated for Bins 3 and 4. Thus, we anticipate the likelihood of exposure to malathion is reduced, due to dilution in Bins 3 and 4, and further mitigated through the implementation of the general conservation measures described above.

The cracking pearlymussel has a high vulnerability based on its status, distribution, and trends. Mortality and sublethal effects to the species are not anticipated. The risk to the species host fish posed by labeled uses across the range is medium, and where individual host fish are exposed, we anticipate medium levels of mortality, depending on application frequency and species of host fish. Mussels depend on host fish to accomplish their reproductive lifecycle. Glochidia (larval stage) are released into the water and within a few days they must attach to an appropriate species of fish, which they parasitize for a short time while they develop into juvenile mussels. Glochidia that do not attach to a host fish will not survive. Where sufficient numbers of suitable host fish are not available, we anticipate reproduction of mussels would be reduced.

We anticipate usage within the non-Federal portion of the species' range will be medium (5.3%), based primarily on the 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 Biological Opinion.

The species is highly vulnerable, as there are only two extant populations, threats to the species remain, and propagation efforts have had only limited success to date. Research in captive breeding efforts have identified marginally successful host fishes including banded sculpin (*Cottus carolinae*), central stoneroller (*Camptostoma anomalum*), Whitetail shiner (*Cyprinella galactura*), streamline chub (*Erimystax dissimilis*), and fantail darter (*Etheostoma flabellare*) (Jones *et al.* 2003). Both *Percina caprodes* (logperch) and *Etheostoma blennioides* (greenside darter) have also been identified as successful host species for captive propagated cracking pearlymussel. While all of these species are relatively common and do not have widespread conservation concerns, we do not have high resolution data on their relative abundances in the range of the cracking pearlymussel or their relative proportion or selection in serving as host fishes. However, as the species is currently limited to a few small isolated river reaches and propagation efforts have been limited, we anticipate localized reductions in the availability of suitable host fish would result in reduced successful reproduction for this species.

Moderate levels of malathion usage (4.82%) are used for mosquito adulticide within the range of the cracking pearlymussel. The species is currently believed to be extant only in the Tennessee River basin in a short reach of the Elk River near the Alabama and Tennessee state line and a short reach of the Clinch River near the Tennessee and Virginia state line (Jones *et al.* 2018, Hagg and Cicerello 2016, Williams *et al.* 2008); areas of which are only a portion of the species overall range. Based on available usage data for mosquito adulticide applications, we are not aware of malathion use in recent years within these two localized areas; although future use

cannot be ruled out. However, it is important to note that malathion is typically used to reduce resistance to the more commonly used insecticides for mosquito control, and if used in these two localized areas, we anticipate usage will be less than what is currently estimated for the range. Other usage across the range is anticipated to be 0.48%, therefore, usage occurring within these two localized areas will be significantly less. Although usage is anticipated to be extremely low within these two localized areas, small numbers of host fish may occur in these areas and be exposed over the duration of the proposed action. Reductions in plankton could be high in localized areas, however, we anticipate additional food resources from upstream sources would quickly recolonize after an application event. In addition, we anticipate that the conservation measures above, including rain restrictions, aquatic habitat buffers, and residential use label changes, will further reduce the risk of exposure to plankton and the mussels' host fish.

As stated previously, conservation measures are aimed at reducing the amount of malathion runoff and spray drift that enter into sensitive habitats (e.g., species habitat, aquatic environments). For example, by placing a 48-hour rain restriction on agricultural applications, malathion has the ability to degrade after application (e.g., by hydrolysis, other processes) prior to any rain/runoff events, thus minimizing malathion runoff into aquatic habitats and decreasing exposure to listed mussels and their host fish. Increasing application buffers reduces the amount of malathion that drifts off target and subsequently into non-target environments. In addition, changes to residential labels limits applications to spot treatments and reduces the number of applications per year (2-4), significantly decreasing the overall amounts of malathion used in residential areas and resulting amounts of runoff and drift. Additional reductions in the number of applications and rates allowed for certain crops (e.g., corn, vegetables and ground fruit) further reduces the amount of malathion used in agricultural settings, thereby decreasing potential exposure to the species and their host fish. Combined, these conservation measures substantially reduce exposure to the cracking pearlymussel and their host fish in the large aquatic waterbodies in which they occur and therefore minimizes overall risk and adverse effects to the species. Thus, we anticipate small numbers of individual host fish will experience low levels of adverse effects either from exposure to malathion or via a loss of prey resources, and very small numbers of mussels will experience low levels of adverse effects due to small reductions of prey items (plankton/zooplankton) over the duration of the action. However, for the reasons described above, we do not anticipate that these adverse effects would have population- or species-level effects. Therefore, we anticipate that the proposed action would not appreciably reduce survival and recovery of the cracking pearlymussel in the wild.

Conclusion: Is not likely to jeopardize.

ADDITIONAL REFERENCES

Services Field Office.

U.S. Fish and Wildlife Service. 2019. Cracking pearlymussel (*Hemistena lata*) 5-Year Review: Summary and Evaluation. Tennessee Ecological Services Field Office, Cookeville, Tennessee. 28 pp.

Integration and Synthesis Summary: Bivalves

| Scientific Name: | Common Name: | Entity ID: |
|----------------------------|---------------------|------------|
| <i>Lampsilis streckeri</i> | Speckled pocketbook | 360 |

Family: Unionidae

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:

The current distribution for Speckled Pocketbook is restricted to the Middle Fork Little Red River from the influence of Greers Ferry Reservoir upstream to the confluence of Little Red Creek (63 river miles (rmi)), the South Fork Little Red River extending from 0.5 rmi downstream of Arkansas Highway 95 upstream to near the western boundary of Gulf Mountain Wildlife Management Area and the Ozark National Forest (15 rmi), Archey Fork Little Red River from approximately one rmi upstream of Arkansas Highway 65 to the confluence of Castleberry Creek (16 rmi), lower Turkey Creek (2 rmi), and Beech Fork (11 rmi). The known range of Speckled Pocketbook in Big Creek includes the reach from Tylar Road to the western (also most downstream) boundary of Big Creek Natural Area.

All extant populations continue to appear stable. Based on 2008 – 2009 sampling at long-term monitoring sites, 59 individuals were collected in the South Fork, 34 individuals in the Archey Fork, 127 individuals in the Middle Fork, and 12 individuals in the Devils Fork complex (Turkey Creek and Beech Fork). Newly established long-term monitoring sites are expected to contribute to a better understanding of population trends. Populations in Archey and Middle forks have documented reproduction and recruitment, but natural recruitment rates and mortality rates are unknown.

Existing threats include sediment and other contaminants derived from a variety of land use practices (*i.e.*, nonpoint source pollutants) and water consumption for fracking natural gas wells (primarily in the South Fork and Big Creek watersheds). Natural gas infrastructure development has subsided substantially since circa 2012. It appears unlikely, at this time, that substantial development of mineral resources (*i.e.*, natural gas) will occur in the upper South Fork, mid to upper Middle Fork, Archey Fork, and upper Devils Fork watersheds due to insufficient quantities of natural gas for profitability. While threats posed by natural gas development in the watershed have subsided, sediment and other chemical contaminants derived from gravel and rock mining,

agricultural practices, and dirt and gravel road maintenance and construction appear to continue degrading suitable Speckled Pocketbook habitat.

A major threat at the time of listing was channelization of the lower Archey and South forks. With completion of the Archey Fork restoration project in 2014, this threat has been alleviated and suitable habitat for recolonization is present. The construction of Greers Ferry Reservoir resulted in the permanent loss of habitat and isolation of populations (Middle and Devils forks, Big Creek) due to inundation and cold tailwater releases downstream of the dam. Information on gene flow between populations and effective population size is lacking at this time. Fragmentation and isolation of small populations, particularly in Big Creek and the Devils Fork complex, may play a magnified role in population extirpation associated with stochastic events.

The life-history traits and habitat requirements of Speckled Pocketbook, and other freshwater mussels in general, make them extremely susceptible to environmental change. Unlike other aquatic organisms (e.g., aquatic insects and fish), mussels have limited refugia from stream disturbances (e.g., droughts, sedimentation, chemical contaminants). Mechanisms leading to Speckled Pocketbook imperilment range from local (e.g., riparian clearing, chemical contaminants, etc.), to regional influences (e.g., altered flow regimes, population isolation, etc.), to potentially global climate change. The synergistic (interaction of two or more components) effects of threats are often complex in aquatic environments, making it difficult to predict changes in mussel and fish host(s) distribution, abundance, and habitat availability that may result from these effects. While these stressors may act in isolation, it is more probable that many stressors are acting simultaneously (or in combination) (Galbraith et al. 2010) on Speckled Pocketbook populations."

EB/CE Source: U.S. Fish and Wildlife Service (FWS). 2021. 5-Year Review Speckled pocketbook (*Lampsilis streckeri*). Arkansas Ecological Services Field Office. Conway, Arkansas. 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 expect the speckled pocketbook will experience direct mortality or sublethal effects from any malathion uses at the maximum rates for all bins (2, 3, 4, 6, 7) . However, risk of mortality to the host fish for bin 2 is high for all use sites except developed where it is medium. Risk of mortality to host fish in bin 6 is low for developed, medium for mosquito control, wheat, other crops, corn, and high for all other uses. Risk of mortality to the host fish in bin 7 is low for mosquito control and developed, and medium for all other uses except for cotton which is high.

We do not expect mussel species to be directly impacted by exposure from malathion. However their lifecycle is such that when glochidia (larval stage) are released into the water, within a few

days they must attach to an appropriate species of fish, which they parasitize for a short time while they develop into juvenile mussels in order to complete their lifecycle; they cannot complete their lifecycle without a fish host.

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.

| | |
|--|---|
| DIRECT (all uses except mosquito control) | |
| Use areas – mortality | No effects expected |
| Sublethal – growth (G), reproduction (R) and behavior (B) enzyme (E) | No effects expected |
| INDIRECT (all uses except mosquito control) | |
| Use areas - Prey item mortality | If plankton: H If detritus: NA |
| Use areas – Fish Host | Total overlap: 1.01%, H, M, L all bins |
| MOSQUITO CONTROL | |
| Direct (mortality) | No effects expected |
| Sublethal | No effects expected |
| Indirect | Total overlap: 3.02%, H M L depending on the bin |

Risk modifiers:

Suitable habitat occurs in pools and runs with small to large boulders which have some accumulation of sand/gravel. Individuals are typically located in crevices between boulders or underneath perched boulders (Harris 1993; Winterringer 2003; C. Davidson pers. comm.) (USFWS 2015). The species is found in coarse to muddy sand in depths up to 0.4 meters (1.3 feet) with a constant flow of water. The occurrence in areas of constant water flow suggests a requirement for well-oxygenated conditions (USFWS 1991). The environmental specificity of this species is narrow, as it does not seem to be able to survive in slow current, pools, or stretches of river with intermittent flow.

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. Further investigation by EPA into Bin 3 and 4 estimated environmental concentrations indicate 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. While the speckled pocketbook also occupies other aquatic habitats that may be exposed to potentially high levels of malathion due to lower volume in those habitats (Bin 2), their potential exposure risk is at least partially lowered based on their reliance upon larger flowing and static aquatic habitats (Bins 3, 4, 6, and 7), reducing the overall risk to the species as a whole.

The Speckled pocketbook is considered a fish host generalist whose glochidia can metamorphosize on a wide variety of fishes from multiple families. While we anticipate some species of the host fish community will exhibit temporary reductions in abundance due to malathion exposure, the species' flexible host requirement will allow the species to be more resilient to temporary losses of host fish, reducing the anticipated indirect 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 to Host Fish associated with bin (H, M, L) |
|------------------|------------------------------|------------------------|--------|---------------------------------------|------|--|---|
| | | Acres | % | | | | |
| Mosquito Control | I | 40,536 | 3.02 | 0 | 0 | 2,3,4,6,7 | 2H 3 4 6M 7L |
| Developed | I | 12,067 | 0.9 | 603 | 0.04 | 2,3,4,6,7 | 2M 3 4 6L 7L |
| Wheat | I | 362 | 0.03 | 356 | 0.03 | 2,3,4,6,7 | 2H 3 4 6M 7L |
| Other Crops | I | 121 | < 0.01 | 0 | 0 | 2,3,4,6,7 | 2H 3 4 6M 7M |

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 to Host Fish associated with bin (H, M, L) |
|--|------------------------------|------------------------|--------|---------------------------------------|--------|--|---|
| | | Acres | % | | | | |
| Orchards and vineyards | I | 22 | < 0.01 | 19 | < 0.01 | 2,3,4,6,7 | 2H 3 4 6H 7M |
| Nurseries | I | 17 | < 0.01 | 17 | < 0.01 | 2,3,4,6,7 | 2H 3 4 6H 7M |
| Corn | I | 7 | < 0.01 | 2 | < 0.01 | 2,3,4,6,7 | 2H 3 4 6M 7M |
| Other Row Crops | I | <1 | < 0.01 | <1 | < 0.01 | 2,3,4,6,7 | 2H 3 4 6H 7M |
| Other Grains | I | 2 | < 0.01 | 2 | < 0.01 | 2,3,4,6,7 | 2H 3 4 6H 7M |
| Cotton | I | 1 | < 0.01 | 0 | 0 | 2,3,4,6,7 | 2H 3 4 6H 7H |
| Vegetables and Ground fruit | I | 1 | < 0.01 | 1 | < 0.01 | 2,3,4,6,7 | 2H 3 4 6H 7M |
| Sub-TOTAL (I): <i>Other uses with indirect effects³</i> | | 12,601 | 1.01 | 1,001 | 0.13 | | |

| Use type | Risk to species ¹ | Use overlap with range | | Estimated usage in range ² | | Bins associated with use type [^] | Effect to Host Fish associated with bin (H, M, L) |
|----------------------|------------------------------|------------------------|------|---------------------------------------|------|--|---|
| | | Acres | % | | | | |
| TOTAL ³ : | | 53,137 | 4.03 | 1,001 | 0.13 | | |

[^]We consider the Bin 2 estimates as an upper bound of Bin 3 & 4 exposures. The estimated environmental concentrations for a Bin 2 water are an order of magnitude greater than Bins 3 and 4; therefore concentrations in Bins 3 and 4 can be reduced by a correction factor of 10.

Exposure Modifiers:

A reassessment of our crop use data layers shows that within the “Other Row Crops” layer shows that usage in this category may be overestimated. This UDL is composed of sunflower, peanuts, tobacco, sugar beets, and hops, of which, only hops is a registered use site on malathion labels and is thus the only crop in this layer that is relevant in our analysis. USDA data shows that 96% of hops are grown in the Pacific Northwest region (in Idaho, Oregon, and Washington), with some small farms in Florida reporting occasional hop production. Given the highly specific regions that hops are grown in, we can assume that potential exposure to malathion from “other row crops” use sites is 0 outside of these areas and thus is not relevant to this species.

acres in species range: 1,341,346 acres

% of range in California (i.e., where CalPUR data is available): 0%

Range overlap with Federal lands: 123,937 acres, 9.240%

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.

³ 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, is not likely to jeopardize the continued existence of the speckled pocketbook. As discussed below, even though the species vulnerability is high and risk to the species host fish is medium, we anticipate the likelihood of exposure of host fish to malathion is low, and the implementation of the general conservation measures described above is expected to further reduce the likelihood of exposure.

The speckled pocketbook has a high vulnerability based on its status, distribution, and trends. Mortality and sublethal effects to the species are not anticipated. The risk to the species host fish posed by labeled uses across the range is medium, and where individual host fish are exposed, we anticipate variable levels of mortality, depending on water body size and use type. Mussels depend on host fish to accomplish their reproductive lifecycle. Glochidia (larval stage) are released into the water and within a few days they must attach to an appropriate species of fish, which they parasitize for a short time while they develop into juvenile mussels. Glochidia that do not attach to a host fish will not survive. Where sufficient numbers of suitable host fish are not available, we anticipate reproduction of mussels would be reduced.

We anticipate usage within the non-Federal portion of the species' range will be low (0.13%), based primarily on the 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 Biological Opinion.

The species range, and thus this species host fish range, is very large (>1.3 million acres) and we do not anticipate that host fish would necessarily be found in the affected areas of the waterbodies near application sites when malathion is applied, although small numbers of host fish may occur in these areas and be exposed over the duration of the proposed action. Reductions in plankton could be high in localized areas, however, we anticipate additional food resources from upstream sources would quickly recolonize after an application event. In addition, we anticipate that the conservation measures above, including rain restrictions, aquatic habitat buffers, and residential use label changes, will further reduce the risk of exposure to plankton and the mussels' host fish.

As stated previously, conservation measures are aimed at reducing the amount of malathion runoff and spray drift that enter into sensitive habitats (e.g., species habitat, aquatic environments). For example, by placing a 48-hour rain restriction on agricultural applications, malathion has the ability to degrade after application (e.g., by hydrolysis, other processes) prior to any rain/runoff events, thus minimizing malathion runoff into aquatic habitats and decreasing exposure to listed mussels and their host fish. Increasing application buffers reduces the amount of malathion that drifts off target and subsequently into non-target environments. In addition, changes to residential labels limits applications to spot treatments and reduces the number of applications per year (2-4), significantly decreasing the overall amounts of malathion used in residential areas and resulting amounts of runoff and drift. Combined, these conservation measures substantially reduce exposure to the speckled pocketbook and their host fish and therefore minimizes overall risk and adverse effects to the species. Thus, while we anticipate small numbers of individual host fish would be lost over the duration of the action, resulting in very small reductions in reproductive success, we do not anticipate species-level effects to this mussel species.

Therefore, we anticipate that the proposed action would not appreciably reduce survival and recovery of the speckled pocketbook in the wild.

Conclusion: Is not likely to jeopardize.

Integration and Synthesis Summary: Bivalves

| Scientific Name: | Common Name: | Entity ID: |
|------------------------------|---------------------|-------------------|
| <i>Alasmidonta heterodon</i> | Dwarf wedgemussel | 363 |

Family: Unionidae

VULNERABILITY

(Summary of status, environmental baseline and cumulative effects)

Status: Endangered

Distribution: Species/Populations neither constrained nor widespread

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:

Since the 2013 review, new information documenting the largest remaining dwarf wedgemussel populations have been reported in the Connecticut River Drainage Basin, including tributaries to the Middle Connecticut River (MA) and the Ashuelot River (NH). The Upper Connecticut River mainstem subpopulation in northern NH and VT, continues to have the largest remaining dwarf wedgemussel population. However, the lower two subpopulations have far fewer occupied sites with lower catch per unit estimates per site (generally less than 10 individuals). The lowest stretch of the main stem of the Connecticut River between VT and NH was considered to host one of the largest populations of the dwarf wedgemussel in its range. In the free-flowing reach downstream of Wilder dam, no live or dead dwarf wedgemussels were found at 39 survey sites in 2013. Other less common species associated with the dwarf wedgemussel were also extremely rare. The 2011 and 2013 field studies detected few dwarf wedgemussels in the upper Wilder and Bellows Falls impoundments, and almost always at very low densities. They were found at only about one-fourth of the sites in both impoundments, and where they were found, a typical survey lasting 1 to 2 hours usually detected fewer than two or three animals (TransCanada Hydro Northeast Inc. 2015). Big and Little Flat Brook and the Paulins Kill in NJ, as well as the Upper Fishing Creek in a portion of the Tar River Basin in NC, remain in healthy condition.

It appears as though many populations in the northern portion of the range (NH, MA, and CT) appear to be healthy, while populations in the Delaware River (NY/NJ) watershed may have been affected by flooding, with the most recent floods of 2011 to 2012, and are currently considered unknown. Additional studies are planned in the Neversink River in 2019, targeting another freshwater mussel, but will also assess Dwarf wedgemussel populations, if found, and in the Delaware River. The populations in NC, VA, MD are declining, as evidenced by low densities, lack of reproduction, and/or inability to locate any dwarf wedgemussels in follow-up surveys.

Although a few new sites have been discovered in MD, and NC, the prognosis for dwarf wedgemussel recovery in the southern portion of its range is not as positive as in the northern portion. Results from surveys in NC make it clear that populations are in decline and habitat is in low to moderate condition, due to beaver activity and development. All populations in the Neuse River Basin are in decline, as are most in the Upper Tar River drainage as discussed above. In 2015, North Carolina Water Resources Commission approved an augmentation proposal for captive propagation and stocking into the Neuse Basin, and in vitro propagation efforts are continuing for the Neuse and Tar Basins (S. McRae, *pers. comm.*).

The damming and channelization of rivers throughout the species' range has resulted in the elimination of much formerly occupied habitat. Dwarf wedgemussels, like all aquatic species, require a certain stream flow regime to persist. Among the greatest threats mussel species face is the alteration of the natural flow regime of a river or stream they occupy. Impoundments, flow diversions, water withdrawals, and other human activities may alter this flow regime. In the Delaware River, drought and an ever-increasing demand for water in New York City and New Jersey can decrease available stream flow, threatening dwarf wedgemussel populations. Additionally, large storm events may trigger flooding in the basin and scour, bury, or relocate individual mussels or entire beds to downstream locations.

Siltation, generated by road construction, agriculture, forestry activities, and removal of streambank vegetation is considered to be an important factor in the decline of many freshwater mussel species, including the dwarf wedge mussel. The continuing decline and ultimate loss of the dwarf wedge mussel from most of its historical sites can best be explained by agricultural, domestic, and industrial pollution of its aquatic habitat. Mussels are known to be sensitive to potassium (a common pollutant associated with paper mills and irrigation return water), zinc, copper, cadmium, and other elements (Havlik and Marking 1987). Pesticides, chlorine, excessive nutrients, and silt carried by agricultural runoff also present a threat to this species. Salanki and Varanka (1978) found that insecticides have significant effects on mussels. Low concentrations of lindane (.006 g/l), phorate (.008 g/l), and trichlorfon (.02 g/l) caused a 50 percent reduction in siphoning activity, and 1 g/l phorate or 1 ml/l trichlorfon were lethal concentrations.

Blakesee *et al.* (2018) conducted semiquantitative surveys along 53.5 km (33 mi) of 121 km (75 mi) of the Delaware River in PA to document mussel community composition and identify impacts from pollution, elevated nutrients, metals, or sulfates. These authors looked specifically at inputs from the Lehigh River, which was severely polluted from acid mine drainage and domestic and industrial waste (e.g., 12 Superfund sites within the watershed). Changes in mussel mean catch per unit effort were found below the Lehigh River, with declines in *Elliptio complanata* (no dwarf wedgemussels were detected); however, no causative argument could be made between the decline and contaminants. They recommended additional investigation, including water quality surveys (Blakesee *et al.* 2018).

Hernandez *et al.* (2016) focused on establishing links between nitrogen pollution and imperiled biodiversity of federally listed species, including the dwarf wedgemussel. They found that 78 federally listed species (out of 1,400 species) were impacted by reactive nitrogen pollution through multiple pathways (e.g., direct toxicity, lethal effects). Direct toxicity or lethal effects of nitrogen were the primary pathway for effects to freshwater mussels. Inorganic nitrogen pollution is highly toxic to aquatic species. Ammonia (NH₃) toxicity in fish and invertebrates

may cause asphyxiation, reduction in blood oxygen, disruption of osmoregulatory activities in the liver and kidneys, repression of the immune system, and increased disease susceptibility (Hernandez *et al.* 2016).

Other threats affecting dwarf wedgemussels include invasive species (e.g., flathead catchfish; prey upon mussels and host fish), beaver dams (i.e., change flow regimes in suitable habitat), flood and drought, and climate change.

EB/CE Source: U.S. Fish and Wildlife Service (FWS). 2019. Dwarf Wedgemussel (Alasmidonta heterodon) 5-Year Review: Summary and Evaluation. New York Field Office. Cortland, NY. 47 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 expect the dwarf wedgemussel will experience direct mortality or sublethal effects from any malathion uses at the maximum rates for all bins (2, 3, 4, 6, 7). However, risk of mortality to the host fish for bin 2 is high for all use sites except developed where it is medium. Risk of mortality to individuals in bin 7 is medium for all uses except for developed, mosquito control, corn and other crops which are low. Risk of mortality to individuals in bin 6 is high for all other uses except medium for mosquito control, corn, and other crops and low for developed.

We do not expect mussel species to be directly impacted by exposure from malathion. However their lifecycle is such that when glochidia (larval stage) are released into the water, within a few days they must attach to an appropriate species of fish, which they parasitize for a short time while they develop into juvenile mussels in order to complete their lifecycle; they cannot complete their lifecycle without a fish host.

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.

| | |
|--|--|
| DIRECT (all uses except mosquito control) | |
| Use areas – mortality | No effects expected |
| Sublethal – growth (G), reproduction (R) and behavior (B) enzyme (E) | No effects expected |
| INDIRECT (all uses except mosquito control) | |
| Use areas - Prey item mortality | If plankton: H, except for developed is L depending on the bin |

| | |
|-------------------------|---|
| | If detritus: NA |
| Use areas – Fish Host | Total overlap: 8.35%, H M for most uses, L for developed bins 6 and 7 |
| MOSQUITO CONTROL | |
| Direct (mortality) | No effects expected |
| Sublethal | No effects expected |
| Indirect | Total overlap: 20.85%, H M L depending on the bin |

Risk modifiers:

The Dwarf wedgemussel lives on muddy sand, sand, and gravel bottoms in creeks and rivers of varying sizes, in areas of slow to moderate current and little silt deposition.

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. Further investigation by EPA into Bin 3 and 4 estimated environmental concentrations indicate 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. While the dwarf wedgemussel also occupies other aquatic habitats that may be exposed to potentially high levels of malathion due to lower volume in those habitats (Bin 2), their potential exposure risk is at least partially lowered based on their reliance upon larger flowing and static aquatic habitats (Bins 3, 4, 6, and 7), reducing the overall risk to the species as a whole.

The Dwarf wedgemussel is considered a fish host generalist whose glochidia can metamorphosize on a wide variety of fishes from multiple families. While we anticipate some species of the host fish community will exhibit temporary reductions in abundance due to malathion exposure, the species’ flexible host requirement will allow the species to be more resilient to temporary losses of host fish, reducing the anticipated indirect 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 to Host Fish associated with bin (H, M, L) |
|------------------|------------------------------|------------------------|-------|---------------------------------------|--------|--|---|
| | | Acres | % | | | | |
| Mosquito Control | I | 3,228,126 | 20.85 | 51,375 | 0.33 | 2,3,4,6,7 | 2H 3 4 6M 7L |
| Developed | I | 458,445 | 2.96 | 22,922 | 0.15 | 2,3,4,6,7 | 2M 3 4 6L 7L |
| Corn | I | 435,399 | 2.81 | 9,760 | 0.06 | 2,3,4,6,7 | 2H 3 4 6M 7L |
| Other Crops | I | 1,153,555 | 0.74 | 97 | < 0.01 | 2,3,4,6,7 | 2H 3 4 6M 7L |
| Cotton | I | 110,831 | 0.72 | 26,051 | 0.17 | 2,3,4,6,7 | 2H 3 4 6H 7M |
| Other Row Crops | I | 51,650 | 0.33 | 4,858 | 0.03 | 2,3,4,6,7 | 2H 3 4 6H 7M |
| Other Grains | I | 33,619 | 0.22 | 5,692 | 0.04 | 2,3,4,6,7 | 2H 3 4 6H 7M |

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 to Host Fish associated with bin (H, M, L) |
|--|------------------------------|------------------------|-------------|---------------------------------------|-------------|--|---|
| | | Acres | % | | | | |
| Wheat | I | 30,588 | 0.20 | 5,231 | 0.03 | 2,3,4,6,7 | 2H 3 4 6H 7M |
| Vegetables & Ground Fruit | I | 26,869 | 0.17 | 7,515 | 0.05 | 2,3,4,6,7 | 2H 3 4 6H 7M |
| Pasture | I | 23,937 | 0.15 | 18,786 | 0.12 | 2,3,4,6,7 | 2H 3 4 6H 7M |
| Nurseries | I | 4,235 | 0.03 | 4,235 | 0.03 | 2,3,4,6,7 | 2H 3 4 6H 7M |
| Orchards & Vineyards | I | 1,241 | < 0.01 | 653 | < 0.01 | 2,3,4,6,7 | 2H 3 4 6H 7M |
| Christmas trees | I | 248 | < 0.01 | 262 | < 0.01 | 2,3,4,6,7 | 2H 3 4 6H 7M |
| Sub-TOTAL (I): <i>Other uses with indirect effects³</i> | | 2,329,376 | 8.35 | 106,062 | 0.71 | | |
| TOTAL³: | | 5,557,502 | 29.2 | 157,437 | 1.04 | | |

³ TOTAL includes usage on all use sites with effects, including mosquito control.

^We consider the Bin 2 estimates as an upper bound of Bin 3 & 4 exposures. The estimated environmental concentrations for a Bin 2 water are an order of magnitude greater than Bins 3 and 4, therefore concentrations in Bins 3 and 4 can be reduced by a correction factor of 10.

Exposure Modifiers:

A reassessment of our crop use data layers shows that within the “Other Row Crops” layer shows that usage in this category may be overestimated. This UDL is composed of sunflower, peanuts, tobacco, sugar beets, and hops, of which, only hops is a registered use site on malathion labels and is thus the only crop in this layer that is relevant in our analysis. USDA data shows that 96% of hops are grown in the Pacific Northwest region (in Idaho, Oregon, and Washington), with some small farms in Florida reporting occasional hop production. Given the highly specific regions that hops are grown in, we can assume that potential exposure to malathion from “other row crops” use sites is 0 outside of these areas, and thus is not relevant to this species.

acres in species range: 15,485,517 acres

% of range in California (i.e., where CalPUR data is available): 0%

Range overlap with Federal lands: 528,719 acres, 3.414%

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 groundfruit lower the maximum allowable number of applications to 2-4 per year (depending on the specific crop). 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 dwarf wedgemussel. As discussed below, even though the species vulnerability is high and risk to the species host fish is medium, we anticipate the likelihood of exposure of host fish to malathion is low, and the implementation of the general conservation measures described above is expected to further reduce the likelihood of exposure.

The dwarf wedgemussel has a high vulnerability based on its status, distribution, and trends. Mortality and sublethal effects to the species are not anticipated. The risk to the species host fish posed by labeled uses across the range is medium, therefore and where individual host fish are exposed, we anticipate high to medium levels of mortality, depending on water body size and use type. Mussels depend on host fish to accomplish their reproductive lifecycle. Glochidia (larval stage) are released into the water and within a few days they must attach to an appropriate species of fish, which they parasitize for a short time while they develop into juvenile mussels. Glochidia that do not attach to a host fish will not survive. Where sufficient numbers of suitable host fish are not available, we anticipate reproduction of mussels would be reduced.

We anticipate usage within the non-Federal portion of the species’ range will be low (1.04 %), based primarily on the 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 Biological Opinion.

The species range, and thus this species host fish range, is very large (>15 million acres) and we do not anticipate that host fish would necessarily be found in the affected areas of the waterbodies near application sites when malathion is applied, although small numbers of host

fish may occur in these areas and be exposed over the duration of the proposed action. Reductions in plankton could be high in localized areas, however, we anticipate additional food resources from upstream sources would quickly recolonize after an application event. In addition, we anticipate that the conservation measures above, including rain restrictions, aquatic habitat buffers, residential use label changes, and reduced number of applications and rates on certain use sites, will further reduce the risk of exposure to plankton and the mussels' host fish.

As stated previously, conservation measures are aimed at reducing the amount of malathion runoff and spray drift that enter into sensitive habitats (e.g., species habitat, aquatic environments). For example, by placing a 48-hour rain restriction on agricultural applications, malathion has the ability to degrade after application (e.g., by hydrolysis, other processes) prior to any rain/runoff events, thus minimizing malathion runoff into aquatic habitats and decreasing exposure to listed mussels and their host fish. Increasing application buffers reduces the amount of malathion that drifts off target and subsequently into non-target environments. In addition, changes to residential labels limits applications to spot treatments and reduces the number of applications per year (2-4), significantly decreasing the overall amounts of malathion used in residential areas and resulting amounts of runoff and drift. Additional reductions in the number of applications and rates allowed for certain crops (e.g., corn, vegetables and ground fruit) further reduces the amount of malathion used in agricultural settings, thereby decreasing potential exposure to the species and their host fish. Combined, these conservation measures substantially reduce exposure to the dwarf wedgemussel and their host fish and therefore minimizes overall risk and adverse effects to the species. Thus, while we anticipate small numbers of individual host fish would be lost over the duration of the action, resulting in very small reductions in reproductive success, we do not anticipate species-level effects to this mussel species.

Therefore, we anticipate that the proposed action would not appreciably reduce survival and recovery of the dwarf wedgemussel in the wild.

Conclusion: Is not likely to jeopardize.

Integration and Synthesis Summary: Bivalves

| Scientific Name: | Common Name: | Entity ID: |
|----------------------------|---------------------|-------------------|
| <i>Cyprogenia stegaria</i> | Fanshell | 368 |

Family: Unionidae

VULNERABILITY

(Summary of status, environmental baseline and cumulative effects)

Status: Endangered

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

Number of Populations: Small number of individuals in one or more populations, Multiple populations (few) Indicates

Species Trends: Declining population(s)

Pesticides noted ☒

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

The fanshell mussel, known only to occur in the Ohio River basin, is now sparsely distributed within most of its highly restricted range. Fanshell populations are known to exist in Indiana, Kentucky, Ohio, Tennessee, Virginia, and West Virginia. Except for populations in the Green, Licking, Rolling Fork, and Clinch Rivers, known populations represent remnants within the historical range of this species. It is unlikely fanshell populations are experiencing any genetic exchange between the different river populations, except possibly in locations where mussels have been transplanted from the Licking River.

The best populations of fanshell mussel occur in the Licking, Green, and Rolling Fork rivers in Kentucky, and in the Clinch River in Tennessee and Virginia. These populations are considered healthy with evidence of recruitment over several years or even decades, with multiple year classes present. The Rolling Fork River population adds one more known reproducing population since the recovery plan was written, but it is a relatively small population compared to the Licking River, Green River, and Clinch River populations. Other locations (Muskingum, Kanawha, Wabash, East Fork White, Tippecanoe, Tennessee, and Ohio Rivers) appear to have small and restricted, extant populations with limited evidence of recruitment.

Ongoing threats to the fanshell include water quality degradation from point and non-point sources, particularly in tributaries that have limited capability to dilute and assimilate sewage, agricultural runoff, and other pollutants. In addition, the species is affected by hydrologic and water quality alterations resulting from the operation of impoundments. The presence of impoundments may have ameliorated the effects of downstream siltation on fanshells, but these structures also control river discharges and the many environmental parameters influenced by discharge, which may profoundly affect the ability of these populations to occupy or successfully reproduce in downstream habitats.

A variety of instream activities (e.g., sand and gravel dredging, road construction, etc.) continue to threaten fanshell populations. Protecting these populations from the direct physical disturbance of such activities depends on accurately identifying the location of the populations. The indirect effects of altering the streambed configuration may cause changes in previously suitable habitat.

Coal, oil, and natural gas resources are present in some of the watersheds known to support fanshell mussels. Exploration and extraction of these resources can result in increased siltation, an altered hydrograph, and degraded water quality.

Land-based development including residential and agricultural activities near streams often results in loss of riparian habitat, increased stormwater runoff due to increased impervious surfaces, increased sedimentation due to loss of streamside vegetation, and subsequent degradation of streambanks.

The species has a number of predators including muskrats, raccoons, otters, molluscivorous fish, and some invertebrates. Zebra mussel populations in the Ohio River could possibly be negatively impacting fanshell mussel populations. FWS (1991) page 1 ... "The distribution and reproductive capacity of this species has been seriously impacted by the construction of impoundments and navigation facilities, dredging for channel maintenance, sand and gravel mining, and water pollution."

EB/CE Source:

U.S. Fish and Wildlife Service (FWS). 2019. Fanshell (*Cyprogenia stegaria*) 5-Year Review: Summary and Evaluation. Kentucky Ecological Services Field Office. Frankfort, Kentucky. 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 expect the fanshell will experience direct mortality or sublethal effects from any malathion uses at the maximum rates for all bins (2, 3, 4, 6, 7). However, risk of mortality to the host fish for bin 2 is high for all use sites except developed where it is medium. Risk of mortality to individuals in bin 7 is medium for all uses except for developed, mosquito control, which are low. Risk of mortality to individuals in bin 6 is high for all other uses except medium for mosquito control, corn, wheat, other crops and low for developed.

We do not expect mussel species to be directly impacted by exposure from malathion. However their lifecycle is such that when glochidia (larval stage) are released into the water, within a few days they must attach to an appropriate species of fish, which they parasitize for a short time

while they develop into juvenile mussels in order to complete their lifecycle; they cannot complete their lifecycle without a fish host.

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.

| | |
|--|---|
| DIRECT (all uses except mosquito control) | |
| Use areas – mortality | No effects expected |
| Sublethal – growth (G), reproduction (R) and behavior (B) enzyme (E) | No effects expected |
| INDIRECT (all uses except mosquito control) | |
| Use areas - Prey item mortality | If plankton: H, except for developed is L depending on the bin If detritus: NA |
| Use areas – Fish Host | Total overlap: 10.52%, H M for most uses, L for developed bins 6 and 7 |
| MOSQUITO CONTROL | |
| Direct (mortality) | No effects expected |
| Sublethal | No effects expected |
| Indirect | Total overlap: 15.25%, H M L depending on the bin |

Risk modifiers:

The fanshell inhabits medium to large rivers (Bates and Dennis, 1985). It has been reported primarily from relatively deep water in gravelly substrate with moderate current (Gordon and Layzer, 1989). It has also been found in river habitats with gravel substrates and a strong current, in both deep and shallow water (Ortmann, 1919; Parmalee, 1967).

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. Further investigation by EPA into Bin 3 and 4 estimated environmental concentrations indicate 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. While the fanshell also occupies other aquatic habitats that may be exposed to potentially high levels of malathion due to lower volume in those habitats (Bin 2), their potential exposure risk is at least partially lowered based on their reliance upon larger flowing and static aquatic habitats (Bins 3, 4, 6, and 7), reducing the overall risk to the species as a whole.

The Fanshell is considered a fish host generalist whose glochidia can metamorphosize on a wide variety of fishes from multiple families. While we anticipate some species of the host fish community will exhibit temporary reductions in abundance due to malathion exposure, the

species' flexible host requirement will allow the species to be more resilient to temporary losses of host fish, reducing the anticipated indirect 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 to Host Fish associated with bin (H, M, L) |
|------------------|------------------------------|------------------------|-------|---------------------------------------|------|--|---|
| | | Acres | % | | | | |
| Mosquito Control | I | 4,640,315 | 15.25 | 203,334 | 0.67 | 2,3,4,6,7 | 2H 3 4 6M 7L |
| Corn | I | 2,051,418 | 6.74 | 48,371 | 0.16 | 2,3,4,6,7 | 2H 3 4 6M 7M |
| Developed | I | 1,003,537 | 3.3 | 50,177 | 0.16 | 2,3,4,6,7 | 2M 3 4 6L 7L |
| Pasture | I | 43,557 | 0.14 | 14,265 | 0.05 | 2,3,4,6,7 | 2H 3 4 6M 7M |
| Wheat | I | 36,268 | 0.12 | 12,556 | 0.04 | 2,3,4,6,7 | 2H 3 4 |

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 to Host Fish associated with bin (H, M, L) |
|---------------------------|------------------------------|------------------------|--------|---------------------------------------|--------|--|---|
| | | Acres | % | | | | |
| | | | | | | | 6M 7M |
| Other Crops | I | 18,860 | 0.06 | 0 | 0 | 2,3,4,6,7 | 2H 3 4 6M 7M |
| Cotton | I | 15,118 | 0.05 | 12,767 | 0.04 | 2,3,4,6,7 | 2H 3 4 6H 7M |
| Other Grains | I | 8,636 | 0.03 | 2,404 | < 0.01 | 2,3,4,6,7 | 2H 3 4 6M 7M |
| Nurseries | I | 4,406 | 0.01 | 4,406 | 0.01 | 2,3,4,6,7 | 2H 3 4 6M 7L |
| Vegetables & Ground Fruit | I | 4,192 | 0.01 | 1,630 | < 0.01 | 2,3,4,6,7 | 2H 3 4 6L 7M |
| Orchards & Vineyards | I | 123 | < 0.01 | 80 | < 0.01 | 2,3,4,6,7 | 2H 3 4 6M 7M |
| Other Row Crops | I | 13,233 | 0.04 | 698 | < 0.01 | 2,3,4,6,7 | 2H 3 4 6M 7M |
| Christmas trees | I | 23 | < 0.01 | 21 | < 0.01 | 2,3,4,6,7 | 2H 3 4 6M 7M |
| Sub-TOTAL (I): | | 3,199,370 | 10.52 | 147,376 | 0.52 | | |

| Use type | Risk to species ¹ | Use overlap with range | | Estimated usage in range ² | | Bins associated with use type [^] | Effect to Host Fish associated with bin (H, M, L) |
|---|------------------------------|------------------------|-------|---------------------------------------|------|--|---|
| | | Acres | % | | | | |
| Other uses with indirect effects ³ | | | | | | | |
| TOTAL ³ : | | 7,839,685 | 25.77 | 350,710 | 1.19 | | |

[^]We consider the Bin 2 estimates as an upper bound of Bin 3 & 4 exposures. The estimated environmental concentrations for a Bin 2 water are an order of magnitude greater than Bins 3 and 4; therefore concentrations in Bins 3 and 4 can be reduced by a correction factor of 10.

acres in species range: 30,431,591 acres

% of range in California (i.e., where CalPUR data is available): 0%

Range overlap with Federal lands: 2,008,729 acres, 6.601%

Overall Usage: ☐ High ☐ Medium ☒ Low

Exposure Modifiers:

A reassessment of our crop use data layers shows that within the “Other Row Crops” layer shows that usage in this category may be overestimated. This UDL is composed of sunflower, peanuts, tobacco, sugar beets, and hops, of which, only hops is a registered use site on malathion labels and is thus the only crop in this layer that is relevant in our analysis. USDA data shows that 96% of hops are grown in the Pacific Northwest region (in Idaho, Oregon, and Washington), with some small farms in Florida reporting occasional hop production. Given the highly specific regions that hops are grown in, we can assume that potential exposure to malathion from “other row crops” use sites is 0 outside of these areas, and thus is not relevant to this species.

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 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.

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 groundfruit lower the maximum allowable number of applications to 2-4 per year (depending on the specific crop). 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 fanshell. As discussed below, even though the species vulnerability is high and risk to the species host fish is medium, we anticipate the likelihood of exposure of host fish to malathion is low, and the implementation of the general conservation measures described above is expected to further reduce the likelihood of exposure.

The fanshell has a high vulnerability based on its status, distribution, and trends. Mortality and sublethal effects to the species are not anticipated. The risk to the species host fish posed by

labeled uses across the range is medium, and where individual host fish are exposed, we anticipate variable levels of mortality, depending on water body size and use type. Mussels depend on host fish to accomplish their reproductive lifecycle. Glochidia (larval stage) are released into the water and within a few days they must attach to an appropriate species of fish, which they parasitize for a short time while they develop into juvenile mussels. Glochidia that do not attach to a host fish will not survive. Where sufficient numbers of suitable host fish are not available, we anticipate reproduction of mussels would be reduced.

We anticipate usage within the non-Federal portion of the species' range will be low (1.19 %), based primarily on the 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 Biological Opinion.

The species range, and thus this species host fish range, is very large (>30 million acres) and we do not anticipate that host fish would necessarily be found in the affected areas of the waterbodies near application sites when malathion is applied, although small numbers of host fish may occur in these areas and be exposed over the duration of the proposed action. Reductions in plankton could be high in localized areas, however, we anticipate additional food resources from upstream sources would quickly recolonize after an application event. In addition, we anticipate that the conservation measures above, including rain restrictions, aquatic habitat buffers, residential use label changes, and reduced number of applications and rates on certain use sites, will further reduce the risk of exposure to plankton and the mussels' host fish.

As stated previously, conservation measures are aimed at reducing the amount of malathion runoff and spray drift that enter into sensitive habitats (e.g., species habitat, aquatic environments). For example, by placing a 48-hour rain restriction on agricultural applications, malathion has the ability to degrade after application (e.g., by hydrolysis, other processes) prior to any rain/runoff events, thus minimizing malathion runoff into aquatic habitats and decreasing exposure to listed mussels and their host fish. Increasing application buffers reduces the amount of malathion that drifts off target and subsequently into non-target environments. In addition, changes to residential labels limits applications to spot treatments and reduces the number of applications per year (2-4), significantly decreasing the overall amounts of malathion used in residential areas and resulting amounts of runoff and drift. Additional reductions in the number of applications and rates allowed for certain crops (e.g., corn, vegetables and ground fruit) further reduces the amount of malathion used in agricultural settings, thereby decreasing potential exposure to the species and their host fish. Combined, these conservation measures substantially reduce exposure to the fanshell and their host fish and therefore minimizes overall risk and adverse effects to the species. Thus, while we anticipate small numbers of individual host fish would be lost over the duration of the action, resulting in very small reductions in reproductive success, we do not anticipate species-level effects to this mussel species.

Therefore, we anticipate that the proposed action would not appreciably reduce survival and recovery of the fanshell in the wild.

Conclusion: Is not likely to jeopardize.

Integration and Synthesis Summary: Bivalves

| Scientific Name: | Common Name: | Entity ID: |
|---------------------------|-----------------------|-------------------|
| <i>Lasmigona decorata</i> | Carolina heelsplitter | 370 |

Family: Unionidae

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:

Although there have been discoveries of additional occurrences of the Carolina heelsplitter since the species was listed as endangered in 1993, the species continues to have a very fragmented, relict distribution. There are currently 11 known extant populations. Based on available survey data, all extant populations are small in number; only four populations appear to be relatively stable; four populations (Sixmile Creek, Gills Creek/Cane Creek), Rocky Creek, Turkey Creek) appear to be in significant decline and likely to become extirpated in the next few years; and although trend data is not currently available for three of the populations, past survey data combined with habitat information indicates that these populations are likely in decline.

Densities of all known populations remain extremely low and highly vulnerable to extirpation from stochastic and chronic events affecting the quality of their habitat. In some of the streams, only a single live individual has been observed; in several, only a few live individuals have been recorded. All surviving populations are isolated from one another and are restricted to short stream reaches. The majority of habitat in the streams where the species exists appears to be marginal at best, patchily distributed, and separated by relatively long reaches of highly degraded habitat.

Carolina heelsplitter populations continue to be threatened by many of the same factors identified during the last five-year review as leading to the loss and decline of the species throughout significant portions of its historic range and threats to surviving populations. These include habitat fragmentation, loss, and alteration resulting from impoundments, mining activities, wastewater discharges, and the runoff of silt and other pollutants from ground-disturbance activities. In addition, drought and other factors affecting water quantity in the streams supporting the Carolina heelsplitter have become a significant threat the species' continued existence.

Extensive recovery activities for the species have taken place over the past six years, including propagation, augmentation, and habitat restoration of the surviving populations. Partnerships with other agencies as well as private landowners have expanded and have increased the momentum and effectiveness of the recovery program as a whole. Life history, genetic, and habitat research has also increased since the last five year review. The next five years will demonstrate the ability of this new research to translate into attainment of population-level recovery goals.

FWS (2012) page 25... "All of the surviving populations of the Carolina heelsplitter continue to be threatened by many of the same factors identified at the time of listing as leading to the loss and decline of the species throughout significant portions of its historic range and threats to surviving populations, including habitat fragmentation, loss, and alteration resulting from impoundments, mining activities, wastewater discharges, and the runoff of silt and other pollutants from ground-disturbance activities. In addition, drought and other factors affecting water quantity in the streams supporting the Carolina heelsplitter have become a significant threat the species' continued existence. Therefore, we believe this mussel still meets the definition of endangered."

EB/CE Source: U.S. Fish and Wildlife Service. 2019. Carolina Heelsplitter (*Lasmigona decorata*) 5-Year Review: Summary and Evaluation. South Carolina Ecological Services Field Office. Charleston, South Carolina. 36 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 expect the Carolina heelsplitter will experience direct mortality or sublethal effects from any malathion uses at the maximum rates for all bins (2, 3, 4, 5, 6, 7) . However, risk of mortality to the host fish for bin 2 is high for all use sites except developed where it is medium. Risk of mortality to the host fish in bin 5 is high for all use sites except developed where it is medium. Risk of mortality to host fish in bin 6 is low for developed, medium for mosquito control and high for all other uses. Risk of mortality to the host fish in bin 7 is low for mosquito control and developed, and medium for all other uses.

We do not expect mussel species to be directly impacted by exposure from malathion. However their lifecycle is such that when glochidia (larval stage) are released into the water, within a few days they must attach to an appropriate species of fish, which they parasitize for a short time while they develop into juvenile mussels in order to complete their lifecycle; they cannot complete their lifecycle without a fish host.

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.

| | |
|--|--|
| DIRECT (all uses except mosquito control) | |
| Use areas – mortality | No effects expected |
| Sublethal – growth (G), reproduction (R) and behavior (B) enzyme (E) | No effects expected |
| INDIRECT (all uses except mosquito control) | |
| Use areas - Prey item mortality | If plankton: H, L in bins 5,6,7 If detritus: NA |
| Use areas – Fish Host | Total overlap: 8.34%, H, M, L all bins |
| MOSQUITO CONTROL | |
| Direct (mortality) | No effects expected |
| Sublethal | No effects expected |
| Indirect | Total overlap: 17.08%, H M L depending on the bin |

Risk modifiers:

This species inhabits cool, slow-moving, small- to medium-sized streams and rivers. The species' distribution is highly fragmented (USFWS 2012). It is usually found in mud, muddy sand, or muddy gravel substrates along stable, well-shaded stream banks (Keferl and Shelly 1988, Keferl 1991). The stability of stream banks appears to be very important to the species (Keferl 1991) (USFWS 1996). The environmental specificity of this species is moderate, as it is sensitive to water clarity and stream bank stability (USFWS, 1996) and substrates found in creek reaches associated with the species vary from clay to various combinations of coarse substrates.

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. Further investigation by EPA into Bin 3 and 4 estimated environmental concentrations indicate 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. While the Carolina heelsplitter also occupies other aquatic habitats that may be exposed to potentially high levels of malathion due to lower volume in those habitats (Bin 2), their potential exposure risk is at least partially lowered based on their reliance upon larger flowing and static aquatic habitats (Bins 3, 4, 5, 6, and 7), reducing the overall risk to the species as a whole.

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 to Host Fish associated with bin (H, M, L) |
|------------------------|------------------------------|------------------------|-------|---------------------------------------|--------|--|---|
| | | Acres | % | | | | |
| Mosquito Control | I | 1,004,066 | 17.08 | 59,330 | 1.01 | 2,3,4,5,6,7 | 2H 3 4 5H 6M 7L |
| Developed | I | 303,757 | 5.17 | 15,188 | 0.26 | 2,3,4,5,6,7 | 2M 3 4 5M 6L 7L |
| Wheat | I | 6,546 | 0.11 | 1,958 | 0.03 | 2,3,4,5,6,7 | 2H 3 4 5H 6H 7M |
| Other Crops | I | 52,071 | 0.89 | 0 | 0 | 2,3,4,5,6,7 | 2H 3 4 5H 6H 7M |
| Other Row Crops | I | 1,920 | 0.03 | 1,743 | 0.03 | 2,3,4,5,6,7 | 2H 3 4 5H 6H 7M |
| Orchards and vineyards | I | 13,385 | 0.23 | 570 | < 0.01 | 2,3,4,5,6,7 | 2H 3 4 5H 6H |

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 to Host Fish associated with bin (H, M, L) |
|-----------------------------|------------------------------|------------------------|--------|---------------------------------------|--------|--|---|
| | | Acres | % | | | | |
| | | | | | | | 7 |
| Nurseries | I | 2,445 | 0.04 | 2,445 | 0.04 | 2,3,4,5,6,7 | 2H 3 4 5H 6H 7M |
| Corn | I | 83,293 | 1.42 | 2,981 | 0.05 | 2,3,4,5,6,7 | 2H 3 4 5H 6H 7M |
| Other Grains | I | 5,746 | 0.1 | 2,121 | 0.04 | 2,3,4,5,6,7 | 2H 3 4 5H 6H 7M |
| Cotton | I | 18,887 | 0.32 | 11,316 | 0.19 | 2,3,4,5,6,7 | 2H 3 4 5H 6H 7M |
| Vegetables and Ground fruit | I | 642 | 0.01 | 251 | < 0.01 | 2,3,4,5,6,7 | 2H 3 4 5H 6H 7M |
| Pasture | I | 247 | < 0.01 | 178 | < 0.01 | 2,3,4,5,6,7 | 2H 3 4 5H 6H 7M |
| Christmas trees | I | 2 | < 0.01 | 2 | < 0.01 | 2,3,4,5,6,7 | 2H 3 4 5H 6H 7M |

| Use type | Risk to species 1 | Use overlap with range | | Estimated usage in range ² | | Bins associated with use type [^] | Effect to Host Fish associated with bin (H, M, L) |
|---|----------------------|------------------------|-------|---------------------------------------|------|--|---|
| | | Acres | % | | | | |
| Sub-TOTAL (I): <i>Other uses with indirect effects³</i> | | 488,941 | 8.34 | 38,753 | 0.69 | | |
| TOTAL ³ : | | 1,493,006 | 25.42 | 98,083 | 1.70 | | |

[^]We consider the Bin 2 estimates as an upper bound of Bin 3 & 4 exposures. The estimated environmental concentrations for a Bin 2 water are an order of magnitude greater than Bins 3 and 4, therefore concentrations in Bins 3 and 4 can be reduced by a correction factor of 10.

Exposure Modifiers:

A reassessment of our crop use data layers shows that within the “Other Row Crops” layer shows that usage in this category may be overestimated. This UDL is composed of sunflower, peanuts, tobacco, sugar beets, and hops, of which, only hops is a registered use site on malathion labels and is thus the only crop in this layer that is relevant in our analysis. USDA data shows that 96% of hops are grown in the Pacific Northwest region (in Idaho, Oregon, and Washington), with some small farms in Florida reporting occasional hop production. Given the highly specific regions that hops are grown in, we can assume that potential exposure to malathion from “other row crops” use sites is 0 outside of these areas, and thus is not relevant to this species.

acres in species range: 5,878,104 acres

% of range in California (i.e., where CalPUR data is available): 0%

Range overlap with Federal lands: 560,733 acres, 9.539%

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 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.

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 groundfruit lower the maximum allowable number of applications to 2-4 per year (depending on the specific crop). 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 Carolina heelsplitter. As discussed below, even though the species vulnerability is high and risk to the species host fish is medium, we anticipate the likelihood of exposure of host fish to malathion is low, and the implementation of the general conservation measures described above is expected to further reduce the likelihood of exposure.

The Carolina heelsplitter has a high vulnerability based on its status, distribution, and trends. Mortality and sublethal effects to the species are not anticipated. The risk to the species host fish

posed by labeled uses across the range is medium, and where individual host fish are exposed, we anticipate high to medium levels of mortality, depending on water body size and use type. Mussels depend on host fish to accomplish their reproductive lifecycle. Glochidia (larval stage) are released into the water and within a few days they must attach to an appropriate species of fish, which they parasitize for a short time while they develop into juvenile mussels. Glochidia that do not attach to a host fish will not survive. Where sufficient numbers of suitable host fish are not available, we anticipate reproduction of mussels would be reduced.

We anticipate usage within the non-Federal portion of the species' range will be low (1.70 %), based primarily on the 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 Biological Opinion.

The species range, and thus this species host fish range, is very large (>5 million acres) and we do not anticipate that host fish would necessarily be found in the affected areas of the waterbodies near application sites when malathion is applied, although small numbers of host fish may occur in these areas and be exposed over the duration of the proposed action. Reductions in plankton could be high in localized areas, however, we anticipate additional food resources from upstream sources would quickly recolonize after an application event. In addition, we anticipate that the conservation measures above, including rain restrictions, aquatic habitat buffers, residential use label changes, and reduced number of applications and rates on certain use sites, will further reduce the risk of exposure to plankton and the mussels' host fish.

As stated previously, conservation measures are aimed at reducing the amount of malathion runoff and spray drift that enter into sensitive habitats (e.g., species habitat, aquatic environments). For example, by placing a 48-hour rain restriction on agricultural applications, malathion has the ability to degrade after application (e.g., by hydrolysis, other processes) prior to any rain/runoff events, thus minimizing malathion runoff into aquatic habitats and decreasing exposure to listed mussels and their host fish. Increasing application buffers reduces the amount of malathion that drifts off target and subsequently into non-target environments. In addition, changes to residential labels limits applications to spot treatments and reduces the number of applications per year (2-4), significantly decreasing the overall amounts of malathion used in residential areas and resulting amounts of runoff and drift. Additional reductions in the number of applications and rates allowed for certain crops (e.g., corn, vegetables and ground fruit) further reduces the amount of malathion used in agricultural settings, thereby decreasing potential exposure to the species and their host fish. Combined, these conservation measures substantially reduce exposure to the Carolina heelsplitter and their host fish and therefore minimizes overall risk and adverse effects to the species. Thus, while we anticipate small numbers of individual host fish would be lost over the duration of the action, resulting in very small reductions in reproductive success, we do not anticipate species-level effects to this mussel species. Therefore, we anticipate that the proposed action would not appreciably reduce survival and recovery of the Carolina heelsplitter in the wild.

Conclusion: Is not likely to jeopardize.

Integration and Synthesis Summary: Bivalves

| Scientific Name: | Common Name: | Entity ID: |
|------------------------------|-----------------------|------------|
| <i>Lampsilis subangulata</i> | Shinyrayed pocketbook | 373 |

Family: Unionidae

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 shinyrayed pocketbook historically occurred in 11 sub-basins (USFWS 2003) and currently occupies Chipola, Middle Chattahoochee, Lower Chattahoochee, Upper Flint, Middle Flint, Lower Flint, Kinchafoonee, Ichawaynochaway, and Spring sub-basins in Alabama, Georgia, and Florida. It now also occurs in the Econfinia sub-basin (Florida), which was not initially included in its historical range. Since the last 5-year review, survey data illustrates mussel distribution varied by subbasin with decreases (Upper Flint), a few increases (Chipola, Middle Chattahoochee and Lower and Middle Flint sub-basins) and potential stability in others (Spring, Lower Chattahoochee and Ichawaynochaway). Populations in the Lower Chattahoochee, Spring, and Chipola sub-basins, that have evidence of recruitment or are limited in distribution, remain susceptible to catastrophic events. Loss of any of these populations may reduce species redundancy and representation. The species has been extirpated from over half of its historical range (USFWS 2007) including possible extirpation in the Upper Ochlockonee River (S. Pursifull et al., in review for publication). Overall, this species distribution has remained stable since the last 5-year review in 2007.

The decline in range and abundance of the shinyrayed pocketbook is due mostly to changes in their riverine habitats resulting from dams, dredging, mining, channelization, pollution, sedimentation, and water withdrawals (USFWS, 2003 and USFWS, 2007). These impacts have decreased water quality, changed natural flow regimes, increased isolation, and directly altered riverine habitat. Many of the threats that lead to the listing of these species continue today.

EB/CE Source: U.S. Fish and Wildlife Service. 2020. 5-Year Review: Shinyrayed Pocketbook (*Lampsilis subangulata*) and Gulf Moccasinshell (*Medionidus penicillatus*). Georgia Ecological Services Field Office. Athens, Georgia. 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 expect the shinyrayed pocketbook will experience direct mortality or sublethal effects from any malathion uses at the maximum rates for all bins (2, 3, 4, 5, 6, 7) . However, risk of mortality to the host fish for bins 2 and bin 5 is high for most uses except for developed where risk of mortality is low for bin 5 and medium for bin 2. Risk of mortality is high for bins 3,4,6, and 7 for cotton and medium for all other uses for these bins except developed. Risk of mortality is medium for bin 3 for developed and low for bins 6 and 7.

We do not expect mussel species to be directly impacted by exposure from malathion. However their lifecycle is such that when glochidia (larval stage) are released into the water, within a few days, they must attach to an appropriate species of fish, which they parasitize for a short time while they develop into juvenile mussels in order to complete their lifecycle; they cannot complete their lifecycle without a fish host.

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.

| | |
|--|---|
| DIRECT (all uses except mosquito control) | |
| Use areas – mortality | No effects expected |
| Sublethal – growth (G), reproduction (R) and behavior (B) enzyme (E) | No effects expected |
| INDIRECT (all uses except mosquito control) | |
| Use areas - Prey item mortality | If plankton: H for all uses except for developed L,M for bins 5,6,7 2,3,4, respectively. If detritus: NA |
| Use areas – Fish Host | Total overlap: 29% H for all uses |
| MOSQUITO CONTROL | Except developed 2,3 M; 5,6,7 L |
| Direct (mortality) | No effects expected |
| Sublethal | No effects expected |
| Indirect | Total overlap: 50% H Bins2,5, M 3,4,6,7 |

Risk modifiers:

Species occurs in Bins 2, 5, 6 and 7. See Risk Assumptions (above) for risk to individuals and species.

Species host (generalist) occurs in Bins 2, 3, 4, 5, 6 and 7. See Risk Assumptions (above) for risk to host species.

Mussels depend on a host fish to accomplish their reproductive lifecycle. Glochidia that do not attach to a host fish will not survive. We anticipate reproduction of mussels would be reduced in areas with insufficient fish hosts available. The mussel glochidia fish host relationship can be categorized into several different categories that capture the breadth of the type of mussel-host relationships such as generalists, specialists, or unknown fish host species. We anticipate that variable numbers of individual host fish may be affected over the duration of the proposed action, some of which would result in local extirpations of these mussel species in their highly isolated and fragmented populations, and we would expect species-level effects to these mussels to occur in the absence of mitigating factors.

Three potential species demonstrated successful transformation in laboratory conditions for the shinyrayed pocketbook; shoal bass (*Micropterus cataractae*), redeye bass (*Micropterus coosae*) and largemouth bass (*Micropterus salmoides*) metamorphosis (mussel larvae to juvenile mussels)(success was greater than (>) 78 percent (%) on all three (5-Year Review Summary and Evaluation USFWS 2019). Because there is limited information currently available regarding which fish species the shinyrayed pocketbook relies on for glochidia attachment regarding the age, size at maturity, or appropriate host fish species, a medium risk is warranted.

The shinyrayed pocketbook occupies aquatic habitats that may be exposed to potentially high levels of malathion due to lower volume in those habitats (Bin 2), their potential exposure risk is at least partially lowered based on their reliance upon larger static aquatic habitats (Bins 5, 6, and 7), reducing the overall risk to the species as a whole.

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 to Host Fish associated with bin (H, M, L) |
|----------------------------|------------------------------|------------------------|-------|---------------------------------------|--------|--|---|
| | | Acres | % | Acres | % | | |
| Mosquito Control | | 5,213,296 | 49.8 | 378,912 | 3.62 | 2,3,4,5,6,7 | 2H 3H 4H 5H 6H 7H |
| Developed | I | 324,478 | 3.10 | 16,224 | 0.155 | 2,3,4,5,6,7 | 2,3 M 5,6,7L |
| Open Space Developed | I | 540,262 | 5.16 | 27,013 | 0.26 | 2,3,4,5,6,7 | 2,3 M 5,6,7L |
| Corn | I | 190,146 | 1.82 | 1,746 | 0.017 | 2,3,4,5,6,7 | 2H 3H 4H 5H 6H 7H |
| Pasture | I | 236 | 0.002 | 71 | 0.0007 | 2,3,4,5,6,7 | 2H 3H 4H 5H 6H 7H |
| Wheat | I | 37,158 | 0.35 | 2,127 | 0.02 | 2,3,4,5,6,7 | 2H 3H 4H 5H 6H 7H |
| Vegetables and Groundfruit | I | 8,533 | 0.08 | 2,676 | 0.03 | 2,3,4,5,6,7 | 2H 3H |

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 to Host Fish associated with bin (H, M, L) |
|----------------------|------------------------------|------------------------|-------|---------------------------------------|-------|--|---|
| | | Acres | % | Acres | % | | |
| | | | | | | | 4H 5H 6H 7H |
| Cotton | I | 688,135 | 6.6 | 49,140 | 0.470 | 2,3,4,5,6,7 | 2H 3H 4H 5H 6H 7H |
| Nurseries | I | 1,542 | 0.014 | 1,542 | 0.015 | 2,3,4,5,6,7 | 2H 3H 4H 5H 6H 7H |
| Orchards & Vineyards | I | 207,624 | 1.98 | 6,760 | 0.06 | 2,3,4,5,6,7 | 2H 3H 4H 5H 6H 7H |
| Other Crops | I | 429,726 | 4.1 | 847 | 0.008 | 2,3,4,5,6,7 | 2H 3H 4H 5H 6H 7H |
| Other Row Crops | I | 418,457 | 4 | 25,878 | 0.25 | 2,3,4,5,6,7 | 2H 3H 4H 5H 6H 7H |
| Other Grains | I | 67,252 | 0.64 | 8,923 | 0.09 | 2,3,4,5,6,7 | 2H 3H 4H 5H |

| Use type | Risk to species ¹ | Use overlap with range | | Estimated usage in range ² | | Bins associated with use type [^] | Effect to Host Fish associated with bin (H, M, L) |
|--|------------------------------|------------------------|---------|---------------------------------------|---------|--|---|
| | | Acres | % | Acres | % | | |
| | | | | | | | 6H 7H |
| Rice | I | 13.4 | 0.0001 | 0 | 0 | 2,3,4,5,6,7 | 2H 3H 4H 5H 6H 7H |
| Christmas trees | I | 5 | 0.00005 | 5 | 0.00005 | 2,3,4,5,6,7 | 2H 3H 4H 5H 6H 7H |
| Pine Seed Orchards | I | 75,518 | 0.72 | 41,671 | 0.40 | 2,3,4,5,6,7 | 2H 3H 4H 5H 6H 7H |
| Sub-TOTAL (I): <i>Other uses with indirect effects³</i> | | 2,989,085 | 28.6 | 184,623 | 1.78 | | |
| TOTAL³: | | 8,202,381.4 | 78.4 | 563,535 | 5.39 | | |

[^]We consider the Bin 2 estimates as an upper bound of Bin 3 & 4 exposures. The estimated environmental concentrations for a Bin 2 water are an order of magnitude greater than Bins 3 and 4; therefore concentrations in Bins 3 and 4 can be reduced by a correction factor of 10.

acres in species range: 10,471,416 acres

% of range in California (i.e., where CalPUR data is available): 0%

³ TOTAL includes usage on all use sites with effects, including mosquito control.

Range overlap with Federal lands: 146,530 acres, 1.399%

Exposure Modifiers:

A reassessment of our crop use data layers shows that within the “Other Row Crops” layer shows that usage in this category may be overestimated. This UDL is composed of sunflower, peanuts, tobacco, sugar beets, and hops, of which, only hops is a registered use site on malathion labels and is thus the only crop in this layer that is relevant in our analysis. USDA data shows that 96% of hops are grown in the Pacific Northwest region (in Idaho, Oregon, and Washington), with some small farms in Florida (Gadsden County) reporting occasional hop production. Given the highly specific regions that hops are grown in, we can assume that potential exposure to malathion from “other row crops” use sites is 0 outside of these areas, however the range of the shinyrayed pocketbook is within Gadsden County (Florida) therefore we assume there is usage for other row crops (hops) within the range of the shinyrayed pocketbook.

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 groundfruit lower the maximum allowable number of applications to 2-4 per year (depending on the specific crop). 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.

Reduced citrus application rate: The reduction in the maximum application rate for citrus (outside of California) is expected to reduce potential environmental concentrations to one-third of modeled values, reducing the effects to species, prey, host fish, and pollinators on and adjacent to these use areas.

The following has been specified for mosquito control measures within the range of the shinyrayed pocketbook:

Where feasible, avoid application. If avoidance is not feasible or impairs the ability of the mosquito control district or agency to protect the public's health and welfare, coordinate with the local FWS Ecological Services field office to determine appropriate measures to minimize exposure and to ensure the proposed application is likely to have no more than minor effects on the species (FWS points of contact and maps of designated critical habitat are available through the Information, Planning, and Consultation (IPaC) website <https://ecos.fws.gov/ipac/>). The applicator must retain documentation of the technical assistance and the agreed upon species-specific measures that were implemented.

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 shinyrayed pocketbook. As discussed below, even though the species vulnerability is high and risk to the species host fish is medium, we anticipate the likelihood of exposure of host fish to malathion is low. In addition, although mosquito adulticide was identified as a driver in our February 2021 draft biological Opinion, our subsequent examination of the usage overlap with the species' refined range indicated this usage is greatly reduced. Thus, for this species, based upon a refinement of the range and mosquito adulticide usage information, we anticipate that mosquito adulticide is only a minor driver for malathion effects and that more than minor effects to host fish are not anticipated from this use. Lastly, since our draft Opinion in February 2021, EPA provided additional information regarding EECs in aquatic Bins 3 and 4. The shinyrayed pocketbook utilizes a wide variety of habitats, including large and/or swift moving streams represented by Bins 3 and 4, and we anticipate that

exposure to malathion was likely previously overestimated. Thus, risk to this species' host fish(es) is medium and for this species, remains unknown, we anticipate the likelihood of exposure to malathion is low and further mitigated through the the implementation of the general conservation measures described above.

The shinyrayed pocketbook has a high vulnerability based on its status, distribution, and trends. Mortality and sublethal effects to the species are not anticipated. The risk to the species host fish posed by labeled uses across the range is medium, and where individual host fish are exposed, we anticipate medium levels of mortality. Mussels depend on host fish to accomplish their reproductive lifecycle. Glochidia (larval stage) are released into the water and within a few days they must attach to an appropriate species of fish, which they parasitize for a short time while they develop into juvenile mussels. Glochidia that do not attach to a host fish will not survive.

We anticipate usage within the non-Federal portion of the species' range will be medium (5.39%), based primarily on the 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 Biological Opinion. Where sufficient numbers of suitable host fish are not available, we anticipate reproduction of mussels would be reduced.

The species range, and thus this species host fish range, is very large (>10.4 million acres) and we do not anticipate that host fish would necessarily be found in the affected areas of the waterbodies near application sites when malathion is applied, although small numbers of host fish may occur in these areas and be exposed over the duration of the proposed action. Reductions in plankton could be high in localized areas, however, we anticipate additional food resources from upstream sources would quickly recolonize after an application event. In addition, we anticipate that the conservation measures above, including rain restrictions, aquatic habitat buffers, residential use label changes, and reduced number of applications and rates on certain use sites, will further reduce the risk of exposure to the mussels' host fish.

As stated previously, conservation measures are aimed at reducing the amount of malathion runoff and spray drift that enter into sensitive habitats (e.g., species habitat, aquatic environments). For example, by placing a 48-hour rain restriction on agricultural applications, malathion has the ability to degrade after application (e.g., by hydrolysis, other processes) prior to any rain/runoff events, thus minimizing malathion runoff into aquatic habitats and decreasing exposure to listed mussels and their host fish. Increasing application buffers reduces the amount of malathion that drifts off target and subsequently into non-target environments. In addition, changes to residential labels limits applications to spot treatments and reduces the number of applications per year (2-4), significantly decreasing the overall amounts of malathion used in residential areas and resulting amounts of runoff and drift. Additional reductions in the number of applications and rates allowed for certain crops (e.g., corn, vegetables and ground fruit) further reduces the amount of malathion used in agricultural settings, thereby decreasing potential exposure to the species and their host fish.

The main use driver for this species is mosquito control. As a result, to reduce anticipated exposure and resultant mortality from mosquito uses, a conservation measure will be

implemented that restricts this use within the range of the mussel. More specifically, use will be prohibited within the low flow areas where malathion concentrations are expected to be highest. If applications are needed to control mosquitos in these areas, such as due to a public health threat, the applicator must contact the local FWS field office to determine alternative measures to minimize exposure and to ensure the proposed application is likely to have no more than minor effects on the species. Discussions at the local level may allow for greater flexibility and less restrictive measures based on site- or species-specific considerations, such as specific timing, species life history, and geographic or habitat factors. Coordination with FWS on measures to minimize exposure to listed species, including avoidance, is a recognized practice by mosquito control professionals. In its 2021 Best Practices for Integrated Mosquito Management, the American Mosquito Control Association (AMCA) instructs applicators with listed species in their treatment area to coordinate with FWS prior to application and maintain records of interactions. Discussions with the AMCA and anecdotal reports from FWS field offices indicate that this type of coordination is presently occurring to varying degrees for mosquito control applications in general. Applicators subject to this conservation measure will be required to maintain records of their interactions with FWS offices, allowing EPA to better track this coordination and its outcomes moving forward.

Combined, these conservation measures substantially reduce exposure to the shinyrayed pocketbook and their host fish and therefore minimizes overall risk and adverse effects to the species. Thus, while we anticipate small numbers of individual host fish would be lost over the duration of the action, resulting in very small reductions in reproductive success, we do not anticipate species-level effects to this mussel species.

Therefore, we anticipate that the proposed action would not appreciably reduce survival and recovery of the shinyrayed pocketbook in the wild.

Conclusion: Is not likely to jeopardize.

Integration and Synthesis Summary: Bivalves

| Scientific Name: | Common Name: | Entity ID: |
|-------------------------------|------------------------|-------------------|
| <i>Ptychobranthus greenii</i> | Triangular kidneyshell | 379 |

Family: Unionidae

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 triangular kidneyshell is currently stable and not known to have lost any known populations since the time of listing. The most robust population is the Cahaba River (Jefferson, Bibb, and Shelby Counties, Alabama), where densities have been found up to 0.25 individuals/m² (P. Johnson pers. comm. 2018). The Sipsey Fork population was believed healthy until the 2000 drought, when the predrought densities were documented at 0.88 individuals/m², but postdrought were measured at 0.18 individuals/m² (Haag and Warren 2008). The triangular kidneyshell was cultured in 2014 using Cahaba River brood stock and when several darters were identified as good hosts, but no stockings have yet taken place (Johnson 2018).

The primary cause of curtailment of range and fragmentation of habitat for all 11 mussel species is construction of dams and impoundment of large reaches of major river channel (58 FR 14330). Although most of these actions took place in the past, the impacted conditions and habitat continue to affect the species.

Other causes of habitat and range curtailment identified at listing included dredging, mining, and historical or episodic pollution events (58 FR 14330), sedimentation, increased nutrients, urbanization, loss of *Podostemum* (submerged river plant), riparian buffers, and climate change. The results of dredging (i.e., headcutting) continues to affect mussel populations in some Tombigbee River tributaries. Coal mining activities continue to expand within the Locust Fork, Cahaba River, and Buttahatchee River basins impacting water quality and habitat conditions.

Pollution and water quality impairments continue to be a factor at most sites where the species occur. Many stream segments that continue to support these species, or streams feeding into their habitats, including some areas designated as critical habitat, are not currently supporting designated uses, (e.g., Conasauga River, Oostanaula River, Holly Creek, Locust Fork, North

River, Cahaba River, Sipsey River, etc.) (Tennessee Department of Environment and Conservation 2005, Georgia Environmental Protection Division 2005, Alabama Department of Environmental Management 2006).

EB/CE Source: U.S. Fish and Wildlife Service. 2019. 5-Year Review: Summary and Evaluation for the Fine-lined Pocketbook (*Hamiota altilis*), Orange-nacre Mucket (*Hamiota perovalis*), Alabama moccasinshell (*Medionidus acutissimus*), Coosa moccasinshell (*Medionidus parvulus*), Southern Combshell (*Pleurobema decisum*), Dark Pigtoe (*Pleurobema furvum*), Southern Pigtoe (*Pleurobema georgianum*), Ovate Clubshell (*Pleurobema perovatum*), and Triangular Kidneyshell (*Ptychobranhus greenii*). Alabama Ecological Services Field Office. Daphne, Alabama. 69 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 expect the triangular kidneyshell will experience direct mortality or sublethal effects from any malathion uses at the maximum rates for all bins (2, 3, 4, 7). . However, risk of mortality to the host fish for bin 2 is high for all use sites except developed where it is medium. Risk of mortality to individuals in bin 7 is medium for all uses except for developed and mosquito control which are low.

We do not expect mussel species to be directly impacted by exposure from malathion. However their lifecycle is such that when glochidia (larval stage) are released into the water, within a few days they must attach to an appropriate species of fish, which they parasitize for a short time while they develop into juvenile mussels in order to complete their lifecycle; they cannot complete their lifecycle without a fish host.

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.

| | |
|--|--|
| DIRECT (all uses except mosquito control) | |
| Use areas – mortality | No effects expected |
| Sublethal – growth (G), reproduction (R) and behavior (B) enzyme (E) | No effects expected |
| INDIRECT (all uses except mosquito control) | |
| Use areas - Prey item mortality | If plankton: H, except for developed is L If detritus: NA |
| Use areas – Fish Host | Total overlap: 5.04%, H M for most uses L for developed |

| MOSQUITO CONTROL | |
|--------------------|--|
| Direct (mortality) | No effects expected |
| Sublethal | No effects expected |
| Indirect | Total overlap: 27.2%, H L depending on the bin |

Risk modifiers:

This species appears most prevalent in sections of river three feet in depth and having a good current and a firm substrate as opposed to coarse gravel and sand (Parmalee and Bogan, 1998) in shoals and runs of small rivers and large streams (USFWS, 2000). The environmental specificity of this species is unknown and it is highly vulnerable.

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. Further investigation by EPA into Bin 3 and 4 estimated environmental concentrations indicate 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. While the triangular kidneyshell also occupies other aquatic habitats that may be exposed to potentially high levels of malathion due to lower volume in those habitats (Bin 2), their potential exposure risk is at least partially lowered based on their reliance upon the larger flowing aquatic habitats (Bin 3, 4, and 7), reducing the overall risk to the species as a whole.

The Triangular Kidneyshell is a considered a fish host generalist whose glochidia can metamorphose on a wide variety of fishes from multiple families. While we anticipate some species of the host fish community will exhibit temporary reductions in abundance due to malathion exposure, the species’ flexible host requirement will allow the species to be more resilient to temporary losses of host fish, reducing the anticipated indirect 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 to Host Fish associated with bin (H, M, L) |
|------------------|------------------------------|------------------------|------|---------------------------------------|--------|--|---|
| | | Acres | % | Acres | % | | |
| Mosquito Control | I | 2,199,686 | 27.2 | 94,024 | 1.16 | 2,3,4,7 | 2H 3 4 7L |
| Developed | I | 305,586 | 3.78 | 15,279 | 0.19 | 2,3,4,7 | 2M 3 4 7L |
| Cotton | I | 42,350 | 0.52 | 10,352 | 0.13 | 2,3,4,7 | 2H 3 4 7M |
| Corn | I | 33,820 | 0.42 | 2,726 | 0.03 | 2,3,4,7 | 2H 3 4 7M |
| Other Crops | I | 17,239 | 0.21 | 35 | < 0.01 | 2,3,4,7 | 2H 3 4 7M |
| Wheat | I | 1,935 | 0.02 | 808 | < 0.01 | 2,3,4,7 | 2H 3 4 7M |
| Nurseries | I | 1,708 | 0.02 | 1,708 | 0.02 | 2,3,4,7 | 2H 3 4 7M |
| Other Grains | I | 1,630 | 0.02 | 1,529 | 0.02 | 2,3,4,7 | 2H 3 4 7M |
| Other Row Crops | I | 1,019 | 0.01 | 998 | 0.01 | 2,3,4,7 | 2H 3 |

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 to Host Fish associated with bin (H, M, L) |
|--|------------------------------|------------------------|--------|---------------------------------------|--------|--|---|
| | | Acres | % | Acres | % | | |
| | | | | | | | 4 7M |
| Vegetables & Ground Fruit | I | 174 | < 0.01 | 132 | < 0.01 | 2,3,4,7 | 2H 3 4 7M |
| Orchards & Vineyards | I | 145 | < 0.01 | 117 | < 0.01 | 2,3,4,7 | 2H 3 4 7M |
| Pasture | I | 17 | < 0.01 | 17 | < 0.01 | 2,3,4,7 | 2H 3 4 7M |
| Christmas trees | I | 4 | < 0.01 | 5 | < 0.01 | 2,3,4,7 | 2H 3 4 7M |
| Sub-TOTAL (I): <i>Other uses with indirect effects³</i> | | 405,627 | 5.04 | 33,707 | 0.46 | | |
| TOTAL³: | | 2,605,313 | 32.24 | 127,731 | 1.62 | | |

[^]We consider the Bin 2 estimates as an upper bound of Bin 3 & 4 exposures. The estimated environmental concentrations for a Bin 2 water are an order of magnitude greater than Bins 3 and 4, therefore concentrations in Bins 3 and 4 can be reduced by a correction factor of 10.

Exposure Modifiers:

A reassessment of our crop use data layers shows that within the “Other Row Crops” layer shows that usage in this category may be overestimated. This UDL is composed of sunflower, peanuts, tobacco, sugar beets, and hops, of which, only hops is a registered use site on malathion labels and is thus the only crop in this layer that is relevant in our analysis. USDA data shows that 96% of hops are grown in the Pacific Northwest region (in Idaho, Oregon, and Washington), with some small farms in Florida reporting occasional hop production. Given the highly specific

³ TOTAL includes usage on all use sites with effects, including mosquito control.

regions that hops are grown in, we can assume that potential exposure to malathion from “other row crops” use sites is 0 outside of these areas, and thus is not relevant to this species.

acres in species range: 8,087,349 acres

% of range in California (i.e., where CalPUR data is available): 0%

Range overlap with Federal lands: 1,346,150 acres, 16.645%

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 groundfruit lower the maximum allowable

number of applications to 2-4 per year (depending on the specific crop). 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 triangular kidneyshell. As discussed below, even though the species vulnerability is high and risk to the species host fish is medium, we anticipate the likelihood of exposure of host fish to malathion is low, and the implementation of the general conservation measures described above is expected to further reduce the likelihood of exposure.

The triangular kidneyshell has a high vulnerability based on its status, distribution, and trends. Mortality and sublethal effects to the species are not anticipated. The risk to the species host fish posed by labeled uses across the range is medium, and where individual host fish are exposed, we anticipate high to medium levels of mortality, depending on water body size and use type. Mussels depend on host fish to accomplish their reproductive lifecycle. Glochidia (larval stage) are released into the water and within a few days they must attach to an appropriate species of fish, which they parasitize for a short time while they develop into juvenile mussels. Glochidia that do not attach to a host fish will not survive. Where sufficient numbers of suitable host fish are not available, we anticipate reproduction of mussels would be reduced.

We anticipate usage within the non-Federal portion of the species' range will be low (1.62 %), based primarily on the 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 Biological Opinion.

The species range, and thus this species host fish range, is very large (>8 million acres) and we do not anticipate that host fish would necessarily be found in the affected areas of the waterbodies near application sites when malathion is applied, although small numbers of host fish may occur in these areas and be exposed over the duration of the proposed action. Reductions in plankton could be high in localized areas, however, we anticipate additional food resources from upstream sources would quickly recolonize after an application event. In addition, we anticipate that the conservation measures above, including rain restrictions, aquatic habitat buffers, residential use label changes, and reduced number of applications and rates on certain use sites, will further reduce the risk of exposure to plankton and the mussels' host fish.

As stated previously, conservation measures are aimed at reducing the amount of malathion runoff and spray drift that enter into sensitive habitats (e.g., species habitat, aquatic environments). For example, by placing a 48-hour rain restriction on agricultural applications, malathion has the ability to degrade after application (e.g., by hydrolysis, other processes) prior to any rain/runoff events, thus minimizing malathion runoff into aquatic habitats and decreasing

exposure to listed mussels and their host fish. Increasing application buffers reduces the amount of malathion that drifts off target and subsequently into non-target environments. In addition, changes to residential labels limits applications to spot treatments and reduces the number of applications per year (2-4), significantly decreasing the overall amounts of malathion used in residential areas and resulting amounts of runoff and drift. Additional reductions in the number of applications and rates allowed for certain crops (e.g., corn, vegetables and ground fruit) further reduces the amount of malathion used in agricultural settings, thereby decreasing potential exposure to the species and their host fish. Combined, these conservation measures substantially reduce exposure to the triangular kidneyshell and their host fish and therefore minimizes overall risk and adverse effects to the species. Thus, while we anticipate small numbers of individual host fish would be lost over the duration of the action, resulting in very small reductions in reproductive success, we do not anticipate species-level effects to this mussel species.

Therefore, we anticipate that the proposed action would not appreciably reduce survival and recovery of the triangular kidneyshell in the wild.

Conclusion: Is not likely to jeopardize.

Integration and Synthesis Summary: Bivalves

| Scientific Name: | Common Name: | Entity ID: |
|--------------------------------|---------------------|-------------------|
| <i>Medionidus penicillatus</i> | Gulf moccasinshell | 384 |

Family: Unionidae

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:

According to the 2020 5-Year Review for the species, the Gulf moccasinshell historically occurred in 11 sub-basins (USFWS 2003) and currently occupies Econfinia, Chipola, Lower Chattahoochee, Ichawaynochaway, Middle Flint and Upper Flint sub-basins in Florida, Alabama, and Georgia. Since the last 5-year review, within sub-basin distribution has mainly decreased with the exception of Sawhatchee Creek (Lower Chattahoochee sub-basin; in Georgia) and Chokey Creek (Middle Flint sub-basin; in Georgia). These two sites where higher densities of Gulf moccasinshells can be found with evidence of recruitment are susceptible to catastrophic events. Loss of any of these populations may reduce species redundancy and representation. Overall, the species has continued to decline in numbers and distribution within its historical range with probable extirpation in Upper and Middle Chattahoochee and Spring sub-basins.

The Econfinia, Lower Chattahoochee (Sawhatchee and Sheffield Mill Creeks), Middle Flint (Chokey Creek), and Chipola populations (i.e., sub-basins) have remained stable and/or have

evidence of recruitment for the Gulf moccasinshell. The remaining sub-basins (Upper and Lower Flint, Kinchafoonee-Muckalee, Ichawaynochaway, Middle Chattahoochee) have minimal numbers of individuals and have no evidence of recruitment. In addition, the Gulf moccasinshell is possibly extirpated from the Spring Creek sub-basin. Most sub-basins consist of localized, fragmented sites with generally small numbers of individuals. Most stable populations are restricted to short stream reaches and remain vulnerable to random natural or human-induced events such as droughts or spills.

The declining range and abundance of the species is due mostly to changes in the river systems resulting from dams, dredging, mining, channelization, pollution, sedimentation, and water withdrawals resulting in habitat loss, fragmentation and degradation. Severe drought contributes to further fragmentation and loss of habitat. These threats occur throughout all the basins to some degree but is the greatest in the Flint, Apalachicola, and Ochlockonee rivers, which are

downstream of major main-stem dams, or in areas of relatively high municipal, industrial, or agricultural water use.

From the species 2007 5-Year Review the seven species [covered in the review, including the Gulf moccasinshell] are highly restricted in distribution, occur in generally small subpopulations, and show little evidence of recovering from historical habitat losses without significant positive human intervention. The species and their habitats continue to be impacted by excessive sediment, channel instability, gravel mining, reduced water quality, developmental activities, water withdrawal, impoundments, and invasive species. Their limited distributions and small populations render them vulnerable to random natural or human-induced events such as droughts or spills. The degree of threat to the persistence of the five endangered species remains high (and moderate for the two threatened species), and the potential for recovery for all seven species remains low. While some progress has been made on achieving the recovery of these mussels none of the subpopulation recovery criteria have been met for any of the seven species. In addition, many of the listing/recovery criteria (threats) are not currently met. Water quality is not meeting designated use (CWA- Section 305(b)) and stream channels are not stable with intact riparian zones throughout the range of the seven species. All seven species continue to have reduced fragmented distribution and continued threats.

EB/CE Source: U.S. Fish and Wildlife Service. 2020. 5-Year Review: Evaluation and Summary for the Shinyrayed Pocketbook (*Lamplilis subangulata*) and Gulf Moccasinshell (*Medionidus penicillatus*). Georgia Ecological Services Field Office. Athens, Georgia. 25 pp.

U.S. Fish and Wildlife Service (FWS). 2007. 5-Year Review: Fat Threeridge (*Amblema neislerii*), Shinyrayed Pocketbook (*Lampsilis subangulata*), Gulf Moccasinshell (*Medionidus penicillatus*), Ochlockonee Moccasinshell (*Medionidus simpsonianus*), Oval Pigtoe (*Pleurobema pyriforme*), Chipola Slabshell (*Elliptio chipolaensis*), Purple Bankclimber (*Elliptioideus sloatianus*). Panama City Field Office. Panama City, Florida. 31 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 expect the Gulf moccasinshell will experience direct mortality or sublethal effects from any malathion uses at the maximum rates for all bins (2, 3, 4, and 5). However, risk of mortality to the host fish for bin 2 is high for all use sites except developed where it is medium. Risk of mortality to the host fish in bin 5 is low for developed and high for all other uses.

We do not expect mussel species to be directly impacted by exposure from malathion. However their lifecycle is such that when glochidia (larval stage) are released into the water, within a few days they must attach to an appropriate species of fish, which they parasitize for a short time

while they develop into juvenile mussels in order to complete their lifecycle; they cannot complete their lifecycle without a fish host.

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.

| | |
|--|--|
| DIRECT (all uses except mosquito control) | |
| Use areas – mortality | No effects expected |
| Sublethal – growth (G), reproduction (R) and behavior (B) enzyme (E) | No effects expected |
| INDIRECT (all uses except mosquito control) | |
| Use areas - Prey item mortality | If plankton: High If detritus: NA |
| Use areas – Fish Host | Total overlap: 29% H for all bins except L for bin 5 |
| MOSQUITO CONTROL | |
| Direct (mortality) | No effects expected |
| Sublethal | No effects expected |
| Indirect | Total overlap: 48%, H |

Risk modifiers:

Mussels depend on a host fish to accomplish their reproductive lifecycle. Glochidia that do not attach to a host fish will not survive. We anticipate reproduction of mussels would be reduced in areas where there are insufficient host fish available. Mussels can be categorized into several different categories that capture the breadth of the type of mussel-host relationships, including host fish generalists, host fish specialists, and those for which the host fish are unknown. Because fish species exhibit a range of sensitivities to malathion, exposure is expected to have varying effects upon these different fish species, thus malathion would have variable impacts to the mussels that parasitize the fish. Gulf moccasinshell glochidia are released in early to late spring, while gravid females were found in March, April, September, and November (O'Brien and Williams, 2002). Primary host fish include *Etheostoma edwini* (brown darter), *Percina nigrofasciata* (blackbanded darter), *Gambusia holbrooki* (eastern mosquitofish), *Poecilia reticulata* (guppy) (Butler and Alam, 1999; USFWS, 2003; O'Brien, 1998; O'Brien and Williams, 2002). Two other fishes, the eastern mosquitofish and guppy, also transformed glochidia but at lower percentage rates (O'Brien and Williams, 2002). The Gulf moccasinshell is probably a host-fish specialist that primarily parasitizes darters (USFWS, 2007a). Recent host fish trials by Fritts and Bringolf (2014) tested between 19-27 fish species for the shinyrayed pocketbook and Gulf moccasinshell. For the Gulf moccasinshell, four potential darter species demonstrated successful transformation in laboratory condition: turquoise darter (*Etheostoma inscriptum*), gulf darter (*Etheostoma swaini*), Halloween darter (*Percina crypta*), and blackbanded darter (*Percina nigrofasciata*). Metamorphosis success varied but was the highest on turquoise darter (40%) and blackbanded darter (39%). This narrow fish host requirement suggests that the Gulf moccasinshell will be less resilient to possible changes in the fish host

community and make it more susceptible to indirect effects of malathion. Thus, the risk is determined to be high for the Gulf moccasinshell.

It occurs in a wide range of habitats, including sandy areas with a slight current (Jenkinson, 1973), streams and rivers where there is a moderate current and sand and gravel substrates (Clench and Turner, 1956), and in muddy sand substrates around tree roots in medium-sized stream with moderate current (Heard, 1975) (NatureServe, 2015). Primary constituent elements include: a geomorphically stable stream channel; a predominantly sand, gravel, and/or cobble stream substrate with low to moderate amounts of silt and clay; permanently flowing water; water quality (including temperature, turbidity, dissolved oxygen, and chemical constituents) that meets or exceeds the current aquatic life criteria established under the Clean Water Act (CWA) (USFWS, 2007a).

As described in the “Approach to the Effects Analysis” section of the main body of the Opinion, we made specific considerations were made 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 Gulf moccasinshell also occupies other aquatic habitats that may be exposed to potentially high levels of malathion due to lower volume in those habitats (Bin 2), their potential exposure risk is at least partially lowered based on their reliance upon the larger flowing and static aquatic habitats (Bin 3, 4, and 5), reducing the overall risk to the species as a whole.

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 to Host Fish associated with bin (H, M, L) |
|------------------|------------------------------|------------------------|----|---------------------------------------|------|--|---|
| | | Acres | % | Acres | % | | |
| Mosquito Control | I | 2,800,867 | 48 | 276,122 | 4.73 | 2,3,4,5 | 2H |

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 to Host Fish associated with bin (H, M, L) |
|---------------------------|------------------------------|------------------------|-------|---------------------------------------|-------|--|---|
| | | Acres | % | Acres | % | | |
| | | | | | | | 3 4 5H |
| Cotton | I | 376,454 | 6.45 | 45,201 | 0.77 | 2,3,4,5 | 2H 3 4 5H |
| Other Row Crops | I | 261,251 | 4.48 | 4258 | 0.35 | 2,3,4,5 | 2H 3 4 5H |
| Other Crops | I | 281,457 | 4.83 | 741 | 0.018 | 2,3,4,5 | 2H 3 4 5H |
| Developed | I | 153,143 | 2.63 | 32359 | 0.13 | 2,3,4,5 | 2M 3 4 5L |
| Open Space Developed | I | 271,431 | 4.65 | 13,572 | 0.23 | 2,3,4,5 | |
| Orchards & Vineyards | I | 128,409 | 2.2 | 5,342 | 0.09 | 2,3,4,5 | 2H 3 4 5H |
| Corn | I | 131,331 | 2.25 | 1,664 | 0.03 | 2,3,4,5 | 2H 3 4 5H |
| Other Grains | I | 41,370 | 0.71 | 8,475 | 0.15 | 2,3,4,5 | 2H 3 4 5H |
| Wheat | I | 25,345 | 0.43 | 25,345 | 0.4 | 2,3,4,5 | 2H 3 4 5H |
| Vegetables & Ground Fruit | I | 5,421 | 0.09 | 1,934 | 0.033 | 2,3,4,5 | 2H 3 4 5 |
| Nurseries | I | 725 | 0.012 | 725 | 0.012 | 2,3,4,5 | 2H 3 |

| Use type | Risk to species ¹ | Use overlap with range | | Estimated usage in range ² | | Bins associated with use type [^] | Effect to Host Fish associated with bin (H, M, L) |
|--|------------------------------|------------------------|-------|---------------------------------------|--------|--|---|
| | | Acres | % | Acres | % | | |
| | | | | | | | 4 5H |
| Pasture | I | 135 | 0.002 | 28 | 0.0005 | 2,3,4,5 | 2H 3 4 5H |
| Pine Seed Orchards | I | 28,068 | 0.48 | 28,068 | 0.48 | 2,3,4,5 | |
| Sub-TOTAL (I): <i>Other uses with indirect effects³</i> | | 1,704,540 | 29.2 | 167,892 | 2.69 | | |
| TOTAL³: | | 4505,407 | 77.2 | 444,014 | 7.42 | | |

[^]We consider the Bin 2 estimates as an upper bound of Bin 3 & 4 exposures. The estimated environmental concentrations for a Bin 2 water are an order of magnitude greater than Bins 3 and 4; therefore concentrations in Bins 3 and 4 can be reduced by a correction factor of 10.

Exposure Modifiers: A reassessment of our crop use data layers shows that within the “Other Row Crops” layer shows that usage in this category may be overestimated. This UDL is composed of sunflower, peanuts, tobacco, sugar beets, and hops, of which, only hops is a registered use site on malathion labels and is thus the only crop in this layer that is relevant in our analysis. USDA data shows that 96% of hops are grown in the Pacific Northwest region (in Idaho, Oregon, and Washington), with some small farms in Florida (Gadsden County) reporting occasional hop production. Given the highly specific regions that hops are grown in, we can assume that potential exposure to malathion from “other row crops” use sites is 0 outside of these areas, however the range of the Gulf moccasinshell is within Gadsden County (Florida) therefore we assume there is usage for other row crops (hops) within the range of the Gulf moccasinshell.

acres in species range: 5,833,077 acres

% of range in California (i.e., where CalPUR data is available): 0%

Range overlap with Federal lands: 3,282 acres, 0.06%

Overall Usage: ☐ High ☒ Medium ☐ Low

³ TOTAL includes usage on all use sites with effects, including mosquito control.

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 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 significantly 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 significantly 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 initial residues to degrade prior to the next application. In addition, exposure to aquatic organisms is reduced due to buffers from waterways 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 groundfruit lower the maximum allowable number of applications to 2-4 per year (depending on the specific crop). 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.

Reduced citrus application rate: The reduction in the maximum application rate for citrus (outside of California) is expected to reduce potential environmental concentrations to one-third of modeled values, reducing the effects to species, prey, host fish, and pollinators on and adjacent to these use areas.

Species specific measures: In addition to the general label changes that would apply to all uses specified on the label, which would be protective of a wide range of species, the registrants have

also agreed to additional conservation measures, such as additional application buffers. The following species-specific measures are now part of the Action and will be included in *BulletinsLive! Two*:

The following has been specified for agricultural uses within the range of the Gulf moccasinshell

Do not apply aerially within 100ft (or 50ft if a full swath displacement is used) of low flow habitats (as defined with input from FWS Field Office staff) for cotton application.

The following has been specified for mosquito control measures within the range of the Gulf moccasinshell:

Where feasible, avoid application. If avoidance is not feasible or impairs the ability of the mosquito control district or agency to protect the public's health and welfare, coordinate with the local FWS Ecological Services field office to determine appropriate measures to minimize exposure and to ensure the proposed application is likely to have no more than minor effects on the species (FWS points of contact and maps of designated critical habitat are available through the Information, Planning, and Consultation (IPaC) website <https://ecos.fws.gov/ipac/>). The applicator must retain documentation of the technical assistance and the agreed upon species-specific measures that were implemented.

Application buffers are designed to reduce spray drift from entering sensitive non-target areas, thereby providing protection to species. While the exact amount of spray drift reduction will vary depending on traits of the ecosystem (e.g. flow rate, volume, etc.) as well as the application method, based on AgDRIFT modeling we can expect spray drift reductions ranging from 82 to 90%.

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 Gulf moccasinshell. As discussed below, even though the species vulnerability is high and risk to the species host fish is high, we anticipate the likelihood of exposure of host fish to malathion is low. In addition, although mosquito adulticide was identified as a driver in our February 2021 draft Opinion, our subsequent examination of the usage overlap with the species' refined range indicated this usage is slightly reduced. Thus, for this species, based upon a refinement of the range and mosquito adulticide usage information and the incorporation of a mosquito adulticide restriction as described above, we anticipate that mosquito adulticide is only a minor driver for malathion effects and that more than minor effects to host fish are not anticipated from this use. Lastly, since our draft Opinion in February 2021, EPA provided additional information regarding EECs in aquatic Bins 3 and 4. The Gulf moccasinshell prefers a variety of habitats, including larger and faster moving streams represented by Bins 3 and 4 and we anticipate that exposure to malathion was likely previously overestimated for Bins 3 and 4. Thus, we anticipate the likelihood of exposure to malathion is

reduced, due to dilution in Bins 3 and 4, and further mitigated through the implementation of the general conservation measures described above.

The Gulf moccasinshell has a high vulnerability based on its status, distribution, and trends. Mortality and sublethal effects to the species are not anticipated. The risk to the species host fish posed by labeled uses across the range is generally high, and where individual host fish are exposed, we anticipate high to medium levels of mortality, depending on water body size and use type. Mussels depend on host fish to accomplish their reproductive lifecycle. Glochidia (larval stage) are released into the water and within a few days they must attach to an appropriate species of fish, which they parasitize for a short time while they develop into juvenile mussels. Glochidia that do not attach to a host fish will not survive. In addition, the Gulf moccasinshell is most likely a fish host specialist and requires specific host fish species upon which the glochidia may attach. Where sufficient numbers of suitable host fish are not available, we anticipate reproduction of mussels would be reduced.

We anticipate usage within the non-Federal portion of the species' range will be medium (7.42 %), based primarily on the usage data we acquired, as described in the Opinion and summarized for this species above. We did not quantitatively evaluate use or usage on the small proportion of Federal lands that overlap with the species range (<2%), but we assume only low levels of usage for this species in these areas, per the rationale related to usage on Federal lands as described in the Biological Opinion.

Primary host fish include *Etheostoma edwini* (brown darter), *Percina nigrofasciata* (blackbanded darter), *Percina crypta* (Halloween darter), *Etheostoma swaini* (Gulf darter) (Butler and Alam, 1999; USFWS, 2003; O'Brien, 1998; O'Brien and Williams, 2002, Fritts and Bringolf 2014). Two other fishes, the eastern mosquitofish and guppy, also transformed glochidia but at lower percentage rates (O'Brien and Williams, 2002). The Gulf moccasinshell is probably a host-fish specialist that primarily parasitizes darters (USFWS, 2007a). While the host fish species herein are relatively common (except for the Halloween darter which is state listed as threatened in Georgia) and do not have widespread conservation concerns, we do not have high resolution data on their relative abundances in the range of the Gulf moccasinshell or their relative proportion or selection in serving as the host fish. In general, we anticipate that locally diminished host fish(es) numbers are an important factor in reducing recruitment and survival of the Gulf moccasinshell in its few remaining populations.

Moderate levels of malathion usage (4.73%) are used for mosquito adulticide within the range of the Gulf moccasinshell. The Gulf moccasinshell remains stable and/or has shown evidence of recruitment in the Econfin, Lower Chattahoochee (Sawhatchee and Sheffield Mill Creeks), Middle Flint (Chokee Creek), and Chipola populations. Based on available usage data for mosquito adulticide applications, we are not aware of malathion use in recent years within the Econfin, Lower Chattahoochee (Sawhatchee and Sheffield Mill Creeks), or Chipola populations. Usage data does overlap with where other populations occur within the Middle Flint sub-basin. Future use of malathion as a mosquito adulticide cannot be ruled out in the other populations; however, it is important to note that malathion is typically used to reduce resistance to the more commonly used insecticides for mosquito control, and if used in these localized areas, we anticipate usage will be less than what is currently estimated for the range. Other usage across the range is anticipated to be low (2.69%), therefore, usage occurring within these localized areas

will be significantly less. Although overall usage is anticipated to be low within these localized areas, small numbers of host fish may occur in these areas and be exposed over the duration of the proposed action. Reductions in plankton could be high in localized areas, however, we anticipate additional food resources from upstream sources would quickly recolonize after an application event. In addition, we anticipate that the conservation measures above, including rain restrictions, aquatic habitat buffers, residential use label changes, reduced number of applications and rates on certain use sites, and specific mosquito control measures, will further reduce the risk of exposure to plankton and the mussels' host fish.

As stated previously, conservation measures are aimed at reducing the amount of malathion runoff and spray drift that enter into sensitive habitats (e.g., species habitat, aquatic environments). For example, by placing a 48-hour rain restriction on agricultural applications, malathion has the ability to degrade after application (e.g., by hydrolysis, other processes) prior to any rain/runoff events, thus minimizing malathion runoff into aquatic habitats and decreasing exposure to listed mussels and their host fish. Increasing application buffers reduces the amount of malathion that drifts off target and subsequently into non-target environments. In addition, changes to residential labels limits applications to spot treatments and reduces the number of applications per year (2-4), significantly decreasing the overall amounts of malathion used in residential areas and resulting amounts of runoff and drift. Additional reductions in the number of applications and rates allowed for certain crops (e.g., corn, vegetables and ground fruit) further reduces the amount of malathion used in agricultural settings, thereby decreasing potential exposure to the species and their host fish. Species-specific measures for agricultural uses (application buffer on low-flow habitats) and mosquito adulticide applications (avoid applications within low flow areas; or implement other minimization measures with collaboration with FWS) will further reduce malathion exposure to this species and their host fish.

The main use driver for this species is mosquito control. As a result, to reduce anticipated exposure and resultant mortality from mosquito uses, a conservation measure will be implemented that restricts this use within the range of the mussel. More specifically, use will be prohibited within the low flow areas where malathion concentrations are expected to be highest. If applications are needed to control mosquitos in these areas, such as due to a public health threat, the applicator must contact the local FWS field office to determine alternative measures to minimize exposure and to ensure the proposed application is likely to have no more than minor effects on the species. Discussions at the local level may allow for greater flexibility and less restrictive measures based on site- or species-specific considerations, such as specific timing, species life history, and geographic or habitat factors. Coordination with FWS on measures to minimize exposure to listed species, including avoidance, is a recognized practice by mosquito control professionals. In its 2021 Best Practices for Integrated Mosquito Management, the American Mosquito Control Association (AMCA) instructs applicators with listed species in their treatment area to coordinate with FWS prior to application and maintain records of interactions. Discussions with the AMCA and anecdotal reports from FWS field offices indicate that this type of coordination is presently occurring to varying degrees for mosquito control applications in general. Applicators subject to this conservation measure will be required to maintain records of their interactions with FWS offices, allowing EPA to better track this coordination and its outcomes moving forward.

Combined, these conservation measures substantially reduce exposure to the Gulf moccasinshell and their host fish and therefore minimizes overall risk and adverse effects to the species. Thus, while we anticipate small numbers of individual host fish would be lost over the duration of the action, resulting in very small reductions in reproductive success, we do not anticipate species-level effects to this mussel species.

Therefore, we anticipate that the proposed action would not appreciably reduce survival and recovery of the Gulf moccasinshell in the wild.

Conclusion: Is not likely to jeopardize.

ADDITIONAL REFERENCES

U.S. Fish and Wildlife Service. 2019. Gulf moccasinshell, oval pigtoe, purple bankclimber, shinyrayed pocketbook Recovery Plan Amendment. September 26, 2019. Atlanta, Georgia. 10 pp.

Integration and Synthesis Summary: Bivalves

| Scientific Name: | Common Name: | Entity ID: |
|--------------------------------|---------------------------|-------------------|
| <i>Medionidus simpsonianus</i> | Ochlockonee moccasinshell | 385 |

Family: Unionidae**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:**

2020 5-Year Review: The Ochlockonee Moccasinshell is currently known from one population in the lower Ochlockonee River (Liberty and Walkulla counties, FL). Abundance of this population is very low, and surveys conducted from 2006 to 2017 throughout the basin by the three agencies (FFWCC, GA DNR and PCFO) located only 30 live individuals and shells of 7 dead individuals (FFWCC unpubl. data, Pursifull et al., in review). Surveys indicate the species is possibly extirpated from the upper basin (upstream of Jackson Bluff dam). Its present range is restricted to a 23 km (14 mi) reach of the lower Ochlockonee River, and this represents 11% of its known historical range.

The main threat to the species is habitat degradation and loss. The upper basin has been impacted by intensive agricultural activities, urban development, industrial and municipal wastewater discharges, groundwater consumption, drought, surface mining, and a mainstem impoundment. Channel instability, altered flow regimes, and contaminants are thought to be the primary reasons for the species' decline in the upper basin. Threats to the newly discovered population in the lower basin includes dam related impacts (e.g. altered flow, sediment, and temperature regimes, and channel incision), pollution, extreme storm surge and flood events, and saltwater encroachment.

Without resilient populations in the upper basin, the species lacks the ability to withstand catastrophic events and maintain adaptive potential. The degree of threat to the persistence of this endangered species remains high and the potential for recovery remains low. There is still uncertainty in the resiliency of the population and the number needed to reduce isolation and increase the potential for genetic exchange.

EB/CE Source: U.S. Fish and Wildlife Service (FWS). 2020. 5-Year Review: Summary and Evaluation, Ochlockonee Moccasinshell (*Medionidus simpsonianus*). Panama City Ecological Services Field Office. Panama City, Florida. 21 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 expect the Ochlockonee moccasinshell will experience direct mortality or sublethal effects from any malathion uses at the maximum rates for all bins (3, 4). However, risk of mortality to the host fish for bin 4 is high for all use sites except wheat, mosquito control, and developed where it is medium. Risk of mortality to individuals in bin 3 is high for all uses except for developed which is low.

We do not expect mussel species to be directly impacted by exposure from malathion. However their lifecycle is such that when glochidia (larval stage) are released into the water, within a few days, they must attach to an appropriate species of fish, which they parasitize for a short time while they develop into juvenile mussels in order to complete their lifecycle; they cannot complete their lifecycle without a fish host.

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.

| | |
|--|--|
| DIRECT (all uses except mosquito control) | |
| Use areas – mortality | No effects expected |
| Sublethal – growth (G), reproduction (R) and behavior (B) enzyme (E) | No effects expected |
| INDIRECT (all uses except mosquito control) | |
| Use areas - Prey item mortality | If plankton: H, except for developed is L If detritus: NA |
| Use areas – Fish Host | Total overlap: 27%, H for most uses M for developed |
| MOSQUITO CONTROL | |
| Direct (mortality) | No effects expected |
| Sublethal | No effects expected |
| Indirect | Total overlap: 68%, M |

Risk modifiers:

Species occurs in Bins 3 and 4. See Risk Assumptions (above) for risk to individuals and species.

Species fish host (generalist) occurs in Bins 3 and 4. See Risk Assumptions (above) for risk to host species.

Mussels depend on a host fish to accomplish their reproductive lifecycle. Glochidia that do not attach to a host fish will not survive. We anticipate reproduction of mussels would be reduced in areas where there are insufficient host fish available. Mussels can be categorized into several different categories that capture the breadth of the type of mussel-host relationships, including host fish generalists, host fish specialists, and those for which the host fish are unknown. Because fish species exhibit a range of sensitivities to malathion, exposure is expected to have varying effects upon these different fish species, thus malathion would have variable impacts to the mussels that parasitize the fish. A recent publication confirms that members of the genus *Medionidus* are host specialists and dependent on darters (Percidae) for reproduction (Johnson et al. 2016). The Ochlockonee Moccasinshell likely relies primarily on blackbanded darter (*Percina nigrofasciata*) as host for its parasitic larval stage. Its reliance on darters indicates the species has limited ability to disperse considerable distances. This narrow fish host requirement suggests that the Ochlockonee moccasinshell will be less resilient to possible changes in the fish host community and make it more susceptible to indirect effects of malathion. Thus, the preliminary risk is determined to be high for the Ochlockonee moccasinshell.

The Ochlockonee moccasinshell is an extremely rare freshwater mussel, found exclusively in large creeks and the main stem of the Ochlockonee River that we have characterized as Bin 3 and 4 type waters. As described in the section “Approach to the Effects Analysis” from the main body of the Opinion and in the introduction section of this appendix, we initially relied on Bin 2 estimates as an upper bound for Bins 3 and 4 exposures in our draft Opinion due to the issues inherent in the modeling for these bins. However, in preparation for finalizing this Opinion, and with further coordination with EPA regarding Bin 3 and 4 EECs, we have revised our assumptions for Bins 3 and 4. We expect that bin 3 and 4 EECs are up to an order of magnitude lower than bin 2 EECs, and the EECs in these habitats would generally not be expected to cause toxic effects, as we anticipate the flow rates and volumes in these aquatic habitats are sufficient to dilute malathion concentrations to a level that will not cause toxic effects to the species. Thus, we have revised our overall risk below to “low.”

Overlap with species range (Total uses without mosquito control/mosquito control):
27.36%/67.6%

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 to Host Fish associated with bin (H, M, L) |
|---------------------------|------------------------------|------------------------|------------|---------------------------------------|------------|--|---|
| | | Acres | % | Acres | % | | |
| Mosquito Control | | 696,760 | 67.6 | 39,367 | 3.82 | 3,4 | 3M 4M |
| Developed | | 16,925 | 1.64 | 846 | 0.082 | 3 | 3L 4L |
| Open Space Developed | | 47,103 | 4.57 | 2,355 | 0.229 | 3,4 | 3L 4L |
| Corn | | 8,383 | 0.81 | 1158 | 0.112 | 3,4 | 3H 4H |
| Wheat | | 1942 | 0.17 | 2081 | 0.2 | 3,4 | 3H 4H |
| Pasture | | 3 | 0.000 3 | 3 | 0.000 3 | 3,4 | 3H 4H |
| Vegetables & Ground Fruit | | 504 | 0.049 | 504 | 0.049 | 3,4 | 3H 4H |
| Other Row Crops | | 31,749 | 3.08 | 11,989 | 1.16 | 3,4 | 3H 4H |
| Other Grains | | 6,214 | 0.6 | 4,286 | 0.42 | 3,4 | 3H 4H |
| Other Crops | | 35,008 | 3.39 | 0 | 0 | 3,4 | 3H 4H |
| Nurseries | | 707 | 0.069 | 707 | 0.069 | 3,4 | 3H 4H |
| Orchards & Vineyards | | 24,604 | 2.39 | 5,203 | 0.5 | 3,4 | 3H 4H |
| Cotton | | 96,607 | 9.37 | 33,760 | 3.27 | 3,4 | 3H |

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 to Host Fish associated with bin (H, M, L) |
|--|------------------------------|------------------------|---------|---------------------------------------|---------|--|---|
| | | Acres | % | Acres | % | | |
| | | | | | | | 4H |
| Pine Seed Orchards | | 6,142 | 0.60 | 6142 | 0.60 | 3,4 | 3H 4H |
| Rice | | 14 | 0.001 | 0 | 0 | 3,4 | 3H 4H |
| Sub-TOTAL (I): <i>Other uses with indirect effects³</i> | | 275,906 | 27.36 | 69,034 | 6.69 | | |
| TOTAL³: | | 972,665.99 | 94.9573 | 108,401 | 10.5113 | | |

[^]We consider the Bin 2 estimates as an upper bound of Bin 3 & 4 exposures. The estimated environmental concentrations for a Bin 2 water are an order of magnitude greater than Bins 3 and 4; therefore, concentrations in Bins 3 and 4 can be reduced by a correction factor of 10.

Exposure Modifiers:

A reassessment of crop UDL showed that usage data in the “Other Row Crops” may be overestimated. This UDL is composed of sunflower, peanuts, tobacco, sugar beets, and hops, of which, only hops is a registered use site on malathion labels and is thus the only crop in this layer that is relevant in our analysis. USDA data shows that 96% of hops are grown in the Pacific Northwest region (Idaho, Oregon, and Washington), with some small farms in Florida (Gadsden County) reporting occasional hop production. Given the highly specific regions that hops are grown in, we can assume that the potential exposure to malathion from “other row crops” use sites is 0 outside the areas indicated above. Given the highly specific regions that hops are grown in, we can assume that potential exposure to malathion from “other row crops” use sites is 0 outside of these areas, however the range of the Ochlockonee moccasinshell is within Gadsden County (Florida) therefore we assume there is usage for other row crops (hops) within the range of the Ochlockonee moccasinshell.

acres in species range: 1,031,377 acres

% of range in California (i.e., where CalPUR data is available): 0%

Range overlap with Federal lands: 118,196 acres, 11.46%

³ 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 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 significantly 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 significantly 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 initial residues to degrade prior to the next application. In addition, exposure to aquatic organisms is reduced due to buffers from waterways 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 groundfruit lower the maximum allowable number of applications to 2-4 per year (depending on the specific crop). 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.

Reduced citrus application rate: The reduction in the maximum application rate for citrus (outside of California) is expected to reduce potential environmental concentrations to one-third of modeled values, reducing the effects to species, prey, host fish, and pollinators on and adjacent to these use areas.

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 Ochlockonee moccasinshell. As discussed below, even though the species vulnerability is high, we anticipate the risk and likelihood of exposure of the species and its host fish to malathion are low. The implementation of the general conservation measures described above is expected to further reduce the likelihood of exposure for certain uses.

The Ochlockonee moccasinshell has a high vulnerability based on its status, distribution, and trends. However, mortality and sublethal effects to the species are not anticipated if individuals are exposed to malathion, as described above in the *Risk* section for this species. Mussels depend on host fish, which are more sensitive to malathion, to accomplish their reproductive lifecycle. Glochidia (larval stage) are released into the water and within a few days they must attach to an appropriate species of fish, which they parasitize for a short time while they develop into juvenile mussels. Glochidia that do not attach to a host fish will not survive. Where sufficient numbers of suitable host fish are not available, we anticipate reproduction of mussels would be reduced. The risk to the species host fish posed by labeled uses across the range was initially estimated to be high, and where individual host fish are exposed, we had previously anticipated high levels of mortality in our draft Opinion, depending on water body size and use type. The Ochlockonee moccasinshell prefers a variety of habitats, including larger and faster moving streams represented by Bins 3 and 4. Our initial estimates of risk were based on using conservative EECs for small flowing water bodies (bin 2) in the absence of reliable EECs for bin 3 and bin 4 habitats, where this species and its host fish reside. However, since our draft Opinion in February 2021, we coordinated with EPA on our assumptions regarding EECs in aquatic bins 3 and 4, and we now believe we previously overestimated exposure to malathion for Bins 3 and 4 (by approximately an order of magnitude). Thus, we now anticipate the risk to this species and its host fish to be substantially reduced due to dilution in bin 3 and 4 habitats, and we now estimate the risk to be low for the species and its host fish.

We anticipate usage within the non-Federal portion of the species' range will be high (10.51%), based primarily on the usage data we acquired (as described in the Opinion) and summarized for this species above. The high usage levels are due primarily to mosquito adulticide (3.82%), cotton (3.27%), and other row crops (1.16%), with other uses making up small amounts of anticipated usage. 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. While both cotton and other row crops also have relatively higher usage in the species range, these values are still relatively low and we expect the risk of exposure for these uses will be further reduced by the general conservation measures described above. For each of these uses, we anticipate the risk to the species and their host fish will be low where exposure occurs due to the types of habitats (medium and larger streams) in which they occur. Moreover, we do not anticipate that host fish would necessarily be found in the affected areas of the waterbodies near application sites when

malathion is applied, although small numbers of host fish may occur in these areas and be exposed over the duration of the proposed action. Food resources for the species may be temporarily reduced near malathion applications, with reductions in plankton anticipated to occur with exposure to malathion; however, we anticipate additional food resources from upstream sources would quickly recolonize after an application event. Furthermore, we anticipate that the conservation measures above, including rain restrictions, aquatic habitat buffers, residential use label changes, and reduced number of applications and rates on certain use sites, will further reduce the risk of exposure to the mussels' host fish and food resources.

Conservation measures are intended to reduce the amount of malathion runoff and spray drift that enter into sensitive habitats (e.g., species habitat, aquatic environments). For example, by placing a 48-hour rain restriction on agricultural applications, malathion has the ability to degrade after application (e.g., by hydrolysis, other processes) prior to any rain/runoff events, thus minimizing malathion runoff into aquatic habitats and decreasing exposure to listed mussels and their host fish. Increasing application buffers reduces the amount of malathion that drifts off target and subsequently into non-target environments. In addition, changes to residential labels limits applications to spot treatments and reduces the number of applications per year (2-4), significantly decreasing the overall amounts of malathion used in residential areas and resulting amounts of runoff and drift. Additional reductions in the number of applications and rates allowed for certain crops (e.g., corn, vegetables and ground fruit) further reduces the amount of malathion used in agricultural settings, thereby decreasing potential exposure to the species and their host fish. Combined, these conservation measures substantially reduce exposure to the Ochlockonee moccasinahell and their host fish and therefore minimize overall risk and adverse effects to the species.

We anticipate only small numbers of host fish and food resources may be exposed over the duration of the proposed action and where exposure occurs, the risk of mortality and sublethal effects to the species host fish is low. In addition, we anticipate that the conservation measures above, including rain restrictions, aquatic habitat buffers, residential use label changes, and reduced number of applications and rates on certain use sites, will further reduce the risk of exposure to plankton and the mussels' host fish in the larger waterbodies in which these species occur. Thus, we anticipate small numbers of individual host fish will experience low levels of adverse effects either from exposure to malathion or via a loss of prey resources, and very small numbers of mussels will experience low levels of adverse effects due to small reductions of prey items (plankton/zooplankton) over the duration of the action. However, we do not anticipate that these adverse effects would have population- or species-level effects.

Therefore, we anticipate that the proposed action would not appreciably reduce survival and recovery of the Ochlockonee moccasinshell in the wild.

Conclusion: Is not likely to jeopardize.

Integration and Synthesis Summary: Bivalves

| Scientific Name: | Common Name: | Entity ID: |
|------------------------------|---------------------|-------------------|
| <i>Elliptio chipolaensis</i> | Chipola slabshell | 386 |

Family: Unionidae

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: Stable

Pesticides noted: ☒

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

The Chipola slabshell is a narrow ranging freshwater mussel species that is endemic to the Chipola River system (Alabama and Florida). There is also one historic record from Howards Mill Creek, AL, in the Chattahoochee River system. “Relative abundance of Chipola slabshell has likely always been low. Van der Schalie (1940) reported 31 specimens of this species from 6 of 25 sites (24% occupancy rate and an average of 5.2 per site of occurrence).” Clench and Turner (1956) considered it to be “rather rare, though it does occur throughout most of the length of the river proper and its smaller tributaries” (USFWS 2003). The Service estimates that the Chipola slabshell are extirpated from about one-third of its historic range.

The declining range and abundance of the Chipola slabshell is due mostly to changes in its riverine habitats resulting from dams, dredging, mining, channelization, pollution, sedimentation, and water withdrawals. These threats continue today.

With primary constituent elements of critical habitat of maintaining a stream bed that is geomorphically stable, predominantly a sand mix substrate (% fine sand, sand, mud, clay), and permanently flowing water that meets or exceeds aquatic life criteria that protect identified fish hosts, threats to the Chipola slabshell include point source pollution (e.g., sedimentation, as from livestock in streams) and barriers to fish passage (e.g., unpaved road crossings). In addition, more recently, EPA, in 2013, and the Florida Department of Environmental Water, in 2016, released and adopted new ammonia criteria for improving water quality standards related to freshwater mussel ammonia toxicity.

EB/CE Source: U.S. Fish and Wildlife Service. 2019. Recovery Plan Amendment for the Chipola Slabshell (*Elliptio chipolaensis*). USFWS Southeast Regional Office. Atlanta, Georgia. 8 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 expect the Chipola slabshell will experience direct mortality or sublethal effects from any malathion uses at the maximum rates for all bins (2,3,4,6, and 7). However, risk of mortality to the host fish for mosquito control was high for bin 2 and medium for all other bins. Risk of mortality to the host fish was medium for bins 2,3, and 4 and low for bins 6, and 7 for developed and open space developed. Risk of mortality was high for bin 2 for the remaining uses and L for bins 3,4,6, and 7.

We do not expect mussel species to be directly impacted by exposure from malathion. However their lifecycle is such that when glochidia (larval stage) are released into the water, within a few days, they must attach to an appropriate species of fish, which they parasitize for a short time while they develop into juvenile mussels in order to complete their lifecycle; they cannot complete their lifecycle without a fish host.

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.

| | |
|--|--|
| DIRECT (all uses except mosquito control) | |
| Use areas – mortality | No effects expected |
| Sublethal – growth (G), reproduction (R) and behavior (B) enzyme (E) | No effects expected |
| INDIRECT (all uses except mosquito control) | |
| Use areas - Prey item mortality | If plankton: H for all uses except bins 3,4, and 7 are M and for developed L, M for bins 6,7 and 2,3,4, respectively. If detritus: NA |
| Use areas – Fish Host | Total overlap: >100% H for all uses except bins 3,4, and 7 are M and for developed L, M for bins 6,7 and 2,3,4, respectively. |
| MOSQUITO CONTROL | H Bin 2, M all other Bins |

| | |
|--------------------|--|
| Direct (mortality) | No effects expected |
| Sublethal | No effects expected |
| Indirect | Total overlap: 90% H Bin 2, M Bins 3,4,6,7 |

Risk modifiers:

Species occurs in Bins 2, 3,4, 6 and 7. See Risk Assumptions (above) for risk to individuals and species.

Species host (generalist) occurs in Bins 2, 3, 4, 6 and 7. See Risk Assumptions (above) for risk to host species.

Mussels depend on a host fish to accomplish their reproductive lifecycle. Glochidia that do not attach to a host fish will not survive. We anticipate reproduction of mussels would be reduced in areas with insufficient fish hosts available. The mussel glochidia fish host relationship can be categorized into several different categories that capture the breadth of the type of mussel-host relationships such as generalists, specialists, or unknown fish host species. We anticipate that variable numbers of individual host fish may be affected over the duration of the proposed action, some of which would result in local extirpations of these mussel species in their highly isolated and fragmented populations, and we would expect species-level effects to these mussels to occur in the absence of mitigating factors.

The host fishes that have been identified are Redbreast sunfish and Bluegill, both are members of the centrarchid family (Preister 2006). Although not yet verified in field or laboratory settings, other centrarchids such as basses (*Micropterus* spp.) and warmouth (*Lepomis gulosus*), may also act as a host fish role, as well. The identified host fish are ubiquitous throughout the range of the Chipola slabshell and their home ranges are typically restricted (Robbins et. al. 2018). A study of two streams near Oak Ridge, Tennessee that tracked the movement of Bluegill and Redbreast sunfish showed very little movement, < 100 m for two thirds of all tagged fish sampled quarterly over a three year period (Gatz and Adams 1994).

In the “Approach to the Effects Analysis” section of the main body of the Opinion that specific considerations were made for species that occur in Bins 3 and 4 and that they were modeled in such a way that likely resulted in overestimation of estimated environmental concentrations, thus overestimating potential exposure. While the Chipola slabshell also occupies other aquatic habitats that may be exposed to potentially high levels of malathion due to lower volume in those habitats (Bin 2), their potential exposure risk is at least partially lowered based on their reliance upon the larger flowing and static aquatic habitats (Bins 3, 4, 6, and 7), reducing the overall risk to the species as a whole.

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 to Host Fish associated with bin (H, M, L) |
|----------------------------|------------------------------|------------------------|-------|---------------------------------------|--------|--|---|
| | | Acres | % | Acres | % | | |
| Mosquito Control | | 1,840,932 | 89.8 | 136,304 | 6.65 | 2,3,4,6,7 | 2H, M all other bins |
| Developed | I | 21,926 | 1.07 | 1,096 | 0.05 | 2,3,4,6,7 | L6,7 and M 2,3,4, |
| Open Space Developed | I | 83,411 | 4.07 | 4,171 | 0.2 | 2,3,4,6,7 | L6,7 and M 2,3,4, |
| Corn | I | 8,229 | 0.4 | 1,746 | 0.08 | 2,3,4,6,7 | 2H L6,3,4 |
| Pasture | I | 36 | 0.002 | 13 | 0.0006 | 2,3,4,6,7 | 2H L6,3,4 |
| Wheat | I | 3,699 | 0.18 | 636 | 0.03 | 2,3,4,6,7 | 2H L6,3,4 |
| Vegetables and Groundfruit | I | 4473 | 0.22 | 729 | 0.04 | 2,3,4,6,7 | 2H L6,3,4 |
| Cotton | I | 84,213 | 4.1 | 15,540 | 0.76 | 2,3,4,6,7 | 2H L6,3,4 |
| Nurseries | I | 76 | 0.004 | 76 | 0.004 | 2,3,4,6,7 | 2H L6,3,4 |
| Other Row Crops | I | 88,341 | 4.3 | 13,631 | 0.66 | 2,3,4,6,7 | 2H L6,3,4 |
| Orchards & Vineyards | I | 791 | 0.04 | 789 | 0.04 | 2,3,4,6,7 | 2H L6,3,4 |
| Other Crops | I | 79,941 | 3.9 | 0 | 0 | 2,3,4,6,7 | 2H L6,3,4 |
| Other Grains | I | 9,936 | 0.48 | 5,869 | 0.29 | 2,3,4,6,7 | 2H L6,3,4 |

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 to Host Fish associated with bin (H, M, L) |
|--|------------------------------|------------------------|------|---------------------------------------|------|--|---|
| | | Acres | % | Acres | % | | |
| Pine Seed Orchards | I | 30,431 | 1.48 | 18,813 | 0.92 | 2,3,4,6,7 | 2H L6,3,4 |
| Sub-TOTAL (I): <i>Other uses with indirect effects³</i> | | 415,503 | 20.2 | 62,839 | 3.08 | | |
| TOTAL³: | | 2,256,435* | 110 | 199,143 | 9.73 | | |

[^]We consider the Bin 2 estimates as an upper bound of Bin 3 & 4 exposures. The estimated environmental concentrations for a Bin 2 water are an order of magnitude greater than Bins 3 and 4; therefore concentrations in Bins 3 and 4 can be reduced by a correction factor of 10.

*use acres can not be more than species range acres

acres in species range: 2,050,573 acres

% of range in California (i.e., where CalPUR data is available): 0%

Range overlap with Federal lands: 150,798 acres, 7.35%

Exposure Modifiers:

A reassessment of our crop use data layers shows that within the “Other Row Crops” layer shows that usage in this category may be overestimated. This UDL is composed of sunflower, peanuts, tobacco, sugar beets, and hops, of which, only hops is a registered use site on malathion labels and is thus the only crop in this layer that is relevant in our analysis. USDA data shows that 96% of hops are grown in the Pacific Northwest region (in Idaho, Oregon, and Washington), with some small farms in Florida (Gadsden County) reporting occasional hop production. Given the highly specific regions that hops are grown in, we can assume that potential exposure to malathion from “other row crops” use sites is 0 outside of these areas, and thus is not relevant to this species.

Overall Usage: ☐ High ☒ Medium ☐ Low

³ TOTAL includes usage on all use sites with effects, including mosquito control.

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 groundfruit lower the maximum allowable number of applications to 2-4 per year (depending on the specific crop). 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.

Reduced citrus application rate: The reduction in the maximum application rate for citrus (outside of California) is expected to reduce potential environmental concentrations to one-third of modeled values, reducing the effects to species, prey, host fish, and pollinators on and adjacent to these use areas.

The following has been specified for mosquito control measures within the range of the Chipola slabshell:

Where feasible, avoid application. If avoidance is not feasible or impairs the ability of the mosquito control district or agency to protect the public's health and welfare, coordinate with the local FWS Ecological Services field office to determine appropriate measures to minimize exposure and to ensure the proposed application is likely to have no more than minor effects on the species (FWS points of contact and maps of designated critical habitat are available through the Information, Planning, and Consultation (IPaC) website <https://ecos.fws.gov/ipac/>). The applicator must retain documentation of the technical assistance and the agreed upon species-specific measures that were implemented.

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 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 Chipola slabshell. As discussed below, even though the species vulnerability is high and risk to the species host fish is medium, we anticipate the likelihood of exposure of host fish to malathion is low. Since our draft Opinion in February 2021, EPA provided additional information regarding EECs in aquatic Bins 3 and 4. The Chipola slabshell prefers a variety of habitats, including larger and faster moving streams represented by Bins 3 and 4 and we anticipate that exposure to malathion was likely previously overestimated for Bins 3 and 4. Thus, we anticipate the likelihood of exposure to malathion is reduced, due to dilution in Bins 3 and 4, and further mitigated through the implementation of the general conservation measures described above.

The Chipola slabshell has a high vulnerability based on its status, distribution, and trends. The Chipola slabshell is a narrow ranging freshwater mussel species that is endemic to the Chipola River system (Alabama and Florida). Currently, the Chipola slabshell "is extant through most of its historical range and is common at some localities" (Williams et al. 2014). While this species ranked high in vulnerability, it is still broadly represented and common at some localities across its historic ranges.

Mortality and sublethal effects to the species are not anticipated. The risk to the species host fish posed by labeled uses across the range is high, and where individual host fish are exposed, we generally anticipate high levels of mortality, depending on water body size and use type. Mussels depend on host fish to accomplish their reproductive lifecycle. Glochidia (larval stage) are released into the water, within a few days they must attach to an appropriate species of fish, which they parasitize for a short time while they develop into juvenile mussels. Glochidia that do not attach to a host fish will not survive. Where sufficient numbers of suitable host fish are not available, we anticipate reproduction of mussels would be reduced.

We anticipate usage within the non-Federal portion of the species' range will be medium (9.73% for the Chipola slabshell), based primarily on the usage data we acquired, as described in 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 Biological Opinion. The species range, and thus this

species host fish range, is very large (>2 million acres) and we do not anticipate that host fish would necessarily be found in the affected areas of the waterbodies near application sites when malathion is applied, although small numbers of host fish may occur in these areas and be exposed over the duration of the proposed action. In addition, the species range has been recently updated and although the counties with mosquito adulticide usage did not change with the range revision, and have very small overlaps with the species range. We anticipate that mosquito adulticide usage is much less than previously estimated (6.65%). Reductions in plankton could be high in localized areas, however, we anticipate additional food resources from upstream sources would quickly recolonize after an application event. In addition, we anticipate that the conservation measures above, including rain restrictions, aquatic habitat buffers, residential use label changes, and reduced number of applications and rates on certain use sites, will further reduce the risk of exposure to the mussels' host fish.

As stated previously, conservation measures are aimed at reducing the amount of malathion runoff and spray drift that enter into sensitive habitats (e.g., species habitat, aquatic environments). For example, by placing a 48-hour rain restriction on agricultural applications, malathion has the ability to degrade after application (e.g., by hydrolysis, other processes) prior to any rain/runoff events, thus minimizing malathion runoff into aquatic habitats and decreasing exposure to listed mussels and their host fish. Increasing application buffers reduces the amount of malathion that drifts off target and subsequently into non-target environments. In addition, changes to residential labels limits applications to spot treatments and reduces the number of applications per year (2-4), significantly decreasing the overall amounts of malathion used in residential areas and resulting amounts of runoff and drift. Additional reductions in the number of applications and rates allowed for certain crops (e.g., corn, vegetables and ground fruit) further reduces the amount of malathion used in agricultural settings, thereby decreasing potential exposure to the species and their host fish.

The main use driver for this species is mosquito control. As a result, to reduce anticipated exposure and resultant mortality from mosquito uses, a conservation measure will be implemented that restricts this use within the range of the mussel. More specifically, use will be prohibited within the low flow areas where malathion concentrations are expected to be highest. If applications are needed to control mosquitos in these areas, such as due to a public health threat, the applicator must contact the local FWS field office to determine alternative measures to minimize exposure and to ensure the proposed application is likely to have no more than minor effects on the species. Discussions at the local level may allow for greater flexibility and less restrictive measures based on site- or species-specific considerations, such as specific timing, species life history, and geographic or habitat factors. Coordination with FWS on measures to minimize exposure to listed species, including avoidance, is a recognized practice by mosquito control professionals. In its 2021 Best Practices for Integrated Mosquito Management, the American Mosquito Control Association (AMCA) instructs applicators with listed species in their treatment area to coordinate with FWS prior to application and maintain records of interactions. Discussions with the AMCA and anecdotal reports from FWS field offices indicate that this type of coordination is presently occurring to varying degrees for mosquito control applications in general. Applicators subject to this conservation measure will be required to maintain records of their interactions with FWS offices, allowing EPA to better track this coordination and its outcomes moving forward.

Combined, these conservation measures substantially reduce exposure to the Chipola slabshell their host fish and therefore minimizes overall risk and adverse effects to the species. Thus, while we anticipate small numbers of individual host fish would be lost over the duration of the action, resulting in very small reductions in reproductive success, we do not anticipate species-level effects to this mussel species.

Therefore, we do not anticipate that the proposed action would appreciably reduce survival and recovery of the Chipola slabshell in the wild.

Conclusion: Is not likely to jeopardize.

Integration and Synthesis Summary: Bivalves

| Scientific Name: | Common Name: | Entity ID: |
|---------------------------------------|---------------------|-------------------|
| <i>Quadrula cylindrica cylindrica</i> | Rabbitsfoot | 3645 |

Family: Unionidae

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 (numerous)

Species Trends: Declining population(s) – one or more populations declining

Pesticides noted ☒

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

At the time of listing, the historical range of the Rabbitsfoot included Alabama, Arkansas, Georgia, Illinois, Indiana, Kansas, Kentucky, Louisiana, Mississippi, Missouri, Ohio, Oklahoma, Pennsylvania, Tennessee, and West Virginia. Biologists considered the Rabbitsfoot extirpated in Georgia and West Virginia. Within the lower Great Lakes Sub-basin and Mississippi River Basin, biologists documented occurrence of the Rabbitsfoot in 139 rivers or creeks. Of those 139 rivers or creeks, they determined status of 51 of the populations as extant (stable, improving, declining, or unknown), a 63% decline in historical occurrence. Butler (2005) determined status of a population as extirpated when results of mussel surveys from the past few decades failed to detect the presence of live individuals or fresh dead specimens. We retained the status of extirpated as reported in Butler (2005) as did the proposed listing rule.

Since publication of the proposed listing rule in 2012, biologists have reported records of occurrence for the Rabbitsfoot from 10 additional rivers or creeks, some of which pre-date listing. In 2008, biologists with the USACE, Memphis District, reported the first record of occurrence from the Hatchie River, which occurs in the Lower Mississippi River Sub-basin. Biologists located a fresh dead specimen at the Highway 70 crossing, southwest of Brownsville, Haywood County, Tennessee (J. Koontz, USACE, personal communication, 2019). This is the first record of occurrence for the Rabbitsfoot from a direct tributary of the Mississippi River in west Tennessee. In 1995, biologists reported 2 live specimens from the North Fork Spring River, near Neck City, Jasper County, Missouri (S. E. McMurray, MDC mussel database, 2019). The North Fork Spring River is a tributary of the Spring River and occurs in the Arkansas River Basin.

Biologists reported records of occurrence from additional rivers or creeks in the Ohio River Basin. In 2010, biologists collected the first record, 1 live specimen, from Jordan Creek, Vermilion County, Illinois (INHS Museum Collection, 2019). Jordan Creek is a tributary of the Middle Branch North Fork Vermilion River. In 2012, biologists also reported 1 live specimen

from Sugar Creek, a tributary of the East Fork White River, Shelby County, Indiana, and an unknown number of weathered shells from the creek in Shelby and Johnson counties, Indiana. This is the first record of occurrence for this creek and the current status of this population is unknown. The Sugar Creek population included in the proposed listing rule is a tributary of the Wabash River and its current status remains extirpated. In 2006 and 2008, biologists reported the first record of occurrence, a weathered dead specimen, from both Big Monon Creek, White County, Indiana, and Pipe Creek, Madison County, Indiana, respectively. Big Monon Creek is a tributary of the Tippecanoe River and Pipe Creek a tributary of the West Fork White River. From 2005–2013, biologists have reported weathered dead specimens from the Salamonie River, Huntington and Wells counties, Ohio. The Salamonie River is a tributary of the Wabash River.

The last 3 additional rivers where biologists reported the first records of occurrence are located in the Red River Basin. In 2017, biologists reported 2 live specimens from Bayou D'Arbonne upstream of Louisiana Highway 143 at the boundary of D'Arbonne NWR, Ouachita Parish, Louisiana (Louisiana Department of Wildlife and Fisheries Wildlife Diversity Program, 2019). Bouldin et al. (2013b) reported the first records for the other 2 rivers in this basin. They surveyed 34 sites along Rolling Fork Little River in Little River and Sevier counties, Arkansas, and reported 3 live specimens from 2 sites in Sevier County for a relative abundance of 0.20%. They also surveyed 45 sites along the Saline River in Howard and Sevier counties, Arkansas, and reported 6 live specimens from 5 sites in Sevier County, Arkansas, for a relative abundance of 0.40%. The Saline River listed in proposed listing rule is a tributary of the Ouachita River whereas this Saline River is a tributary of the Little River.

Currently, biologists consider Rabbitsfoot extant in 63 of 149 rivers, a 58% decline in historical occurrence. Of the 63 extant rivers, 25% are considered stable or improving, while 17% are considered declining. We considered the current status of 36 extant populations (57%) as unknown either because biologists did not report any new information since publication of the proposed listing rule in 2012 with which to assess population status or reported the first records of occurrence for a river or creek since publication of the proposed listing rule.

The Rabbitsfoot faces a variety of threats from declines in water quality, altered hydrology, riparian habitat fragmentation, and deterioration of instream habitat. These threats, which urbanization may exacerbate within portions of the range coupled with climate change, are important factors affecting future viability of the Rabbitsfoot. Captive propagation, augmentation, and reintroduction may be necessary to increase resiliency and achieve sufficient redundancy in the future. Due to the restricted range of the Rabbitsfoot, geographic isolation of most extant populations, and small population size, this mussel species is likely suffering genetic isolation and reduced adaptive capacity throughout much of its range, resulting in lower representation. Given current and expected future decreases in resiliency, populations become more vulnerable to extirpation from stochastic events resulting in concurrent losses in representation and redundancy.

The current status of the Rabbitsfoot is similar to its status at time of listing with widely scattered individuals in isolated populations with low abundance. Since publication of the proposed listing rule, biologists have reported records of occurrence for the Rabbitsfoot from 10 additional rivers or creeks, some of which pre-date listing. The status of 7 of these population is unknown and the other 3 are extirpated. Results of surveys conducted since listing found that 5 populations whose

status biologists determined as extirpated still persist. However, few extant populations (22%) are stable or improving. Threats associated with impoundments, sedimentation, chemical contaminants, mining, inadequacy of State and Federal water quality programs, population fragmentation, climate change, and invasive species continue at levels similar to at the time of listing and continue to threaten extant populations.

EB/CE Source: U.S. Fish and Wildlife Service (FWS). 2020. 5-Year Review: Summary and Evaluation for Rabbitsfoot (*Quadrula cylindrica cylindrica*). Arkansas Ecological Services Field Office. Conway, Arkansas. 107 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 expect the rabbitsfoot will experience direct mortality or sublethal effects from any malathion uses at the maximum rates for all bins (2, 3, 4, 6, 7). However, risk of mortality to the host fish for bin 2 is high for all use sites except developed where it is medium. Risk of mortality to individuals in bin 7 is medium for all uses except for developed and mosquito control which are low. Risk of mortality to individuals in bin 6 is high for orchards and vineyards, cotton, nurseries, and Christmas trees, and low for developed and medium for all other uses.

We do not expect mussel species to be directly impacted by exposure from malathion. However their lifecycle is such that when glochidia (larval stage) are released into the water, within a few days they must attach to an appropriate species of fish, which they parasitize for a short time while they develop into juvenile mussels in order to complete their lifecycle; they cannot complete their lifecycle without a fish host.

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.

| | |
|--|--|
| DIRECT (all uses except mosquito control) | |
| Use areas – mortality | No effects expected |
| Sublethal – growth (G), reproduction (R) and behavior (B) enzyme (E) | No effects expected |
| INDIRECT (all uses except mosquito control) | |
| Use areas - Prey item mortality | If plankton: H, except for developed is L If detritus: NA |
| Use areas – Fish Host | Total overlap: 10.4%, H M for most uses L for developed |

| MOSQUITO CONTROL | |
|--------------------|--|
| Direct (mortality) | No effects expected |
| Sublethal | No effects expected |
| Indirect | Total overlap: 13.1%, H M L depending on the bin |

Risk modifiers:

According to Gordon and Layzer (1989) the typical habitat for this species is small to medium rivers with moderate to swift currents, and in smaller streams it inhabits bars or gravel and cobble close to the fast current. Found in medium to large rivers in sand and gravel (Cummings and Mayer, 1992). In streams where it remains extant, populations are highly fragmented and restricted to short reaches (USFWS, 2012).

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. Further investigation by EPA into Bin 3 and 4 estimated environmental concentrations indicate 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. While the rabbitsfoot also occupies other aquatic habitats that may be exposed to potentially high levels of malathion due to lower volume in those habitats (Bin 2), their potential exposure risk is at least partially lowered based on their reliance upon larger flowing and static aquatic habitats (Bins 3, 4, 6, and 7), reducing the overall risk to the species as a whole.

The Rabbitsfoot is a considered a fish host generalist whose glochidia can metamorphosize on a wide variety of fishes from multiple families. While we anticipate some species of the host fish community will exhibit temporary reductions in abundance due to malathion exposure, the species’ flexible host requirement will allow the species to be more resilient to temporary losses of host fish, reducing the anticipated indirect 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 to Host Fish associated with bin (H, M, L) |
|------------------|------------------------------|------------------------|------|---------------------------------------|------|--|---|
| | | Acres | % | Acres | % | | |
| Mosquito Control | I | 8,890,593 | 13.1 | 610,413 | 0.9 | 2,3,4,6,7 | 2H 3 4 6M 7L |
| Corn | I | 4,463,375 | 6.57 | 73,811 | 0.11 | 2,3,4,6,7 | 2H 3 4 6M 7M |
| Developed | I | 1,394,498 | 2.05 | 69,725 | 0.1 | 2,3,4,6,7 | 2M 3 4 6L 7L |
| Other Crops | I | 567,759 | 0.84 | 0 | 0 | 2,3,4,6,7 | 2H 3 4 6M 7M |
| Cotton | I | 232,382 | 0.34 | 60,785 | 0.09 | 2,3,4,6,7 | 2H 3 4 6H 7M |
| Wheat | I | 182,519 | 0.27 | 107,863 | 0.16 | 2,3,4,6,7 | 2H 3 4 6M 7M |
| Other Grains | I | 80,668 | 0.12 | 28,114 | 0.04 | 2,3,4,6,7 | 2H 3 4 6M 7M |

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 to Host Fish associated with bin (H, M, L) |
|--|------------------------------|------------------------|--------|---------------------------------------|--------|--|---|
| | | Acres | % | Acres | % | | |
| Other Row Crops | I | 25,176 | 0.04 | 1,969 | < 0.01 | 2,3,4,6,7 | 2H 3 4 6M 7M |
| Pasture | I | 66,635 | 0.1 | 31,342 | 0.05 | 2,3,4,6,7 | 2H 3 4 6M 7M |
| Vegetables & Ground Fruit | I | 17,308 | 0.03 | 4,842 | < 0.01 | 2,3,4,6,7 | 2H 3 4 6M 7M |
| Orchards & Vineyards | I | 11,907 | 0.02 | 6,830 | 0.01 | 2,3,4,6,7 | 2H 3 4 6H 7M |
| Nurseries | I | 5,146 | < 0.01 | 5,146 | < 0.01 | 2,3,4,6,7 | 2H 3 4 6H 7M |
| Christmas trees | I | 92 | < 0.01 | 85 | < 0.01 | 2,3,4,6,7 | 2H 3 4 6H 7M |
| Sub-TOTAL (I): <i>Other uses with indirect effects³</i> | | 7,047,463 | 10.4 | 390,512 | 2.32 | | |
| TOTAL³: | | 15,938,057 | 23.5 | 1,000,925 | 3.22 | | |

³ TOTAL includes usage on all use sites with effects, including mosquito control.

^We consider the Bin 2 estimates as an upper bound of Bin 3 & 4 exposures. The estimated environmental concentrations for a Bin 2 water are an order of magnitude greater than Bins 3 and 4, therefore concentrations in Bins 3 and 4 can be reduced by a correction factor of 10.

Exposure Modifiers:

A reassessment of our crop use data layers shows that within the “Other Row Crops” layer shows that usage in this category may be overestimated. This UDL is composed of sunflower, peanuts, tobacco, sugar beets, and hops, of which, only hops is a registered use site on malathion labels and is thus the only crop in this layer that is relevant in our analysis. USDA data shows that 96% of hops are grown in the Pacific Northwest region (in Idaho, Oregon, and Washington), with some small farms in Florida reporting occasional hop production. Given the highly specific regions that hops are grown in, we can assume that potential exposure to malathion from “other row crops” use sites is 0 outside of these areas, and thus is not relevant to this species.

acres in species range: 67,889,318 acres

% of range in California (i.e., where CalPUR data is available): 0%

Range overlap with Federal lands: 5,463,671 acres, 8.048%

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, is not likely to jeopardize the continued existence of the rabbitsfoot. As discussed below, even though the species vulnerability is high and risk to the species host fish is medium, we anticipate the likelihood of exposure of host fish to malathion is low, and the implementation of the general conservation measures described above is expected to further reduce the likelihood of exposure.

The rabbitsfoot has a high vulnerability based on its status, distribution, and trends. Mortality and sublethal effects to the species are not anticipated. The risk to the species host fish posed by labeled uses across the range is medium and where individual host fish are exposed, we anticipate variable levels of mortality, depending on water body size and use type. Mussels depend on host fish to accomplish their reproductive lifecycle. Glochidia (larval stage) are released into the water and within a few days they must attach to an appropriate species of fish, which they parasitize for a short time while they develop into juvenile mussels. Glochidia that do not attach to a host fish will not survive. Where sufficient numbers of suitable host fish are not available, we anticipate reproduction of mussels would be reduced.

We anticipate usage within the non-Federal portion of the species’ range will be low (3.22 %), based primarily on the 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 Biological Opinion.

The species range, and thus this species host fish range, is very large (>67 million acres) and we do not anticipate that host fish would necessarily be found in the affected areas of the waterbodies near application sites when malathion is applied, although small numbers of host fish may occur in these areas and be exposed over the duration of the proposed action. Reductions in plankton could be high in localized areas, however, we anticipate additional food resources from upstream sources would quickly recolonize after an application event. In addition, we anticipate that the conservation measures above, including rain restrictions, aquatic habitat buffers, and residential use label changes, will further reduce the risk of exposure to plankton and the mussels’ host fish.

As stated previously, conservation measures are aimed at reducing the amount of malathion runoff and spray drift that enter into sensitive habitats (e.g., species habitat, aquatic environments). For example, by placing a 48-hour rain restriction on agricultural applications, malathion has the ability to degrade after application (e.g., by hydrolysis, other processes) prior to any rain/runoff events, thus minimizing malathion runoff into aquatic habitats and decreasing exposure to listed mussels and their host fish. Increasing application buffers reduces the amount of malathion that drifts off target and subsequently into non-target environments. In addition, changes to residential labels limits applications to spot treatments and reduces the number of applications per year (2-4), significantly decreasing the overall amounts of malathion used in residential areas and resulting amounts of runoff and drift. Combined, these conservation measures substantially reduce exposure to the rabbitsfoot and their host fish and therefore minimizes overall risk and adverse effects to the species. Thus, while we anticipate small numbers of individual host fish would be lost over the duration of the action, resulting in very small reductions in reproductive success, we do not anticipate species-level effects to this mussel species.

Therefore, we anticipate that the proposed action would not appreciably reduce survival and recovery of the rabbitsfoot in the wild.

Conclusion: Is not likely to jeopardize.

Integration and Synthesis Summary: Bivalves

| Scientific Name: | Common Name: | Entity ID: |
|-------------------------------|---------------------|-------------------|
| <i>Pleurobema hanleyianum</i> | Georgia pigtoe | 3833 |

Family: Unionidae

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 Georgia pigtoe is endemic to the Coosa River drainage of the Mobile River basin in Alabama, Georgia, and Tennessee (Figure 1). It has disappeared from 90 percent or more of its historical range, primarily due to the impoundment of riverine habitats.

The Georgia pigtoe was historically found in shoals of large creeks and small to large rivers of the Coosa River drainage of Alabama, Georgia, and Tennessee (Johnson and Evans 2000; Williams et al. 2008). There are historical reports or museum records of the Georgia pigtoe from Tennessee (Conasauga River in Polk and Bradley counties), Georgia (Coosawatee River in Murray County, Conasauga River in Murray and Whitfield counties, Chatooga River in Chatooga County, Coosa River in Floyd County, and Etowah River in Floyd County), and Alabama (Coosa River in Cherokee County, Terrapin Creek in Cherokee County, Little Canoe and Shoal creeks in St. Clair County, Morgan Creek in Shelby County, and Hatchet Creek in Coosa County) (USFWS 2010, Gangloff 2003, Gangloff pers. comm. 2020). Based on these historical records, the range of the Georgia pigtoe included more than 480 kilometers (km) (298 miles (mi)) of river and stream channels. Additional historical Coosa River tributary records credited to Hurd (for example, Big Wills, Little Wills, Oothcalooga, Holly creeks) have been found to be misidentifications of other species as Georgia pigtoe (USFWS 2010).

It is currently known from a few isolated shoals in the Upper Conasauga River in Murray and Whitfield counties, Georgia; in Polk County, Tennessee (Johnson and Evans 2000; Evans 2001; Johnson et al. 2005; MRBMRC 2010); and in the Big Canoe and Little Canoe creeks in St. Clair and Etowah counties, Alabama. Single records have been documented from the Weiss Bypass of the Coosa River (2002) and from Hatchet Creek (2001), though more surveys are required before it can be confidently declared that Georgia pigtoe populations exist at these locations.

The range curtailment for the Georgia pigtoe has predominately been through modification and destruction of river and stream habitats, primarily by the construction of large hydropower dams

on the Coosa River. Dams eliminate or reduce river flow within impounded areas, trap silt and cause sediment deposition, alter water temperature and dissolved oxygen levels, change downstream water flow and quality, affect normal flood patterns, and block upstream and downstream movement of aquatic species (Watters 1996; Marcinek et al. 2005).

In addition, dam construction fragments populations leaving them more vulnerable to natural events (such as droughts), runoff from common land-use practices (such as agriculture, mining, urbanization), discharges (such as municipal and industrial wastes), and accidents (such as chemical spills) that can reduce population levels or eliminate habitat (Neves et al. 1997; USFWS 2000).

Historic causes of water quality degradation in the Coosa River and its tributaries included drainage from gold mining activities, industrial and municipal pollution events, and construction and agricultural runoff (Hurd 1974; Lydeard and Mayden 1995; Freeman et al. 2005). Although Federal and State water quality laws and regulations have greatly improved and generally reduced the impacts of point source discharges, nonpoint source pollution continues to affect and possibly threaten the Georgia pigtoe populations. Nonpoint source pollution from land surface runoff originates from virtually all land use activities and includes sediments; fertilizer, herbicide, and pesticide residues; animal or human wastes; septic tank leakage and gray water discharge; and oils and greases (USFWS 2010).

EB/CE Source: U.S. Fish and Wildlife Service. 2021. Georgia Pigtoe (*Pleurobema hanleyianum*) 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 expect the Georgia pigtoe will experience direct mortality or sublethal effects from any malathion uses at the maximum rates for Bin 3. . However, risk of mortality to the host fish for bin 3 is medium for mosquito control and developed and high for the remaining uses.

We do not expect mussel species to be directly impacted by exposure from malathion. However their lifecycle is such that when glochidia (larval stage) are released into the water, within a few days, they must attach to an appropriate species of fish, which they parasitize for a short time while they develop into juvenile mussels in order to complete their lifecycle; they cannot complete their lifecycle without a fish host.

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.

| | |
|--|---|
| DIRECT (all uses except mosquito control) | |
| Use areas – mortality | No effects expected |
| Sublethal – growth (G), reproduction (R) and behavior (B) enzyme (E) | No effects expected |
| INDIRECT (all uses except mosquito control) | |
| Use areas - Prey item mortality | If plankton: H for all uses If detritus: NA |
| Use areas – Fish Host | Total overlap: 12.8% H for all uses except developed and mosquito control M |
| MOSQUITO CONTROL | |
| Direct (mortality) | No effects expected |
| Sublethal | No effects expected |
| Indirect | Total overlap: 4.5% |

Risk modifiers:

Mussels depend on a host fish to accomplish their reproductive lifecycle. Glochidia that do not attach to a host fish will not survive. We anticipate reproduction of mussels would be reduced in areas with insufficient fish hosts available. The mussel glochidia fish host relationship can be categorized into several different categories that capture the breadth of the type of mussel-host relationships such as generalists, specialists, or unknown fish host species. There is no information currently available regarding which fish species the Georgia pigtoe relies on for glochidia attachment. Given the lack of information we have regarding the age, size at maturity, or appropriate host fish species, we anticipate a high risk of indirect effects (loss of host fish species) due to malathion exposure.

Little is known about the habitat requirements or life history of the Georgia pigtoe; however, it is currently found in shallow runs and riffles with strong to moderate current and coarse sand–gravel–cobble bottoms, which we characterized as bin 3. In the “Approach to the Effects Analysis” section of the main body of the Opinion, we stated that specific considerations were made for species that occur in Bins 3 and 4 and they were modeled in such a way that likely resulted in overestimation of EECs, thus overestimating potential exposure. Further investigation by EPA into Bin 3 and 4 estimated environmental concentrations indicate 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 to Host Fish associated with bin (H, M, L) |
|---|------------------------------|------------------------|-------------|---------------------------------------|-------------|--|---|
| | | Acres | % | Acres | % | | |
| Mosquito Control | I | 84,993 | 4.5 | 18,167 | 0.96 | 3 | 3M |
| Developed | I | 25,876 | 1.37 | 2,459 | 0.13 | 3 | 3M |
| Open Space Developed | I | 60,053 | 5.5 | 5,189 | 0.27 | 3 | 3H |
| Corn | I | 8,816 | 0.47 | 2,697 | 0.14 | 3 | 3H |
| Pasture | I | 7.3 | 0.0004 | 7.3 | 0.0004 | 3 | 3H |
| Wheat | I | 801 | 0.04 | 801 | 0.04 | 3 | 3H |
| Vegetables and Groundfruit | I | 48 | 0.0025 | 48 | 0.0025 | 3 | 3H |
| Cotton | I | 17,094 | 0.9 | 8,216 | 0.44 | 3 | 3H |
| Nurseries | I | 345 | 0.018 | 345 | 0.018 | 3 | 3H |
| Orchards & Vineyards | I | 19 | 0.001 | 13.7 | 0.0007 | 3 | 3H |
| Other Crops | I | 111 | 0.006 | 0 | 0 | 3 | 3H |
| Other Grains | I | 703 | 0.04 | 703 | 0.04 | 3 | 3H |
| Sub-TOTAL (I): <i>Other uses with indirect effects³</i> | | 113,873 | 8.3 | 20,479 | 1.08 | | |
| TOTAL³: | | 198,866 | 12.8 | 38,646 | 2.04 | | |

acres in species range: 1,887,086 acres

% of range in California (i.e., where CalPUR data is available): 0%

Range overlap with Federal lands: 415,170 acres, 22.001%

Exposure Modifiers:

A reassessment of our crop use data layers shows that within the “Other Row Crops” layer shows that usage in this category may be overestimated. This UDL is composed of sunflower, peanuts, tobacco, sugar beets, and hops, of which, only hops is a registered use site on malathion labels and is thus the only crop in this layer that is relevant in our analysis. USDA data shows that 96%

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

of hops are grown in the Pacific Northwest region (in Idaho, Oregon, and Washington), with some small farms in Florida reporting occasional hop production. Given the highly specific regions that hops are grown in, we can assume that potential exposure to malathion from “other row crops” use sites is 0 outside of these areas, and thus is not relevant to this species.

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 groundfruit lower the maximum allowable number of applications to 2-4 per year (depending on the specific crop). 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 Georgia pigtoe. As discussed below, even though the species vulnerability is high and risk to the species host fish is medium, we anticipate the likelihood of exposure of host fish to malathion is low, and the implementation of the general conservation measures described above is expected to further reduce the likelihood of exposure. In addition, although mosquito adulticide was identified as an anticipated usage category in our February 2021 draft biological opinion, our subsequent reexamination of the usage overlap with the species' refined range indicated this usage was overestimated. Thus, for this species, based upon a refinement of the range and mosquito adulticide usage information, we conclude that mosquito adulticide is a minor driver for malathion effects and that only minimal effects to host fish are anticipated from this use.

The Georgia pigtoe has a high vulnerability based on its status, distribution, and trends. Mortality and sublethal effects to the species are not anticipated. The risk to the species host fish posed by labeled uses across the range is medium, and where individual host fish are exposed, we generally anticipate medium levels of mortality, depending on water body size and use type. Mussels depend on host fish to accomplish their reproductive lifecycle. Glochidia (larval stage) are released into the water and within a few days they must attach to an appropriate species of fish, which they parasitize for a short time while they develop into juvenile mussels. Glochidia that do not attach to a host fish will not survive. Where sufficient numbers of suitable host fish are not available, we anticipate reproduction of mussels would be reduced.

We anticipate usage within the non-Federal portion of the species' range will be low (2.04%), based primarily on the usage data we acquired, as described in the Opinion and summarized for this species above. This usage value is reduced from the value listed in our draft Opinion, due in large part to the adjustment of the mosquito adulticide usage revised estimate. 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.

The species range, and thus this species host fish range, is very large (>1.8 million acres) and we do not anticipate that host fish would necessarily be found in the affected areas of the waterbodies near application sites when malathion is applied, although small numbers of host fish may occur in these areas and be exposed over the duration of the proposed action. Reductions in plankton could be high in localized areas, however, we anticipate additional food resources from upstream sources would quickly recolonize after an application event. In addition, we anticipate that the conservation measures above, including rain restrictions, aquatic habitat buffers, residential use label changes, and reduced number of applications and rates on certain use sites, will further reduce the risk of exposure to the mussels' host fish.

As stated previously, conservation measures are aimed at reducing the amount of malathion runoff and spray drift that enter into sensitive habitats (e.g., species habitat, aquatic environments). For example, by placing a 48-hour rain restriction on agricultural applications, malathion has the ability to degrade after application (e.g., by hydrolysis, other processes) prior to any rain/runoff events, thus minimizing malathion runoff into aquatic habitats and decreasing exposure to listed mussels and their host fish. Increasing application buffers reduces the amount of malathion that drifts off target and subsequently into non-target environments. In addition, changes to residential labels limits applications to spot treatments and reduces the number of applications per year (2-4), significantly decreasing the overall amounts of malathion used in residential areas and resulting amounts of runoff and drift. Additional reductions in the number of applications and rates allowed for certain crops (e.g., corn, vegetables and ground fruit) further reduces the amount of malathion used in agricultural settings, thereby decreasing potential exposure to the species and their host fish. Combined, these conservation measures substantially reduce exposure to the Georgia pigtoe and their host fish and therefore minimizes overall risk and adverse effects to the species in the larger waterbodies in which they occur. Thus, while we anticipate small numbers of host fish will experience low levels of adverse effects either from exposure to malathion or via a loss of prey resources, and very small numbers of mussels will experience low levels of adverse effects due to small reductions of prey items (plankton/zooplankton) over the duration of the action. However, we do not anticipate that these adverse effects would have population- or species-level effects

.

Therefore, we anticipate that the proposed action would not appreciably reduce survival and recovery of the Georgia pigtoe in the wild.

Conclusion: Is not likely to jeopardize.

Integration and Synthesis Summary: Bivalves

| Scientific Name: | Common Name: | Entity ID: |
|--------------------------------|---------------|------------|
| <i>Lampsilis rafinesqueana</i> | Neosho Mucket | 4086 |

Family: Unionidae

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:

Neosho Mucket historically occurred in at least 17 streams within the Illinois, Neosho, and Verdigris River basins covering four states (Arkansas, Kansas, Oklahoma, and Missouri). It is endemic to the Arkansas River system (Gordon 1981; Harris and Gordon 1987; Mather 1990; Obermeyer 1996; Vaughn 1996; Obermeyer *et al.* 1997a; Harris *et al.* 2009). Based on historical and current data, Neosho Mucket no longer occurs in approximately 1,317 km (818 mi) of its historical range (61 percent). Most of this extirpation has occurred within the Oklahoma and Kansas portions of its range. Extant populations are disjunct (not contiguous) in approximately 844 km (524 mi) of its range (78 FR 57076).

Two Neosho Mucket populations persist within the Verdigris River basin, one population within the Illinois River basin, and five populations within the Neosho River basin, while its persistence in Cow Creek is unknown and Cottonwood River is questionable due to its recent (2015) reintroduction (Neosho River basin). Reservoir construction isolated each river basin and most populations within the river basin from each other. The Spring and North Fork Spring river populations are the only extant populations connected without barriers (e.g., dams) in the Neosho River basin, and the North Fork may be a meta-population depending upon results from ongoing genetics work. There also is connectivity between the two extant stream populations in the Verdigris River basin. Neosho Mucket individuals are widely scattered in isolated concentrations with low abundance within each population (river), except the Spring River where relatively high abundance still occurs at extant sites.

The Neosho Mucket faces a variety of threats from declines in water quality, altered hydrology, riparian habitat fragmentation, and deterioration of instream habitat. These threats, which urbanization may exacerbate within portions of the range coupled with climate change, are important factors affecting future viability of Neosho Mucket. Captive propagation, augmentation, and reintroduction are necessary to increase resiliency and achieve sufficient redundancy. Due to the restricted range, geographic isolation of most extant populations, and

small population size, the species is likely suffering genetic isolation and reduced adaptive capacity throughout much of its range, resulting in lower representation. An ongoing conservation genomics study of Neosho Mucket will better inform within-river and among-population genetic variation for development of future management and recovery strategies. Given current and expected future decreases in resiliency, populations become more vulnerable to extirpation from stochastic events resulting in concurrent losses in representation and redundancy.

The status of Neosho Mucket is similar to its status at time of listing with widely scattered individuals in isolated populations with low abundance, except the Spring River where this species persists in relatively high abundance. No new information indicates curtailment of threats to the species. Threats associated with impoundments, sedimentation, chemical contaminants, mining, inadequacy of state and federal water quality programs, population fragmentation, climate change, and invasive species continue to threaten extant populations.

EB/CE Source: U.S. Fish and Wildlife Service (FWS). 2020. 5-Year Review: Summary and Evaluation for Neosho Mucket (*Lampsilis rafinesqueana*). Arkansas Ecological Services Field Office. Conway, Arkansas. 49 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 expect the Neosho mucket will experience direct mortality or sublethal effects from any malathion uses at the maximum rates for all bins (2, 3, 4, 5, 6, 7). However, risk of mortality to the host fish for bin 2 is high for all use sites except developed where it is medium. Risk of mortality to the host fish for bin 6 is low for developed, medium for mosquito control and corn, all high for all other uses. Risk of mortality to host fish in bin 7 is low for developed and mosquito control, medium for all uses except high for cotton.

We do not expect mussel species to be directly impacted by exposure from malathion. However their lifecycle is such that when glochidia (larval stage) are released into the water, within a few days they must attach to an appropriate species of fish, which they parasitize for a short time while they develop into juvenile mussels in order to complete their lifecycle; they cannot complete their lifecycle without a fish host.

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.

| DIRECT (all uses except mosquito control) | |
|---|---------------------|
| Use areas – mortality | No effects expected |

| | |
|--|---|
| Sublethal – growth (G), reproduction (R) and behavior (B) enzyme (E) | No effects expected |
| INDIRECT (all uses except mosquito control) | |
| Use areas - Prey item mortality | If plankton: H If detritus: NA |
| Use areas – Fish Host | Total overlap: 6.74%, H, M all bins M and L for developed all bins |
| MOSQUITO CONTROL | |
| Direct (mortality) | No effects expected |
| Sublethal | No effects expected |
| Indirect | Total overlap: 7.29%, H M L depending on the bin |

Risk modifiers:

Neosho mucket spawns in late April and May, and female brooding occurs May through August. Suitable fish hosts for Neosho mucket glochidia include smallmouth bass (*Micropterus dolomieu*), largemouth bass (*Micropterus salmoides*), and spotted bass (*Micropterus punctulatus*) (USFWS 2015).

Generally, the Neosho mucket is found embedded in stable substrates associated with shallow riffles and runs (intermediate areas between pools and riffles with moderate current) with gravel and sand substrate and moderate to swift currents (Oesch 1984, p. 221; Harris 1998, p. 5; Obermeyer 2000, pp. 15–16). However, in Shoal Creek and the Illinois River, the Neosho mucket prefers near-shore areas or areas out of the main current (Harris 1998, p. 5). Neosho mucket is dependent on areas with flow refuges where shear stress (the stream's ability to entrain and transport bed material created by the flow acting on the bed material) is low and sediments remain stable during flood events (Layzer and Madison 1995, p. 341; Strayer 1999, pp. 468 and 472; Hastie et al. 2001, pp. 111–114).

Recall from the “Approach to the Effects Analysis” section of the main body of the Opinion that specific considerations were made for species that occur in Bins 3 and 4 and that 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 Bin 3 and 4 estimated environmental concentrations indicate 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. While the Neosho mucket also occupies other aquatic habitats that may be exposed to potentially high levels of malathion due to lower volume in those habitats (Bin 2), their potential exposure risk is at least partially lowered based on their reliance upon larger flowing and static aquatic habitats (Bins 3, 4, 6, and 7), reducing the overall risk to the species as a whole.

The Neosho Mucket is considered a fish host generalist whose glochidia can metamorphosize on a wide variety of fishes from multiple families. While we anticipate some species of the host fish community will exhibit temporary reductions in abundance due to malathion exposure, the

species' flexible host requirement will allow the species to be more resilient to temporary losses of host fish, reducing the anticipated indirect 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 to Host Fish associated with bin (H, M, L) |
|------------------|------------------------------|------------------------|------|---------------------------------------|------|--|---|
| | | Acres | % | | | | |
| Mosquito Control | I | 1,177,292 | 7.29 | 0 | 0 | 2,3,4,6,7 | 2H 3 4 6M 7L |
| Developed | I | 327,007 | 2.03 | 16,350 | 0.13 | 2,3,4,6,7 | 2M 3 4 6L 7L |
| Corn | I | 546,457 | 3.38 | 15,579 | 0.1 | 2,3,4,6,7 | 2H 3 4 6M 7M |
| Wheat | I | 138,708 | 0.86 | 138,708 | 0.86 | 2,3,4,6,7 | 2H 3 4 6H 7M |
| Pasture | I | 20,056 | 0.12 | 16,196 | 0.1 | 2,3,4,6,7 | 2H 3 4 |

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 to Host Fish associated with bin (H, M, L) |
|--|------------------------------|------------------------|--------|---------------------------------------|--------|--|---|
| | | Acres | % | | | | |
| | | | | | | | 6H 7M |
| Nurseries | I | 989 | < 0.01 | 989 | < 0.01 | 2,3,4,6,7 | 2H 3 4 6H 7M |
| Other Crops | I | 18,580 | 0.12 | 0 | 0 | 2,3,4,6,7 | 2H 3 4 6H 7M |
| Other Row Crops | I | 77 | < 0.01 | 77 | < 0.01 | 2,3,4,6,7 | 2H 3 4 6H 7M |
| Other Grains | I | 26,995 | 0.17 | 26,995 | 0.17 | 2,3,4,6,7 | 2H 3 4 6H 7M |
| Vegetables & Ground Fruit | I | 106 | < 0.01 | 106 | < 0.01 | 2,3,4,6,7 | 2H 3 4 6H 7M |
| Orchards & Vineyards | I | 2,434 | 0.02 | 210 | < 0.01 | 2,3,4,6,7 | 2H 3 4 6H 7M |
| Cotton | I | 58 | < 0.01 | 6 | < 0.01 | 2,3,4,6,7 | 2H 3 4 6H 7H |
| Sub-TOTAL (I): <i>Other uses with indirect effects³</i> | | 108,1467 | 6.74 | 215,216 | 1.42 | | |

| Use type | Risk to species ¹ | Use overlap with range | | Estimated usage in range ² | | Bins associated with use type [^] | Effect to Host Fish associated with bin (H, M, L) |
|----------------------|------------------------------|------------------------|-------|---------------------------------------|------|--|---|
| | | Acres | % | | | | |
| TOTAL ³ : | | 2,258,759 | 14.03 | 215,216 | 1.42 | | |

[^]We consider the Bin 2 estimates as an upper bound of Bin 3 & 4 exposures. The estimated environmental concentrations for a Bin 2 water are an order of magnitude greater than Bins 3 and 4; therefore concentrations in Bins 3 and 4 can be reduced by a correction factor of 10.

Exposure Modifiers:

A reassessment of crop UDL showed that usage data in the “Other Row Crops” may be overestimated. This UDL is composed of sunflower, peanuts, tobacco, sugar beets, and hops, of which, only hops is a registered use site on malathion labels and is thus the only crop in this layer that is relevant in our analysis. USDA data shows that 96% of hops are grown in the Pacific Northwest region (Idaho, Oregon, and Washington), with some small farms in Florida reporting occasional hop production. Given the highly specific regions that hops are grown in, we can assume that the potential exposure to malathion from “other row crops” use sites is 0 outside the areas indicated above, and thus is not relevant to this species.

acres in species range: 16,148,284 acres

% of range in California (i.e., where CalPUR data is available): 0%

Range overlap with Federal lands: 335,118 acres, 2.075%

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.

³ 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 groundfruit lower the maximum allowable number of applications to 2-4 per year (depending on the specific crop). 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 Neosho mucket. As discussed below, even though the species vulnerability is high and risk to the species host fish is high, we anticipate the likelihood of exposure of host fish to malathion is low, and the implementation of the general conservation measures described above is expected to further reduce the likelihood of exposure.

The Neosho mucket has a high vulnerability based on its status, distribution, and trends. Mortality and sublethal effects to the species are not anticipated. The risk to the species host fish posed by labeled uses across the range is medium, and where individual host fish are exposed, we anticipate high to medium levels of mortality, depending on water body size and use type. However, the Neosho mucket also requires a specific species of fish for glochidia to attach

therefore, so where this fish species is exposed to malathion and suitable hosts are lost, we anticipate overall risk to the species would be high. Mussels depend on host fish to accomplish their reproductive lifecycle. Glochidia (larval stage) are released into the water and within a few days they must attach to an appropriate species of fish, which they parasitize for a short time while they develop into juvenile mussels. Glochidia that do not attach to a host fish will not survive. Where sufficient numbers of suitable host fish are not available, we anticipate reproduction of mussels would be reduced.

We anticipate usage within the non-Federal portion of the species' range will be low (1.43 %), based primarily on the 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 Biological Opinion.

However, the species range, and thus this species host fish range, is very large (>16.1 million acres) and we do not anticipate that host fish would necessarily be found in the affected areas of the waterbodies near application sites when malathion is applied, although small numbers of host fish may occur in these areas and be exposed over the duration of the proposed action. Reductions in plankton could be high in localized areas, however, we anticipate additional food resources from upstream sources would quickly recolonize after an application event. In addition, we anticipate that the conservation measures above, including rain restrictions, aquatic habitat buffers, residential use label changes, and reduced number of applications and rates on certain use sites, will further reduce the risk of exposure to plankton and the mussels' host fish.

As stated previously, conservation measures are aimed at reducing the amount of malathion runoff and spray drift that enter into sensitive habitats (e.g., species habitat, aquatic environments). For example, by placing a 48-hour rain restriction on agricultural applications, malathion has the ability to degrade after application (e.g., by hydrolysis, other processes) prior to any rain/runoff events, thus minimizing malathion runoff into aquatic habitats and decreasing exposure to listed mussels and their host fish. Increasing application buffers reduces the amount of malathion that drifts off target and subsequently into non-target environments. In addition, changes to residential labels limits applications to spot treatments and reduces the number of applications per year (2-4), significantly decreasing the overall amounts of malathion used in residential areas and resulting amounts of runoff and drift. Additional reductions in the number of applications and rates allowed for certain crops (e.g., corn, vegetables and ground fruit) further reduces the amount of malathion used in agricultural settings, thereby decreasing potential exposure to the species and their host fish. Combined, these conservation measures substantially reduce exposure to the Neosho mucket and their host fish and therefore minimizes overall risk and adverse effects to the species. Thus, while we anticipate small numbers of individual host fish would be lost over the duration of the action, resulting in very small reductions in reproductive success, we do not anticipate species-level effects to this mussel species. Therefore, we anticipate that the proposed action would not appreciably reduce survival and recovery of the Neosho mucket in the wild.

Conclusion: Is not likely to jeopardize.

Integration and Synthesis Summary: Bivalves

| Scientific Name: | Common Name: | Entity ID: |
|--------------------------------|--------------------|------------|
| <i>Margaritifera marrianae</i> | Alabama pearlshell | 4411 |

Family: Margaritiferidae

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:

Historically, the Alabama pearlshell was known from the Big Flat, Brushy, and Limestone creeks in the Alabama River drainage and in the Autrey, Beaver, Bottle, Brushy, Burnt Corn, Horse, Hunter, Jordan, Little Cedar, Murder, Otter, and Sandy creeks in the Escambia River drainage. Current distribution of the Alabama pearlshell includes Big Flat Creek in the Alabama River drainage and the Amos Mill, Bottle, Burnt Corn, Hunter, Jordan, Little Cedar, Otter and Sandy creeks in the Escambia River drainage. The Amos Mill population, discovered in 2010, represents a new record, and possibly the only known surviving population in the Sepulga River drainage. The Burnt Corn and Otter Creek populations reaffirm historical records that had not been reported in nearly 30 years. Two of the Sandy Creek locations, discovered in 2011, are new populations. Since the late 1990s, more than 70 locations within the Alabama River Basin were surveyed for mollusks (McGregor et al. 1999; Powell and Ford 2010 pers. obs.; Buntin and Fobian 2011 pers. comm.), 35 of which were located in the Limestone and Big Flat Creek drainages, and no live Alabama pearlshell were reported. The last documented occurrence in Big Flat Creek was a fresh dead individual collected in 1995 (Shelton 1999 in litt.), and the last reported occurrence in the Limestone Creek drainage was 1974, where Williams (2009 pers. comm.) reported it as common. Despite numerous visits, the pearlshell has not been collected in this system since 1974. A fresh dead individual collected by Shelton in 1995, represents the most recent record from the Big Flat Creek drainage. Recent data suggest that, of the nine remaining populations, the largest may occur in Little Cedar and Otter Mill creeks.

Evidence suggests that much of the rangewide decline of this species has occurred within the past few decades. Specific causes of the decline and disappearance of the Alabama pearlshell from historical stream localities are unknown. However, they are likely related to past and present land use patterns. Many of the small streams historically inhabited by the Alabama pearlshell are impacted to various degrees by nonpoint-source pollution.

EB/CE Source:

U.S. Fish and Wildlife Service. 2012. Endangered and Threatened Wildlife and Plants; Determination of Endangered status for the Alabama Pearlshell, Round Ebonyshell, Southern Kidneyshell, and Choctaw Bean, and Threatened Species Status for the Tapered Pigtoe, Narrow Pigtoe, Southern Sandshell, and Fuzzy Pigtoe, and Designation of Critical Habitat. Federal Register Vol. 77, No. 196. October 10, 2012. 61664-61719. **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 expect the Alabama pearlshell will experience direct mortality or sublethal effects from any malathion uses at the maximum rates for all bins (2, 3, 4, and 7). However, risk of mortality to the host fish for bin 2 is high for all use sites except developed where it is medium. Risk of mortality to the host fish in bin 7 is low for mosquito control and developed and medium for all other uses.

We do not expect mussel species to be directly impacted by exposure from malathion. However their lifecycle is such that when glochidia (larval stage) are released into the water, within a few days they must attach to an appropriate species of fish, which they parasitize for a short time while they develop into juvenile mussels in order to complete their lifecycle; they cannot complete their lifecycle without a fish host.

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.

| | |
|--|--|
| DIRECT (all uses except mosquito control) | |
| Use areas – mortality | No effects expected |
| Sublethal – growth (G), reproduction (R) and behavior (B) enzyme (E) | No effects expected |
| INDIRECT (all uses except mosquito control) | |
| Use areas - Prey item mortality | High if plankton, NA if detritus |
| Use areas – Fish Host | 2.22% total overlap HM depending on bin, M for developed |
| MOSQUITO CONTROL | |
| Direct (mortality) | NA |
| Sublethal | No effects expected |
| Indirect | 47.7% total overlap High Bin 2, Low Bin 7 |

Risk modifiers:

The Alabama pearlshell typically inhabits small headwater streams with mixed sand and gravel substrates, occasionally in sandy mud, with slow to moderate current. The habitat is linear in nature. Primary constituent elements include geomorphically stable stream and river channels and banks; stable substrates of sand or mixtures of sand with clay or gravel with low to moderate amounts of fine sediment; a hydrologic flow regime (magnitude, frequency, duration, and seasonality of discharge over time) necessary to maintain benthic habitats; water quality, including temperature (not greater than 32 °C), pH (between 6.0 to 8.5), oxygen content (not less than 5.0 mg/L), hardness, turbidity, and other chemical characteristics necessary for normal behavior, growth, and viability of all life stages (USFWS 2012). The environmental specificity of this species is narrow, as it is sensitive to pollution, siltation, habitat perturbation, inundation, and loss of glochidial hosts.

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. Further investigation by EPA into Bin 3 and 4 estimated environmental concentrations indicate 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. While the Alabama pearlshell also occupies other aquatic habitats that may be exposed to potentially high levels of malathion due to lower volume in those habitats (Bin 2), their potential exposure risk is at least partially lowered based on their reliance upon larger flowing and static aquatic habitats (Bins 3, 4, and 7), reducing the overall risk to the species as a whole.

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 to fish host associated with bin (H, M, L) |
|----------------------|------------------------------|------------------------|------|---------------------------------------|------|--------------------------------|---|
| | | Acres | % | Acres | % | | |
| Mosquito Control | I | 676,585 | 47.7 | 18,267 | 1.29 | 2,3,4,7 | 2H 3 4 7L |
| Cotton | I | 13,170 | 0.93 | 9,720 | 0.69 | 2,3,4,7 | 2H 3 4 7M |
| Developed | I | 4,861 | 0.34 | 243 | 0.02 | 2,3,4,7 | 2M 3 4 7L |
| Corn | I | 4,194 | 0.30 | 585 | 0.04 | 2,3,4,7 | 2H 3 4 7M |
| Other Crops | I | 4,064 | 0.29 | 0 | 0 | 2,3,4,7 | 2H 3 4 7M |
| Other Grains | I | 788 | 0.06 | 649 | 0.05 | 2,3,4,7 | 2H 3 4 7M |
| Orchards & Vineyards | I | 326 | 0.02 | 312 | 0.02 | 2,3,4,7 | 2H 3 4 7M |
| Other Row Crops | I | 3,451 | 0.24 | 3,451 | 0.24 | 2,3,4,7 | 2H 3 4 7M |
| Wheat | I | 263 | 0.02 | 228 | 0.02 | 2,3,4,7 | 2H 3 4 |

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 to fish host associated with bin (H, M, L) |
|--|------------------------------|------------------------|--------|---------------------------------------|--------|--|---|
| | | Acres | % | Acres | % | | |
| | | | | | | | 7M |
| Vegetables & Ground Fruit | I | 25 | < 0.01 | 11 | < 0.01 | 2,3,4,7 | 2H 3 4 7M |
| Nurseries | I | 1 | < 0.01 | 1 | < 0.01 | 2,3,4,7 | 2H 3 4 7M |
| Sub-TOTAL (I): <i>Other uses with indirect effects³</i> | | 31,142 | 2.22 | 15,201 | 1.11 | | |
| TOTAL³: | | 707,727 | 49.92 | 33,468 | 2.40 | | |

[^]We consider the Bin 2 estimates as an upper bound of Bin 3 & 4 exposures. The estimated environmental concentrations for a Bin 2 water are an order of magnitude greater than Bins 3 and 4, therefore concentrations in Bins 3 and 4 can be reduced by a correction factor of 10.

Exposure Modifiers:

A reassessment of crop UDL showed that usage data in the “Other Row Crops” may be overestimated. This UDL is composed of sunflower, peanuts, tobacco, sugar beets, and hops, of which, only hops is a registered use site on malathion labels and is thus the only crop in this layer that is relevant in our analysis. USDA data shows that 96% of hops are grown in the Pacific Northwest region (Idaho, Oregon, and Washington), with some small farms in Florida reporting occasional hop production. Given the highly specific regions that hops are grown in, we can assume that the potential exposure to malathion from “other row crops” use sites is 0 outside the areas indicated above, and thus is not relevant to this species.

acres in species range: 1,417,122 acres

% of range in California (i.e., where CalPUR data is available): 0%

Range overlap with Federal lands: 25,480 acres, 1.798%

Overall Usage: ☐ High ☐ Medium ☒ Low

³ TOTAL includes usage on all use sites with effects, including mosquito control.

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 groundfruit lower the maximum allowable number of applications to 2-4 per year (depending on the specific crop). 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 Alabama pearlshell. As discussed below, even though the species vulnerability is high and risk to the species host fish is medium, we anticipate the likelihood of exposure of host fish to malathion is low, and the implementation of the general conservation measures described above is expected to further reduce the likelihood of exposure.

The Alabama pearlshell has a high vulnerability based on its status, distribution, and trends. Mortality and sublethal effects to the species are not anticipated. The risk to the species host fish posed by labeled uses across the range is medium, and where individual host fish are exposed, we anticipate high to medium levels of mortality, depending on water body size and use type. Mussels depend on host fish to accomplish their reproductive lifecycle. Glochidia (larval stage) are released into the water and within a few days they must attach to an appropriate species of fish, which they parasitize for a short time while they develop into juvenile mussels. Glochidia that do not attach to a host fish will not survive. Where sufficient numbers of suitable host fish are not available, we anticipate reproduction of mussels would be reduced.

We anticipate usage within the non-Federal portion of the species' range will be low (2.40 %), based primarily on the 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 Biological Opinion.

The species range, and thus this species host fish range, is very large (>1.4 million acres) and we do not anticipate that host fish would necessarily be found in the affected areas of the waterbodies near application sites when malathion is applied, although small numbers of host fish may occur in these areas and be exposed over the duration of the proposed action. Reductions in plankton could be high in localized areas, however, we anticipate additional food resources from upstream sources would quickly recolonize after an application event. In addition, we anticipate that the conservation measures above, including rain restrictions, aquatic habitat buffers, residential use label changes, and reduced number of applications and rates on certain use sites, will further reduce the risk of exposure to plankton and the mussels' host fish.

As stated previously, conservation measures are aimed at reducing the amount of malathion runoff and spray drift that enter into sensitive habitats (e.g., species habitat, aquatic environments). For example, by placing a 48-hour rain restriction on agricultural applications, malathion has the ability to degrade after application (e.g., by hydrolysis, other processes) prior to any rain/runoff events, thus minimizing malathion runoff into aquatic habitats and decreasing exposure to listed mussels and their host fish. Increasing application buffers reduces the amount of malathion that drifts off target and subsequently into non-target environments. In addition, changes to residential labels limits applications to spot treatments and reduces the number of applications per year (2-4), significantly decreasing the overall amounts of malathion used in residential areas and resulting amounts of runoff and drift. Additional reductions in the number of applications and rates allowed for certain crops (e.g., corn, vegetables and ground fruit)

further reduces the amount of malathion used in agricultural settings, thereby decreasing potential exposure to the species and their host fish. Combined, these conservation measures substantially reduce exposure to the Alabama pearlshell and their host fish and therefore minimizes overall risk and adverse effects to the species. Thus, while we anticipate small numbers of individual host fish would be lost over the duration of the action, resulting in very small reductions in reproductive success, we do not anticipate species-level effects to this mussel species.

Therefore, we anticipate that the proposed action would not appreciably reduce survival and recovery of the Alabama pearlshell in the wild.

Conclusion: Is not likely to jeopardize.

Integration and Synthesis Summary: Bivalves

| Scientific Name: | Common Name: | Entity ID: |
|-------------------------------|------------------------|-------------------|
| <i>Cumberlandia monodonta</i> | Spectaclecase (mussel) | 4490 |

Family: Margaritiferidae

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:

At the time of listing, the spectaclecase was considered to be extant in 20 streams in Alabama, Arkansas, Illinois, Kentucky, Minnesota, Missouri, Tennessee, Virginia, West Virginia, and Wisconsin. Records indicate that the species historically occurred in at least 44 streams and also historically occurred in Indiana, Kansas, and Ohio. In the 20 streams, the species status was declining in 5 streams, stable in 5 streams, and unknown in 10 streams. No streams were categorized as improving at the time of listing. Since the time of listing, a relatively large spectaclecase population was discovered on the Ouachita River in Arkansas and an apparent reproducing population was found in the Green River in Kentucky in 2012 (Lewis Environmental Consulting 2013). Both of the rivers with these new populations were known to be occupied at the time of listing. Two streams (Ohio River (IL) and Duck River (TN)) where the species was thought to be extant at the time of listing are now questionable due to the small number of individuals observed and the number of years since the last detection of the species (1994 and 1999, respectively) despite more recent surveys. The species is now presumed extirpated in the Mullberry River in Arkansas (it was considered unknown at the time of listing).

Large-river habitat throughout most of the spectaclecase's range has been impounded, leaving short, isolated patches of habitat in areas between dams. Other threats include impoundments, point and nonpoint source pollution, sedimentation, and physical changes in streambed structure. These threats are exacerbated as a result of the small size and isolation of remaining populations.

See the 2012 listing rule (77 FR 14914) for a detailed discussion of these factors.

EB/CE Source: U.S. Fish and Wildlife Service (FWS). 2019. 5-Year Review: Summary and Evaluation for Spectaclecase mussel (*Cumberlandia monodonta*). Minnesota/Wisconsin Ecological Services Field Office. Bloomington, Minnesota. 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 expect the spectaclecase will experience direct mortality or sublethal effects from any malathion uses at the maximum rates for all bins (2, 3, 4, 6, 7). However, risk of mortality to the host fish for bin 2 is high for all use sites except developed where it is medium. Risk of mortality to individuals in bin 7 is medium for all uses except for developed, mosquito control, which are low. Risk of mortality to individuals in bin 6 is high for all other uses except medium for mosquito control, and low for developed.

We do not expect mussel species to be directly impacted by exposure from malathion. However their lifecycle is such that when glochidia (larval stage) are released into the water, within a few days they must attach to an appropriate species of fish, which they parasitize for a short time while they develop into juvenile mussels in order to complete their lifecycle; they cannot complete their lifecycle without a fish host.

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.

| | |
|--|---|
| DIRECT (all uses except mosquito control) | |
| Use areas – mortality | No effects expected |
| Sublethal – growth (G), reproduction (R) and behavior (B) enzyme (E) | No effects expected |
| INDIRECT (all uses except mosquito control) | |
| Use areas - Prey item mortality | If plankton: H, except for developed is L depending on the bin If detritus: NA |
| Use areas – Fish Host | Total overlap: 55.1%, H M for most uses, L for developed bins 6 and 7 |
| MOSQUITO CONTROL | |
| Direct (mortality) | No effects expected |
| Sublethal | No effects expected |
| Indirect | Total overlap: 96.6%, H M L depending on the bin |

Risk modifiers:

The spectaclecase is a freshwater mussel that generally inhabits large rivers, and is typically found aggregated in microhabitats sheltered from the main force of current, such as under slab

boulders or bedrock shelves. It occurs in substrates from mud and sand to gravel, cobble, and boulders in relatively shallow riffles and shoals with a slow to swift current.

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. Further investigation by EPA into Bin 3 and 4 estimated environmental concentrations indicate 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. While the spectaclecase also occupies other aquatic habitats that may be exposed to potentially high levels of malathion due to lower volume in those habitats (Bin 2), their potential exposure risk is at least partially lowered based on their reliance upon larger flowing and static aquatic habitats (Bins 3, 4, 6, and 7), reducing the overall risk to the species as a whole.

The Spectaclecase (mussel) is considered a fish host generalist whose glochidia can metamorphosize on a wide variety of fishes from multiple families. While we anticipate some species of the host fish community will exhibit temporary reductions in abundance due to malathion exposure, the species’ flexible host requirement will allow the species to be more resilient to temporary losses of host fish, reducing the anticipated indirect effects to the species.

Two fish hosts for spectaclecase were confirmed in 2017; mooneye (*Hiodon tergisus*) and goldeye (*H. alosoides*) (Sietman et al. 2017, p. 18). Host research is now focused on these two species, although efforts continue to identify additional hosts. Identification of host species now allows for propagation of juvenile mussels. Research continues on husbandry of host fish and juvenile mussels in laboratory conditions.

In early 2018, the Kentucky Department of Fish and Wildlife Resources mussel facility successfully transformed several hundred spectaclecase larvae into juvenile mussels using the “in-vitro” method, which is the first time this was ever done (L. Koch, USFWS, 2018, pers. comm.). This method provides another recovery tool for this species.

Allowable uses driving effects/other considerations: Prior to finalizing this Biological Opinion, we discovered that the overlap of malathion use sites with the species range was calculated based on an inaccurate range map for this species. As a result, we did not carry forward the overlap values from the draft Opinion into this final Opinion. Instead, we qualitatively estimated the types and extent of malathion use sites occurring within the range by visually examining mapped crop data layers in proximity to the species range, which occurs in small areas in the following States: Alabama, Arkansas, Illinois, Kansas, Kentucky, Minnesota, Missouri, Tennessee, Virginia, West Virginia, and Wisconsin.

A visual inspection of cropland data layers indicates that crops within the corn, developed, other grains, open space developed, and pasture UDLs have the most overlap with the range of this species. Though overlap information was not available to quantitatively evaluate risk and usage, we anticipate low risk to the species posed by labeled malathion uses across the range based on low anticipated effects to the host fish (from occupation of bin 3, 4, and 7 waters for the mussel itself).

Overall Risk: ☐ High ☒ Medium ☐ Low

USAGE

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

For estimation of usage, we considered state-level data for agriculture, county level sales and usage data for mosquito adulticide, and developed and open space developed usage consistent with our overall estimates for listed species.

We anticipate a medium amount of estimated usage within the non-Federal portion of the range based on usage data for corn, other crops, other grains, and pasture. We estimate that up to 5% of developed and open space developed use sites within the species range could undergo some level of treatment with malathion. Past usage data indicates that malathion has been used very little for mosquito control within the range of the species (two counties in one state within the last 6 years).

acres in species range: not available

% of range in California (i.e., where CalPUR data is available): 0%

Range overlap with Federal lands: not available

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 groundfruit lower the maximum allowable number of applications to 2-4 per year (depending on the specific crop). 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 Spectaclecase (mussel). As discussed below, even though the species vulnerability is high and risk to the species host fish is medium for this species, we anticipate the likelihood of exposure of host fish to malathion is low, and the implementation of the general conservation measures described above is expected to further reduce the likelihood of exposure.

The spectaclecase (mussel) has a high vulnerability based on its status, distribution, and trends. Mortality and sublethal effects to the species are not anticipated. The risk to the species host fish posed by labeled uses across the range is medium, and where individual host fish are exposed, we anticipate variable levels of mortality, depending on water body size and use type. Mussels depend on host fish to accomplish their reproductive lifecycle. Glochidia (larval stage) are released into the water and within a few days they must attach to an appropriate species of fish, which they parasitize for a short time while they develop into juvenile mussels. Glochidia that do not attach to a host fish will not survive. Where sufficient numbers of suitable host fish are not available, we anticipate reproduction of mussels would be reduced.

We anticipate usage within the non-Federal portion of the species’ range will be low (3.68 %), based primarily on the 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 Biological Opinion.

The species range, and thus this species host fish range, is very large (>3 million acres) and we do not anticipate that host fish would necessarily be found in the affected areas of the waterbodies near application sites when malathion is applied, although small numbers of host fish may occur in these areas and be exposed over the duration of the proposed action. Reductions in plankton could be high in localized areas, however, we anticipate additional food resources from upstream sources would quickly recolonize after an application event. In addition, we anticipate that the conservation measures above, including rain restrictions, aquatic habitat buffers, residential use label changes, and reduced number of applications and rates on certain use sites, will further reduce the risk of exposure to plankton and the mussels' host fish.

As stated previously, conservation measures are aimed at reducing the amount of malathion runoff and spray drift that enter into sensitive habitats (e.g., species habitat, aquatic environments). For example, by placing a 48-hour rain restriction on agricultural applications, malathion has the ability to degrade after application (e.g., by hydrolysis, other processes) prior to any rain/runoff events, thus minimizing malathion runoff into aquatic habitats and decreasing exposure to listed mussels and their host fish. Increasing application buffers reduces the amount of malathion that drifts off target and subsequently into non-target environments. In addition, changes to residential labels limits applications to spot treatments and reduces the number of applications per year (2-4), significantly decreasing the overall amounts of malathion used in residential areas and resulting amounts of runoff and drift. Additional reductions in the number of applications and rates allowed for certain crops (e.g., corn, vegetables and ground fruit) further reduces the amount of malathion used in agricultural settings, thereby decreasing potential exposure to the species and their host fish. Combined, these conservation measures substantially reduce exposure to the spectaclecase (mussel) and their host fish and therefore minimizes overall risk and adverse effects to the species. Thus, while we anticipate small numbers of individual host fish would be lost over the duration of the action, resulting in very small reductions in reproductive success, we do not anticipate species-level effects to this mussel species.

Therefore, we anticipate that the proposed action would not appreciably reduce survival and recovery of the spectaclecase (mussel) in the wild.

Conclusion: Is not likely to jeopardize.

Integration and Synthesis Summary: Bivalves

| Scientific Name: | Common Name: | Entity ID: |
|--------------------------|--------------------|------------|
| <i>Hamiota australis</i> | Southern sandshell | 7349 |

Family: Unionidae

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: Declining population(s) – one or more populations declining

Pesticides noted ☐

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

The southern sandshell is endemic to the Escambia River drainage in Alabama, and the Yellow and Choctawhatchee River drainages in Alabama and Florida (Blalock-Herod et al. 2002).

The southern sandshell persists in its historic range; however, its range is fragmented and numbers appear to be declining (Williams et al. 2008). In the Escambia River drainage, the species was detected at 1 of 4 historic locations surveyed recently. Also, its numbers are very low in the drainage; a total of 20 individuals from 6 locations have been collected in the Escambia River drainage since 1995. Southern sandshell numbers in the Yellow River drainage are also fairly low, with 65 individuals collected recently at a total of 17 locations. The species was not detected at 2 of the 4 historic locations examined recently in the drainage. In the Choctawhatchee River drainage, the number of historic locations that currently support the species has declined from 16 to 5, and it appears to be extirpated from central portions of the Choctawhatchee River main channel and from some tributaries. Sedimentation could be one factor contributing to its decline. In order to reproduce, the southern sandshell must attract a sight-feeding fish to its superconglutinate lure. Waters clouded by silt and sediment would reduce the chance of this interaction occurring (Haag et al. 1995, p. 475).

The habitats of freshwater mussels are vulnerable to habitat modification and water quality degradation from a number of activities associated with modern civilization. The primary cause of the decline of these eight mussels has been the modification and destruction of their stream and river habitat, with sedimentation as the leading cause. Their stream habitats are subject to pollution and alteration from a variety of sources including adjacent land use activities, in-water activities, effluent discharges, and impoundments. Nonpoint-source pollution from land surface runoff originates from virtually all land use activities and includes sediments, fertilizer, herbicide and pesticide residues; animal wastes; septic tank leakage and gray water discharge; and oils and greases. Current activities and land uses that can negatively affect populations of these eight mussels include unpaved road crossings, improper silviculture and agriculture practices, highway

construction, housing developments, pipeline crossings, and cattle grazing. These activities can result in physical disturbance of stream substrates or the riparian zone, excess sedimentation and eutrophication, decreased dissolved oxygen concentration, increased acidity and conductivity, and altered flow.

Limited range and low numbers make these eight mussels vulnerable to land use changes that would result in increases in nonpoint-source pollution.

EB/CE Source: U.S. Fish and Wildlife Service (FWS). 2012. Endangered and Threatened Wildlife and Plants; Determination of Endangered Species Status for the Alabama Pearlshell, Round Ebonyshell, Southern Kidneyshell, and Choctaw Bean, and Threatened Species Status for the Tapered Pigtoe, Narrow Pigtoe, Southern Sandshell, and Fuzzy Pigtoe, and Designation of Critical Habitat. Federal Register. 77 (196): 61664-61719.

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 expect the southern sandshell will experience direct mortality or sublethal effects from any malathion uses at the maximum rates for all bins (2, 3, 4). However, risk of mortality to the host fish for bin 2 is high for all use sites except developed where it is medium.

We do not expect mussel species to be directly impacted by exposure from malathion. However, their lifecycle is such that when glochidia (larval stage) are released into the water, within a few days they must attach to an appropriate species of fish, which they parasitize for a short while they develop into juvenile mussels in order to complete their lifecycle; they cannot complete their lifecycle without a fish host.

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.

| | |
|--|--|
| DIRECT (all uses except mosquito control) | |
| Use areas – mortality | No effects expected |
| Sublethal – growth (G), reproduction (R) and behavior (B) enzyme (E) | No effects expected |
| INDIRECT (all uses except mosquito control) | |
| Use areas - Prey item mortality | If plankton: H If detritus: NA |
| Use areas – Fish Host | Total overlap: 8.75%, H, M for developed |

| MOSQUITO CONTROL | |
|--------------------|--------------------------|
| Direct (mortality) | No effects expected |
| Sublethal | No effects expected |
| Indirect | Total overlap: 50.42%, H |

Risk modifiers:

It is a long-term brooder, and females are gravid from late summer or autumn to the following spring (Williams et al. 2008, p. 338). The southern sandshell is one of only four species that produce a superconglutinate to attract a host. This requires clear water to attract a sight-feeding fish. The superconglutinate mimics the shape, coloration, and movement of a fish and is produced by the female mussel to hold all glochidia (larval mussels) from one year's reproductive effort (Haag et al. 1995, p. 472). Although the fish host for the southern sandshell has not been identified, it likely uses predatory sunfishes such as basses, like other *Hamiota* species (Haag et al. 1995, p. 475; O'Brien and Brim Box 1999, p. 134; Blalock-Herod et al. 2002, p. 1885). (USFWS 2012)

The southern sandshell is typically found in small creeks and rivers in stable substrates of sand or mixtures of sand and fine gravel, with slow to moderate current. The habitat is linear in nature. Primary constituent elements include (1) Geomorphically stable stream and river channels and banks (2) Stable substrates of sand or mixtures of sand with clay or gravel with low to moderate amounts of fine sediment and attached filamentous algae (3) A hydrologic flow regime necessary to maintain benthic habitats and connectivity of rivers with the floodplain (4) Water quality, including temperature (not greater than 32 oC), pH (between 6.0 to 8.5), oxygen content (not less than 5.0 mg/L). (USFWS 2012) The environmental specificity of this species is narrow, as this species is thought to require clean waters and stable substrates.

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. Further investigation by EPA into Bin 3 and 4 estimated environmental concentrations indicate 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.

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 to Host Fish associated with bin (H, M, L) |
|---------------------------|------------------------------|------------------------|--------|---------------------------------------|--------|--|---|
| | | Acres | % | | | | |
| Mosquito Control | I | 4,087,614 | 50.42 | 140,291 | 1.73 | 2,3,4 | 2H 3 4 |
| Developed | I | 114,300 | 1.41 | 5,696 | 0.07 | 2,3,4 | 2M 3 4 |
| Corn | I | 37,933 | 0.47 | 743 | < 0.01 | 2,3,4 | 2H 3 4 |
| Wheat | I | 6,059 | 0.07 | 436 | 0.01 | 2,3,4 | 2H 3 4 |
| Pasture | I | 58 | < 0.01 | 28 | < 0.01 | 2,3,4 | 2H 3 4 |
| Nurseries | I | 492 | < 0.01 | 492 | < 0.01 | 2,3,4 | 2H 3 4 |
| Other Crops | I | 171,211 | 2.11 | 0 | 0 | 2,3,4 | 2H 3 4 |
| Other Grains | I | 41,186 | 0.51 | 7,057 | 0.09 | 2,3,4 | 2H 3 4 |
| Vegetables & Ground Fruit | I | 2,664 | 0.03 | 280 | < 0.01 | 2,3,4 | 2H 3 4 |
| Christmas trees | I | <1 | < 0.01 | <1 | < 0.01 | 2,3,4 | 2H |

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 to Host Fish associated with bin (H, M, L) |
|--|------------------------------|------------------------|-------|---------------------------------------|------|--|---|
| | | Acres | % | | | | |
| | | | | | | | 3 4 |
| Orchards & Vineyards | I | 4,291 | 0.05 | 1,151 | 0.01 | 2,3,4 | 2H 3 4 |
| Other Row Crops | I | 144,658 | 1.78 | 9,836 | 0.12 | 2,3,4 | 2H 3 4 |
| Cotton | I | 185,837 | 2.29 | 12,656 | 0.16 | 2,3,4 | 2H 3 4 |
| Sub-TOTAL (I): <i>Other uses with indirect effects³</i> | | 708,690 | 8.75 | 38,376 | 0.51 | | |
| TOTAL³: | | 4,796,304 | 59.17 | 178,667 | 2.24 | | |

[^]We consider the Bin 2 estimates as an upper bound of Bin 3 & 4 exposures. The estimated environmental concentrations for a Bin 2 water are an order of magnitude greater than Bins 3 and 4; therefore concentrations in Bins 3 and 4 can be reduced by a correction factor of 10.

Exposure Modifiers:

A reassessment of our crop use data layers shows that within the “Other Row Crops” layer shows that usage in this category may be overestimated. This UDL is composed of sunflower, peanuts, tobacco, sugar beets, and hops, of which, only hops is a registered use site on malathion labels and is thus the only crop in this layer that is relevant in our analysis. USDA data shows that 96% of hops are grown in the Pacific Northwest region (in Idaho, Oregon, and Washington), with some small farms in Florida (Gadsden county) reporting occasional hop production. Given the highly specific regions that hops are grown in, we can assume that potential exposure to malathion from “other row crops” use sites is 0 outside of these areas. The range of the southern sandshell is within Florida but is outside of Gadsden county therefore we assume there is no usage for other row crops (hops) within the range of the southern sandshell.

acres in species range: 8,106,348 acres

% of range in California (i.e., where CalPUR data is available): 0%

³ TOTAL includes usage on all use sites with effects, including mosquito control.

Range overlap with Federal lands: 539,942 acres, 6.661%

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 groundfruit lower the maximum allowable number of applications to 2-4 per year (depending on the specific crop). 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 southern sandshell. As discussed below, even though the species vulnerability is high and risk to the species host fish is high, we anticipate the likelihood of exposure of host fish to malathion is low, and the implementation of the general conservation measures described above is expected to further reduce the likelihood of exposure.

The southern sandshell has a high vulnerability based on its status, distribution, and trends. Mortality and sublethal effects to the species are not anticipated. The risk to the species host fish posed by labeled uses across the range is high, and where individual host fish are exposed, we anticipate high to medium levels of mortality, depending on water body size and use type. Mussels depend on host fish to accomplish their reproductive lifecycle. Glochidia (larval stage) are released into the water and within a few days they must attach to an appropriate species of fish, which they parasitize for a short time while they develop into juvenile mussels. Glochidia that do not attach to a host fish will not survive. Where sufficient numbers of suitable host fish are not available, we anticipate reproduction of mussels would be reduced.

We anticipate usage within the non-Federal portion of the species' range will be low (2.24 %), based primarily on the 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 Biological Opinion.

The species range, and thus this species host fish range, is very large (>8 million acres) and we do not anticipate that host fish would necessarily be found in the affected areas of the waterbodies near application sites when malathion is applied, although small numbers of host fish may occur in these areas and be exposed over the duration of the proposed action. Reductions in plankton could be high in localized areas, however, we anticipate additional food resources from upstream sources would quickly recolonize after an application event. In addition, we anticipate that the conservation measures above, including rain restrictions, aquatic habitat buffers, residential use label changes, and reduced number of applications and rates on certain use sites, will further reduce the risk of exposure to plankton and the mussels' host fish.

As stated previously, conservation measures are aimed at reducing the amount of malathion runoff and spray drift that enter into sensitive habitats (e.g., species habitat, aquatic environments). For example, by placing a 48-hour rain restriction on agricultural applications, malathion has the ability to degrade after application (e.g., by hydrolysis, other processes) prior to any rain/runoff events, thus minimizing malathion runoff into aquatic habitats and decreasing exposure to listed mussels and their host fish. Increasing application buffers reduces the amount of malathion that drifts off target and subsequently into non-target environments. In addition, changes to residential labels limits applications to spot treatments and reduces the number of applications per year (2-4), significantly decreasing the overall amounts of malathion used in residential areas and resulting amounts of runoff and drift. Additional reductions in the number of applications and rates allowed for certain crops (e.g., corn, vegetables and ground fruit)

further reduces the amount of malathion used in agricultural settings, thereby decreasing potential exposure to the species and their host fish. Combined, these conservation measures substantially reduce exposure to the southern sandshell and their host fish and therefore minimizes overall risk and adverse effects to the species. Thus, while we anticipate small numbers of individual host fish would be lost over the duration of the action, we do not anticipate species-level effects to this mussel species.

Therefore, we anticipate that the proposed action would not appreciably reduce survival and recovery of the southern sandshell in the wild.

Conclusion: Is not likely to jeopardize.

Integration and Synthesis Summary: Bivalves

| Scientific Name: | Common Name: | Entity ID: |
|---------------------------|------------------------|-------------------|
| <i>Medionidus walkeri</i> | Suwannee moccasinshell | 7372 |

Family: Unionidae

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: Declining population(s) – one or more populations declining

Pesticides noted ☒

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

The primary reason for the Suwannee moccasinshell's decline is the degradation of its habitat due to polluted runoff from agricultural lands, polluted discharges from industrial and municipal facilities and mining operations, decreased flows due to groundwater extraction and drought, and stream channel instability. These threats occur throughout its range, but are more intense in the two tributaries, the Withlacoochee and Santa Fe River systems. In portions of its range, sedimentation has also impacted its habitat. Other threats to the species include State and Federal water quality standards that are inadequate to protect sensitive aquatic organisms like mussels; accidental contaminant releases from industrial, municipal, and mining sources, and as a result of transportation accidents; increased drought frequency and higher temperatures as a result of changing climatic conditions; greater vulnerability to certain threats because of small population size and range; and competition and disturbance from the introduced Asian clam. These threats have resulted in the decline of the species throughout its range, and pose the highest risk to populations in the two tributary systems, as evidenced by the species' decline and possible disappearance in the Withlacoochee River, and its decline in the Santa Fe River subbasin.

In addition, the species likely has a limited ability to disperse and, therefore, may not be able recolonize areas from which it has been extirpated. Currently, nearly the entire population resides in the middle and lower reach of the Suwannee River main channel, where the two greatest threats, pollutants and reduced flows, are attenuated by higher flow volumes. Therefore, Suwannee moccasinshell populations in the Withlacoochee and Santa Fe River subbasins are presently facing threats that are high in magnitude, and populations in the Suwannee River main channel are presently facing threats that are moderate in magnitude. Most of these threats, including reduced flows, pollution, degraded water quality, and channel instability, are expected to increase in the future due to human population growth and climate change."

Suwannee moccasinshell larvae are obligate parasites on darters, primarily on blackbanded darters (*Percina nigrofasciata*) and to a lesser extent, on brown darters (*Etheostoma edwini*) (Johnson et al. 2016).

EB/CE Source: U.S. Fish and Wildlife Service (FWS). 2016. Endangered and Threatened Wildlife and Plants; Threatened Species Status for Suwannee Moccasinshell. Federal Register. 81 (194): 69417-69425 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 expect the Suwannee moccasinshell will experience direct mortality or sublethal effects from any malathion uses at the maximum rates for all bins (3, 4). However, risk of mortality to the host fish for bins 3 and bin 4 is high for most uses except for developed and mosquito control where risk of mortality is medium for bins 3 and 4.

We do not expect mussel species to be directly impacted by exposure from malathion. However their lifecycle is such that when glochidia (larval stage) are released into the water, within a few days, they must attach to an appropriate species of fish, which they parasitize for a short time while they develop into juvenile mussels in order to complete their lifecycle; they cannot complete their lifecycle without a fish host.

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.

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| | |
|--|---|
| DIRECT (all uses except mosquito control) | |
| Use areas – mortality | No effects expected |
| Sublethal – growth (G), reproduction (R) and behavior (B) enzyme (E) | No effects expected |
| INDIRECT (all uses except mosquito control) | |
| Use areas - Prey item mortality | If plankton: H for all uses and all Bins If detritus: NA |
| Use areas – Fish Host | Total overlap: 10.2% H for all uses except M for Developed Mosquito Control, and wheat |
| MOSQUITO CONTROL | |
| Direct (mortality) | No effects expected |

| | |
|-----------|---------------------|
| Sublethal | No effects expected |
| Indirect | Total overlap: 43% |

Risk modifiers:

Species occurs in Bins 3 and 4. See Risk Assumptions (above) for risk to individuals and species.

Species host (unknown) occurs in Bins 3 and 4. See Risk Assumptions (above) for risk to host species.

The Suwannee moccasinshell is generally considered a host-fish specialist that primarily parasitizes darters, similar to other species in the *Medionidus* genus. This narrow fish host requirement suggests that the Suwannee moccasinshell will be less resilient to possible changes in the fish host community and make it more susceptible to indirect effects of malathion. Thus, the risk was initially determined to be high for the Suwannee moccasinshell.

The Suwannee moccasinshell is primarily found in muddy sand or sand with some gravel and in areas with slow to moderate current, which was characterized as bins 3/4. As described in section “Approach to the Effects Analysis” from the main body of the Opinion and in the introduction section of this appendix, we initially relied on Bin 2 estimates as an upper bound for Bins 3 and 4 exposures in our draft Opinion due to the issues inherent in the modeling for these bins.

However, in preparation for finalizing this Opinion, and with further coordination with EPA regarding Bin 3 and 4 EECs, we have revised our assumptions for Bins 3 and 4. We expect that bin 3 and 4 EECs are up to an order of magnitude lower than bin 2 EECs, and the EECs in these habitats would generally not be expected to cause toxic effects, as we anticipate the flow rates and volumes in these aquatic habitats are sufficient to dilute malathion concentrations to a level that will not cause toxic effects to the species. Thus, we estimate that the level of exposure to malathion for the Suwannee moccasinshell and its host fish will be low.

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 to Host Fish associated with bin (H, M, L) |
|----------------------------|------------------------------|------------------------|-------|---------------------------------------|------|--|---|
| | | Acres | % | Acres | % | | |
| Mosquito Control | I | 802,507 | 42.6 | 220,656 | 11.7 | 3,4 | 3M 4M |
| Developed | I | 25,051 | 1.33 | 1,252 | 0.07 | 3,4 | 3M 4M |
| Corn | I | 36,574 | 1.94 | 1,120 | 0.06 | 3,4 | 3H 4H |
| Other Grains | I | 14,401 | 0.76 | 13,824 | 0.73 | 3,4 | 3H 4H |
| Cotton | I | 10,019 | 0.53 | 8041 | 0.43 | 3,4 | 3H 4H |
| Vegetables and Groundfruit | I | 6,446 | 0.34 | 2,431 | 0.13 | 3,4 | 3H 4H |
| Orchards and Vineyards | I | 3,087 | 0.16 | 2,428 | 0.13 | 3,4 | 3H 4H 5 H |
| Wheat | I | 863 | 0.046 | 601 | 0.03 | 3,4 | 3H 4H |
| Other Row Crops | I | 52,839 | 2.81 | 7,024 | 0.37 | 3,4 | 3H 4H |

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 to Host Fish associated with bin (H, M, L) |
|---|------------------------------|------------------------|----------|---------------------------------------|---------|--|---|
| | | Acres | % | Acres | % | | |
| Nurseries | I | 839 | 0.04 | 838 | 0.04 | 3,4 | 3H 4H |
| Pasture | I | 1 | 0.00005 | 0 | 0.00005 | 3,4 | 3H 4H |
| Pine Seed Orchards | I | 12,228 | 0.65 | 12,229 | 0.65 | 3,4 | 3H 4H |
| Other Crops | I | 30,501 | 1.62 | 0 | 0 | 3,4 | 3H 4H |
| Rice | I | 0.037 | 0.000002 | 0 | 0 | 3,4 | 3H 4H |
| Sub-TOTAL (I): <i>Other uses with indirect effects³</i> | | 192,849 | 10.2 | 49,788 | 2.64 | | |
| TOTAL ³ : | | 995,356 | 52.8 | 270,444 | 14.3 | | |

Exposure Modifiers:

A reassessment of our crop use data layers shows that within the “Other Row Crops” layer usage in this category may be overestimated. This UDL is composed of sunflower, peanuts, tobacco, sugar beets, and hops, of which, only hops is a registered use site on malathion labels and is thus the only crop in this layer that is relevant in our analysis. USDA data shows that 96% of hops are grown in the Pacific Northwest region (in Idaho, Oregon, and Washington), with some small farms in Florida (Gadsden County) reporting occasional hop production. Given the highly specific regions that hops are grown in, we can assume that potential exposure to malathion from “other row crops” use sites is 0 outside of these areas. The range of the Suwannee moccasinshell is within Florida however it is outside of the range of the hop production in Florida (Gadsden County), and thus is not relevant to this species.

³ TOTAL includes usage on all use sites with effects, including mosquito control.

acres in species range: 1,886,373 acres

% of range in California (i.e., where CalPUR data is available): 0%

Range overlap with Federal lands: 5,201.8 acres, 0.276%

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 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 significantly reduce exposure to aquatic organisms and subsequent risk of direct and indirect effects. Changes to the general labels (e.g. reduction in number of applications allowed per year, timing restrictions, habitat buffers, etc.) would further reduce potential impacts to the Georgia pigtoe and reduce take of the species.

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 groundfruit lower the maximum allowable number of applications to 2-4 per year (depending on the specific crop). 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 Suwannee moccasinshell. As discussed below, even though the species vulnerability is high, we anticipate the risk and likelihood of exposure of the species and its host fish to malathion is low. The implementation of the general conservation measures described above is expected to further reduce the likelihood of exposure for certain uses.

The Suwannee moccasinshell has a high vulnerability based on its status, distribution, and trends. However, mortality and sublethal effects to the species are not anticipated if individuals are exposed to malathion, as described above in the *Risk* section for this species. Mussels depend on host fish which are more sensitive to malathion, to accomplish their reproductive lifecycle. Glochidia (larval stage) are released into the water and within a few days they must attach to an appropriate species of fish, which they parasitize for a short time while they develop into juvenile mussels. Glochidia that do not attach to a host fish will not survive. Where sufficient numbers of suitable host fish are not available, we anticipate reproduction of mussels would be reduced. The risk to the species host fish posed by labeled uses across the range was initially estimated to be high, and where individual host fish are exposed, we had generally anticipated high levels of mortality in our draft Opinion, depending on water body size and use type. The Suwannee moccasinshell prefers a variety of habitats, including larger and faster moving streams represented by Bins 3 and 4. Our initial estimates of risk were based on using conservative EECs for small flowing water bodies (bin 2) in the absence of reliable EECs for bin 3 and bin 4 habitats, where this species and its host fish reside. However, since our draft Opinion in February 2021, we coordinated with EPA on our assumptions; we now believe we previously overestimated likely exposure for Bins 3 and 4 (by approximately an order of magnitude). Thus, we now anticipate the risk to this species and its host fish to be substantially reduced due to dilution in bin 3 and 4 habitats, and we estimate the risk to be low for the species and its host fish.

We anticipate usage within the non-Federal portion of the species' range will be high (14.3%), based primarily on the usage data we acquired, as described in the Opinion and summarized for this species above. Most of the usage is attributed to mosquito adulticide use (11.7%), with lower usage from the remaining uses combined (2.64%). 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. While we anticipate high usage of mosquito adulticide, we anticipate the risk to the species and their host fish is low where exposure occurs due to the types of habitats (medium and larger streams) in which they occur. Moreover, we do not anticipate that host fish would necessarily be found in the affected areas of the waterbodies near application sites when

malathion is applied, although small numbers of host fish may occur in these areas and be exposed over the duration of the proposed action. Food resources for the species may be temporarily reduced near malathion applications, with reductions in plankton anticipated to occur with exposure to malathion; however, we anticipate additional food resources from upstream sources would quickly recolonize after an application event. However, we anticipate that the conservation measures above, including rain restrictions, aquatic habitat buffers, residential use label changes, and reduced number of applications and rates on certain use sites, will further reduce the risk of exposure to the mussels' host fish and food resources.

As stated previously, conservation measures are aimed at reducing the amount of malathion runoff and spray drift that enter into sensitive habitats (e.g., species habitat, aquatic environments). For example, by placing a 48-hour rain restriction on agricultural applications, malathion has the ability to degrade after application (e.g., by hydrolysis, other processes) prior to any rain/runoff events, thus minimizing malathion runoff into aquatic habitats and decreasing exposure to listed mussels and their host fish. Increasing application buffers reduces the amount of malathion that drifts off target and subsequently into non-target environments. In addition, changes to residential labels limits applications to spot treatments and reduces the number of applications per year (2-4), significantly decreasing the overall amounts of malathion used in residential areas and resulting amounts of runoff and drift. Additional reductions in the number of applications and rates allowed for certain crops (e.g., corn, vegetables and ground fruit) further reduces the amount of malathion used in agricultural settings, thereby decreasing potential exposure to the species and their host fish. Combined, these conservation measures substantially reduce exposure to the Suwannee moccasinshell and their host fish and therefore minimizes overall risk and adverse effects to the species.

We anticipate only small numbers of host fish and food resources may be exposed over the duration of the proposed action, and where exposure occurs, the risk of mortality and sublethal effects to the species host fish is low. In addition, we anticipate that the conservation measures above, including rain restrictions, aquatic habitat buffers, residential use label changes, and reduced number of applications and rates on certain use sites, will further reduce the risk of exposure to plankton and the mussels' host fish. Thus, while we anticipate small numbers of individual host fish would be lost over the duration of the action, resulting in very small reductions in reproductive success, we do not anticipate species-level effects to this mussel species.

Therefore, we anticipate that the proposed action would not appreciably reduce survival and recovery of the Suwannee moccasinshell in the wild.

Conclusion: Is not likely to jeopardize.

Integration and Synthesis Summary: Bivalves

| Scientific Name: | Common Name: | Entity ID: |
|---------------------------|---------------------|-------------------|
| <i>Truncilla macrodon</i> | Texas fawnsfoot | 9967 |

Family: Unionidae

VULNERABILITY

(Summary of status, environmental baseline and cumulative effects)

Status: Proposed Threatened

Distribution: Species/Populations neither constrained nor widespread

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:

From 86 FR 47916-48011: Texas fawnsfoot occurs in the lower reaches of the Colorado and Brazos Rivers, and in the Trinity River (Randklev et al. 2017b, p. 4) in seven populations: East Fork Trinity River, Middle Trinity River, Clear Fork Brazos River, Upper Brazos River, Middle/Lower Brazos River, San Saba/Colorado Rivers, and Lower Colorado River. Texas fawnsfoot was historically distributed throughout the Colorado and Brazos River basins (Howells 2014; and reviewed in Randklev et al. 2017c) and in the Trinity River basin (Randklev et al. 2017b). Texas fawnsfoot historically occurred in, but is now absent from, the Leon River (Popejoy et al. 2016). Randklev et al. (2017c) surveyed the Llano, San Saba, and Pedernales Rivers and found neither live individuals nor dead shells of Texas fawnsfoot. Isolated individuals not considered part of functioning populations have been found in the Little River.

FWS (2015) page 8-9... "The decline of mussels in Texas and across the United States is primarily the result of habitat loss and degradation (Neves 1991, pp. 252, 265; Howells et al. 1996, pp. 21–22). Chief among the causes of mussel decline in Texas are the effects of impoundments, sedimentation, dewatering, sand and gravel mining, and chemical contaminants (Neck 1982a, pp. 33–35; Howells et al. 1996, pp. 21–22; Winemiller et al. pp. 17–18)."

FWS (2015) page 17-19 ... "In addition to ammonia, agricultural sources of chemical contaminants include two broad categories that have the potential to adversely affect mussel species: Nutrients and pesticides. High amounts of nutrients, such as nitrogen and phosphorus, in streams can stimulate excessive plant growth (algae and periphyton, among others), which in turn can reduce dissolved oxygen levels when dead plant material decomposes. Nutrient over-enrichment in streams is primarily a result of runoff of fertilizer and animal manure from livestock farms, feedlots, and heavily fertilized row crops (Peterjohn and Correll 1984, p. 1471). Over-enriched conditions are exacerbated by low-flow stream conditions, such as those experienced during typical summer season flows. Bauer (1988, p.244) found that excessive

nitrogen concentrations can be detrimental to the adult freshwater pearl mussel (*Margaritifera margaritifera*), as was evident by the positive linear relationship between mortality and nitrate concentrations.

FWS (2011) page 62182... “Pesticides are another source of contaminants in streams. Elevated concentrations of pesticides frequently occur in streams due to pesticide runoff, overspray application to row crops, and lack of adequate riparian buffers. The timing of agricultural pesticide applications in the spring often coincides with the reproductive and early life stages of mussels, which may increase the vulnerability of mussels to pesticides (Bringolf et al. 2007a, p. 2094). Little is known regarding the effect of currently used pesticides to freshwater mussels even though some pesticides, such as glyphosate (active ingredient in Roundup®), are used globally. Recent studies tested the toxicity of glyphosate, its formulations, and a surfactant (MON 0810) used in several glyphosate formulations, to early life stages of the fatmucket (*Lampsilis siliquoidea*) (Bringolf et al. 2007a, p. 2094), a freshwater mussel closely related to the Texas fatmucket. Studies conducted with fatmucket juveniles and glochidia determined that the surfactant was the most toxic of the compounds tested and that fatmucket glochidia were the most sensitive organisms tested to date (Bringolf et al. 2007a, p. 2094). Roundup®, technical grade glyphosate isopropylamine salt, and isopropylamine were also acutely toxic to juveniles and glochidia (Bringolf et al. 2007a, p. 2097). These commonly applied pesticides may be adversely affecting Texas fatmucket populations. The effects of other widely used pesticides, including atrazine, chlorpyrifos, and permethrin, on glochidia and juvenile life stages have also recently been studied (Bringolf et al. 2007b, p. 2101). Environmentally relevant concentrations (concentrations that may be found in streams) of permethrin and chlorpyrifos were found to be toxic to glochidia and juvenile fatmucket (Bringolf et al. 2007b, pp. 2104–2106). Commonly applied pesticides are a threat to mussels as a result of their widespread use. All of these pesticides are commonly used on agricultural lands throughout the range of the Texas fatmucket, which may be adversely affecting the species.”

EB/CE Source:

US. Fish and Wildlife Service. 2021. Endangered and Threatened Wildlife and Plants; Endangered Species Status With Critical Habitat for Guadalupe Fatmucket, Texas Fatmucket, Guadalupe Orb, Texas Pimpleback, and False Spike, and Threatened Species Status With Section 4(d) Rule and Critical Habitat for Texas Fawnsfoot. Proposed Rule. Federal Register. 86(163): 47916-48011.

U.S. Fish and Wildlife Service (FWS). 2015. U.S. Fish and Wildlife Service Species Assessment and Listing Priority Assignment Form: Texas Fawnsfoot (*Truncilla macrodon*). Texas Coastal Ecological Services Field Office. Houston, Texas. 50 pp.

U.S. Fish and Wildlife Service (FWS). 2011. Endangered and Threatened Wildlife and Plants; 12-Month Finding on a Petition To List Texas Fatmucket, Golden Orb, Smooth Pimpleback, Texas Pimpleback, and Texas Fawnsfoot as Threatened or Endangered; Proposed Rule. Federal Register. 76(194): 62165-62212.

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 expect the Texas fawnsfoot will experience direct mortality or sublethal effects from any malathion uses at the maximum rates for all bins (2, 3, 4, 5, 6, 7). However, risk of mortality to the host fish for bins 2 and 5 is high for all use sites except developed where it is medium. Risk of mortality to individuals in bins 3 and 4 is moderate for all uses. Risk of mortality to individuals in bins 6 and 7 is moderate for all uses except for developed which is low.

We do not expect mussel species to be directly impacted by exposure from malathion. However their lifecycle is such that when glochidia (larval stage) are released into the water, within a few days, they must attach to an appropriate species of fish, which they parasitize for a short time while they develop into juvenile mussels in order to complete their lifecycle; they cannot complete their lifecycle without a fish host.

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.M

| | |
|--|---|
| DIRECT (all uses except mosquito control) | |
| Use areas – mortality | No effects expected |
| Sublethal – growth (G), reproduction (R) and behavior (B) enzyme (E) | No effects expected |
| INDIRECT (all uses except mosquito control) | |
| Use areas - Prey item mortality | If plankton: H for all bins except Bin5 developed, L If detritus: NA |
| Use areas – Fish Host | Total overlap: 31.1 %, H, for most uses except Bins 6 and 7 most uses are M. Bins 2,3,4, 5 are M for developed and L in Bins 6 and 7 |
| MOSQUITO CONTROL | |
| Direct (mortality) | No effects expected |
| Sublethal | No effects expected |
| Indirect | Total overlap: 15.7 %, H for bins 2 and 5, M for Bins 3,4,6 and 7 |

Overlap with species range (Total uses without mosquito control/mosquito control):

15.4%/31.1%

Risk modifiers:

Species occurs in Bins 2, 3, 4, 5, 6 and 7. See Risk Assumptions (above) for risk to individuals and species.

Species host (specialist) occurs in Bins 2, 3, 4, 5, 6 and 7. See Risk Assumptions (above) for risk to host species. Mussels depend on a host fish to accomplish their reproductive lifecycle. Glochidia that do not attach to a host fish will not survive. Where sufficient numbers of suitable host fish are not available, we anticipate reproduction of mussels would be reduced. Mussels can be categorized into different categories that reflect the type of mussel-host relationships, including host fish generalists, host fish specialists, and those for which the host fish are unknown. There is no specific information on age, size of maturity, or host fish use for Texas fawnsfoot. However, other species in the genus *Truncilla* parasitize freshwater drum (*Aplodinotus grunniens*) (Barnhart et al. 2008, p. 373 and Howells, 2014 p. 111, both as cited in the 2015 Species Status Assessment), and it is likely the Texas fawnsfoot does as well. Therefore we anticipate the risk to the Texas fawnsfoot will be greater due to the fact that there is no specific information on age, size of maturity, or host fish use for Texas fawnsfoot. This suggests that the Texas fawnsfoot may be less resilient to possible changes in the fish host community and make it more susceptible to indirect effects of malathion. Thus, the risk is determined to be higher for the Texas fawnsfoot.

In the “Approach to the Effects Analysis” section of the main body of the Opinion, we stated that specific considerations were made 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. Further investigation by EPA into Bin 3 and 4 estimated environmental concentrations indicate 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 to Host Fish associated with bin (H, M, L) |
|--|------------------------------|------------------------|-------|---------------------------------------|-------|--|---|
| | | Acres | % | Acres | % | | |
| Mosquito Control | I | 3,057,770 | 15.7 | 391,533 | 2.01 | 2,3,4,5,6,7 | H:2,5 M:3,4,6,7 |
| Developed | I | 670,473 | 3.45 | 33,524 | 0.172 | 2,3,4,5,6,7 | L |
| Open Space Developed | I | 1,008,037 | 5.18 | 50,402 | 0.26 | 2,3,4,5,6,7 | L |
| Corn | I | 49,583 | 0.25 | 4,101 | 0.02 | 2,3,4,5,6,7 | H:2,3,4,5 M:6,7 |
| Wheat | I | 389,144 | 2.41 | 506,320 | 2.60 | 2,3,4,5,6,7 | H:2,5 M:3,4,6,7 |
| Pasture | I | 267 | 0.003 | 267 | 0.003 | 2,3,4,5,6,7 | H:2,3,4,5 M:6,7 |
| Vegetables & Ground Fruit | I | 402 | 0.003 | 402 | 0.003 | 2,3,4,5,6,7 | H: 2,3,4,5,6 M:7 |
| Other Row Crops | I | 3890 | 0.02 | 1596 | 0.008 | 2,3,4,5,6,7 | H: 2,3,4,5,6 M:7 |
| Other Grains | I | 363,940 | 1.87 | 78,854 | 0.41 | 2,3,4,5,6,7 | H: 2,3,4,5,6 M:7 |
| Other Crops | I | 205,813 | 1.06 | 0 | 0 | 2,3,4,5,6,7 | H: 2,3,4,5,6 M:7 |
| Nurseries | I | 3886 | 0.020 | 3,886 | 0.020 | 2,3,4,5,6,7 | H: 2,3,4,5,6 M:7 |
| Orchards & Vineyards | I | 10,481 | 0.05 | 9,558 | 0.049 | 2,3,4,5,6,7 | H, 2,3,4,5,6 M: 7 |
| Cotton | I | 202,112 | 1.04 | 144,863 | 0.74 | 2,3,4,5,6,7 | H: 2,3,4,5,6,7 |
| Rice | I | 9,671 | 0.09 | 4,104 | 0.02 | 2,3,4,5,6,7 | H: |
| Sub-TOTAL (I): <i>Other uses with indirect effects³</i> | | 2,914,307 | 15.4 | 837,877 | 4.31 | | |
| TOTAL³: | | 5,972,077 | 31.1 | 1,229,410 | 6.32 | | |

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

^We consider the Bin 2 estimates as an upper bound of Bin 3 & 4 exposures. The estimated environmental concentrations for a Bin 2 water are an order of magnitude greater than Bins 3 and 4; therefore concentrations in Bins 3 and 4 can be reduced by a correction factor of 10.

Exposure Modifiers:

A reassessment of crop UDL showed that usage data in the “Other Row Crops” may be overestimated. This UDL is composed of sunflower, peanuts, tobacco, sugar beets, and hops, of which, only hops is a registered use site on malathion labels and is thus the only crop in this layer that is relevant in our analysis. USDA data shows that 96% of hops are grown in the Pacific Northwest region (Idaho, Oregon, and Washington), with some small farms in Florida reporting occasional hop production. Given the highly specific regions that hops are grown in, we can assume that the potential exposure to malathion from “other row crops” use sites is 0 outside the areas indicated above, and thus is not relevant to this species.

acres in species range: 19,450,900 acres

% of range in California (i.e., where CalPUR data is available): 0%

Range overlap with Federal lands: 121,166 acres, 0.62%

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 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 significantly 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 significantly 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 initial residues to degrade prior to the next application. In addition, exposure to aquatic organisms is reduced due to buffers from waterways 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 groundfruit lower the maximum allowable number of applications to 2-4 per year (depending on the specific crop). 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.

Species specific measures: In addition to the general label changes that would apply to all uses specified on the label, which would be protective of a wide range of species, the registrants have also agreed to additional conservation measures, such as additional application buffers. The following species-specific measures are now part of the Action and will be included in BulletinsLive! Two:

The following has been specified for the Texas fawnsfoot for agricultural uses within its range:

Do not apply aerially within 100ft (or 50ft if a full swath displacement is used) of low flow habitats (as defined with input from FWS Field Office staff) for grain, wheat, and cotton applications.

The following has been specified for mosquito control use of malathion within the Texas fawnsfoot range:

Where feasible, avoid application. If avoidance is not feasible or impairs the ability of the mosquito control district or agency to protect the public's health and welfare, coordinate with the local FWS Ecological Services field office to determine appropriate measures to minimize exposure and to ensure the proposed application is likely to have no more than minor effects on the species (FWS points of contact and maps of designated critical habitat are available through the Information, Planning, and Consultation (IPaC) website <https://ecos.fws.gov/ipac/>). The applicator must retain documentation of the technical assistance and the agreed upon species-specific measures that were implemented.

Application buffers are designed to reduce spray drift from entering sensitive non-target areas, thereby providing protection to species. While the exact amount of spray drift reduction will vary depending on traits of the ecosystem (e.g. flow rate, volume, etc.) as well as the application method, based on AgDRIFT modeling we can expect spray drift reductions ranging from 82 to 90%.

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 Texas fawnsfoot. As discussed below, even though the species vulnerability is medium and risk to the species host fish is high, we anticipate the likelihood of exposure of host fish to malathion is low, and the implementation of the general and species specific conservation measures described above is expected to further reduce the likelihood of exposure. In addition, although mosquito adulticide was identified as a significant driver in our February 2021 draft biological opinion, our subsequent rerun of the usage overlap with the species' refined range indicated this usage is greatly reduced. Thus, for this species, based upon a refinement of the range and mosquito adulticide usage information, we anticipate that mosquito adulticide is a minor driver for malathion effects. Coupled with the mosquito control use restriction described above, we anticipate no more than minor effects to host fish from this use.

The Texas fawnsfoot has a medium vulnerability based on its status, distribution, and trends. Mortality and sublethal effects to the species are not anticipated. The risk to the species host fish posed by labeled uses across the range is high, and where individual host fish are exposed, we anticipate medium to high levels of mortality. Mussels depend on host fish to accomplish their reproductive lifecycle. Glochidia (larval stage) are released into the water and within a few days they must attach to an appropriate species of fish, which they parasitize for a short time while they develop into juvenile mussels. Glochidia that do not attach to a host fish will not survive.

We anticipate usage within the non-Federal portion of the species' range will be medium (6.32%), based primarily on the 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 Biological Opinion. Where sufficient numbers of suitable host fish are not available, we anticipate reproduction of mussels would be reduced.

The species range, and thus this species host fish range, is very large (>19.5 million acres) and we do not anticipate that host fish would necessarily be found in the affected areas of the waterbodies near application sites when malathion is applied, although small numbers of host fish may occur in these areas and be exposed over the duration of the proposed action. Reductions in plankton could be high in localized areas, however, we anticipate additional food resources from upstream sources would quickly recolonize after an application event. In addition, we anticipate that the conservation measures above, including rain restrictions, aquatic habitat buffers, residential use label changes, and reduced number of applications and rates on certain use sites, will further reduce the risk of exposure to plankton and the mussels' host fish.

As stated previously, conservation measures are aimed at reducing the amount of malathion runoff and spray drift that enter into sensitive habitats (e.g., species habitat, aquatic environments). For example, by placing a 48-hour rain restriction on agricultural applications, malathion has the ability to degrade after application (e.g., by hydrolysis, other processes) prior

to any rain/runoff events, thus minimizing malathion runoff into aquatic habitats and decreasing exposure to listed mussels and their host fish. Increasing application buffers reduces the amount of malathion that drifts off target and subsequently into non-target environments. In addition, changes to residential labels limits applications to spot treatments and reduces the number of applications per year (2-4), significantly decreasing the overall amounts of malathion used in residential areas and resulting amounts of runoff and drift. Additional reductions in the number of applications and rates allowed for certain crops (e.g., corn, vegetables and ground fruit) further reduces the amount of malathion used in agricultural settings, thereby decreasing potential exposure to the species and their host fish. Species specific measures for agricultural uses (application buffer on low-flow habitats) and mosquito adulticide applications (avoid applications within low flow areas; or implement other minimization measures with collaboration with FWS) will further reduce malathion exposure to this species and their host fish.

The main use driver for this species is mosquito control, although, as noted above, the usage is now lower than estimated in our draft Opinion, based on our rerun of the overlap. Furthermore, a conservation measure will be implemented that restricts this use within the range of the mussel. More specifically, use will be prohibited within the low flow areas where malathion concentrations are expected to be highest. If applications are needed to control mosquitos in these areas, such as due to a public health threat, the applicator must contact the local FWS field office to determine alternative measures to minimize exposure and to ensure the proposed application is likely to have no more than minor effects on the species. Discussions at the local level may allow for greater flexibility and less restrictive measures based on site- or species-specific considerations, such as specific timing, species life history, and geographic or habitat factors. Coordination with FWS on measures to minimize exposure to listed species, including avoidance, is a recognized practice by mosquito control professionals. In its 2021 Best Practices for Integrated Mosquito Management, the American Mosquito Control Association (AMCA) instructs applicators with listed species in their treatment area to coordinate with FWS prior to application and maintain records of interactions. Discussions with the AMCA and anecdotal reports from FWS field offices indicate that this type of coordination is presently occurring to varying degrees for mosquito control applications in general. Applicators subject to this conservation measure will be required to maintain records of their interactions with FWS offices, allowing EPA to better track this coordination and its outcomes moving forward.

Combined, these conservation measures substantially reduce exposure to the Texas fawnsfoot and their host fish and therefore minimizes overall risk and adverse effects to the species. Thus, while we anticipate small numbers of individual host fish would be lost over the duration of the action, resulting in very small reductions in reproductive success, we do not anticipate species-level effects to this mussel species.

Therefore, we anticipate that the proposed action would not appreciably reduce survival and recovery of the Texas fawnsfoot in the wild.

Conclusion: Is not likely to jeopardize.

Integration and Synthesis Summary: Bivalves

| Scientific Name: | Common Name: | Entity ID: |
|-------------------------|------------------|------------|
| <i>Quadrula petrina</i> | Texas pimpleback | 9968 |

Family: Unionidae

VULNERABILITY

(Summary of status, environmental baseline and cumulative effects)

Status: Proposed endangered

Distribution: Species/Populations neither constrained nor widespread

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:

Texas pimpleback occurs in the Colorado River basin in five isolated populations: Concho River, Upper San Saba River, Lower San Saba River/ Colorado River, Llano River, and the Lower Colorado River. Only the Lower San Saba and Llano River populations are known to be successfully reproducing. Texas pimpleback was historically distributed throughout the Colorado River basin (Howells 2014; reviewed in Randklev et al. 2017).

The primary risk factors (i.e., threats) affecting the status of the Central Texas mussels are: (1) Increased fine sediment, (2) changes in water quality, (3) altered hydrology in the form of inundation, (4) altered hydrology in the form of loss of flow and scour of substrate, (5) predation and collection, and (6) barriers to fish movement. These factors are all exacerbated by the ongoing and expected effects of climate change.

The decline of mussels in Texas and across the United States is primarily the result of habitat loss and degradation (Neves 1991, pp. 252, 265; Howells et al. 1996, pp. 21–22). Chief among the causes of mussel decline in Texas are the effects of impoundments, sedimentation, dewatering, sand and gravel mining, and chemical contaminants (Neck 1982a, pp. 33–35; Howells et al. 1996, pp. 21–22; Winemiller et al. pp. 17–18)." FWS (2016) page 20-21 ..."In addition to ammonia, agricultural sources of chemical contaminants include two broad categories that have the potential to adversely affect mussel species: Nutrients and pesticides. High amounts of nutrients, such as nitrogen and phosphorus, in streams can stimulate excessive plant growth (algae and periphyton, among others), which in turn can reduce dissolved oxygen levels when dead plant material decomposes. Nutrient over-enrichment in streams is primarily a result of runoff of fertilizer and animal manure from livestock farms, feedlots, and heavily fertilized row crops (Peterjohn and Correll 1984, p. 1471). Over-enriched conditions are exacerbated by low-flow stream conditions, such as those experienced during typical summer season flows. Bauer (1988, p.244) found that excessive nitrogen concentrations can be detrimental to the adult

freshwater pearl mussel (*Margaritifera margaritifera*), as was evident by the positive linear relationship between mortality and nitrate concentrations. Also, a study of mussel life span and size (Bauer 1992, p. 425) showed a negative correlation between growth rate and high nutrient concentrations, and longevity was reduced as the concentration of nitrates increased. Juvenile mussels in interstitial habitats are particularly affected by depleted dissolved oxygen levels resulting from nutrient over-enrichment (Sparks and Strayer 1998, p. 133). The Texas pimple occurs within the Concho River watershed, which has been documented as having particularly high nitrates for nearly 20 years, likely due to intensive agriculture in the area (Texas Clean Rivers Program 2008, p. 2), which may be affecting the Texas pimpleback population."

EB/CE Source:

U.S. Fish and Wildlife Service (FWS). 2021. Endangered and Threatened Wildlife and Plants; Endangered Species Status With Critical Habitat for Guadalupe Fatmucket, Texas Fatmucket, Guadalupe Orb, Texas Pimpleback, and False Spike, and Threatened Species Status With Section 4(d) Rule and Critical Habitat for Texas Fawnsfoot. Federal Register. 86(163): 47916-48011.

U.S. Fish and Wildlife Service (FWS). 2016. U.S. Fish and Wildlife Service Species Assessment and Listing Priority Assignment Form: Texas Pimpleback (*Quadrula petrina*). Texas Coastal Ecological Services Field Office. Houston, Texas. 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 expect the Texas pimpleback will experience direct mortality or sublethal effects from any malathion uses at the maximum rates for all bins (2, 5, 6, 7). However, risk of mortality to the host fish for all bins is high for all use sites except bins 3 and 4 where it is medium.

We do not expect mussel species to be directly impacted by exposure from malathion. However their lifecycle is such that when glochidia (larval stage) are released into the water, within a few days, they must attach to an appropriate species of fish, which they parasitize for a short time while they develop into juvenile mussels in order to complete their lifecycle; they cannot complete their lifecycle without a fish host.

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.M

| DIRECT (all uses except mosquito control) | |
|---|---------------------|
| Use areas – mortality | No effects expected |

| | |
|--|--|
| Sublethal – growth (G), reproduction (R) and behavior (B) enzyme (E) | No effects expected |
| INDIRECT (all uses except mosquito control) | |
| Use areas - Prey item mortality | If plankton: H all uses If detritus: NA |
| Use areas – Fish Host | Total overlap: 16% H all uses except developed: M bins 2,3,4, L bins 5,6,7 |
| MOSQUITO CONTROL | |
| Direct (mortality) | No effects expected |
| Sublethal | No effects expected |
| Indirect | Total overlap: 11.2% |

Risk modifiers:

Species occurs in Bins 2, 5, 6 and 7. See Risk Assumptions (above) for risk to individuals and species.

Species host (generalist) occurs in Bins 2, 3, 4, 5, 6 and 7. See Risk Assumptions (above) for risk to host species.

Mussels depend on a host fish to accomplish their reproductive lifecycle. Glochidia that do not attach to a host fish will not survive. Where sufficient numbers of suitable host fish are not available, we anticipate reproduction of mussels would be reduced. Mussels can be categorized into different categories that reflect the type of mussel-host relationships, including host fish generalists, host fish specialists, and those for which the host fish are unknown. New research conducted by USGS and the Service on host fish use for central Texas candidate mussels revealed that Texas pimpleback use the channel catfish as a host fish (Johnson et al. 2014). Its specific reliance on catfish indicates the species may have limited ability to disperse considerable distances. This narrow fish host requirement suggests that the Texas pimpleback may be less resilient to possible changes in the fish host community and make it more susceptible to indirect effects of malathion. Thus, the risk is determined to remain high for the Texas pimpleback.

As described in section “Approach to the Effects Analysis” from 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 estimated environmental concentrations, thus overestimating potential exposure. Due to the potential issues inherent in the modeling for these bins, we instead relied on Bin 2 estimates as an upper bound for Bins 3 and 4 exposures. We acknowledge that the EEC estimates for the uses within the range of this species from a Bin 2 water are overestimates and we do not anticipate the Texas pimpleback would be exposed to the concentrations of malathion in a Bin 2 water modeled by EPA from the BE. Thus, we can conclude that the level of exposure to malathion for the Texas pimpleback will be low.

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 to Host Fish associated with bin (H, M, L) |
|---------------------------|------------------------------|------------------------|-------|---------------------------------------|-------|--|---|
| | | Acres | % | Acres | % | | |
| Mosquito Control | I | 964,479 | 11.2 | 83,630 | 0.97 | 2,3,4,5,6,7 | H:2,5 M: 6,7 L:3,4 |
| Developed | I | 59,831 | 0.69 | 2,992 | 0.035 | 2,3,4,5,6,7 | M:2,3,4 L: 5,6,7 |
| Open Space Developed | I | 364,842 | 4.23 | 18,242 | 0.21 | 2,3,4,5,6,7 | M:2,3,4 L: 5,6,7 |
| Corn | I | 73,867 | 0.8 | 4,101 | 0.048 | 2,3,4,5,6,7 | H:2,5,6 M:3,4,7 |
| Wheat | I | 388,581 | 4.50 | 398,540 | 4.62 | 2,3,4,5,6,7 | H:2,5,6 M:3,4 |
| Pasture | I | 267 | 0.003 | 267 | 0.003 | 2,3,4,5,6,7 | H:2,5,6 M:3,4,7 |
| Vegetables & Ground Fruit | I | 402 | 0.005 | 402 | 0.005 | 2,3,4,5,6,7 | H:2,5,6 M:3,4,7 |
| Other Grains | I | 144,509 | 1.33 | 78854 | 0.91 | 2,3,4,5,6,7 | H:2,5 M:3,4,6,7 |
| Other Crops | I | 109,378 | 1.27 | 0 | 0 | 2,3,4,5,6,7 | H:2,5,6 M:3,4,7 |
| Nurseries | I | 338 | 0.004 | 338 | 0.004 | 2,3,4,5,6,7 | H:2,5,6 M:3,4,7 |
| Orchards & Vineyards | I | 7,957 | 0.09 | 7,850 | 0.09 | 2,3,4,5,6,7 | H:2,5,6 M:3,4,7 |

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 to Host Fish associated with bin (H, M, L) |
|--|------------------------------|------------------------|-------|---------------------------------------|-------|--|---|
| | | Acres | % | Acres | % | | |
| Cotton | I | 240,708 | 2.79 | 149,771 | 1.73 | 2,3,4,5,6,7 | H:2,5,6 M:3,4,7 |
| Rice | I | 9,671 | 0.112 | 4,104 | 0.048 | 2,3,4,5,6,7 | |
| Sub-TOTAL (I): <i>Other uses with indirect effects</i> ³ | | 1,400,351 | 15.8 | 665,959 | 7.71 | | |
| TOTAL ³ : | | 2,364,830 | 27 | 749,589 | 8.68 | | |

Exposure Modifiers:

A reassessment of our crop use data layers shows that within the “Other Row Crops” layer usage in this category may be overestimated. This UDL is composed of sunflower, peanuts, tobacco, sugar beets, and hops, of which, only hops is a registered use site on malathion labels and is thus the only crop in this layer that is relevant in our analysis. USDA data shows that 96% of hops are grown in the Pacific Northwest region (in Idaho, Oregon, and Washington), with some small farms in Florida (Gadsden County) reporting occasional hop production. Given the highly specific regions that hops are grown in, we can assume that potential exposure to malathion from “other row crops” use sites is 0 outside of these areas, and thus is not relevant to this species.

acres in species range: 8,632,607 acres

% of range in California (i.e., where CalPUR data is available): 0%

Range overlap with Federal lands: 12,472 acres, 0.14%

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 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 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 significantly reduce exposure to aquatic organisms and subsequent risk of direct and indirect effects. Changes to the general labels (e.g. reduction in number of applications allowed per year, timing restrictions, habitat buffers, etc.) would further reduce potential impacts to the Georgia pigtoe and reduce take of the species.

Residential use label changes: New restrictions to the method and frequency of application for residential use of malathion are expected to significantly 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 initial residues to degrade prior to the next application. In addition, exposure to aquatic organisms is reduced due to buffers from waterways 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 groundfruit lower the maximum allowable number of applications to 2-4 per year (depending on the specific crop). 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.

Species specific measures: In addition to the general label changes that would apply to all uses specified on the label, which would be protective of a wide range of species, the registrants have also agreed to additional conservation measures, such as additional application buffers. The following species-specific measures are now part of the Action and will be included in *BulletinsLive! Two*:

For the Texas pimpleback, the following measure has also been specified:

Do not apply aerially within 100ft (or 50ft if a full swath displacement is used) of low flow habitats (as defined with input from FWS Field Office staff) for grain, wheat, and cotton applications.

Application buffers are designed to reduce spray drift from entering sensitive non-target areas, thereby providing protection to species. While the exact amount of spray drift reduction will vary

depending on traits of the ecosystem (e.g. flow rate, volume, etc.) as well as the application method, based on AgDRIFT modeling we can expect spray drift reductions ranging from 82 to 90%.

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 Texas pimpleback. As discussed below, even though the species vulnerability is high and risk to the species host fish is high, we anticipate the likelihood of exposure of host fish to malathion is low, and the implementation of the general conservation measures and the species-specific measure described above is expected to further reduce the likelihood of exposure.

The Texas pimpleback has a high vulnerability based on its status, distribution, and trends. Mortality and sublethal effects to the species are not anticipated. The risk to the species host fish posed by labeled uses across the range is high, and where individual host fish are exposed, we generally anticipate high levels of mortality, depending on water body size and use type. Mussels depend on host fish to accomplish their reproductive lifecycle. Glochidia (larval stage) are released into the water and within a few days they must attach to an appropriate species of fish, which they parasitize for a short time while they develop into juvenile mussels. Glochidia that do not attach to a host fish will not survive. Where sufficient numbers of suitable host fish are not available, we anticipate reproduction of mussels would be reduced.

We anticipate usage within the non-Federal portion of the species' range will be low (8.68%), based primarily on the 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 Biological Opinion.

The species range, and thus this species host fish range, is very large (>8.6 million acres) and we do not anticipate that host fish would necessarily be found in the affected areas of the waterbodies near application sites when malathion is applied, although small numbers of host fish may occur in these areas and be exposed over the duration of the proposed action. Reductions in plankton could be high in localized areas, however, we anticipate additional food resources from upstream sources would quickly recolonize after an application event. In addition, we anticipate that the conservation measures above, including rain restrictions, aquatic habitat buffers, residential use label changes, and reduced number of applications and rates on certain use sites, will further reduce the risk of exposure to the mussels' host fish.

As stated previously, conservation measures are aimed at reducing the amount of malathion runoff and spray drift that enter into sensitive habitats (e.g., species habitat, aquatic environments). For example, by placing a 48-hour rain restriction on agricultural applications, malathion has the ability to degrade after application (e.g., by hydrolysis, other processes) prior

to any rain/runoff events, thus minimizing malathion runoff into aquatic habitats and decreasing exposure to listed mussels and their host fish. Increasing application buffers reduces the amount of malathion that drifts off target and subsequently into non-target environments. In addition, changes to residential labels limits applications to spot treatments and reduces the number of applications per year (2-4), significantly decreasing the overall amounts of malathion used in residential areas and resulting amounts of runoff and drift. Additional reductions in the number of applications and rates allowed for certain crops (e.g., corn, vegetables and ground fruit) further reduces the amount of malathion used in agricultural settings, thereby decreasing potential exposure to the species and their host fish. Species-specific measures for agricultural uses (application buffer on low-flow habitats) will further reduce malathion exposure to this species and their host fish. Combined, these conservation measures substantially reduce exposure to the Texas pimpleback and their host fish and therefore minimizes overall risk and adverse effects to the species. Thus, while we anticipate small numbers of individual host fish would be lost over the duration of the action, resulting in very small reductions in reproductive success, we do not anticipate species-level effects to this mussel species.

Therefore, we anticipate that the proposed action would not appreciably reduce survival and recovery of the Texas pimpleback in the wild.

Conclusion: Is not likely to jeopardize.

Integration and Synthesis Summary: Bivalves

| Scientific Name: | Common Name: | Entity ID: |
|--------------------------|--------------------------|------------|
| <i>Amblema neislerii</i> | Fat three-ridge (mussel) | 375 |

Family: Unionidae

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:

FWS (2007) page 22... "The seven species are highly restricted in distribution, occur in generally small subpopulations, and show little evidence of recovering from historical habitat losses without significant positive human intervention. The species and their habitats continue to be impacted by excessive sediment, channel instability, gravel mining, reduced water quality, developmental activities, water withdrawal, impoundments, and invasive species. Their limited distributions and small populations render them vulnerable to random natural or human-induced events such as droughts or spills. The degree of threat to the persistence of the five endangered species remains high (and moderate for the two threatened species), and the potential for recovery for all seven species remains low.

While some progress has been made on achieving the recovery of these mussels, with the exception of range increases in the shinyrayed pocketbook, none of the subpopulation recovery criteria have been met for any of the seven species. Importantly, we do not yet understand how many subpopulations are necessary to ensure population viability, reduce isolation among populations, and increase the potential for genetic exchange. These data gaps were to be addressed in three specific recovery tasks; however, no progress has been made on these tasks. In addition, many of the listing/recovery criteria (threats) are not currently met. Water quality is not meeting designated use (CWA- Section 305(b)) and stream channels are not stable with intact riparian zones throughout the range of the seven species. Further, recent research indicates some numerical criteria for pollutants are not protective of early life stages of these mussels. Because all seven species continue to have reduced fragmented distribution and continued threats, the status of all seven species should remain unchanged."

EB/CE Source U.S. Fish and Wildlife Service (FWS). 2007. 5-Year Review: Fat Threeridge (*Amblema neislerii*), Shinyrayed Pocketbook (*Lampsilis subangulata*), Gulf Moccasinshell (*Medionidus penicillatus*), Ochlockonee Moccasinshell (*Medionidus simpsonianus*), Oval Pigtoe

(Pleurobema pyriforme), Chipola Slabshell (Elliptio chipolaensis), Purple Bankclimber (Elliptoideus sloatianus). Panama City Field Office. Panama City, Florida. 31 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 expect the fat three-ridge mussel will experience direct mortality or sublethal effects from any malathion uses at the maximum rates for all bins (2, 3, 4, 6, 7). However, risk of mortality to the host fish for bin 2 is high and medium for all other bins for mosquito control. For developed risk of mortality is medium in bins 2, 3,4, and low for bins 6 and 7. For corn, wheat and other row crops for all bins, risk is high. For the remaining uses, risk for mortality is high for bins 2,3,4, and 6 and medium for bin 7.

We do not expect mussel species to be directly impacted by exposure from malathion. However their lifecycle is such that when glochidia (larval stage) are released into the water, within a few days, they must attach to an appropriate species of fish, which they parasitize for a short time while they develop into juvenile mussels in order to complete their lifecycle; they cannot complete their lifecycle without a fish host.

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.

| | |
|--|---|
| DIRECT (all uses except mosquito control) | |
| Use areas – mortality | No effects expected |
| Sublethal – growth (G), reproduction (R) and behavior (B) enzyme (E) | No effects expected |
| INDIRECT (all uses except mosquito control) | |
| Use areas - Prey item mortality | If plankton: H all uses If detritus: NA |
| Use areas – Fish Host | H all uses for Bin 2. Bins 3,4,6,7 M toH for all uses except developed. For developed: M Bins 2,3,4 L Bins 5,6,7 |
| MOSQUITO CONTROL | |
| Direct (mortality) | No effects expected |
| Sublethal | No effects expected |
| Indirect | Total overlap: 69%, H Bin2, M for all other Bins |

Risk Modifiers: *Species occurs in Bins 2,3,4, 6 and 7. See Risk Assumptions (above) for risk to individuals and species.*

Species host (generalist) occurs in Bins 2, 3, 4, 6 and 7. See Risk Assumptions (above) for risk to host species.

Mussels depend on a host fish to accomplish their reproductive lifecycle. Glochidia that do not attach to a host fish will not survive. Where sufficient numbers of suitable host fish are not available, we anticipate reproduction of mussels would be reduced. The mussel glochidia fish host relationship can be categorized into several different categories that capture the breadth of the type of mussel-host relationships. We anticipate that mussel species that are generalists and can rely on a wide variety of fish host species upon which to attach, we anticipate would fare better than those mussel species that rely on specific fish species or those species where the fish host species is unknown. Therefore we anticipate the risk to the fat three-ridge mussel will be reduced due to the fact that it has been documented to rely on 23 species of fish, including common river species [e.g., bluegill (*Lepomis macrochirus*) and largemouth bass (*Micropterus salmoides*)] and therefore host fish abundance is not considered a limiting factor for the fat threeridge mussel, and the risk is considered to be low.

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 to Host Fish associated with bin (H, M, L) |
|------------------|------------------------------|------------------------|------|---------------------------------------|------|--|---|
| | | Acres | % | Acres | % | | |
| Mosquito Control | I | 3,669,221 | 68.9 | 415,100 | 7.8 | 2,3,4,6,7 | 2H 3,4,6,7M |
| Developed | I | 77,302 | 1.45 | 3,865 | 0.07 | 2,3,4,6,7 | 2,3,4 M 6,7 L |

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 to Host Fish associated with bin (H, M, L) |
|--|------------------------------|------------------------|--------------|---------------------------------------|--------------|--|---|
| | | Acres | % | Acres | % | | |
| Open Space Developed | I | 207,768 | 3.9 | 10,388 | 0.195 | 2,3,4,6,7 | 2,3,4 M 6,7 L |
| Corn | I | 108,273 | 2.03 | 1,558 | 0.03 | 2,3,4,6,7 | 2,3,4,6,7 H |
| Wheat | I | 21,741 | 0.41 | 2,008 | 0.04 | 2,3,4,6,7 | 2,3,4,6,7 H |
| Other Row Crops | I | 253,244 | 4.75 | 25,877 | 0.49 | 2,3,4,6,7 | 2,3,4,6,7 H |
| Pasture | I | 80 | 0.002 | 37 | 0.000 7 | 2,3,4,6,7 | 2,3,4,6,H 7M |
| Vegetables & Ground Fruit | I | 4,276 | 0.08 | 2,241 | 0.04 | 2,3,4,6,7 | 2,3,4,6,H 7M |
| Other Grains | I | 35,920 | 0.67 | 7,868 | 0.15 | 2,3,4,6,7 | 2,3,4,6,H 7M |
| Other Crops | I | 238,353 | 4.47 | 0 | 0 | 2,3,4,6,7 | 2,3,4 H 6,7M |
| Nurseries | I | 367 | 0.007 | 367 | 0.007 | 2,3,4,6,7 | 2,3,4,6,H 7M |
| Orchards & Vineyards | I | 146,675 | 2.75 | 6,514 | 0.122 | 2,3,4,6,7 | 2,3,4,6,H 7M |
| Cotton | I | 459,819 | 8.63 | 45,477 | 0.85 | 2,3,4,6,7 | 2,3,4,6,H 7M |
| Rice | I | 0.33 | 0.000 006 | 0 | 0 | 2,3,4,6,7 | |
| Pine seed orchards | I | 88,179 | 1.66 | 39,200 | 0.74 | 2,3,4,6,7 | 2,3,4,6,H 7M |
| Christmas trees | I | 0.19 | 0.000 035 | 0 | 0.000 035 | 2,3,4,6,7 | 2,3,4,6,H 7M |
| Sub-TOTAL (I): <i>Other uses with indirect effects</i> ³ | | 1,641,997. 5 | 30.8 | 145,400 | 2.7 | | |
| TOTAL ³ : | | 5,311,218. 52 | 99.7 | 560,500 | 10.5 | | |

³ TOTAL includes usage on all use sites with effects, including mosquito control.

Exposure Modifiers:

A reassessment of crop UDL showed that usage data in the “Other Row Crops” may be overestimated. This UDL is composed of sunflower, peanuts, tobacco, sugar beets, and hops, of which, only hops is a registered use site on malathion labels and is thus the only crop in this layer that is relevant in our analysis. USDA data shows that 96% of hops are grown in the Pacific Northwest region (Idaho, Oregon, and Washington), with some small farms in Florida reporting occasional hop production (Gadsden County). Given the highly specific regions that hops are grown in, we can assume that the potential exposure to malathion from “other row crops” use sites is 0 outside the areas indicated above. however the range of the fat threeridge is within Gadsden County (Florida) therefore we assume there is usage for other row crops (hops) within the range of the fat threeridge mussel.

acres in species range: 5,326,817 acres

% of range in California (i.e., where CalPUR data is available): 0%

Range overlap with Federal lands: 190,574 acres, 3.578%

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 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 significantly 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 significantly 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 initial residues to degrade prior to the next application. In addition, exposure to aquatic organisms is reduced due to buffers from waterways 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 groundfruit lower the maximum allowable number of applications to 2-4 per year (depending on the specific crop). 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.

Reduced citrus application rate: The reduction in the maximum application rate for citrus (outside of California) is expected to reduce potential environmental concentrations to one-third of modeled values, reducing the effects to species, prey, host fish, and pollinators on and adjacent to these use areas.

The following has been specified for mosquito control measures within the range of the fat three-ridge mussel:

Where feasible, avoid application. If avoidance is not feasible or impairs the ability of the mosquito control district or agency to protect the public's health and welfare, coordinate with the local FWS Ecological Services field office to determine appropriate measures to ensure the proposed application is likely to have no more than minor effects on the species (FWS points of contact and maps of designated critical habitat are available through the Information, Planning, and Consultation (IPaC) website <https://ecos.fws.gov/ipac/>). The applicator must retain documentation of the technical assistance and the agreed upon species-specific measures that were implemented.

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 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 fat threeridge (mussel). As discussed below, even though the species vulnerability is high and risk to the species host fish is low for this species, we anticipate the likelihood of host fish exposure to malathion is low and the fat threeridge is a host fish generalist. Implementation of the general conservation measures described above is also expected to further reduce the likelihood of exposure. Since our draft Opinion in February 2021, EPA provided additional information regarding EECs in aquatic Bins 3 and 4. The fat threeridge prefers a variety of habitats, including larger and faster moving streams represented by Bins 3, 4, 6 and 7 and we anticipate that exposure to malathion was likely previously overestimated for Bins 3 and 4. Thus, risk to this species’ host fish(es) is low, we anticipate the likelihood of

exposure to malathion is low, due to dilution in Bins 3 and 4, and further mitigated through the implementation of species-specific and the general conservation measures described above.

Although the fat threeridge's (mussel) vulnerability ranked high based on its status, distribution, and trends, recent surveys (Smit and Kaeser 2016) suggest robust and abundant populations in the Apalachicola and Chipola Rivers. Flint River (Georgia) and the Chipola River above Dead Lakes to river kilometer 36.5, support low abundance populations of the mussel. Mortality and sublethal effects to the species are not anticipated. The risk to the species host fish posed by labeled uses across the range is high, and where individual host fish are exposed, we generally anticipate high levels of mortality, depending on water body size and use type. Mussels depend on host fish to accomplish their reproductive lifecycle. Glochidia (larval stage) are released into the water, within a few days they must attach to an appropriate species of fish, which they parasitize for a short time while they develop into juvenile mussels. Glochidia that do not attach to a host fish will not survive. Where sufficient numbers of suitable host fish are not available, we anticipate reproduction of mussels would be reduced.

We anticipate usage within the non-Federal portion of the species' range will be high (10.52%), based primarily on the usage data we acquired, as described in 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 Biological Opinion.

According to the 2019 Recovery Plan Amendment, fat threeridge mussels are host-fish generalists (O'Brien and Williams 2002, Fritts and Bringolf 2014). Fritts and Bringolf (2014) reported transformation of fat threeridge on 23 species of fish, including common river species [e.g., bluegill (*Lepomis macrochirus*) and largemouth bass (*Micropterus salmoides*)]. Host fish abundance is not considered a limiting factor for fat threeridge.

Although usage within the species range (>5 million acres), and thus the species host fish range, is high, only portions of the range will be treated within a given year. Since fat threeridge's utilize a wide variety of host fish (23 species, including common river species), mortality to host fish within a given application area is not likely to affect the overall abundance of host fish within the species range. As stated previously, host fish abundance is not considered a limiting factor for this mussel. In addition, one of the mussels' food resources is plankton, which could be affected in localized areas after a malathion treatment; however, any reduction in plankton will be quickly replaced by additional food resources from upstream sources. In addition, we anticipate that the conservation measures above, including rain restrictions, aquatic habitat buffers, residential use label changes, and reduced number of applications and rates on certain use sites, will further reduce the risk of exposure to plankton and the mussels' host fish.

As stated previously, conservation measures are aimed at reducing the amount of malathion runoff and spray drift that enter into sensitive habitats (e.g., species habitat, aquatic environments). For example, by placing a 48-hour rain restriction on agricultural applications, malathion has the ability to degrade after application (e.g., by hydrolysis, other processes) prior to any rain/runoff events, thus minimizing malathion runoff into aquatic habitats and decreasing exposure to listed mussels and their host fish. Increasing application buffers reduces the amount of malathion that drifts off target and subsequently into non-target environments. In addition,

changes to residential labels limits applications to spot treatments and reduces the number of applications per year (2-4), significantly decreasing the overall amounts of malathion used in residential areas and resulting amounts of runoff and drift. Additional reductions in the number of applications and rates allowed for certain crops (e.g., corn, vegetables and ground fruit) further reduces the amount of malathion used in agricultural settings, thereby decreasing potential exposure to the species and their host fish.

The main use driver for this species is mosquito control. As a result, to reduce anticipated exposure and resultant mortality from mosquito uses, a conservation measure will be implemented that restricts this use within the range of the mussel. If applications are needed to control mosquitos in these areas, such as due to a public health threat, the applicator must contact the local FWS field office to determine alternative measures to minimize exposure and to ensure the proposed application is likely to have no more than minor effects on the species. Discussions at the local level may allow for greater flexibility and less restrictive measures based on site- or species-specific considerations, such as specific timing, species life history, and geographic or habitat factors. Coordination with FWS on measures to minimize exposure to listed species, including avoidance, is a recognized practice by mosquito control professionals. In its 2021 Best Practices for Integrated Mosquito Management, the American Mosquito Control Association (AMCA) instructs applicators with listed species in their treatment area to coordinate with FWS prior to application and maintain records of interactions. Discussions with the AMCA and anecdotal reports from FWS field offices indicate that this type of coordination is presently occurring to varying degrees for mosquito control applications in general. Applicators subject to this conservation measure will be required to maintain records of their interactions with FWS offices, allowing EPA to better track this coordination and its outcomes moving forward.

Combined, these conservation measures substantially reduce exposure to the fat threeridge (mussel) and its host fish and therefore minimizes overall risk and adverse effects to the species. Subsequently, based on the fat threeridge's ability to utilize a wide variety of host fish, incorporation of conservation measures to minimize impacts to plankton and host fish, we do not anticipate species-level effects.

Therefore, we do not anticipate that the proposed action would appreciably reduce survival and recovery of the fat threeridge (mussel) in the wild.

Conclusion: Is not likely to jeopardize.

ADDITIONAL REFERENCES

U.S. Fish and Wildlife Service. 2019. Recovery Plan Amendment for the Fat Threeridge (*Amblema neislerii*). South Atlantic-Gulf Region Regional Office. Atlanta, Georgia. 10 pp.

Subset 2: Summarized Analysis

The following section includes a summarized analysis of risk related to overlap and usage (without including information in the tables for these species I&S sections, as we did for Subset 1). All species in this subset are anticipated to have low usage (<5%). We are presenting the conclusions for the Subset 2 taxa in a streamlined, abbreviated manner for the Biological Opinion.

We considered the vulnerability of each species together with their status, environmental baseline and cumulative effects. We also briefly considered the overlap with the species range, and whether and to what the degree the species overlapped with Federal lands (where we anticipate only low levels of usage, as described in the Usage section of the Biological Opinion). Our assumptions related to anticipated risk to individuals from lethal, sublethal, and prey base effects were not described individually for each of the species in Subset 2, but are presented below by aquatic habitat bin category and general trends we observed during the analyses (see *Risk Assumptions* below). We then determined whether the proposed action is likely to jeopardize the continued existence of the listed entity in question¹.

Risk Assumptions:

We do not anticipate direct effects (mortality or sublethal effects) to the mussels themselves; however, we do anticipate effects to their host fish. In general, all mussels have medium or high vulnerabilities based on their status, distribution and trends.

The following mussels have high levels of vulnerability and risk, but usage and anticipated exposure is low. For this subset, we considered the relevant aquatic habitat bins for the species, then reviewed the use and usage data to confirm our assumptions about effects anticipated with combinations of bins. We found several general patterns that were applicable to the analysis and served as assumptions to inform our conclusions that were consistent with the overall approach considered in the Biological Opinion. These are related to Bin combinations, where the species may be found in:

- Small waterbodies (e.g., Bins 2, 5):
 - Indirect Effects: We generally see high levels of mortality effects to host fish for most or all uses, except for developed use sites, which is medium.

¹ For ease of organization, after listing the species within the usage category in the sections below, we provide our determination prior to describing the species-specific information (i.e., status, vulnerability, environmental baseline, cumulative effects, and overlap information).

- Larger flowing waterbodies (Bins 3, 4):
 - Indirect Effects: We generally see high levels of mortality effects to host fish for most or all uses, except for developed use sites, which is medium.
- Medium static waterbodies (Bin 6), with flowing waterbodies
 - Indirect Effects: We generally see medium to high levels of mortality effects to host fish for most or all uses, except for developed, which is low.
- Medium static waterbodies (Bin 6) without flowing waterbodies
 - Indirect Effects: We generally see medium to high levels of mortality effects to host fish for most or all uses, except for developed, which is low.
- Large static waterbodies (Bin 7):
 - Indirect Effects: We generally see low to high levels of mortality effects to host fish for most or all uses.

Remaining Species with ***Low Anticipated Usage*** (<5%):

This category includes the remaining mussel species considered in this Opinion, shown below in Table C-1. These species have variable levels of vulnerability but are not at risk to direct effects (mortality, sublethal). We considered all of the available use and usage data for these species and their host fish, and have determined that risk to host fish can be expected if exposed, but all of the following species and their host fish would be anticipated to have a low risk of exposure based on the usage data. The species, their assigned bins, and our conclusion are found in the table below, followed by a summary of risk and exposure modifiers, applicable conservation measures, our conclusion that applies for each of the species in this group, and individuals species-specific information shown for each species.

Table C-1. Species by taxonomic group and their assigned aquatic habitat bins. (NJ = Is not likely to jeopardize)

| Order | Family | Scientific Name | Common Name | Entity Id | Aquatic Bins | Aquatic Bins (Host Fish) | Conclusion |
|----------|-----------|---------------------------------------|---|-----------|--------------|--------------------------|------------|
| Unionida | Unionidae | <i>Villosa perpurpurea</i> | Purple bean | 318 | 4,6,7 | 2,3,6,7 | NJ |
| Unionida | Unionidae | <i>Epioblasma obliquata obliquata</i> | Purple Cat's paw (=Purple Cat's paw pearlymussel) | 323 | 2,7 | 2,3,4,7 | NJ |

| Order | Family | Scientific Name | Common Name | Entity Id | Aquatic Bins | Aquatic Bins (Host Fish) | Conclusion |
|----------|-----------|-------------------------------|---------------------------------------|-----------|--------------|--------------------------|------------|
| Unionida | Unionidae | <i>Lampsilis virescens</i> | Alabama lampmussel | 326 | 2,3,4,6,7 | 2,3,4,6,7 | NJ |
| Unionida | Unionidae | <i>Toxolasma cylindrellus</i> | Pale lilliput (pearlymussel) | 327 | 2,3,4,6,7 | 2,3,4,6,7 | NJ |
| Unionida | Unionidae | <i>Quadrula fragosa</i> | Winged Mapleleaf | 328 | 2,6,7 | 2,3,4,6,7 | NJ |
| Unionida | Unionidae | <i>Quadrula sparsa</i> | Appalachian monkeyface (pearlymussel) | 329 | 2 | 2 | NJ |
| Unionida | Unionidae | <i>Quadrula intermedia</i> | Cumberland monkeyface (pearlymussel) | 330 | 2,3 | 2,3,4 | NJ |
| Unionida | Unionidae | <i>Lampsilis abrupta</i> | Pink mucket (pearlymussel) | 331 | 2,4,5,6,7 | 2,3,4,5,6,7 | NJ |
| Unionida | Unionidae | <i>Dromus dromas</i> | Dromedary pearlymussel | 334 | 2,6,7 | 2,3,4,6,7 | NJ |
| Unionida | Unionidae | <i>Pegias fabula</i> | Littlewing pearlymussel | 335 | 2,6,7 | 2,3,4,6,7 | NJ |
| Unionida | Unionidae | <i>Fusconaia cuneolus</i> | Finerayed pigtoe | 337 | 2,6,7 | 2,3,4,6,7 | NJ |
| Unionida | Unionidae | <i>Pleurobema plenum</i> | Rough pigtoe | 338 | 3,4 | 3,4 | NJ |
| Unionida | Unionidae | <i>Fusconaia cor</i> | Shiny pigtoe | 339 | 2,4,6,7 | 2,3,4,6,7 | NJ |

Bivalves, Entity ID:

| Order | Family | Scientific Name | Common Name | Entity Id | Aquatic Bins | Aquatic Bins (Host Fish) | Conclusion |
|----------|-----------|--|-------------------------|-----------|--------------|--------------------------|------------|
| Unionida | Unionidae | <i>Obovaria retusa</i> | Ring pink (mussel) | 341 | 3,4 | 3,4 | NJ |
| Unionida | Unionidae | <i>Quadrula cylindrica strigillata</i> | Rough rabbitsfoot | 344 | 7 | 2,3,4,7 | NJ |
| Unionida | Unionidae | <i>Leptodea leptodon</i> | Scaleshell mussel | 345 | 2,3,4,5,6,7 | 2,3,4,5,6,7 | NJ |
| Unionida | Unionidae | <i>Epioblasma florentina walkeri</i> (=E. walkeri) | Tan riffleshell | 346 | 2,3,4,6,7 | 2,3,4,6,7 | NJ |
| Unionida | Unionidae | <i>Epioblasma brevidens</i> | Cumberlandian combshell | 353 | 2,6,7 | 2,3,4,6,7,9 | NJ |
| Unionida | Unionidae | <i>Alasmidonta raveneliana</i> | Appalachian elktoe | 354 | 2,3,4 | 2,3 | NJ |
| Unionida | Unionidae | <i>Potamilus inflatus</i> | Inflated heelsplitter | 356 | 2,3,4,5,6,7 | 2,3,4,5,6,7 | NJ |
| Unionida | Unionidae | <i>Lampsilis perovalis</i> | Orangenacre mucket | 357 | 4,6,7 | 2,3,4,6,7 | NJ |
| Unionida | Unionidae | <i>Epioblasma capsaeformis</i> | Oyster mussel | 358 | 6,7 | 2,3,4,6,7,9 | NJ |
| Unionida | Unionidae | <i>Pleurobema collina</i> | James spiny mussel | 361 | 6,7 | 2,3,4,6,7,8 | NJ |

| Order | Family | Scientific Name | Common Name | Entity Id | Aquatic Bins | Aquatic Bins (Host Fish) | Conclusion |
|----------|-----------|-------------------------------------|-----------------------------|-----------|--------------|--------------------------|------------|
| Unionida | Unionidae | <i>Margaritifera hembeli</i> | Louisiana pearlshell | 364 | 3,4,6,7 | 2,3,4,6,7 | NJ |
| Unionida | Unionidae | <i>Elliptoideus sloatianus</i> | Purple bankclimber (mussel) | 366 | 2,5,6,7 | 2,3,4,5,6,7,9,10 | NJ |
| Unionida | Unionidae | <i>Lampsilis powellii</i> | Arkansas fatmucket | 369 | 2,3,4,6,7 | 2,3,4,6,7 | NJ |
| Unionida | Unionidae | <i>Pleurobema pyriforme</i> | Oval pigtoe | 371 | 2,5 | 2,3,5 | NJ |
| Unionida | Unionidae | <i>Lampsilis altilis</i> | Finelined pocketbook | 372 | 6,7 | 2,3,4,6,7 | NJ |
| Unionida | Unionidae | <i>Epioblasma torulosa rangiana</i> | Northern riffleshell | 374 | 5,6 | 2,3,4,5,6,7,9 | NJ |
| Unionida | Unionidae | <i>Pleurobema gibberum</i> | Cumberland pigtoe | 376 | 2,3,4,6,7 | 2,3,4,6,7 | NJ |
| Unionida | Unionidae | <i>Pleurobema perovatum</i> | Ovate clubshell | 377 | 3 | 3 | NJ |
| Unionida | Unionidae | <i>Pleurobema decisum</i> | Southern clubshell | 378 | 2,7 | 2,3,4,7 | NJ |
| Unionida | Unionidae | <i>Medionidus acutissimus</i> | Alabama moccasinshell | 380 | 7 | 2,3,4,7 | NJ |
| Unionida | Unionidae | <i>Medionidus parvulus</i> | Coosa moccasinshell | 381 | 2,3,4 | 2,3,4 | NJ |

Bivalves, Entity ID:

| Order | Family | Scientific Name | Common Name | Entity Id | Aquatic Bins | Aquatic Bins (Host Fish) | Conclusion |
|----------|-----------|--------------------------------|-----------------------|-----------|--------------|--------------------------|------------|
| Unionida | Unionidae | <i>Pleurobema furvum</i> | Dark pigtoe | 382 | 4,7 | 2,3,4,7 | NJ |
| Unionida | Unionidae | <i>Pleurobema georgianum</i> | Southern pigtoe | 383 | 2,4,7 | 2,3,4,7 | NJ |
| Unionida | Unionidae | <i>Pleurobema strodeanum</i> | Fuzzy pigtoe | 1369 | 2,3,4,6,7 | 2,3,4,6,7 | NJ |
| Unionida | Unionidae | <i>Ptychobranhus subtentum</i> | Fluted kidneyshell | 1559 | 6,7 | 2,3,4,6,7,9 | NJ |
| Unionida | Unionidae | <i>Popenaias popeii</i> | Texas Hornshell | 2917 | 4,5,6,7 | 2,3,4,5,6,7,8,9,10 | NJ |
| Unionida | Unionidae | <i>Villosa choctawensis</i> | Choctaw bean | 4042 | 3,4 | 3,4 | NJ |
| Unionida | Unionidae | <i>Elliptio lanceolata</i> | Yellow lance | 4074 | 2,3 | 2,3 | NJ |
| Unionida | Unionidae | <i>Elliptio spinosa</i> | Altamaha Spiny mussel | 4210 | 4 | 4 | NJ |
| Unionida | Unionidae | <i>Epioblasma triquetra</i> | Snuffbox mussel | 5281 | 2,3,4,5,6,7 | 2,3,4,5,6,7 | NJ |
| Unionida | Unionidae | <i>Fusconaia mitchelli</i> | False spike | 5380 | 2,3 | 2,3,4 | NJ |
| Unionida | Unionidae | <i>Villosa fabalis</i> | Rayed Bean | 6062 | 4,6 | 2,3,4,6,7 | NJ |

Bivalves, Entity ID:

| Order | Family | Scientific Name | Common Name | Entity Id | Aquatic Bins | Aquatic Bins (Host Fish) | Conclusion |
|----------|-----------|---------------------------------|-----------------------|-----------|--------------|--------------------------|------------|
| Unionida | Unionidae | <i>Fusconaia burkei</i> | Tapered pigtoe | 6534 | 2,3,4,6,7 | 2,3,4,6,7 | NJ |
| Unionida | Unionidae | <i>Pleuronaia dolabelloides</i> | Slabside Pearlymussel | 6841 | 2,6,7 | 2,3,4,6,7 | NJ |
| Unionida | Unionidae | <i>Fusconaia masoni</i> | Atlantic pigtoe | 7048 | 2, 3,4 | 2,3,4,5,6,7 | NJ |
| Unionida | Unionidae | <i>Fusconaia escambia</i> | Narrow pigtoe | 7177 | 2,3,7 | 2,3,7 | NJ |
| Unionida | Unionidae | <i>Fusconaia rotulata</i> | Round Ebonyshell | 7363 | 3,4 | 3,4 | NJ |
| Unionida | Unionidae | <i>Plethobasus cyphus</i> | Sheepnose Mussel | 7816 | 2,3,5,6,7 | 2,3,4,5,6,7 | NJ |
| Unionida | Unionidae | <i>Ptychobranhus jonesi</i> | Southern kidneyshell | 7949 | 2,3,4 | 2,3,4 | NJ |
| Unionida | Unionidae | <i>Pleurobema athearni</i> | Canoe Creek clubshell | 9222 | 2,3 | 2,3 | NJ |
| Unionida | Unionidae | <i>Lampsilis bracteata</i> | Texas fatmucket | 10038 | 2,3,4,5,6,7 | 2,3,4,5,6,7 | NJ |
| Unionida | Unionidae | <i>Obovaria subrotunda</i> | Round hickorynut | 10837 | 2,3,4 | 2,3,4 | NJ |
| Unionida | Unionidae | <i>Fusconaia subrotunda</i> | Longsolid | 10838 | 2,3,4 | 2,3,4 | NJ |

| Order | Family | Scientific Name | Common Name | Entity Id | Aquatic Bins | Aquatic Bins (Host Fish) | Conclusion |
|----------|-----------|------------------------------------|---------------------|-----------|--------------|--------------------------|------------|
| Unionida | Unionidae | <i>Cyclonaias necki</i> | Guadalupe orb | 11577 | 2,3 | 2,3,4 | NJ |
| Unionida | Unionidae | <i>Lampsilis sp. cf. bracteata</i> | Guadalupe fatmucket | 11578 | 2,3 | 2,3,4 | NJ |

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 and 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 Bin 3 and 4 estimated environmental concentrations indicate 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.

Exposure Modifiers:

A reassessment of our crop use data layers shows that within the “Other Row Crops” layer shows that usage in this category may be overestimated. This UDL is composed of sunflower, peanuts, tobacco, sugar beets, and hops, of which, only hops is a registered use site on malathion labels and is thus the only crop in this layer that is relevant in our analysis. USDA data shows that 96% of hops are grown in the Pacific Northwest region (in Idaho, Oregon, and Washington), with some small farms in Florida reporting occasional hop production. Given the highly specific regions that hops are grown in, we can assume that potential exposure to malathion from “other row crops” use sites is 0 outside of these areas, and thus is not relevant to this species.

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

Bivalves, Entity ID:

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

Aquatic habitat buffers: Application buffers 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 significantly 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 significantly 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 initial residues to degrade prior to the next application. In addition, exposure to aquatic organisms is reduced due to buffers from waterways 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 groundfruit lower the maximum allowable number of applications to 2-4 per year (depending on the specific crop). 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 for the species shown above in Table 1, it is the Service’s biological opinion that the registration of malathion, as proposed, is not likely to jeopardize the continued existence of these species. As discussed below, even though these species generally have high vulnerabilities and risk (i.e., specifically, risk to their host fish), we anticipate the likelihood of exposure of each of these species’ host fish to malathion is low, and the implementation of the general conservation measures described above is expected to further reduce the likelihood of exposure for each of the species and their host fish.

While these species have varying levels of vulnerability and risk to individual host fish, and mortality of host fish is anticipated to be relatively high where exposure occurs, we anticipate low usage and, thus, low levels of exposure to host fish. Usage of malathion could reduce plankton; however, any reductions in plankton would likely replenish relatively quickly from upstream resources. In addition, we anticipate that the conservation measures above, including rain restrictions, aquatic habitat buffers, residential use label changes, and reduced application number and rates on certain use sites will minimize the risk of exposure to plankton and each of these mussels' host fish.

As stated previously, conservation measures are aimed at reducing the amount of malathion runoff and spray drift that enter into sensitive habitats (e.g., species habitat, aquatic environments). For example, by placing a 48-hour rain restriction on agricultural applications, malathion has the ability to degrade after application (e.g., by hydrolysis, other processes) prior to any rain/runoff events, thus minimizing malathion runoff into aquatic habitats and decreasing exposure to each of the listed mussels and their host fish. Increasing application buffers reduces the amount of malathion that drifts off target and subsequently into non-target environments. In addition, changes to residential labels limits applications to spot treatments and reduces the number of applications per year (2-4), significantly decreasing the overall amounts of malathion used in residential areas and resulting amounts of runoff and drift. Additional reductions in the number of applications and rates allowed for certain crops (e.g., corn, vegetables and ground fruit) further reduces the amount of malathion used in agricultural settings, thereby decreasing potential exposure to each of the species and their host fish. Combined, these conservation measures substantially reduce exposure to the mussel species above (Table 1) and their host fish and therefore minimizes overall risk and adverse effects to these species. Thus, while we anticipate small numbers of individual host fish for each of the mussels would be lost over the duration of the action, we do not anticipate species-level effects to any of these mussel species.

To provide additional context for our determination that the use of malathion, as proposed, is not likely to jeopardize these species, we discuss vulnerability, risk to individual host fish (if exposed), and usage, using examples of our considerations from the list above. We also provide information on vulnerability for each of the species in this subgroup in the following pages. However, in each case, we expect exposure will be limited, based primarily on the very low anticipated usage on both Federal and non-Federal lands. We also anticipate the general conservation measures will further reduce exposure of each of these mussel species, their forage base, and their host fish to malathion.

Vulnerability: For each species, we considered the information available for the species, as summarized in the Status of the Species (Appendix C of this Opinion) and in the accounts for each species below. Most species in Table 1 are considered highly vulnerable, based on the one or more factors related to their status, as described in the Biological Opinion. Assumptions about vulnerability are informed by the species status (e.g., endangered, threatened, recommended for a change in listing status from a recent 5-Year review), number of populations, population size and distribution, and species trends. Some species are limited to a small number of populations (e.g., Coosa moccasinshell, dark pigtoe, inflated heelsplitter, Texas hornshell). Some of these species may be narrow endemics or have isolated or constrained populations that are vulnerable to

stochastic events or localized extirpations where a large proportion of a population(s) is impacted. Other species may have numerous populations or subpopulations, or have relatively widespread ranges (e.g., snuffbox, yellow lance), which reduce the likelihood of population-level effects from stochastic events or localized extirpations. The vulnerability rankings assigned to each of the following species below were estimated based on these factors.

Risk to individuals. As with analyses presented above, and according to the *Risk Assumptions described above*, we generally anticipate high levels of lethal and sublethal effects to individual host fish where exposure occurs, for most use categories (with the exception of Developed uses, as previously described), and to a lesser degree, by water body size. We assume that where waterbodies tend to be smaller streams or static waters (e.g., Bin 2, Bin 5), these impacts are likely to be higher, compared to larger water bodies (e.g., where concentrations may be lower due to dilution or other factors as described in the *Effects of the Action* Section of the Biological Opinion. Where host fish of these species are exposed to malathion applications, we generally anticipate high levels of mortality, with survivors experiencing sublethal effects, and with each of these effects varying in part by use category. Mussels depend on host fish to accomplish their reproductive lifecycle. Glochidia (larval stage) are released into the water and within a few days they must attach to an appropriate species of fish, which they parasitize for a short time while they develop into juvenile mussels. Glochidia that do not attach to a host fish will not survive. Where sufficient numbers of suitable host fish are not available, we anticipate reproduction of mussels would be reduced.

We anticipate high levels of mortality to host fish prey (e.g., other fish, invertebrates) and prey of mussels (zooplankton/plankton), where malathion enters the waterbody from runoff or spray drift. We anticipate small numbers of these individual prey items may occur in the areas exposed to malathion via runoff or spray drift from application areas and would be exposed over the duration of the proposed action. Where localized effects (e.g., reductions in prey) occur as a result of applications of malathion, we anticipate additional food resources from upstream sources would quickly recolonize affected areas. Mussels also generally consume phytoplankton and detritus which is not anticipated to be impacted by malathion applications.

Usage Data and Likelihood of Exposure. We anticipate usage within the non-Federal portion of the species' range will be low (<5%), based primarily on the 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 ranges, 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. Thus, while the risk to individuals may be high if exposure occurs, we anticipate that such exposure would be rare and infrequent based on the usage data for each species, and only very small numbers of individual host fish of these species would be exposed over the duration of the proposed action, but that any reductions in reproduction of mussels from such a loss would not lead to species-level effects.

For many of the species, pesticides were mentioned in species' listing or recovery documents as either a potential concern or previously identified threat or stressor. In some cases, specific pesticides were mentioned or just the general term "pesticides" was mentioned, but the

description did not further identify or exclude malathion from the analysis. This information is shown, where available in the vulnerability accounts for each species in the sections that follow. We considered whether the use of the generic term “pesticide” without further definition or classification in a given species’ listing or recovery documents should be indicative of malathion usage in particular, for the purposes of our determinations for the species in Table C-1 above. We recognize there are a large number of pesticides that have been used and are currently used in agricultural and non-agricultural use sites.

Our assumptions about the best available scientific and commercial usage data in particular, as described in the Usage Section of the Biological Opinion suggest that, for malathion, the low usage values for the species under consideration are the best representation of anticipated usage and resulting exposure and effects to individual host fish and host fish and mussels prey resources. Therefore, without malathion-specific information in the information provided below (primarily from species listing and recovery documents), we did not assume that generic use of the word “pesticides” should have a greater weight on our determinations than the general or California PUR usage data described in the Usage Section of the Biological Opinion.

In summary, we anticipate that, over the duration of the proposed action, very small numbers of individual host fish of the species in Table C-1 above will experience low levels of adverse effects either from exposure to malathion or via a loss of prey resources, and very small numbers of mussels will experience low levels of adverse effects due to small reductions of prey items (plankton/zooplankton). However, for the reasons described above, we do not anticipate that these adverse effects would have population- or species-level effects for any of the mussel species in Table C-1.

Thus, we do not anticipate that the proposed action would not appreciably reduce survival and recovery of the following species in the wild.

Integration and Synthesis Summary: Bivalves

| Scientific Name: | Common Name: | Entity ID: |
|---|-------------------------------|------------|
| <i>Venustaconcha trabalis</i> (= <i>Villosa perpurpurea</i>) | Tennessee bean (=Purple bean) | 318 |

Family: Unionidae

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:

When listed in 1997 (62 FR 1648) and last reviewed in 2013, the purple bean (*Villosa perpurpurea*) was limited to the Tennessee River system and recognized as a mussel with a purple nacre. At that time its close relative, the Cumberland bean 3 (*Villosa trabalis*), was reported to occur in both the Tennessee and Cumberland River systems as a white-nacred mussel. Recently, taxonomy for the Cumberland bean and purple bean has changed based on genetic and phylogenetic taxonomic assessments by Kuenhl (2009) and Lane et al. (2016, 2019). These studies provided evidence supporting recognition of the Cumberland River populations of the Cumberland bean as *Venustaconcha troostensis*, while the Tennessee River populations of both *Villosa trabalis* and *Villosa perpurpurea* were combined and recognized as a single species, now *Venustaconcha trabalis* (Tennessee bean). Williams et al. (2017) provided a revised list of 298 mussel species of the United States and Canada, including the Tennessee bean, which incorporated changes in nomenclature and systematic taxonomy since the most recent checklist in 1998. This document is accepted by most mussel experts as the most current and accepted taxonomic structure of North American unionids.

Previously, the Tennessee bean (=purple bean) was described as endemic to the upper Tennessee River system upstream of what is now Watts Bar Lake. Primarily a species of the Ridge and Valley Physiographic Province, it also occurs at the eastern edge of the Cumberland Plateau. Considering the recent genetic and taxonomic changes for this species, its range has been expanded slightly based on the inclusion of the Hiwassee River population, which was previously thought to be Cumberland bean, but is now known to be Tennessee bean. The entire range of the Tennessee bean still occurs in Tennessee River basin.

Most extant populations of Tennessee bean persist in limited geographic areas and at small population sizes. Three of these populations show limited evidence of reproduction and recruitment, and the remainder show either declining trends or little change from previous

evaluations. None of the extant populations has shown any signs of population expansion as measured by either increased range within stream segments or increased population density.

The species' recovery plan and 5-year reviews from 2006 and 2013 identified impoundments, channelization, mineral extraction (surface coal mining), gravel mining, contaminants, toxic chemical spills, and sedimentation as threats to the Tennessee bean; all of these threats remain. Additional, ongoing threats to the mussel include increased urbanization, streambank erosion, water withdrawals, and impacts associated with agricultural practices (e.g., sedimentation). There may also be increasing levels of timber harvest on private lands (D. Kirk, U.S. Forest Service, email to J. Richard, Service, June 12, 2019). Timber harvest leads to reduced forest cover and increased rates of sedimentation reaching streams and rivers.

Propagation efforts for this species have been substantial, and improved culture techniques have resulted in steady increases in survival, growth, and propagation capacity.

EB/CE Source: U.S. Fish and Wildlife Service (FWS). 2020. Purple Bean (*Villosa perpurpurea*; = Tennessee Bean (*Venustaconcha trabilis*)) 5-Year Review: Summary and Evaluation. Southwestern Virginia Field Office. Abingdon, Virginia. 24 pp.

Overall Vulnerability: ☒ High ☐ Medium ☐ Low

acres in species range: 3,658,143 acres

% of range in California (i.e., where CalPUR data is available): 0%

Range overlap with Federal lands: 404,764 acres, 11.065%

Integration and Synthesis Summary: Bivalves

| Scientific Name: | Common Name: | Entity ID: |
|---------------------------------------|---|------------|
| <i>Epioblasma obliquata obliquata</i> | Purple cat's paw (=purple cat's paw pearlymussel) | 323 |

Family: Unionidae

VULNERABILITY

(Summary of status, environmental baseline and cumulative effects)

Status: Endangered

Distribution: Small, endemic, constrained, and/or isolated population(s); Sensitive to stochastic events (natural and/or anthropogenic)

Number of Populations: Multiple populations (few); Small number of individuals in one or more populations

Species Trends: Declining population(s) – one or more populations declining

Pesticides noted ☐

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

The purple cat's paw pearlymussel was historically distributed in the Ohio, Cumberland, and Tennessee River systems in Ohio, Illinois, Indiana, Kentucky, Tennessee, and Alabama (Bogan and Parmalee 1983; Isom et al. 1979; Kentucky State Nature Preserves Commission 1980; Parmalee et al. 1980; Stansbery 1970; Watters 1986). Currently, the subspecies occurs in the Ohio River and four of its tributaries (Killbuck Creek (OH), Walhonding River (OH), Green River (KY), Licking River (KY)) and one Tennessee River tributary (Duck River (TN)). With the exception of the Killbuck Creek population, all of these populations were reintroduced into these streams in 2017.

Although recruitment has occurred within the past several years based on the finding of young individuals, long-term viability of the Killbuck Creek population is questionable due to the very small population size that appears to be concentrated in one riffle. The species is likely extirpated from the Cumberland River as no individuals have been observed there in over 30 years. Reintroduced populations in the Walhonding River, Ohio River, Licking River, Green River, and Duck River currently only harbor juveniles and young adults and natural reproduction of the species has not yet been documented in these populations.

Many of the historic populations of purple cat's paw were apparently lost when the river sections they inhabited were impounded. These impoundments seriously reduced the availability of riverine habitat and likely affected the distribution and availability of the mussel's fish hosts (USFWS 1992). The Green River in Kentucky has also experienced water quality problems related to the impacts from oil and gas production in the watershed (USFWS 1992). Ahlstedt (2007) reported that mussel habitat in Killbuck Creek is "severely degraded." The substrate is severely imbedded and relatively hard packed which doesn't allow for mussel colonization. The riparian zone is impacted by timber removal, field crops, and cattle accessing the stream. Ahlstedt (2007) also noted that "fish are noticeably absent and Asian clams were abundant" in Killbuck Creek. The Killbuck watershed also contains many operating oil and gas wells, though it is unknown if these wells are impacting the creek.

Any individuals that do still survive in the Cumberland River are threatened by commercial mussel fishing. Although the subspecies is not commercially valuable, incidental take of the species has occurred in the Cumberland River during commercial mussel fishing for other species (USFWS 1992).

Climate change likely constitutes a threat for the species. Current climate change predictions in the Northern Hemisphere indicate warmer air temperatures and more intense precipitation events are likely to occur in the future (IPCC 2007). The predicted impacts on streams include changes in the distribution of algae, plankton, and fish, as well as changes in water temperatures and oxygen levels. Warming of waters in rivers and streams may make these habitats less able to support their current fish and mussel fauna (IPCC 2007). Highly specialized species, such as freshwater mussels, are likely to be most susceptible to the additional stresses of a changing climate. The most recent literature on climate change includes predictions of hydrological changes, higher temperatures, and expansion of drought areas, resulting in a northward and/or upward elevation shift in range for many species (IPCC 2007). Although the specific effects of climate change on the purple cat's paw pearlymussel are unknown, altered hydrology in rivers, increased frequency of extreme weather events, and a changing abundance and distribution of fish species have the potential to adversely affect this species. The magnitude of the climate change threat to the purple cat's paw pearlymussel is unknown.

EB/CE Source: U.S. Fish and Wildlife Service (FWS). 2020. Purple Cat's Paw Pearlymussel (*Epioblasma obliquata obliquata*) 5-Year Review: Summary and Evaluation. Ohio Ecological Services Field Office. Columbus, Ohio. 21 pp.

U.S. Fish and Wildlife Service (FWS). 2005. Purple Cat's Paw Pearlymussel (*Epioblasma obliquata obliquata*) 5-Year Review: Summary and Evaluation. Ohio Ecological Services Field Office. Columbus, Ohio. 15 pp.

Overall Vulnerability: ☒ High ☐ Medium ☐ Low

acres in species range: 35,993,273 acres

% of range in California (i.e., where CalPUR data is available): 0%

Range overlap with Federal lands: 1,716,456 acres, 4.769%

Integration and Synthesis Summary: Bivalves

| Scientific Name: | Common Name: | Entity ID: |
|----------------------------|---------------------|-------------------|
| <i>Lampsilis virescens</i> | Alabama lampmussel | 326 |

Family: Unionidae

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 Alabama lampmussel historically occurred from the headwaters of the Tennessee River in eastern Tennessee downstream to Bear Creek in northwestern Alabama (Mirarchi 2004, Williams et al. 2008).

Natural Alabama lampmussel populations are restricted to the headwaters of the Paint Rock River (Mirarchi 2004) and the upper Emory River (Dinkins et al. 2012) and tends to occur in low numbers where found (McGregor and Shelton 1995, Ahlstedt 1998, Godwin 2002, Fobian et al. 2008, Dinkins et al. 2012). Since 2004, extensive reintroduction events have occurred in 11 northern Alabama and southern watersheds in Tennessee.

The Paint Rock River was substantially altered in the 1960s from a series of channel engineering projects which involved extensive stream channelization and removal of snags and riverbank timber in the mainstem Paint Rock River, Larkin Fork, Estill Fork, and Hurricane Creek (Barbour 2003). Ahlstedt (1998) noted that riffle and shoal habitats have never recovered from this effort and the restoration of natural hydromorphology continues to be aggravated by non-point source pollution associated with agricultural runoff. The mussel fauna may continue to decline until measures are taken to reduce these substantial stream alterations and perturbations (Ahlstedt 1998).

The Emory River population may historically have suffered from mining activity along the river (Hubbs pers. comm. 2018). Most mines adjacent to the Emory River are currently abandoned and the affected stream miles appear to be recovering from those activities (Hubbs pers. comm. 2018). However, impairment caused by livestock accessing the river is now apparent in these reaches (Hubbs pers. comm. 2018).

Habitat destruction or modification is presently the greatest threat to this species. Since agriculture is the predominant stream-side land use, partnerships with private landowners to

implement conservation practices, easements, and/or best management practices on their properties are vital to the continued existence of the lampmussel.

EB/CE Source: U.S. Fish and Wildlife Service. 2020. Alabama Lampmussel (*Lampsilis virescens*) 5-Year Review: Summary and Evaluation. Alabama Ecological Services Field Office. Daphne, Alabama. 38 pp.

Overall Vulnerability: ☒ High ☐ Medium ☐ Low

acres in species range: 2,225,132 acres

% of range in California (i.e., where CalPUR data is available): 0%

Range overlap with Federal lands: 90,297 acres, 4.058%

Integration and Synthesis Summary: Bivalves

| Scientific Name: | Common Name: | Entity ID: |
|-------------------------------|------------------------------|------------|
| <i>Toxolasma cylindrellus</i> | Pale lilliput (pearlymussel) | 327 |

Family: Unionidae

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 pale lilliput historically occurred from the middle reaches of the Tennessee River system, across northern Alabama, and in the Duck River system in central Tennessee (Ortmann 1924, Ortmann 1925, Parmalee and Bogan 1998, Mirarchi 2004, Williams et al. 2008). It was previously considered extirpated from the Duck River (Ahlstedt et al. 2017); however, a population is now known to occur in Lick Creek, a tributary to Duck River in Maury County, TN. The only other known natural population for the pale lilliput is believed to be limited to the upper reaches of the Paint Rock River system, Jackson County, AL, and potentially in its headwaters in Franklin County, TN (Parmalee and Bogan 1998).

There is also a single record of pale lilliput from Swamp Creek, Whitfield County, GA, a Mobile River system tributary (Lea 1856). This record is either an exception to its distribution (Parmalee and Bogan 1998), a mistaken identification, or an invalid record (USFWS 2011); therefore we do not consider this part of the current or historic range for the species.

The pale lilliput is restricted to the headwaters of the Paint Rock River (USFWS 1984) where it appears to occur in extremely low numbers (McGregor and Shelton 1995, Ahlstedt 1998, Godwin 2002, Fobian et al. 2008), and to Lick Creek where it has been increasingly difficult to locate (D. Hubbs pers. comm. 2018). Since 2014, over 8,500 individuals have been reintroduced into several stream reaches within the species' historical range in AL and TN. Limited surveys and captures in natural and reintroduced habitats have prevented any assessment of population or abundance trends.

Although some development has occurred in the Painted Rock River watershed, it has been relatively low compared to other areas in the Tennessee Valley (Barbour 2003). One of the most damaging modifications may have been the U.S. Army's Corps of Engineers' channelization projects of the 1960s, which involved extensive stream channelization and removal of snags and riverbank timber in the Paint Rock River main stem, Larkin Fork, Estill Fork, and Hurricane

Creek (Barbour 2003). Ahlstedt (1998) noted that riffle and shoal habitats have never recovered from those events and continue to be aggravated by non-point source pollution associated with agricultural runoff. The mussel fauna may continue to decline until measures are taken to reduce and remediate these stream perturbations (Ahlstedt 1998).

In 1995, Godwin reported 100 potential non-point source impacts at 85 of his survey sites. Of the 100 impacts, 75 impacted sites were within the PRR main stem, 18 in Estill Fork, 5 in Hurricane Creek, and 2 within Larkin Fork. The most common impact was lack of riparian vegetation 12 (47%), followed by cattle access to the stream (19%) and fording sites for agricultural vehicles (14%). Other documented impacts were sedimentation from mining and off-road vehicles (4% each), cropland erosion and timber harvest sites (3% each), and dumping of debris (2%). Godwin (1995) noted single occurrences of the following potential impacts: sewage inflow, major logjam, siltation from construction, and drainage pipe, during the survey. Lilliput habitat has also been disturbed and degraded by unauthorized removal of creek gravel from within the stream channel at several locations within the PRR drainage basin (USFWS 2011). However, in recent years, many improvements have been made to the pale lilliput's habitat and to the areas surrounding its range.

Habitat destruction or modification is presently the greatest threat to this species. Since agriculture is the predominant land use, partnerships with private 17 landowners to implement conservation practices, easements, and/or best management practices on their properties are vital to the continued existence of the pale lilliput.

EB/CE Source: U.S. Fish and Wildlife Services (FWS). 2021. Pale Lilliput (*Toxolasma cylindrellus*) 5-Year Review: Summary and Evaluation. Alabama Ecological Services Field Office. Daphne, Alabama. 28 pp.

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

acres in species range: 3,478,057 acres

% of range in California (i.e., where CalPUR data is available): 0%

Range overlap with Federal lands: 60,859 acres, 1.750%

Integration and Synthesis Summary: Bivalves

| Scientific Name: | Common Name: | Entity ID: |
|-------------------------|---------------------------|------------|
| <i>Quadrula fragosa</i> | Winged mapleleaf (mussel) | 328 |

Family: Unionidae

VULNERABILITY

(Summary of status, environmental baseline and cumulative effects)

Status: Endangered

Distribution: Small, endemic, constrained, and/or isolated population(s); Sensitive to stochastic events (natural and/or anthropogenic)

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:

Specific habitat requirements of this species are not known. The St. Croix River is in a moderately to minimally disturbed watershed with generally high water quality. The river is a National Wild and Scenic River and this designation confers some protection from anthropogenic disturbance of the population. Major factors of concern for the population are: (a) low reproduction, (b) low stream flow episodes, (c) high variation in stream flow caused by hydroelectric dam peaking operation during certain seasons, (d) toxic spills, (e) potential zebra mussels colonization of the St. Croix River, (f) habitat disturbance or alteration by recreational or commercial activities, (g) human and nonhuman predation and disturbance, (h) water quality deterioration, (i) land-use changes in the watershed; and (j) lack of knowledge of the mussel's life history, especially its glochidial host.

From the 2015 5-year Review:

The discovery of four additional populations has expanded the known range of *Q. fragosa* since the species was listed in 1991 and has greatly changed the context for recovery planning. The discovery of live *Q. fragosa* in Arkansas' Quachita River in 1996 preceded approval of the recovery plan, but there was some initial uncertainty regarding the identity of the specimens found there and the Service based its plan on the assumption that there was still only a single extant population (Posey et al. 1996; USFWS 1997). After the discovery in the Quachita River, biologists have also confirmed extant populations in Arkansas in the Saline River (Davidson and Clem 2002; 2004), in Missouri in the Bourbeuse River (A. Roberts, USFWS, pers. Comm. 17 September 2008; S. McMurray, Missouri Department of Conservation, pers. Comm. 19 September 2008) and in Oklahoma in the Little River (Allen and Vaughn 2008).

EB/CE Source: U.S. Fish and Wildlife Service (FWS). 1997. Winged Mapleleaf Mussel (*Quadrula fragosa*) Recovery Plan. Ft. Snelling, Minnesota. 359 pp.

U.S. Fish and Wildlife Service (FWS). 2015. Winged Mapleleaf (*Quadrula fragosa*) 5-Year Review: Summary and Evaluation. Twin Cities Field Office. Bloomington, Minnesota. 71 pp.

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

acres in species range: 15,664,414 acres

% of range in California (i.e., where CalPUR data is available): 0%

Range overlap with Federal lands: 731,187 acres, 4.668%

Integration and Synthesis Summary: Bivalves

| Scientific Name: | Common Name: | Entity ID: |
|-------------------------|------------------------|-------------------|
| <i>Quadrula sparsa</i> | Appalachian monkeyface | 329 |

Family: Unionidae

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:

Early survey records and archeological finds of the Appalachian Monkeyface indicate the species once occurred in the headwaters of the Cumberland River system and the upper Tennessee River system (Service 1984). However, the species has only been confirmed from the Powell, Clinch, and Holston Rivers in the upper Tennessee River system. The population in the Holston River system was extirpated at the time of listing.

Presently, the species is known only from the unimpounded reaches of the Powell River and Clinch Rivers above Norris Reservoir, although with so few animals detected during decades of sampling, the Clinch River population is likely extirpated. Failure to produce live individuals from numerous surveys has left significant doubt that the species occurs anywhere within its historical range other than the Powell River.

One live individual was discovered during a June 2002 survey of the Cleveland Island reach of the Clinch River (CRM 270.7), Russell County, VA (Eckert and Pinder 2010). This record represents the furthest upstream occurrence of the Clinch River population. Prior to 2002, the last live specimen found in the Clinch River was documented in 1983.

The population in the Powell River has declined by over 12 miles from 1989, and now exists in a 46-mile reach, located between Yellow Shoals Ford, Claiborne County, TN (PRM 84.8) and Flanary Bridge, Lee County, VA (PRM 130.6); however, Parmalee and Bogan (1998) observed that the species had “nearly disappeared” from the river. Live specimens in the Powell River have become increasingly rare and there has been no recruitment noted outside a 0.5-mile linear stretch of the river in the last decade (Johnson 2011).

Impoundments; urbanization; poor silvicultural, agricultural and mining practices; and with a limited distribution in one river system, chemical spills, drought, and other stochastic events remain major threats to the Appalachian Monkeyface. The recovery plan identified three major

stressors that precipitate from these threats and continue to affect the Appalachian Monkeyface. These include impoundments, siltation, and pollution. In addition to the recovery plan's description of the various threats that contribute to these stressors, there are additional continued threats from development and operation of coal and gas resources. Although existing regulatory mechanisms including the CWA and SMCRA provide some protections to the Appalachian Monkeyface, they have been inadequate in protecting the Appalachian Monkeyface from habitat degradation.

Additional threats to the remaining Appalachian Monkeyface population include climate change; the restricted range and small population size, which leaves the species extremely vulnerable to localized extinctions or other stochastic disturbances; reduced genetic diversity; and impacts from nonnative species and disease.

EB/CE Source: U.S. Fish and Wildlife Services (FWS). 2020. Appalachian Monkeyface (*Quadrula sparsa*) 5-Year Review: Summary and Evaluation. Southwestern Virginia Field Office. Abindon, Virginia. 26 pp.**Overall Vulnerability:** ☒ **High** ☐ **Medium** ☐ **Low**

acres in species range: 3,200,402 acres

% of range in California (i.e., where CalPUR data is available): 0%

Range overlap with Federal lands: 582,167 acres, 18.190%

Integration and Synthesis Summary: Bivalves

| Scientific Name: | Common Name: | Entity ID: |
|----------------------------|---------------------------------------|-------------------|
| <i>Quadrula intermedia</i> | Cumberland monkeyface (pearly mussel) | 330 |

Family: Unionidae

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:

2021 5-Year Review: The Elk River, one of the three populations known at the time the Recovery Plan was published (1984), is now considered extirpated. The species is currently restricted to approximately 62 miles of the Powell River, representing a 2.5-mile increase of linear range since 1990, and 22 miles of the Duck River, representing a 6-mile increase in linear range since 1988. Although non-essential experimental populations have been established in different river drainages to establish it and several other endangered mussels, no individuals of *Quadrula intermedia* have been reintroduced into these stream reaches to date.

Primary threats to the species remain similar to what they were in 1976 when this species was listed as endangered in the Federal Register and to what they were in 1984 when the Recovery Plan was written. Coal mining activities appear to be increasing in southwestern Virginia, where a new coal-fired power plant is under construction on the upper Clinch River. There have been no significant improvements regarding these threats, and coal mining is considered to be an increasing threat to the Powell River population. Since the 1984 Recovery Plan was published, the Elk River population has become extirpated, but the Duck River population has expanded significantly and become more abundant. Although a few new sites of occurrence in the Powell River were recently discovered, the viability status of this population continues to be questionable with little evidence of recent recruitment. The Duck River population is considered viable with evidence of recent recruitment. Considering the overall poor quality of the Powell River population, the Duck River is the only sound population remaining of this species. Some life history research has been conducted. Additional research will increase our level of knowledge for this species and aid significantly in its recovery.

In summary, three populations were considered extant at the time the Recovery Plan was published (1984). Since the mid-1980s, the Elk River population has become extirpated. The Powell River population, despite a few newly discovered localities of occurrence, remains at depressed levels and is imminently threatened by increasing coal mining activities. The Duck

River population has expanded its range and become more widespread and abundant with evidence of recent recruitment but is limited to a 22-river mile reach. If the Powell River population is lost, this species will become restricted to a linear population in the Duck River that is highly susceptible to a stochastic event, such as a chemical spill or extreme drought. All of the surviving populations continue to be threatened by many of the same factors identified at the time of listing and the Recovery Plan which contributed to the loss and decline of the species throughout significant portions of its historical range as well as continuing threats to surviving populations (e.g., habitat fragmentation, loss, and alteration resulting from impoundments; stochasticity; operation of hydroelectric dams; instream mining; wastewater discharges; water withdrawal; and the runoff of silt and other pollutants from ground disturbance activities).

EB/CE Source: U.S. Fish and Wildlife Service (FWS). 2021. Cumberland Monkeyface (*Quadrula intermedia*) 5-Year Review: Summary and Evaluation. Asheville Ecological Services Field Office. Asheville, North Carolina. 30 pp.

U.S. Fish and Wildlife Service (FWS). 2011. Cumberland Monkeyface (*Quadrula intermedia*) 5-Year Review: Summary and Evaluation. Asheville Ecological Services Field Office. Asheville, North Carolina. 16 pp.

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

acres in species range: 7,623,040 acres

% of range in California (i.e., where CalPUR data is available): 0%

Range overlap with Federal lands: 829,824 acres, 10.886%

Integration and Synthesis Summary: Bivalves

| Scientific Name: | Common Name: | Entity ID: |
|--------------------------|----------------------------|-------------------|
| <i>Lampsilis abrupta</i> | Pink mucket (pearlymussel) | 331 |

Family: Unionidae

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:

General threats to the species remain similar to 1976 when this species was listed as endangered and to 1985 when the Recovery Plan was written (e.g., habitat degradation from impoundments, sedimentation, pollution). An exception is commercial harvest, which is now nearly non-existent as a threat to the species. Threats that were not mentioned in the Recovery Plan but exist today include the deleterious effects of habitat fragmentation and population isolation, stochasticity, toxic pharmaceuticals and personal care products, and emerging issues such as climate change that threaten pink mucket populations rangewide. Extant populations are now primarily affected by navigational activities, reservoir releases, mining practices, inadequately treated wastewater discharges, and factors associated with small disjunct populations (e.g., stochasticity, low genetic diversity, habitat fragmentation and population isolation).

The total population size for pink mucket, though undetermined, is relatively small. With few exceptions, its 29 extant populations are: 1) small and have low relative abundance; 2) sporadically or occasionally distributed in most rivers and nearly all river reaches; 3) generally limited in linear extent, and 4) typically lacking evidence of recent recruitment.

The species is considered generally distributed and relatively common only in a narrow reach of Cumberland River, sites associated with several islands in Pickwick Landing tailwaters of lower Tennessee River, and single beds in a few other streams. In all other stream or stream reaches the species is sporadic or occasional in distribution and generally considered rare or uncommon in abundance.

EB/CE Source: U.S. Fish and Wildlife Service (FWS). 2019. Pink Mucket (*Lampsilis abrupta*) 5-Year Review: Summary and Evaluation. Asheville Field Office. Asheville, North Carolina. 68 pp.

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

acres in species range: 38,322,272 acres

% of range in California (i.e., where CalPUR data is available): 0%

Range overlap with Federal lands: 2,988,741 acres, 7.799%

Integration and Synthesis Summary: Bivalves

| Scientific Name: | Common Name: | Entity ID: |
|----------------------|------------------------|------------|
| <i>Dromus dromas</i> | Dromedary pearlymussel | 334 |

Family: Unionidae

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 Dromedary Pearlymussel is currently in decline, and its current area of known distribution is limited to the Clinch and Powell rivers near the Virginia-Tennessee border. It has likely been extirpated from the Tennessee River (where it was believed extant at the time the recovery plan was written in 1983) and the Cumberland River (where it has not been found alive since 1994). Historically, the Dromedary Pearlymussel occupied approximately 1,810 miles of rivers and streams in Tennessee, Virginia, Alabama, Mississippi and Kentucky. Across its range, the species' area of known occupation has diminished to only 85 miles (a 95% reduction in range). The population in the Clinch River remain the most robust, but has suffered recent declines as a possible result of an on-going mussel die-off that was first documented in 2016. The Powell River population remains viable, but less robust than the one in the Clinch River. Both remaining populations are small and highly localized and have declined since the last 5-year review in 2011.

The recovery plan included habitat loss and water quality deterioration, attributed to impoundments, industrial and municipal pollution, acid mine drainage, and siltation resulting from mining, agriculture, and construction activities, as the primary reasons for the decline of this species. The current status of the species is likely still attributable to these threats.

EB/CE Source: U.S. Fish and Wildlife Service (FWS). 2020. Dromedary pearlymussel (*Dromus dromas*) 5-Year Review: Summary and Evaluation. Tennessee Ecological Services Field Office. Cookeville, Tennessee. 22 pp.

Overall Vulnerability: ☒ High ☐ Medium ☐ Low

acres in species range: 8,259,406 acres

% of range in California (i.e., where CalPUR data is available): 0%

Range overlap with Federal lands: 677,474 acres, 8.202%

Integration and Synthesis Summary: Bivalves

| Scientific Name: | Common Name: | Entity ID: |
|-------------------------|-------------------------|-------------------|
| <i>Pegias fabula</i> | Littlewing pearlymussel | 335 |

Family: Unionidae

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 Little-wing Pearlymussel was historically a widespread Cumberlandian mussel species. Its range included four physiographic provinces (Interior Plateau, Ridge and Valley, Blue Ridge, and Southeastern Plain) and five States (Alabama, Kentucky, North Carolina, Tennessee, and Virginia). In the Cumberland River drainage, it occurred in 15 different streams and rivers. The Little-wing Pearlymussel is now considered extirpated from the entire Cumberland River system, except for a few miles of the Big South Fork Cumberland River upstream and downstream of the Tennessee and Kentucky border and one short reach of Cane Creek in Tennessee. In the Tennessee River system, it was known from 17 streams and rivers, but is now likely extirpated from the system. The last known living little-wing pearlymussel in the Tennessee River system was found in the Clinch River near Pounding Mill, Tazewell County, Virginia, in the late 1990s.

Threats to the species remain similar to those presented in the recovery plan and consist primarily of industrial and municipal pollution, oil extraction, coal mining, acid mine drainage, and siltation resulting from mining, agriculture, and construction activities (USFWS 1989). Past unregulated activities from coal and oil and gas extraction were believed to have contributed to the species' decline, especially in Horse Lick Creek, Big South Fork Cumberland River, Little South Fork Cumberland River, Clinch River, and Cane Creek. Except for Big South Fork Cumberland River and Cane Creek, all of these populations are now extirpated. The threats to the species continue to exist at some level. Moreover, no specific information is available to

indicate a single factor, or combination of factors, caused the decline of the species. There is only one potentially viable population of this species known (population in Big South Fork Cumberland River), rendering the species vulnerable to stochastic events.

EB/CE Source: U.S. Fish and Wildlife Service (FWS). 2020. Littlewing Pearlymussel (*Pegias fabula*) 5-Year Review: Summary and Evaluation. Kentucky Ecological Services Field Office. Frankfort, Kentucky. 28 pp.

Overall Vulnerability: ☒ High ☐ Medium ☐ Low

acres in species range: 10,205,819 acres

% of range in California (i.e., where CalPUR data is available): 0%

Range overlap with Federal lands: 3,458,335 acres, 33.886%

Integration and Synthesis Summary: Bivalves

| Scientific Name: | Common Name: | Entity ID: |
|---------------------------|---------------------|-------------------|
| <i>Fusconaia cuneolus</i> | Finerayed pigtoe | 337 |

Family: Unionidae

VULNERABILITY

(Summary of status, environmental baseline and cumulative effects)

Status: Endangered

Distribution: Small, endemic, constrained, and/or isolated population(s); Sensitive to stochastic events (natural and/or anthropogenic)

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:

Threats to the species remain similar to what they were in 1976, when this species was listed as endangered, and to what they were in 1984 when the Recovery Plan was written (i.e., impoundment, siltation, and pollution). The Sequatchie and Elk River populations, two of seven known populations at the time of listing, are now considered extirpated (Service 2013). Also, the Little River component of the Clinch population and the Possum Creek component of the North Fork Holston population are considered extirpated.

The finerayed pigtoe is now restricted to linear populations in the Powell, North Fork Holston, Little, and Paint Rock rivers, and the only tributary currently considered occupied is Copper Creek. The number of individuals in these populations have declined through time and in some instances have become almost undetectable. Additionally, linear populations are highly susceptible to stochastic events, such as contaminant spills, prolonged flooding, and extreme drought, and their isolated natures make natural recolonization after extirpation almost impossible.

These remaining populations continue to be affected by many of the same factors identified at the time of listing and the Recovery Plan, and only the Clinch River and Little River, Tennessee, have documentation of recruitment since the last five-year review was completed in 2013, and are considered viable. The prolonged effects of mussel declines in many rivers of occurrence have been especially detrimental to rare and uncommon species such as the finerayed pigtoe.

EB/CE Source: U.S. Fish and Wildlife Service (FWS). 2022. Finerayed Pigtoe (*Fusconaia cuneolus*) 5-Year Review: Summary and Evaluation. Asheville Ecological Services Field Office. Asheville, North Carolina. 22 pp.

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

acres in species range: 8,456,905 acres

% of range in California (i.e., where CalPUR data is available): 0%

Range overlap with Federal lands: 944,409 acres, 11.167%

Integration and Synthesis Summary: Bivalves

| Scientific Name: | Common Name: | Entity ID: |
|--------------------------|---------------------|-------------------|
| <i>Pleurobema plenum</i> | Rough pigtoe | 338 |

Family: Unionidae

VULNERABILITY

(Summary of status, environmental baseline and cumulative effects)

Status: Endangered

Distribution: Small, endemic, constrained, and/or isolated population(s); Sensitive to stochastic events (natural and/or anthropogenic)

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:

Populations of the Rough Pigtoe currently exist in portions of the Clinch, Tennessee, Cumberland, Green, Barren, and Licking rivers. The species was observed in the East Fork White River in Indiana in 1992, but the species has not been observed there since that time. Currently, the Clinch (Tennessee) and Green (Kentucky) rivers represent the only populations with evidence of successful reproduction.

Rough Pigtoe mussels typically do not exist in populations large enough to support translocation. However, recent host trials may provide hope that propagation can be successful in producing juvenile mussels for recovery actions (reintroductions at extirpated sites or augmentation of existing populations). As such, future reintroductions, augmentations, and translocations of individuals will likely be accomplished through introductions of captively-propagated juveniles.

Numerous threats persist for Rough Pigtoe populations, including habitat alteration (e.g., impoundments), land use changes, competition from invasive species, large-scale die-offs and subsequent small population size, and point and non-point source pollution. The species continues to show declines; it is limited to only a few small populations, with evidence of reproduction in only the Clinch River and Green River; it continues to be influenced by high magnitude threats; and the criteria for delisting or downlisting have not been met.

EB/CE Source: U.S. Fish and Wildlife Service (FWS). 2021. Rough Pigtoe (*Pleurobema plenum*) 5-Year Review: Summary and Evaluation. Kentucky Ecological Services Field Office. Frankfort, Kentucky. 26 pp.

Overall Vulnerability: ☒ High ☐ Medium ☐ Low

acres in species range: 19,127,869 acres

% of range in California (i.e., where CalPUR data is available): 0%

Range overlap with Federal lands: 1,438,861 acres, 7.522%

Integration and Synthesis Summary: Bivalves

| Scientific Name: | Common Name: | Entity ID: |
|-------------------------|---------------------|-------------------|
| <i>Fusconaia cor</i> | Shiny pigtoe | 339 |

Family: Unionidae

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:

Primary threats to the species (e.g., from coal mining, urbanization, agriculture, toxic chemical spills) remain similar to what they were in 1976 when it was listed as endangered and to what they were in 1984 when the Recovery Plan (USFWS 1984) was written. Although there have been few significant improvements regarding threats to the species rangewide, the Service and numerous partners are working to reduce impacts from various activities detrimental to its recovery. In recent years, some restricted habitat reaches within its historical range are considered to have improved enough to consider shiny pigtoe augmentations or reintroductions (e.g., Clinch River, Virginia; Powell River, Tennessee; Paint Rock River, Alabama). Despite coal mining in Virginia having declined in recent decades, production of coal and particularly natural gas may increase due to factors such as demographic trends, energy demand, and ongoing construction of a hybrid energy power plant on upper Clinch River.

All populations of the shiny pigtoe have declined since the early 1980s. One of the five shiny pigtoe populations extant at the time the Recovery Plan (USFWS 1984) was published (Elk River) is likely extirpated. Populations in Powell and Paint Rock Rivers continue to decline. The species has shown limited recruitment in Paint Rock River, but there has been no evidence of recruitment in recent years in Powell River making its viability there questionable. The once large North Fork Holston River population has also declined significantly over the past 20 years due to a dieoff of unknown causes but continues to exhibit some level of viability based on limited evidence of recent recruitment. Generally, these shiny pigtoe populations are small, linearly distributed, and reach limited, making them especially susceptible to stochastic events, such as chemical spills. For decades the Clinch River population trended downward in status until recently improving, though it is still rare. The shiny pigtoe population in Clinch River is sporadically distributed over about 80 river miles and represents the only population that is considered sizable, displays ample evidence of recent recruitment, and is unquestionably viable. Despite the long-term decline in the status of the shiny pigtoe, we consider the overall status of

the species to have been stable over the past few years, due primarily to the relatively extensive Clinch River population which now comprises a large percentage of its global abundance.

EB/CE Source: U.S. Fish and Wildlife Service (FWS). 2021. Shiny Pigtoe (*Fusconaia cor*) 5-Year Review: Summary and Evaluation. Asheville Ecological Services Field Office. Asheville, North Carolina. 40 pp.

Overall Vulnerability: ☒ High ☐ Medium ☐ Low

acres in species range: 7,120,302 acres

% of range in California (i.e., where CalPUR data is available): 0%

Range overlap with Federal lands: 1,032,326 acres, 14.498%

Integration and Synthesis Summary: Bivalves

| Scientific Name: | Common Name: | Entity ID: |
|-------------------------|---------------------|-------------------|
| <i>Obovaria retusa</i> | Ring pink (mussel) | 341 |

Family: Unionidae

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:

It appears that no viable populations remain for this species in the Ohio River basin. At the time the recovery plan was completed in 1991, five populations were known; however, even these populations were considered to be relic and possibly non-reproducing. Threats to the remaining populations identified in the recovery plan included water quality problems due to oil and gas production, gravel dredging, channel maintenance, commercial mussel fishing, and reduced natural reproduction. The record from the Kanawha River in West Virginia has since been determined to be a misidentification (Tolin 1991); therefore, this species is considered extirpated from West Virginia. Records from the Tennessee River are 25 years old or more (Leroy Koch 2007; Don Hubbs 2017). The most-recent record from the Tennessee River downstream of Wilson Dam is from the early 1990s due to a commercial mussel harvest (Richardson 2005). The species likely has been extirpated from all but the following five river reaches: the Green River in Kentucky, the Tennessee River downstream of Wilson Dam in Alabama, the Tennessee River downstream of Pickwick Landing Dam in Tennessee, portions of the Cumberland River, and the Tennessee River downstream of Kentucky Dam in Kentucky.

The most recent records are from the Green River, where four live adults have been found since 1998. We assume the species still exists in the Green River, but in extremely low numbers that hamper detection efforts. It may occur in other river systems, but the likelihood of detecting this species is extremely low. Ring Pink mussels are rare and occur in such low densities that they are unlikely to be detected during typical mussel surveys, which are often of limited scope and duration. They are also a relatively longlived mussel species, so a population may persist for many decades, which can provide future opportunities to locate individuals. These factors, combined with the recent progress in mussel in-vitro culture methods, suggest that numerous juvenile Ring Pinks could be produced for recovery efforts from only one or a few gravid females, if those females can be found.

Il threats identified in the recovery plan likely remain for this species. Natural factors or threats affecting the continued existence of the Ring Pink include its restricted range, small population numbers, and its apparent inability or limited ability to recruit individuals into the population. Habitat improvements, if any, are either considered negligible and/or have not been studied sufficiently to document improvements and/or a reduction of habitat degradation. The Green River population may benefit from the 2017 removal of Green River Lock and Dam 6, but it will likely require many years or decades to determine if the dam removal benefitted the species.

EB/CE Source: U.S. Fish and Wildlife Service (FWS). 2019. Ring Pink (*Obovaria retusa*, Lamarck, 1819) 5-Year Review: Summary and Evaluation. Kentucky Ecological Services Field Office. Frankfort, Kentucky. 13 pp.

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

acres in species range: 13,803,513 acres

% of range in California (i.e., where CalPUR data is available): 0%

Range overlap with Federal lands: 796,849 acres, 5.773%

Integration and Synthesis Summary: Bivalves

| Scientific Name: | Common Name: | Entity ID: |
|--|---------------------|-------------------|
| <i>Quadrula cylindrica strigillata</i> | Rough rabbitsfoot | 344 |

Family: Unionidae

VULNERABILITY

(Summary of status, environmental baseline and cumulative effects)

Status: Endangered

Distribution: Small, endemic, constrained, and/or isolated population(s); Sensitive to stochastic events (natural and/or anthropogenic)

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 rough rabbitsfoot is considered a subspecies of the wide-ranging rabbitsfoot (Turgeon et al. 1998). The type locality is the Clinch River in Virginia (erroneously given as “Lee Co., VA.”; Ortmann 1918). The historical distribution of this taxon is generally considered to be above the Norris Reservoir (Powell and Clinch Rivers) and in the North Fork and South Fork of the Holston River in northeastern Tennessee and southwestern Virginia (Ortmann 1918). Downstream (main stem of the Tennessee River and larger tributaries), the typical form (*Quadrula c. cylindrica*) is presumed to have occurred. The rough rabbitsfoot is restricted to the upland-most portion of the Ridge and Valley Physiographic Province, making it one of the more narrowly distributed species endemic to the Cumberlandian Region.

Ortmann (1924a) stated that the range of the rough rabbitsfoot was the headwaters of the Powell, Clinch, and Holston Rivers. Today, the entire Holston River system population of the rough rabbitsfoot has been extirpated (e.g., North Fork Holston River, South Fork Holston River, Big Moccasin Creek, Possum Creek). Populations of this species remain in the Clinch River in Russell, Scott, and (possibly) Tazewell Counties, Virginia, and Hancock County, Tennessee; Indian Creek, Tazewell County, Virginia; and the Powell River, Lee County, Virginia, and Hancock and Claiborne Counties, Tennessee. Ahlstedt (1981a) reported it live from Copper Creek in 1980, but only relic shells were reported in 1998 by Fraley and Ahlstedt (2000). They indicated that it “may be extirpated” from the stream, which is the viewpoint taken in this recovery plan. The rough rabbitsfoot persists, however, in the Clinch River in areas adjacent to the mouth of Copper Creek (Jones, pers. comm., 2003). It is therefore possible that it will be discovered to persist in the lower portions of Copper Creek.

Currently, the species and their habitats continue to be impacted by excessive sediment bed loads of smaller sediment particles, changes in turbidity, increased suspended solids (primarily resulting from nonpoint-source loading from poor land-use practices, lack of BMPs, and

maintenance of existing BMPs), and pesticides. Other primarily localized impacts include coal mining, gravel mining, reduced water quality below dams, developmental activities, water withdrawal, impoundments, and alien species. Toxic spills are also a possibility in all extant populations. Many of the impacts discussed above occurred in the past as unintended consequences of human development in the Cumberlandian Region. An improved understanding of these consequences has led to regulatory actions (e.g., the CWA); voluntary landowner measures (e.g., BMPs for agricultural, silvicultural, and construction activities); and improved land-use practices (e.g., maintaining riparian buffers, practicing no-till agriculture). These activities and others discussed under “Conservation Measures” are contributing to a reduction in threats to these mussels. Nonetheless, the five species are highly restricted in distribution, occur in generally small populations, and show little evidence of recovering from historical habitat losses without significant human intervention.

EB/CE Source: U.S. Fish and Wildlife Service. 2004. Recovery Plan for Cumberland Elktote, Oyster Mussel, Cumberlandian Combshell, Purple Bean, and Rough Rabbitsfoot. Atlanta, Georgia. 168 pp.

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

acres in species range: 4,696,875 acres

% of range in California (i.e., where CalPUR data is available): 0%

Range overlap with Federal lands: 668,214 acres, 14.227%

Integration and Synthesis Summary: Bivalves

| Scientific Name: | Common Name: | Entity ID: |
|--------------------------|---------------------|-------------------|
| <i>Leptodea leptodon</i> | Scaleshell mussel | 345 |

Family: Unionidae

VULNERABILITY

(Summary of status, environmental baseline and cumulative effects)

Status: Endangered

Distribution: Small, endemic, constrained, and/or isolated population(s); Sensitive to stochastic events (natural and/or anthropogenic)

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:

From the 2021 5-Year Review: The Scaleshell is still present, although rare, within its stronghold populations in the Meramec, Bourbeuse, and Gasconade rivers in Missouri. It was also collected live in the last 10 years in three streams where it has been documented previously in Arkansas, Missouri, and Illinois. No other collections have been reported for the Scaleshell during the review period from 2011 to the present. Overall, the species distribution remains the same as described in our 2011 review (USFWS 2011, Appendix II) and this information does not alter our understanding of the species' current distribution. Likewise, the evaluation of threats affecting the species under the factors in 4(a)(1) of the Act and analysis of the status of the species in the 2011 status review and recovery plan (USFWS 2010) remains an accurate reflection of the species current status.

The major causes of habitat loss are still present in streams throughout its range including water quality degradation, sedimentation, channelization, sand and gravel mining, dredging, and impoundments (USFWS 2010). New information has been discovered with respect to water quality. In studies since 2001, mussels have been found to be very sensitive to ammonia, which is one of the most common pollutants in streams (Augsburger et al. 2003; Wang et al. 2007a; Wang et al. 2007b). These studies have called into question whether or not the Environmental Protection Agency's (EPA) current national water quality criteria are protective of freshwater mussels because those criteria were derived from a toxicity database predating data recently available for freshwater mussels. The EPA is currently in the process of updating the 1999 national water quality criteria for ammonia (EPA 2009). Ammonia is a common pollutant in streams occupied by the scaleshell range-wide and is associated with both point and nonpoint sources. Ammonia is associated with animal feedlots, nitrogenous fertilizers, industrial effluents, and municipal wastewater treatment plants (Goudreau et al. 1993; USFWS 2010). Declines of mussel populations in the Big River have been attributed to the effects of past and present lead

mining (USFWS 2010). Recent studies have confirmed that stream sediments in the Big River are contaminated with high levels of heavy metals (e.g., lead, zinc, cadmium) as a result of lead mining in the upper portion of the watershed (Roberts et al. 2009). These contaminated sediments have greatly affected mussel populations in the Big River. Sites with impacted mussel communities included over 158.7 km (98.6 mi) of the river, including the reach from river mile 113 to 14.4 (Roberts et al. 2009). The scaleshell is known to occur at two sites in the lower 16.1 km (10 mi) (MDC Mussel Database 2009; Roberts et al. 2009). If contaminated sediments continue to migrate downstream, scaleshell populations in the lower Big River would be impacted, as well as populations in the Meramec River downstream from the confluence of the two rivers. The USFWS is currently monitoring mussel populations and sediment contamination in the lower 10 miles of the Big River.

EB/CE Source: U.S. Fish and Wildlife Service. 2021. Scaleshell Mussel (*Leptodea leptodon*) 5-Year Review: Summary and Evaluation. Missouri Ecological Services Field Office. Columbia, Missouri. 31 pp.

U.S. Fish and Wildlife Service. 2011. Scaleshell Mussel (*Leptodea leptodon*) 5-Year Review: Summary and Evaluation. Missouri Ecological Services Field Office. Columbia, Missouri. 19 pp.

Overall Vulnerability: ☒ High ☐ Medium ☐ Low

acres in species range: 25,029,433 acres

% of range in California (i.e., where CalPUR data is available): 0%

Range overlap with Federal lands: 2,445,403 acres, 9.770%

Integration and Synthesis Summary: Bivalves

| Scientific Name: | Common Name: | Entity ID: |
|--|-----------------|------------|
| <i>Epioblasma florentina walkeri</i> (= <i>E. walkeri</i>) | Tan riffleshell | 346 |

Family: Unionidae**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 tan riffleshell was once widely distributed in nearly 30 streams in upland portions of the Cumberlandian Region. Only a few small populations were known to exist in 1976, prompting the listing of the species as endangered under the ESA. At the time the 1984 Recovery Plan was written, the tan riffleshell was known to occur with certainty only in Middle Fork Holston River, while populations were suspected in Duck and Red Rivers. Three decades later, two populations are known—both discovered since 1984: Big South Fork and Indian Creek. In Big South Fork, it occurs in a 12-river mile reach straddling the Kentucky and Tennessee border. The Indian Creek population is restricted to about 2 river miles in the lowermost portion of the creek in Virginia. The Indian Creek population was contiguous with the species in the Clinch River, its parent stream, until a 1998 chemical spill eliminated it from the Clinch. All other populations where the species was known historically—including the three populations potentially extant in 1984—are now considered extirpated.

Most general threats (i.e., impoundment, pollution, and siltation) to the tan riffleshell remain similar to what they were in 1976 when listed and 1984 when the Recovery Plan was written. In addition to fossil fuel extraction activities and the potential effects of climate change, the myriad effects resulting from small population size, population fragmentation and isolation, and stochasticity are the primary factors that threaten the continued existence of the tan riffleshell. We do have considerably more information since 1984 on its life history, population estimates, development of propagation technology, and a clearer understanding of stressors, but there have been no significant improvements regarding these threats. Population size has been in decline for the past 15 years due to the decrease in the upper Clinch River/Indian Creek population. Reduction of global distribution to a total of 14 river miles, coupled with the heightened possibility for stochastic events to decimate its two small populations, makes the tan riffleshell arguably one of the most highly imperiled species listed under the ESA.

EB/CE Source: U.S. Fish and Wildlife Service (FWS). 2021. Tan Riffleshell (*Epioblasma florentina walkeri*) 5-Year Review: Summary and Evaluation. Asheville Ecological Services Field Office. Asheville, North Carolina. 46 pp.

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

acres in species range: not available

% of range in California (i.e., where CalPUR data is available): 0%

Range overlap with Federal lands: not available

Integration and Synthesis Summary: Bivalves

| Scientific Name: | Common Name: | Entity ID: |
|-----------------------------|-------------------------|-------------------|
| <i>Epioblasma brevidens</i> | Cumberlandian combshell | 353 |

Family: Unionidae

VULNERABILITY

(Summary of status, environmental baseline and cumulative effects)

Status: Endangered

Distribution: Small, endemic, constrained, and/or isolated population(s); Sensitive to stochastic events (natural and/or anthropogenic)

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:

Historically, the Cumberlandian combshell ranged throughout the Cumberlandian Region, occurring in three physiographic provinces (Interior Low Plateau, Cumberland Plateau, and Ridge and Valley) and five states (Alabama, Kentucky, Mississippi, Tennessee, and Virginia). It has now been extirpated from a large percentage of its former range, including the Cumberland River mainstem and Tennessee River mainstem (Service 2004). The species' current distribution is limited to Bear Creek (Alabama and Mississippi), Big South Fork (Kentucky and Tennessee), Buck Creek (Kentucky), Clinch River (Tennessee and Virginia), Duck River (Tennessee), Elk River (Tennessee), Nolichucky River (Tennessee), and Powell River (Virginia). The most viable populations occur in the Big South Fork and Clinch River. The species is reproducing and recruiting in the Powell River, Bear Creek, and Buck Creek, but the species occurs in lower densities in these watersheds. Populations in the Duck River, Elk River, Nolichucky River, and Rockcastle River are the result of recent reintroduction efforts. The Service and its partners are monitoring these populations.

The Recovery Plan listed excessive sedimentation (primarily resulting from nonpoint-source loading), coal mining, gravel mining, reduced water quality below existing dams, developmental activities, water withdrawal, impoundments, and alien species as threats to the Cumberlandian Combshell and its habitat. Because of the past occurrence of multiple pollution events in the Powell and Clinch rivers and the declines in mussel populations that resulted from those spills, the Service considers toxic spills to be a threat that could either reduce Cumberlandian Combshell populations to inviable status or lead to their extirpation from portions of the species' restricted range. All of these threats continue to impact the species across its range.

While the Service and its state partners have worked to protect some significant habitat areas, the degree of threat for this species remains high. We continue to assume that threats to this species remain high and that the recovery potential remains low. Augmentation of juveniles are taking

place, but the success of those efforts are unknown at this time. **EB/CE Source:** U.S. Fish and Wildlife Service (FWS). 2019. Cumberlanian Combshell (*Epioblasma brevidens* (Lea, 1861)) 5-Year Review: Summary and Evaluation. Cookeville Ecological Services Field Office. Cookeville, Tennessee. 31 pp.

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

acres in species range: 9,444,081 acres

% of range in California (i.e., where CalPUR data is available): 0%

Range overlap with Federal lands: 1,207,797 acres, 12.789%

Integration and Synthesis Summary: Bivalves

| Scientific Name: | Common Name: | Entity ID: |
|--------------------------------|---------------------|-------------------|
| <i>Alasmidonta raveneliana</i> | Appalachian elktoe | 354 |

Family: Unionidae

VULNERABILITY

(Summary of status, environmental baseline and cumulative effects)

Status: Endangered

Distribution: Small, endemic, constrained, and/or isolated population(s); Sensitive to stochastic events (natural and/or anthropogenic)

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:

At the time of listing, only two populations of the Appalachian elktoe were known to exist: one in the main stem of the Little Tennessee River in Swain and Macon Counties, North Carolina and one in the Nolichucky River system including the mainstem of the Toe River, Yancey and Mitchell Counties, North Carolina; the mainstem of the Cane River, Yancey County, North Carolina; and the mainstem of the Nolichucky River in Yancey and Mitchell Counties, North Carolina and Unicoi County, Tennessee. Since listing, five additional populations have been discovered: (1) in 1996, a population was discovered in the Tuckasegee River in Jackson and Swain Counties, North Carolina; (2) another population was discovered in 1999 in the West Fork Pigeon River and the Pigeon River in Haywood County, North Carolina; (3) a small population was discovered in 2000 in the Cheoah River in Graham County, North Carolina; (4) a population was discovered in the Little River in 2000 (Service 2002) and this population was found in 2005 to extend into the French Broad River near the mouth of the Little River, Transylvania County, North Carolina (S. Fraley, NCWRC, personal communication 2005); and, (5) in 2003, a population was discovered in the Mills River, Henderson County, North Carolina (T. Savidge, The Catena Group [now Three Oaks Engineering], pers. comm. 2003).

Of the seven known surviving Appalachian elktoe populations, two, the Nolichucky River population and the Tuckasegee River population, are currently the largest populations and are the most likely to maintain long-term viability. Recent expansion of the species in the upper French Broad River is promising, and this population may be considered viable if the increasing trend continues. Of the remaining populations, only the Nolichucky River and French Broad River populations are dendritic (occupying multiple independent watersheds), providing protection from an event that might affect only one of the watersheds. The upper French Broad River population is also dendritic, but most of this population is contained within a short section of the Little River watershed, somewhat reducing its resiliency compared to the Nolichucky population.

The other populations are contained within single linear stretches of river, making them vulnerable to extirpation from a single event, such as a major chemical spill or large-scale development of the watershed.

The unexplained decline of the Appalachian elktoe in the Little Tennessee River between 2005 and 2015 is an unprecedented occurrence. It is difficult to assess the magnitude of this loss with certainty, but the Little Tennessee River formerly represented the majority of all individual Appalachian elktoe throughout the species' range and likely numbered in the tens of thousands, or perhaps even hundreds of thousands. The loss of this population marks a substantial decrease of the global population. As noted in Section II.C.2.c, the physiology of individuals that were experimentally caged in the Little Tennessee River have indicated that the animals declined in health, but no causative agent has been determined. At this time, we are extremely concerned about the viability of the remaining populations. The surviving populations are small in size compared to the Little Tennessee River population and generally occupy isolated reaches of river, leaving them vulnerable to events that could affect the entire population.

All of the surviving populations continue to be threatened by many of the same factors identified at the time of listing throughout significant portions of its historic range, including habitat fragmentation, loss, and alteration resulting from impoundments, the operation of hydroelectric dams, in-stream mining, wastewater discharges, and the runoff of silt and other pollutants from ground disturbing activities.

EB/CE Source: U.S. Fish and Wildlife Service (FWS). 2017. Appalachian elktoe (*Alasmidonta raveneliana*) 5-Year Review: Summary and Evaluation. Asheville Ecological Services Field Office. Asheville, North Carolina. 24 pp.

Overall Vulnerability: ☒ High ☐ Medium ☐ Low

acres in species range: 4,771,467 acres

% of range in California (i.e., where CalPUR data is available): 0%

Range overlap with Federal lands: 2,799,318 acres, 58.668%

Integration and Synthesis Summary: Bivalves

| Scientific Name: | Common Name: | Entity ID: |
|---------------------------|-----------------------|-------------------|
| <i>Potamilus inflatus</i> | Inflated heelsplitter | 356 |

Family: Unionidae

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: Stable

Pesticides noted ☐

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

The inflated heelsplitter is currently known to occupy a larger extent of habitat in the Tombigbee, East Fork Tombigbee, and Black Warrior River than was known at the time of listing. The species appears to be viable and self-sustaining in these rivers as it may be locally common and represented by a variety of size classes. The distribution and viability of these populations in the Mobile River Basin has been documented for more than 10 years. Although the Amite River population remains viable and self-sustaining in some reaches, overall distribution in the river has declined since listing and demographic shifts in dominant size classes have been documented (Brown *et al.* 2010, Brown and Daniel 2014). Actual and potential impacts of urbanization and increased runoff to the species have yet to be fully understood in the Amite River. The species has been discovered in the Pearl and Alabama rivers, although very few individuals have been observed in either river. Therefore, population size is expected to be extremely small in both the Pearl and Alabama rivers, and distribution and viability remains to be determined.

The final rule listing the inflated heelsplitter as threatened (55 FR 39868), identified destruction of habitat and curtailment of range in the Alabama, Tombigbee, and Black Warrior rivers due to impoundment and channelization for navigation, flood control, and hydropower. These factors continue to influence habitat within these three river systems; however, the inflated heelsplitter has expanded its range in both the Tombigbee and Black Warrior rivers, and has been found in the Alabama River since the listing. While impoundments apparently limits the distribution of the species in pools, the host fish (freshwater drum) can apparently move between the different pool and riverine reaches at times important for mussel recruitment. Maintenance dredging in the Black Warrior and Tombigbee rivers was identified as a threat to surviving populations following modification of those systems for navigation. In a survey for mussels in dredge disposal areas on mussels, Miller (1994) found the inflated heelsplitter to be the most abundant mussel species present around dredge disposal areas in the Tombigbee and Black Warrior rivers,

however, abundance of all species was very low in the dredge disposal areas. In 1990, major threats in the Amite River were identified as reduction of range associated with sand and gravel mining and the resulting channel instability, as well as proposed channel modifications for flood control (55 FR 39868). Development and urbanization within the Amite Basin also appears to be a growing threat to the Amite River population of inflated heelsplitter.

EB/CE Source: U.S. Fish and Wildlife Service (FWS). 2018. Inflated Heelsplitter (*Potamilus inflatus*) 5-Year Review: Summary and Evaluation. Alabama Ecological Services Field Office. Daphne, Alabama. 21 pp.

Overall Vulnerability: ☐ High ☒ Medium ☐ Low

acres in species range: 13,521,434 acres

% of range in California (i.e., where CalPUR data is available): 0%

Range overlap with Federal lands: 249,458 acres, 1.845%

Integration and Synthesis Summary: Bivalves

| Scientific Name: | Common Name: | Entity ID: |
|----------------------------|--------------------|------------|
| <i>Lampsilis perovalis</i> | Orangenacre mucket | 357 |

Family: Unionidae

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: Stable

Pesticides noted ☐

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

The orangenacre mucket was historically known from the Alabama, Tombigbee, Black Warrior, and Cahaba Rivers and their tributaries in Alabama and Mississippi. Williams *et al.* (2008) reported that the orangenacre mucket occurs in the Alabama, Black Warrior and Tombigbee River drainages. In the Black Warrior, it only occurs above the Fall Line. Williams *et al.* (2008) also suggests that while some specimens from the Cahaba, Coosa and Tallapoosa River drainages look very similar to the orangenacre mucket, their final identity remains unresolved.

Most populations for the orangenacre mucket are small and localized where they are found. Trend data is generally lacking, but is available from the National Forest Service, where the orangenacre mucket continues to be one of the most abundant mussels in the Forest Service's Bankhead National Forest monitoring (Moran 2010, 2011, 2012, 2013, 2015, 2016, 2017, 2018). Even though the Sipsey Fork and its tributary populations continue to be the most robust, Haag and Warren (2008) documented significant declines following the 2000 drought when orangenacre mucket abundance declined in density between 0.19-0.79 individuals/m², in pre-drought (1993) versus post-drought (2001 or 2002) scenarios.

The orangenacre mucket is not known to have lost any known populations since the time of listing, but a few new tributary populations have been discovered from the lower Tombigbee and Alabama drainages, including Bogue Chitto Creek (Choctaw County, Alabama); Limestone Creek and Big Flat Creek (Monroe County, Alabama) (AST 2016 and 2019, Fobian *et al.* 2013, and A Ford, pers. observ. 2010). Orangenacre mucket has also been stocked into Tallatchee Creek (Monroe County, Alabama) (Johnson 2012c and 2018) and multiple Locust Fork sites (Blount and Jefferson Counties, Alabama) (Johnson 2014 and 2018).

From the 2005 5-Year Review: The primary cause of curtailment of range and fragmentation of habitat for all 11 mussel species is construction of dams and impoundment of large reaches of major river channel (58 FR 14330). These conditions continue to affect the species, although

flow improvements have been made, or are planned below some Coosa River dams (e.g., Weiss Bypass Working Group 2005). Effects of such flow improvements, however, have not yet been evaluated in relation to any of these 11 species. Other causes of habitat and range curtailment identified at listing included dredging, mining, and historical or episodic pollution events (58 FR 14330). Dredging is not known to currently affect any of the surviving populations of these species. A Safe Harbor Agreement was developed to mitigate for potential stream dewatering and hann to fine-lined pocketbook by a quarry in upper Chewacla Creek (U.S. Fish and Wildlife Service 2003). Pollution continues to be a factor at most sites where the species occur. Many stream segments that continue to support these species, or streams feeding into their habitats, including some areas designated as critical habitat, are not currently supporting designated uses, (e.g., Conasauga River, Oostanaula River, Holly Creek, Locust Fork, North River, Cahaba River, Sipsey River, etc.) (Tennessee Department of Environment and Conservation 2005, Georgia Environmental Protection Division 2005, Alabama Department of Environmental Management 2006). Currently surviving populations of these 11 endangered and threatened mussel species retain to habitat and the cumulative effects of land use activities on aquatic environments (U.S. Fish and Wildlife Service, 2000).

EB/CE Source: U.S. Fish and Wildlife Service (FWS). 2019. Fine-lined Pocketbook (*Hamiota* (= *Lampsilis*) *altilis*), Orange-nacre Mucket (*Hamiota* (= *Lampsilis*) *perovalis*), Alabama moccasinshell (*Medionidus acutissimus*), Coosa moccasinshell (*Medionidus parvulus*), Southern Clubshell (*Pleurobema decisum*), Dark Pigtoe (*Pleurobema furvum*), Southern Pigtoe (*Pleurobema georgianum*), Ovate Clubshell (*Pleurobema perovatum*), Triangular Kidneyshell (*Ptychobranhus greenii*), 5-Year Review: Summary and Evaluation. Alabama Ecological Service Field Office. Daphne, Alabama. 69 pp.

U.S. Fish and Wildlife Service. 2005. 5-Year Review: Summary and Evaluation for the Fine-lined Pocketbook (*Hamiota altilis*), Orange-nacre Mucket (*Hamiota perovalis*), Alabama moccasinshell (*Medionidus acutissimus*), Coosa moccasinshell (*Medionidus parvulus*)

Overall Vulnerability: ☒ High ☐ Medium ☐ Low

acres in species range: 11,098,781 acres

% of range in California (i.e., where CalPUR data is available): 0%

Range overlap with Federal lands: 598,775 acres, 5.395%

Integration and Synthesis Summary: Bivalves

| Scientific Name: | Common Name: | Entity ID: |
|--------------------------------|---------------|------------|
| <i>Epioblasma capsaeformis</i> | Oyster mussel | 358 |

Family: Unionidae

VULNERABILITY

(Summary of status, environmental baseline and cumulative effects)

Status: Endangered

Distribution: Small, endemic, constrained, and/or isolated population(s); Sensitive to stochastic events (natural and/or anthropogenic)

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 oyster mussel was historically one of the most widely distributed Cumberlandian mussel species. Its range historically included four physiographic provinces (Interior Low Plateau, Cumberland Plateau, Ridge and Valley, and Blue Ridge) and six states (Alabama, Georgia, Kentucky, North Carolina, Tennessee, and Virginia). In the Cumberland River, it occurred from the base of Cumberland Falls, McCreary and Whitely counties, Kentucky, downstream to Stewart County, Tennessee. In the Tennessee River, it occurred throughout the main stem, downstream to Colbert and Lauderdale counties, Alabama. Dozens of tributaries in the Cumberland and Tennessee River systems also harbored this species historically. The oyster mussel is now considered extirpated from the entire Cumberland River system, although augmentations in the Big South Fork Cumberland River should be assessed. Oyster mussels also have been eliminated from the entire Tennessee River main stem and numerous tributaries. The remaining natural extant populations occur in the Clinch and Nolichucky rivers.

The Duck River population has been determined to be a separate species, the Duck River dartersnapper, and has only one extant population and should be considered for listing under the Act.

The Recovery Plan listed excessive sedimentation (primarily resulting from nonpoint-source loading), coal mining, gravel mining, reduced water quality below existing dams, developmental activities, water withdrawal, impoundments, and alien species as threats to the oyster mussel and its habitat.

EB/CE Source: U.S. Fish and Wildlife Service (FWS). 2019. Oyster Mussel (*Epioblasma capsaeformis*, Lea, 1831) 5-Year Review: Summary and Evaluation. Tennessee Ecological Services Field Office. Cookeville, Tennessee. 28 pp.

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

acres in species range: 11,258,596 acres

% of range in California (i.e., where CalPUR data is available): 0%

Range overlap with Federal lands: 1,814,833 acres, 16.120%

Integration and Synthesis Summary: Bivalves

| Scientific Name: | Common Name: | Entity ID: |
|---------------------------|-------------------|------------|
| <i>Pleurobema collina</i> | James spinymussel | 361 |

Family: Unionidae

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:

Although the James spinymussel still occurs at a number of sites, its rapid decline during the past two decades as well as the small size and extent of most of its remaining populations indicate that it is highly vulnerable to extirpation. This section provides a general discussion of activities in the James River basin and other river systems, and how they are thought to have contributed to the decline of freshwater mussels in the Southeast, including the James spinymussel. Siltation, generated by agricultural and forestry activities and road construction, is a significant factor contributing to water quality problems and the consequent decline of the James spinymussel. Mussels are sedentary and unable to move long distances to more suitable areas in response to heavy silt loads. Natural sedimentation resulting from seasonal storm events probably does not significantly affect mussels, but human activities often create excessively heavy silt loads that can have severe effects on mussels and other aquatic organisms (USFWS 1987). For instance, reductions in mussel abundance in the Stones River in Tennessee were thought to be a partial result of siltation from gravel dredging during summer low flow conditions (Schmidt 1982). Suspended sediment can clog the gills of filter feeding mussels and eventually suffocate them, so mussels often respond by closing their valves (Ellis 1936). Kitchel et al. (1981) reported reduced siphoning activity, and consequently reduced feeding, by mussels placed in aquaria with suspended coal fines. Indications are that siltation can severely stress mussels and lead to chronic effects. The invasion of the Asian clam may be one of the most significant threats to both the James spinymussel and the Tar River spinymussel (Clarke and Neves 1984). This potential problem was discussed in the Tar River Spinymussel Recovery Plan (USFWS 1987) and is restated in the following paragraphs. The Asian clam is one of 204 introduced mollusk species in North America (Dundee 1969). It was first discovered in the United States in the Columbia River, Oregon, in 1939. It appeared in California in the 1940's and 1950's, in the Ohio/Mississippi and Gulf of Mexico drainages in the 1960's and 1970's, and in the Atlantic drainage in the 1970's and 1980's (Clarke 1988). Once established in a river, *Corbicula fluminea* populations achieve high densities and expand rapidly. Densities of 1,000/in² in the James River,

Virginia (Diaz 1974), the New River, Virginia (Rodgers et al. 1977), and the Tar River, North Carolina (Clarke 1983), and 10,000/in² in the Altamaha River in Georgia (Gardner et al. 1976) have been reported. Clarke (1988) indicates that *Corbicula* was first introduced into the James River in 1971 near Hopewell, Virginia, about 15 miles below Richmond, and by 1984 had spread upstream to the mouth of Craig Creek, a distance of about 195 miles (an average of 15 miles per year). Malacologists are now concerned about the possibility of a competitive interaction between Asian clams and native bivalves. Quantitative studies by Cohen et al. (1984) support the hypothesis that an extensive *C. fluminea* bed in a reach of the Potomac River removed 40-60% of the phytoplankton in this reach. It is not unreasonable to conclude that *C. fluminea* has the potential to deplete the food supply of unionids. Disturbance of watersheds appears to play a role in the expansion of the Asian clam; it predominates in rivers altered by human activities, and may exclude native unionids even when suitable habitat exists. Because it is hermaphroditic, requires no fish host, and spawns twice each year, *C. fluminea* may be competitively superior to native mussels in disturbed habitats. However, even in undisturbed areas the Asian clam may ultimately gain a competitive advantage by producing larger broods (Kraemer 1979). Competition with unionids may not occur among adults but rather at the juvenile stage (Neves and Widlak 1987). Impoundments on rivers in the Southeast have been responsible for the decline of many mussel populations. Mussel populations have been eliminated from large sections of the Tennessee and Cumberland Rivers in Tennessee and Kentucky by the construction of more than 50 dams (USFWS 1984a, 1984b, 1984c, 1984d, 1987). Flood control dams under consideration in the upper James River present a similar threat to the James spiny mussel. The effects of impoundments on mussels are well documented. Closure of dams changes habitat from lotic to lentic conditions. Depth increases, flow decreases, and silt accumulates on the bottom. Hypolimnetic discharge lowers water temperatures downstream. Fish communities change, and host fish species may be eliminated. Mussel communities change, as species requiring clean gravel and sand substrate are replaced by silt-tolerant species (Bates 1962).

EB/CE Source: U.S. Fish and Wildlife Service. 1990. James Spiny mussel (*Pleurobema collina*) Recovery Plan. Newton Corner, Massachusetts. 38 pp.

Overall Vulnerability: ☒ High ☐ Medium ☐ Low

acres in species range: 8,961,720 acres

% of range in California (i.e., where CalPUR data is available): 0%

Range overlap with Federal lands: 2,033,215 acres, 22.688%

Integration and Synthesis Summary: Bivalves

| Scientific Name: | Common Name: | Entity ID: |
|------------------------------|----------------------|-------------------|
| <i>Margaritifera hembeli</i> | Louisiana pearlshell | 364 |

Family: Unionidae

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: Declining population(s) – one or more populations declining

Pesticides noted ☐

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

At the time the Recovery Plan was finalized in 1990, the state endemic Louisiana pearlshell mussel was known only to occur within the Bayou Boeuf and Bayou Rapides drainages in Rapides Parish, Louisiana. Since the finalization of that plan, the species was discovered in Grant Parish within the Bayou Rigolette watershed of the Red River drainage.

Populations of the Louisiana pearlshell mussel continue to be fragmented and isolated by impoundments. Results from a recent genetic study (Roe 2009) indicate genetic structuring and increased genetic distance between mussels on either side of the Red River, indicating that the Red River is an effective barrier to migration. That study also indicates that future impacts to genetic composition of fragmented and isolated populations are likely, with those populations upstream of Lake Iatt beginning to show signs of genetic isolation. Published survey data from the Kisatchie Nation Forest and private lands show that beaver activity in 77% of all Louisiana pearlshell mussel streams continue to cause direct effects to individuals and populations of Louisiana pearlshell mussels through inundation or stranding. Although the level of threat has been somewhat reduced via beaver control on the Kisatchie Nation Forest and private land, this threat is still significant across the range based on the distribution and number of large beds; i.e., a beaver dam could have a large impact on the total population were it to cause local extirpation of numerous beds or extremely large ones. Feral hog activity is possibly another source of impact to Louisiana pearlshell mussel. Other threats to Louisiana pearlshell mussels result from soil disturbance and sedimentation that occurs from detrimental forestry practices, all-terrain vehicle use, and construction with inadequate erosion control. Without proper installation and maintenance of temporary and long-term erosion control measures; soil disturbance, accelerated erosion, and run-off from project sites have the potential to affect Louisiana pearlshell mussels downstream, whether on private or public land. When working in Louisiana pearlshell mussel watersheds it is imperative that all concerned agencies and individuals work together, in consultation with the Service, throughout all project phases; i.e., the planning, implementation,

and maintenance phases, to ensure that water quality is protected from undue project-related erosion and sedimentation to minimize potential impacts to Louisiana pearlshell mussels. Since the Louisiana pearlshell mussel was reclassified, restrictions on forestry activities in the Kisatchie Nation Forest within stream-side management zones (USFS 1999) have been developed to protect Louisiana pearlshell mussel beds and stream water quality. Timber harvest within those zones is restricted to selective cutting for the purpose of wildlife habitat improvement. In addition to those restrictions on timber harvest, all-terrain vehicular use is restricted to designated trails only and cross-country travel is prohibited (USFS 2007a). On private land, there are voluntary BMPs associated with forestry operations but no requirements preventing the use of all-terrain vehicles in or near Louisiana pearlshell mussel habitat. Widespread adherence to the forestry BMPs would reduce the threat to the species associated with forestry practices on private land; however, to date, not all landowners are enacting the BMPs. The Louisiana Forestry Association holds private landowner workshops on forestry BMPs. The LDWF is helping interested private landowners protect Louisiana pearlshell mussel streams on their properties from detrimental uses through education and through programs like the Natural Areas Registry program.

Threats to the species have been reduced on both the Kisatchie Nation Forest and private lands via beaver control and habitat restoration activities; however, those threats identified at the time of reclassification continue to affect the species. Also, there is the potential of new threats on the horizon that warrant further investigation; i.e., feral hog activity, possible increasing predation by otters, possible raw sewage discharge into streams, stream invasion by the Asiatic clam, and possibility of extended, range-wide drought conditions. Furthermore, the overall population trend for this species (i.e., increasing, decreasing, or stable) has not yet been determined, although the second set of range-wide data needed to run the trend analysis has recently been collected (2007-2009).

EB/CE Source: U.S. Fish and Wildlife Service. 2017. Louisiana Pearlshell Mussel (*Margaritifera hembeli*) 5-Year Review: Summary and Evaluation. Louisiana Ecological Services Office. Lafayette, Louisiana. 55 pp.

Overall Vulnerability: ☒ High ☐ Medium ☐ Low

acres in species range: 2,706,561.2 acres

% of range in California (i.e., where CalPUR data is available): 0%

Range overlap with Federal lands: 514,709.7 acres, 19.02%

Integration and Synthesis Summary: Bivalves

| Scientific Name: | Common Name: | Entity ID: |
|---------------------------------|-----------------------------|-------------------|
| <i>Elliptioideus sloatianus</i> | Purple bankclimber (mussel) | 366 |

Family: Unionidae

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:

Five populations appear stable with varying numbers of juveniles and/or sub-adults: Apalachicola, Chipola, Middle Flint, Lower Flint, and Lower Ochlockonee. However, evidence of natural recruitment is limited and the species is presumably relying on secondary host fish within most of its range. Despite a large estimated subpopulation in the upper reaches of the Apalachicola River, the species occurs sporadically and in low numbers in the rest of the river and in the Upper Flint and Chipola sub-basins. The species is also experiencing an apparent decline in abundance in the Upper Ochlockonee sub-basin.

The decline in range and abundance of the purple bankclimber was due to activities that decreased water quality, changed natural flow regimes, increased isolation, and directly altered riverine habitat. These effects were the result of dams, dredging, mining, channelization, pollution, sedimentation, and water withdrawals (USFWS 2003; 71 FR 32746).

Overall, the species and its habitat continue to be impacted by excessive sediment, channel instability, reduced water quality, developmental activities, water withdrawal, drought, impoundments, and invasive species. The degree of threat to the persistence of this threatened species remains moderate, and the potential for recovery remains low.

EB/CE Source: U.S. Fish and Wildlife Service (FWS). 2020. Purple Bankclimber (*Elliptioideus sloatianus*) 5-Year Review: Summary and Evaluation. Panama City Ecological Services Field Office. Panama City, Florida. 26pp.

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

acres in species range: 0 acres

% of range in California (i.e., where CalPUR data is available): 0%

Range overlap with Federal lands: acres, %

Integration and Synthesis Summary: Bivalves

| Scientific Name: | Common Name: | Entity ID: |
|---------------------------|---------------------|-------------------|
| <i>Lampsilis powellii</i> | Arkansas fatmucket | 369 |

Family: Unionidae**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:** Declining population(s)**Pesticides noted** ☐**Environmental Baseline/Cumulative Effects (EB/CE) Summary:**

At the time of listing in 1990, Arkansas Fatmucket was extant in the Ouachita River upstream of Lake Ouachita, South Fork Ouachita River upstream of Lake Ouachita, Alum, Middle, North forks of the Saline River, Saline River upstream of the Fall Line, and Caddo River. There are new range extensions within the Ouachita and Saline rivers since listing, but not since the last 5-year review. While extant populations of Arkansas Fatmucket occur throughout most of the historical range, Scott (2004) and Christian et al. (2006) documented significant population declines and reduced distribution. The AGFC and Service conducted two rangewide, comprehensive surveys since these assessments, the most recent occurring in 2015, and document further declines in distribution and abundance (K. Moles, AGFC, pers. comm.; C. Davidson, Service, pers. comm.). The demise of population strongholds during a relatively short period (late 1980s – 2015) is perplexing. With increased distance between occupied habitat patches, reduced abundance, and continuing or increasing threats to Arkansas Fatmucket, this species faces potential extirpation from the Ouachita, South Fork Ouachita, Middle Fork Saline, North Fork Saline, and Caddo rivers. Populations thought to be strongholds in the Saline River headwaters (Alum, Middle, North forks) during the last 5-year review now face potential extirpation due to recent substantial population declines (fewer sites and individuals) from 2007 – 2015. Potential extinction is imminent without continued propagation and widespread conservation to minimize threats. Addressing threats alone is insufficient to ensure population viability due to small population size and stochastic events such as multiple large flood events in past decade and increasing urbanization that contributed to increased sedimentation and reductions in number of sites and individuals. Increasingly small and isolated populations in the Saline River basin are becoming increasingly more susceptible to stochastic events and ongoing and/or increasing anthropogenic effects (see Five Factor Analysis). The Alum Fork Saline River and Saline River appear to be the strongholds for this species, but these populations face threats associated with encroaching urbanization.

A number of factors continue to affect extant populations and/or limit recovery of the species. Urbanization into rural areas of the upper Saline and Caddo watersheds continues to increase and appears to be a primary source of habitat and water quality degradation. Percent urban land use in the Saline and Caddo watersheds was 5 and 6 percent, respectively, in 2016. From 2011 – 2016, percent urban land cover increased 0.5 and 0.9 percent, respectively, in these watersheds (2016 Land Use Land Cover dataset). However, the majority of this conversion to urban in the Saline River watershed is occurring in the headwaters (Benton, Bryant, Haskell, Salem) where Arkansas Fatmucket occurs, which likely means the percent land conversion within the headwaters region is greater than 1%. Threats appear to be stable since the last 5-year review in the Ouachita River headwaters.

The expansion of consumptive water withdrawals, diversions, and impoundments is another contributing factor to increases in elevated turbidity during storm events, soil erosion/sediment instability, and hydrologic alteration in the upper Saline River watershed. Extant populations vary in levels of protection, and effects from these threats may be difficult to alleviate. Encouraging private landowners, corporations, and local, state, and federal governments to be more proactive in implementing conservation measures that benefit both terrestrial and aquatic habitats in these watersheds is critical.

Captive propagation, augmentation, and reintroduction are necessary to increase resiliency and achieve sufficient redundancy. Due to the restricted range, geographic isolation of most extant populations, and small population size, the species is likely suffering genetic isolation and reduced adaptive capacity throughout much of its range, resulting in lower representation. Given current and expected future decreases in resiliency, populations become more vulnerable to extirpation from stochastic events resulting in concurrent losses in representation and redundancy.

The synergistic (interaction of two or more components) effects of threats are often complex in aquatic environments, making it difficult to predict changes in mussel and fish host(s) distribution, abundance, and habitat availability that may result from these effects. While these stressors may act in isolation, it is more probable that many stressors are acting simultaneously (or in combination) on Arkansas Fatmucket populations. Given increases in threats in the Saline River headwaters and Caddo River and decreases in population range and size, we conclude that the Arkansas Fatmucket is in danger of extinction throughout all or a significant portion of its range; and therefore, we recommend reclassification to endangered.

EB/CE Source: U.S. Fish and Wildlife Service (FWS). 2020. Arkansas Fatmucket (*Lampsilis powellii*) 5-Year Review: Summary and Evaluation. Arkansas Ecological Services Field Office. Conway, Arkansas. 40 pp.

Overall Vulnerability: ☒ High ☐ Medium ☐ Low

acres in species range: 2,767,156 acres

% of range in California (i.e., where CalPUR data is available): 0%

Range overlap with Federal lands: 1,115,032 acres, 40.295%



Integration and Synthesis Summary: Bivalves

| Scientific Name: | Common Name: | Entity ID: |
|-----------------------------|---------------------|-------------------|
| <i>Pleurobema pyriforme</i> | Oval pigtoe | 371 |

Family: Unionidae

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 oval pigtoe historically occurred in 14 sub-basins (USFWS 2003) and currently occupies 10 sub-basins in Georgia, Alabama, and Florida: the Upper Flint, Middle Flint, Kinchafoonee-Muckalee, Ichawaynochaway, Spring Creek, Lower Chattahoochee, Chipola, Santa Fe, Lower Suwannee, and Econfinia Creek. During this review period, survey data illustrates within sub-basin mussel distribution varied by sub-basin with localized extirpations (e.g., Upper Flint and Upper Ochlockonee), potential stability (e.g., Chipola, Econfinia Creek, Lower Chattahoochee, Middle Flint, and Spring Creek), and possible expansion (e.g., Lower Suwannee). The Lower Chattahoochee, Middle Flint, and Spring Creek populations are isolated and limited in distribution, and thus are susceptible to human or naturally caused catastrophic events and environmental variability. Loss of any of these populations may reduce species redundancy and representation. Overall, the species has continued to decline in distribution within its historical range.

The Econfinia, Lower Chattahoochee (Sawhatchee and Sheffield Mill Creeks), Middle Flint (Chokee Creek), Spring, and Chipola populations (i.e., sub-basins) have remained stable and/or have evidence of recruitment. The remaining sub-basins (e.g., Upper Flint, Kinchafoonee-Muckalee, Ichawaynochaway, Santa Fe, and Lower Suwannee) have minimal numbers of individuals and have no evidence of recruitment. In addition, the oval pigtoe is possibly extirpated from the Upper Ochlockonee sub-basin. Most sub-basins consist of localized, fragmented sites with generally small numbers of individuals. Three of the stable populations are restricted to short stream reaches and remain vulnerable to random natural or human-induced events such as droughts or spills.

The decline in range and abundance of the oval pigtoe was due to activities that decreased water quality, changed natural flow regimes, increased isolation, and directly altered riverine habitat. These effects were the result of dams, dredging, mining, channelization, pollution, sedimentation, and water withdrawals (USFWS 2003; 71 FR 32746).

Overall, the species and its habitat continue to be impacted by excessive sediment, channel instability, reduced water quality, developmental activities, water withdrawal, drought, impoundments, and invasive species. The degree of threat to the persistence of this endangered species remains high, and the potential for recovery remains low.

EB/CE Source: U.S. Fish and Wildlife Service (FWS). 2020. Oval Pigtoe (*Pleurobema pyriforme*) 5-Year Review: Summary and Evaluation. Panama City Ecological Services Field Office. Panama City, Florida. 27pp.

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

acres in species range: 15,056,748 acres

% of range in California (i.e., where CalPUR data is available): 0%

Range overlap with Federal lands: 421,658 acres, 2.800%

Integration and Synthesis Summary: Bivalves

| Scientific Name: | Common Name: | Entity ID: |
|--------------------------|----------------------|-------------------|
| <i>Lampsilis altilis</i> | Finelined pocketbook | 372 |

Family: Unionidae

VULNERABILITY

(Summary of status, environmental baseline and cumulative effects)

Status: Threatened

Distribution: Species/Populations neither constrained nor widespread

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 finelined pocketbook was historically reported from the Tombigbee, Black Warrior, Cahaba, Alabama, Tallapoosa, and Coosa Rivers and many of the their tributaries in Alabama, Georgia, Mississippi, and Tennessee. Williams et al. (2008) reports that the finelined pocketbook occurs in the eastern portion of the Mobile Basin from the Coosa River drainage headwaters downstream to Claiborne, Monroe County, Alabama. Williams et al. (2008) also suggests that while some specimens from the Black Warrior and Tombigbee drainages look very similar to the finelined pocketbook, their identity remains unresolved.

The finelined pocketbook continues to survive in the upper Cahaba River and its tributaries Shades Creek (Shelby/Bibb Counties, Alabama), Sixmile Creek (Bibb County, Alabama), and Little Cahaba River (Jefferson, Shelby, and Bibb Counties, Alabama). It also continues to survive in the Coosa River (Elmore County, Alabama to Floyd County, Georgia) and its tributaries, including, Ellijay River and its tributary, Boardtown Creek (Gilmer County, Georgia), Shoal Creek (Cherokee County, Georgia), Duck Creek (Walker County, Georgia), Armuchee Creek (Floyd County, Georgia), Euharlee Creek (Bartow and Polk Counties, Georgia), Conasauga River (Murray and Whitfield Counties, Georgia; Polk and Bradley Counties, Tennessee), and Holly Creek (Murray County, Georgia), Terrapin Creek and South Fork Terrapin Creek (Cleburne County, Alabama), Big Canoe Creek (St. Claire County, Alabama) and its tributary Little Canoe Creek (Etowah and St. Claire Counties, Alabama), Chestnut Creek (Chilton County, Alabama); Yellowleaf Creek and its tributary Muddy Prong (Shelby County, Alabama); Kelly Creek and its tributary Shoal Creek (Shelby and St. Claire County, Alabama); Choccolocco Creek (Calhoun County, Alabama) and its tributary Cheaha Creek (Talladega and Clay Counties, Alabama) and its tributaries Hubbard Creek (Clay County, Alabama), and Horse Creek (Talladega County, Alabama); Shoal Creek (Cleburne County, Alabama), Hatchet Creek (Coosa and Clay Counties, Alabama), and Tallasahatchee Creek (Talladega County, Alabama); and the Tallapoosa River and tributaries, including Uphapee

Creek (Macon County, Alabama), Choctafaula Creek (Macon and Lee Counties, Alabama), Boba Creek (Cleburne County, Alabama), Sandy and Little Creeks (Chambers County, Alabama); Chewacla Creek (Macon and Lee Counties, Alabama) and its tributary Cossey Branch (Macon County, Alabama), Opintlocco Creek (Macon County, Alabama), Cane and Little Cane Creeks (Cleburne County, Alabama), Muscadine Creek (Cleburne County, Alabama); Big Creek, Little River, Little Creek, Beach Creek, Brooks Creek, and Watermill Creek (Haralson County, Georgia), and McClendon Creek (Paulding County, Georgia).

The primary cause of curtailment of range and fragmentation of habitat for the finelined pocketbook is construction of dams and impoundment of large reaches of major river channel (58 FR 14330). These conditions continue to affect the species, although flow improvements have been made, or are planned below some Coosa River dams (e.g., Weiss Bypass Working Group 2005).

Other causes of habitat and range curtailment identified at listing included dredging, mining, and historical or episodic pollution events (58 FR 14330), sedimentation, increased nutrients, urbanization, loss of *Podostemum* (aquatic plant) and riparian buffers, and climate change. The results of dredging (i.e., headcutting) continues to affect mussel populations in some Tombigbee River tributaries. Coal mining activities continue to expand within the Locust Fork, Cahaba River, and Buttahatchee River basins. Pollution continues to be a factor at most sites as well.

EB/CE Source: U.S. Fish and Wildlife Service (FWS). 2019. Finelined Pocketbook (*Hamiota* (= *Lampsilis*) *altilis*), Orange-nacre Mucket (*Hamiota* (= *Lampsilis*) *perovalis*), Alabama moccasinshell (*Medionidus acutissimus*), Coosa moccasinshell (*Medionidus parvulus*), Southern Clubshell (*Pleurobema decisum*), Dark Pigtoe (*Pleurobema furvum*), Southern Pigtoe (*Pleurobema georgianum*), Ovate Clubshell (*Pleurobema perovatum*), and Triangular Kidneyshell (*Ptychobranhus greenii*) 5-Year Review: Summary and Evaluation. Alabama Ecological Service Field Office. Daphne, Alabama. 69 pp.

Overall Vulnerability: ☒ High ☐ Medium ☐ Low

acres in species range: 10,589,776 acres

% of range in California (i.e., where CalPUR data is available): 0%

Range overlap with Federal lands: 1,282,854 acres, 12.114%

Integration and Synthesis Summary: Bivalves

| Scientific Name: | Common Name: | Entity ID: |
|-------------------------------------|----------------------|------------|
| <i>Epioblasma torulosa rangiana</i> | Northern riffleshell | 374 |

Family: Unionidae

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 best available information indicates that the northern riffleshell is known to currently occur in 13 populations, four of which are stable and recruiting. Of the four recruiting populations, three are apparently large and occur in the Allegheny River, French Creek, and East Branch Sydenham River. A fourth, smaller population occurs, as of 2006, in the Ausable River. Each of these populations is susceptible to both natural stochastic events, such as floods, and anthropogenic threats, such as toxic spills. Although northern riffleshells have been documented in one additional Allegheny River tributary (besides French Creek), and two French Creek tributaries, the species occurs in the lower reaches of these streams, and these occurrences may not be self-sustaining if the mainstem population is damaged.

In contrast to the above populations, five northern riffleshell populations have declined since the species was listed as endangered in 1994, and some of these may be extirpated. Extirpated or nearly extirpated populations include the following: the Detroit River, following zebra mussel infestation; the Green River, possibly due to point and non-point inputs, and hydrologic controls on flow and temperature from Green River Reservoir; Big Darby Creek, as a result of urban and agricultural runoff; Fish Creek, following a 1993 diesel fuel spill; and the Tippecanoe River, where no living or freshly dead northern riffleshells have been observed since the 1970s. A few individual specimens have been reported from the Elk River in West Virginia; however, no evidence of successful reproduction has been reported from this stream since 2003. Although specific events are cited as causing the apparent loss of several northern riffleshell populations, these events likely worked in concert with other events that cumulatively reduced overall population levels to the extent that a single event likely resulted in extirpation. However, translocations may bolster populations in some streams such as Big Darby Creek, which has received several thousand northern riffleshells from the Allegheny River between 2010 and 2018, and the Tippecanoe River, which has received over 3,000 northern riffleshells from the Allegheny River from 2016 to 2018.

In many cases, diverse freshwater mussel populations persist where northern riffleshells have not. Like other *Epioblasma*, this species may be more sensitive to environmental perturbations than other mussel species (Haag 2012). This may be because life history traits make recovery from a disturbance less likely than with other mussels, or because this species is more sensitive to silt and contaminants.

The large populations of the northern riffleshell in Pennsylvania provide a potential source of animals to implement recovery actions described in the Recovery Plan. For example, in 2015-2016, 27,506 individuals were removed from bridge and pipeline project sites to augment populations in 11 rivers elsewhere in the species' range. However, translocation and population augmentation will work only to the extent that historical habitat is now suitable. Because the reasons for the original decline of the northern riffleshell have often not been identified, transferred animals may also not survive.

The northern riffleshell should continue to remain listed as endangered because the species has continued to decline and threats have not been ameliorated, as evidenced by the unmet criterion for downlisting to threatened. Declining populations and loss of habitat in the Ohio River basin are not compensated for by the locally abundant but geographically limited populations in Pennsylvania and Ontario. Numerous threats persist for the remaining northern riffleshell populations, including invasive species, the effects of small population sizes, habitat alteration, land-use changes, changing precipitation and temperature patterns, and point and non-point source pollution. The life history and environmental sensitivity of the northern riffleshell is poorly known, increasing the threat that previously unidentified activities could cause a precipitous decline of one or more of the remaining reproducing populations.

EB/CE Source: U.S. Fish and Wildlife Service (FWS). 2019. Northern Riffleshell (*Epioblasma torulosa rangiana*) 5-Year Review: Summary and Evaluation. Pennsylvania Field Office. State College, Pennsylvania. 33 pp.

Overall Vulnerability: ☒ High ☐ Medium ☐ Low

acres in species range: 14,500,152 acres

% of range in California (i.e., where CalPUR data is available): 0%

Range overlap with Federal lands: 322,312 acres, 2.223%

Integration and Synthesis Summary: Bivalves

| Scientific Name: | Common Name: | Entity ID: |
|----------------------------|---------------------|-------------------|
| <i>Pleurobema gibberum</i> | Cumberland pigtoe | 376 |

Family: Unionidae

VULNERABILITY

(Summary of status, environmental baseline and cumulative effects)

Status: Endangered

Distribution: Small, endemic, constrained, and/or isolated population(s); Sensitive to stochastic events (natural and/or anthropogenic)

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 Cumberland pigtoe was listed due to reduction of its historical range and ongoing threats to its continued existence. The species appears extirpated from the mainstem Caney Fork River and lower Hickory Creek (Service 1992). Since the recovery plan was written, additional populations of the Cumberland pigtoe have been discovered in several other upper Caney Fork River drainage streams, including Liberty Creek, North Prong Barren Fork, Witty Creek, Hills Creek, and West Fork Hickory Creek (Ahlstedt et al. 2004). While the species may persist in streams where it currently occurs, natural recovery may be precluded throughout the entirety of its known range due to sediment, contaminants, and continued operations at Great Falls Dam that manipulate Great Falls Reservoir pool elevations. These threats have fragmented Cumberland pigtoe populations and continue to affect water quality and habitat. The potential for stochastic events such as toxic chemical spills also remain a threat to the Cumberland pigtoe. Unless these threats are addressed and/or new populations are discovered or created using propagated individuals, achieving existing recovery criteria to reestablish the species will be problematic.

While some life history aspects of the Cumberland pigtoe have been studied since the recovery plan was finalized, resulting in new information about the species' glochidial fish hosts, reproductive cycle and habitat utilization (Layzer et al. 2003), much of the recovery criteria in the recovery plan have not been met. Comprehensive surveys to locate and quantify Cumberland pigtoes in the upper Caney Fork River drainage have not been attempted in over a decade. The total amount of suitable habitat available to the species has also not been quantified.

EB/CE Source: U.S. Fish and Wildlife Service (FWS). 2015. Cumberland Pigtoe (*Pleurobema gibberum* = *Pleuonaia gibberum*) 5-Year Review: Summary and Evaluation. Tennessee Ecological Services Field Office. Cookeville, Tennessee. 24 pp.

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

acres in species range: 2,363,093 acres

% of range in California (i.e., where CalPUR data is available): 0%

Range overlap with Federal lands: 43,329 acres, 1.834%

Integration and Synthesis Summary: Bivalves

| Scientific Name: | Common Name: | Entity ID: |
|-----------------------------|-----------------|------------|
| <i>Pleurobema perovatum</i> | Ovate clubshell | 377 |

Family: Unionidae

VULNERABILITY

(Summary of status, environmental baseline and cumulative effects)

Status: Endangered

Distribution: Small, endemic, constrained, and/or isolated population(s); Sensitive to stochastic events (natural and/or anthropogenic)

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 ovate clubshell was historically distributed in the Tombigbee, Black Warrior, Alabama, Cahaba, and Coosa Rivers and their tributaries in Mississippi and Alabama; and in Chewacla, Uphapee and Opintlocco Creeks in the Tallapoosa River drainage, Alabama.

The Sipsey River (Tuscaloosa, Greene, and Pickens County, Alabama) has the most robust populations (MRDMRC 2010), and is locally common at some locations in the lower Sipsey River (McCullagh et al. 202), where recent (2016) surveys recorded densities between 0-0.2 individuals/m² (C. Atkinson pers. comm. 2018). During a 2013-2014 survey of the Buttahatchee River drainage (Alabama and Mississippi), a total of 28 ovate clubshell were found at 13 of 35 sites (qualitative samples) and was the 10th most encountered out of 27 total mussel species, but was only detected in three of 389 quadrants for a mean density of 0.03/m² (Gangloff et al. 2015). Several juvenile *Pleurobema perovatum* were found at a site in Wilson Creek (Lamar County, Alabama), indicative of a healthy, reproducing population (Buntin et al. 2015). Additionally, tributary populations have been discovered in several Tombigbee River tributaries, including East Fork Tombigbee River and Bull Mountain Creek (Itawamba County, Mississippi), Trussels Creek (Greene County, Alabama), and Wilson Creek (Lamar County, Alabama) (Buntin et al. 2015); the Cahaba River tributary, Oakmulgee Creek (Dallas County, Alabama); and several Alabama River tributaries, McCalls and Sturdivant Creek (Wilcox County, Alabama) and Tallatchee Creek (Monroe County, Alabama).

The primary cause of curtailment of range and fragmentation of habitat for the ovate clubshell is construction of dams and impoundment of large reaches of major river channel (58 FR 14330). Although most of these actions took place in the past, the impacted conditions and habitat continue to affect the species.

Other causes of habitat and range curtailment identified at listing included dredging, mining, and historical or episodic pollution events (58 FR 14330), sedimentation, increased nutrients, urbanization, loss of *Podostemum* (aquatic plant) and riparian buffers, and climate change. The results of dredging (i.e., headcutting) continues to affect mussel populations in some Tombigbee River tributaries. Coal mining activities continue to expand within the Locust Fork, Cahaba River, and Buttahatchee River basins impacting water quality and habitat conditions. Pollution and water quality impairments continue to be a factor at most sites as well.

EB/CE Source: U.S. Fish and Wildlife Service (FWS). 2019. Fine-lined Pocketbook (*Hamiota* (= *Lampsilis*) *altilis*), Orange-nacre Mucket (*Hamiota* (= *Lampsilis*) *perovalis*), Alabama moccasinshell (*Medionidus acutissimus*), Coosa moccasinshell (*Medionidus parvulus*), Southern Clubshell (*Pleurobema decisum*), Dark Pigtoe (*Pleurobema furvum*), Southern Pigtoe (*Pleurobema georgianum*), Ovate Clubshell (*Pleurobema perovatum*), and Triangular Kidneyshell (*Ptychobranhus greenii*) 5-Year Review: Summary and Evaluation. Alabama Ecological Service Field Office. Daphne, Alabama. 69 pp.

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

acres in species range: 14,973,728 acres

% of range in California (i.e., where CalPUR data is available): 0%

Range overlap with Federal lands: 1,349,390 acres, 9.012%

Integration and Synthesis Summary: Bivalves

| Scientific Name: | Common Name: | Entity ID: |
|---------------------------|---------------------|-------------------|
| <i>Pleurobema decisum</i> | Southern clubshell | 378 |

Family: Unionidae

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:

With the exception of the Tensaw/Mobile River, the southern clubshell was formerly known from every major river system in the Mobile River Basin, including the Alabama, Tombigbee, Black Warrior, Cahaba, Tallapoosa, and Coosa Rivers and many of their tributaries in Mississippi, Alabama, Georgia, and Tennessee. The southern clubshell has improved since the time of listing and now is known to occur within 24 mainstem or tributary populations within each of the historic major river systems; the Mobile River Basin; Alabama River, Cahaba River, Coosa River, Tallapoosa River, and the Tombigbee River. Southern clubshell continues to inhabit the East Fork Tombigbee River, Bull Mountain Creek, Buttanhatchee River, Luxapalila and Yellow Creeks, Bogue Chitto Creek, Lubbub Creek and its tributary Bear Creek, and Sipsey River in the Tombigbee drainage; a short reach of the Alabama River and Gogue Chitto Creek; Cahaba River and its tributary Shultz Creek; Uphapsee Creek and Chewacla Creek in the Tallapoosa drainage; Coosa River below Weiss Dam, below Logan Martin Dam, and below Jordan Dam, and tributaries Yellowleaf Creek, Big Canoe Creek and both Little Canoe creeks, Terrapin Creek, and Conasauga River (Alabama Department of Conservation and Natural Resources/U.S. Fish and Wildlife Service collection records, 1998, 1999; Buntin 2017; Buntin *et al.* 2015; Devries 2012; Devries and Stoeckel 2018; Dinkins 2008; Evans 2001; Feminella Gangloff 2000; Gangloff 2005; Gangloff 2015; Gangloff and Feminella 2007; Golder Associates 2008; Fobian *et al.* 2017; Harfield and Bowker 1992; Hartfield and Jones 1989, 1990; Herod *et al.* 2001; Johnson *et al.* 2005; Jones 1991; Jones and Majure 1999; McGregor 1993, 1999; McGregor *et al.* 1996; Miller 2000; Miller and Hartfield, 1988; Pierson, 1991a, b; Wynn *et al.* 2016; Yokley 2001; and Wisniewski pers. comm. 2019).

The primary cause of curtailment of range and fragmentation of habitat for southern clubshell has been contributed to the historic construction of dams and impoundment of large reaches of major river channel (58 FR 14330). Although most of these actions took place in the past, the impacted conditions and habitat continue to affect the species. In recent years, some

improvements have been made below Weiss Dam on the Coosa River that benefit existing populations of southern clubshell located downstream of the dam.

Other potential causes of habitat and range curtailment include dredging, mining, and historical or episodic pollution events (58 FR 14330), sedimentation, increased nutrients, urbanization, loss of Podostemum (aquatic plants) and riparian buffers, and climate change. The results of dredging (i.e., headcutting) continues to affect mussel populations in some Tombigbee River tributaries. Coal mining activities continue to expand within the Locust Fork, Cahaba River, and buttahatchee River basins impacting water quality and habitat conditions. Pollution and water quality impairments continue to be a factor at most sites as well.

EB/CE Source: U.S. Fish and Wildlife Service (FWS). 2019. Fine-lined Pocketbook (*Hamiota* (=Lampsilis) *altilis*), Orange-nacre Mucket (*Hamiota* (=Lampsilis) *perovalis*), Alabama moccasinshell (*Medionidus acutissimus*), Coosa moccasinshell (*Medionidus parvulus*), Southern Clubshell (*Pleurobema decisum*), Dark Pigtoe (*Pleurobema furvum*), Southern Pigtoe (*Pleurobema georgianum*), Ovate Clubshell (*Pleurobema perovatum*), and Triangular Kidneyshell (*Ptychobranhus greenii*) 5-Year Review: Summary and Evaluation. Alabama Ecological Service Field Office. Daphne, Alabama. 69 pp.

Overall Vulnerability: ☒ High ☐ Medium ☐ Low

acres in species range: 21,475,329 acres

% of range in California (i.e., where CalPUR data is available): 0%

Range overlap with Federal lands: 1,340,457 acres, 6.242%

Integration and Synthesis Summary: Bivalves

| Scientific Name: | Common Name: | Entity ID: |
|-------------------------------|-----------------------|------------|
| <i>Medionidus acutissimus</i> | Alabama moccasinshell | 380 |

Family: Unionidae

VULNERABILITY

(Summary of status, environmental baseline and cumulative effects)

Status: Threatened

Distribution: Small, endemic, constrained, and/or isolated population(s); Sensitive to stochastic events (natural and/or anthropogenic)

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 Alabama moccasinshell was historically known from the Alabama, Tombigbee, Black Warrior, Cahaba, and Coosa Rivers and their tributaries in Alabama, Mississippi, Georgia, and Tennessee. The species has disappeared from the mainstems of all these rivers, but continues to survive in Tombigbee River tributaries, including Bull Mountain Creek, Trussels Creek, Luxapalila Creek including Yellow Creek and tributary Wilson Creek; Buttahatchee River, and tributary Sipsey Creek, Lubbub Creek and its tributary Bear Creek, and Sipsey River; Black Warrior River tributaries, including Fivemile Creek and the Sipsey Fork and tributaries; and the Conasauga River and its tributary, Holly Creek in the Coosa River drainage (Buntin *et al.* 2015; Dodd *et al.* 1986; Evans 2001; Gangloff 2015; Hartfield and Bowker 1992; Hartfield and Jones 1989, 1990; Johnson *et al.* 2005; Johnson and Evans 2000; Jones 1991; Jones and Majure 1999; McGregor 1992; McGregor *et al.* 1996; McGregor 2000; McGregor *et al.* 2000; Moran 2016, 2017; MRBMRC 2010; MS Museum of Natural Science collection record 1984-2001; Pierson, 1991a, b; USFWS 2011; Waren and Haag 1994; Yokley 2001; and C. Atkinson pers. comm. 2018). The Alabama moccasinshell is currently stable and not known to have lost any known populations since the time of listing.

The primary cause of curtailment of range and fragmentation of habitat for Alabama moccasinshell has been contributed to the historic construction of dams and impoundment of large reaches of major river channel (58 FR 14330). Although most of these actions took place in the past, the impacted conditions and habitat continue to affect the species.

Other potential causes of habitat and range curtailment include dredging, mining, and historical or episodic pollution events (58 FR 14330), sedimentation, increased nutrients, urbanization, loss of Podostemum (aquatic plants) and riparian buffers, and climate change. The results of dredging (i.e., headcutting) continues to affect mussel populations in some Tombigbee River tributaries. Coal mining activities continue to expand within the Locust Fork, Cahaba River, and

buttahatchee River basins impacting water quality and habitat conditions. Pollution and water quality impairments continue to be a factor at most sites as well.

EB/CE Source: U.S. Fish and Wildlife Service (FWS). 2019. Fine-lined Pocketbook (*Hamiota* (= *Lampsilis*) *altilis*), Orange-nacre Mucket (*Hamiota* (= *Lampsilis*) *perovalis*), Alabama moccasinshell (*Medionidus acutissimus*), Coosa moccasinshell (*Medionidus parvulus*), Southern Clubshell (*Pleurobema decisum*), Dark Pigtoe (*Pleurobema furvum*), Southern Pigtoe (*Pleurobema georgianum*), Ovate Clubshell (*Pleurobema perovatum*), and Triangular Kidneyshell (*Ptychobranthus greenii*) 5-Year Review: Summary and Evaluation. Alabama Ecological Service Field Office. Daphne, Alabama. 69 pp.

Overall Vulnerability: ☒ High ☐ Medium ☐ Low

acres in species range: 10,502,156 acres

% of range in California (i.e., where CalPUR data is available): 0%

Range overlap with Federal lands: 1,096,180 acres, 10.438%

Integration and Synthesis Summary: Bivalves

| Scientific Name: | Common Name: | Entity ID: |
|----------------------------|---------------------|-------------------|
| <i>Medionidus parvulus</i> | Coosa moccasinshell | 381 |

Family: Unionidae

VULNERABILITY

(Summary of status, environmental baseline and cumulative effects)

Status: Endangered

Distribution: Small, endemic, constrained, and/or isolated population(s); Sensitive to stochastic events (natural and/or anthropogenic)

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 Coosa moccasinshell has been historically reported from the Cahaba River, the Sipsey Fork of the Black Warrior River, and the Coosa River, and their tributaries, in Alabama, Georgia and Tennessee. Since this species was listed, its presence has been confirmed only in the Conasauga River and its tributary, Holly Creek. Its total distribution is thought to be less than eight stream miles in the Conasauga River and Holly Creek combined (Johnson 2012a). It has apparently been eliminated from the Cahaba and Black Warrior River drainages, as well as from the Coosa River and many of its tributaries.

The primary cause of curtailment of range and fragmentation of habitat for Coosa moccasinshell has been contributed to the historic construction of dams and impoundment of large reaches of major river channel (58 FR 14330). Although most of these actions took place in the past, the impacted conditions and habitat continue to affect the species.

Other potential causes of habitat and range curtailment include dredging, mining, and historical or episodic pollution events (58 FR 14330), sedimentation, increased nutrients, urbanization, loss of *Podostemum* (aquatic plants) and riparian buffers, and climate change. Pollution and water quality impairments continue to be a factor at most sites as well.

The primary cause of curtailment of range and fragmentation of habitat for all 11 mussel species is construction of dams and impoundment of large reaches of major river channel (58 FR 14330).

EB/CE Source: U.S. Fish and Wildlife Service (FWS). 2019. Fine-lined Pocketbook (*Hamiota* (= *Lampsilis*) *altilis*), Orange-nacre Mucket (*Hamiota* (= *Lampsilis*) *perovalis*), Alabama moccasinshell (*Medionidus acutissimus*), Coosa moccasinshell (*Medionidus parvulus*), Southern Clubshell (*Pleurobema decisum*), Dark Pigtoe (*Pleurobema furvum*), Southern Pigtoe (*Pleurobema georgianum*), Ovate Clubshell (*Pleurobema perovatum*), and Triangular

Kidneyshell (*Ptychobranhus greenii*) 5-Year Review: Summary and Evaluation. Alabama Ecological Service Field Office. Daphne, Alabama. 69 pp.

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

acres in species range: 4,165,840 acres

% of range in California (i.e., where CalPUR data is available): 0%

Range overlap with Federal lands: 893,943 acres, 21.459%

Integration and Synthesis Summary: Bivalves

| Scientific Name: | Common Name: | Entity ID: |
|--------------------------|--------------|------------|
| <i>Pleurobema furvum</i> | Dark pigtoe | 382 |

Family: Unionidae

VULNERABILITY

(Summary of status, environmental baseline and cumulative effects)

Status: Endangered

Distribution: Small, endemic, constrained, and/or isolated population(s); Sensitive to stochastic events (natural and/or anthropogenic)

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 historic distribution of the dark pigtoe was probably restricted to the Black Warrior River system above the fall line. Since listing, the presence of the dark pigtoe has been confirmed in the Black Warrior River drainage from Sipsey Fork and its tributaries Caney, Borden, Flannigan, Brushy, Brown, Rush, and Capsey Creeks; North River and its tributary Clear Creek; and from Locust Fork (Alabama Malacological Research Center, *in litt.*, 1996 Dodd *et al.* 1986; McGregor 1992; McGregor *et al.* 2013; McGregor and Wynn 2008, Moran 2010, 2011, 2012, 2013, 2015, 2017; Pierson 1992a; Shepard *et al.* 1998; USFWS 2011; Vittor and Associates 1993; Warren and Haag 1994).

The primary cause of curtailment of range and fragmentation of habitat for Dark pigtoe has been contributed to the historic construction of dams and impoundment of large reaches of major river channel (58 FR 14330). Although most of these actions took place in the past, the impacted conditions and habitat continue to affect the species.

Other potential causes of habitat and range curtailment include dredging, mining, and historical or episodic pollution events (58 FR 14330), sedimentation, increased nutrients, urbanization, loss of *Podostemum* (aquatic plants) and riparian buffers, and climate change. Pollution and water quality impairments continue to be a factor at most sites as well.

EB/CE Source: U.S. Fish and Wildlife Service (FWS). 2019. Fine-lined Pocketbook (*Hamiota* (= *Lampsilis*) *altilis*), Orange-nacre Mucket (*Hamiota* (= *Lampsilis*) *perovalis*), Alabama moccasinshell (*Medionidus acutissimus*), Coosa moccasinshell (*Medionidus parvulus*), Southern Clubshell (*Pleurobema decisum*), Dark Pigtoe (*Pleurobema furvum*), Southern Pigtoe (*Pleurobema georgianum*), Ovate Clubshell (*Pleurobema perovatum*), and Triangular Kidneyshell (*Ptychobranhus greenii*) 5-Year Review: Summary and Evaluation. Alabama Ecological Service Field Office. Daphne, Alabam. 69 pp.

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

acres in species range: 2,834,403 acres

% of range in California (i.e., where CalPUR data is available): 0%

Range overlap with Federal lands: 354,824 acres, 12.518%

Integration and Synthesis Summary: Bivalves

| Scientific Name: | Common Name: | Entity ID: |
|------------------------------|-----------------|------------|
| <i>Pleurobema georgianum</i> | Southern pigtoe | 383 |

Family: Unionidae

VULNERABILITY

(Summary of status, environmental baseline and cumulative effects)

Status: Endangered

Distribution: Small, endemic, constrained, and/or isolated population(s); Sensitive to stochastic events (natural and/or anthropogenic)

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:

All populations of the southern pigtoe appear to be small and localized. The most robust population of southern pigtoe is Shoal Creek located in an isolated ten kilometer reach in Talladega National Forest between Sweetwater and Highrock Lakes (MRBMRC 2010). Warren et al. (2004) had previously estimated the Shoal Creek population size to be 800 individuals in 2003, but this population seems to have declined in recent years due to recent exceptional drought conditions in 2007-2008 and 2017 (United States Drought Monitor 2019; <https://droughtmonitor.unl.edu>), J. Moran and P. Johnson pers. comm. 2019). Biologists were unable to estimate density during a 2011 follow-up survey due to lack of animals found during quantitative sampling; however, qualitative searches did indicate low relative abundance (collecting only two individuals) (Krause *et al.* 2012). New tributary occurrences have been documented in Armuchee Creek, Terrapin Creek, Yellowleaf Creek, and Hatchet Creek since listing (Gangloff 2004; Buntin 2015; Johnson 2018; USFWS Alabama Field Office database). While attempts to culture this mussel were made in 2010 and 2015, these attempts were only of limited success, producing only 49 juveniles.

The primary cause of curtailment of range and fragmentation of habitat for southern pigtoe has been contributed to the historic construction of dams and impoundment of large reaches of major river channel (58 FR 14330). Although most of these actions took place in the past, the impacted conditions and habitat continue to affect the species.

Other potential causes of habitat and range curtailment include dredging, mining, and historical or episodic pollution events (58 FR 14330), sedimentation, increased nutrients, urbanization, loss of *Podostemum* (aquatic plants) and riparian buffers, and climate change. Pollution and water quality impairments continue to be a factor at most sites as well.

EB/CE Source: U.S. Fish and Wildlife Service (FWS). 2019. Fine-lined Pocketbook (*Hamiota* (= *Lampsilis*) *atilis*), Orange-nacre Mucket (*Hamiota* (= *Lampsilis*) *perovalis*), Alabama moccasinshell (*Medionidus acutissimus*), Coosa moccasinshell (*Medionidus parvulus*), Southern Clubshell (*Pleurobema decisum*), Dark Pigtoe (*Pleurobema furvum*), Southern Pigtoe (*Pleurobema georgianum*), Ovate Clubshell (*Pleurobema perovatum*), and Triangular Kidneyshell (*Ptychobranhus greenii*) 5-Year Review: Summary and Evaluation. Alabama Ecological Service Field Office. Daphne, Alabama. 69 pp.

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

acres in species range: 6,322,519 acres

% of range in California (i.e., where CalPUR data is available): 0%

Range overlap with Federal lands: 980,081 acres, 15.501%

Integration and Synthesis Summary: Bivalves

| Scientific Name: | Common Name: | Entity ID: |
|------------------------------|---------------------|-------------------|
| <i>Pleurobema strodeanum</i> | Fuzzy pigtoe | 1369 |

Family: Unionidae**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:** Declining population(s) – one or more populations declining**Pesticides noted** ☐**Environmental Baseline/Cumulative Effects (EB/CE) Summary:**

Specifically, these factors include excessive sedimentation, municipal and industrial effluents, pesticides, excessive nutrients, impoundment of stream channels, recurring drought and flooding, contaminant spills, and the introduced Asian clam. In addition, existing regulatory mechanisms are inadequate to ameliorate some of the threats affecting these mussels and their habitats. Based on the best available science, these threats are currently impacting these species and are projected to continue and potentially worsen in the future. These eight mussels are also at increased threat due to the loss of genetic viability and the reduction or absence of fish hosts (described under Factor E); however, these threats are not currently known to be imminent.

EB/CE Source: U.S. Fish and Wildlife Service (FWS). 2012. Endangered and Threatened Wildlife and Plants; Determination of Endangered Species Status for the Alabama Pearlshell, Round Ebonyshell, Southern Kidneyshell, and Choctaw Bean, and Threatened Species Status for the Tapered Pigtoe, Narrow Pigtoe, Southern Sandshell, and Fuzzy Pigtoe, and Designation of Critical Habitat; Final Rule. Federal Register. 77 (196): 61664-61719.

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

acres in species range: 8,203,649 acres

% of range in California (i.e., where CalPUR data is available): 0%

Range overlap with Federal lands: 539,942 acres, 6.582%

Integration and Synthesis Summary: Bivalves

| Scientific Name: | Common Name: | Entity ID: |
|---------------------------------|---------------------|-------------------|
| <i>Ptychobranthus subtentum</i> | Fluted kidneyshell | 1559 |

Family: Unionidae

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 fluted kidneyshell is endemic to the Cumberland and Tennessee River drainages of the Ohio River Basin and was reported historically from Alabama, Kentucky, Tennessee, and Virginia. Including the recently discovered historical Red River population, there are 21 known historical populations (excluding potential populations based only on archeological records) (Service 2021). After assessing available data and literature, ten populations are currently considered to be extant (Service 2021). The Rockcastle population, considered extant at the time of listing, is now considered extirpated. Of the ten extant populations, five are considered to have low resiliency, and the remaining five are considered to have moderate resiliency. Three of the populations are extant due to recent reintroductions (the Upper Duck and Nolichucky in 2004; the Lower Elk in 2016). The Obey population is likely extant based on records for the species in the Wolf River from 2005-2006 (Moles et al. 2007). A recent survey in August 2020 confirmed that fluted kidneyshell persists in the Wolf River Fluted Kidneyshell 5-Year Review as two live and five fresh dead individuals were found, including one fresh dead individual recruited within the last five years (Service, unpublished data). This recent survey information does not change the characterization of the resiliency of the Obey population as low (Service 2021)

The final listing rule (Service 2013) identified habitat modification as the primary cause of the species' decline and cited impoundments, gravel and coal mining, sedimentation, water pollution, and stream channel alterations as major causes of habitat loss and degradation. The construction of dams within the range of the fluted kidneyshell has resulted in major enduring effects to the species by isolating populations, altering the physical habitat, and changing flow and temperature regimes. A variety of other human activities, especially those associated with urban development, agriculture, and resource extraction, have changed and continue to alter physical stream habitats and water quality.

EB/CE Source:

U.S. Fish and Wildlife Service (FWS). 2021. Fluted Kidneyshell (*Prychobranhus subtentum* (=subtentus)) 5-Year Review: Summary and Evaluation. Tennessee Ecological Service Field Office. Cookeville, Tennessee. 16 pp.

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

acres in species range: 10,478,878 acres

% of range in California (i.e., where CalPUR data is available): 0%

Range overlap with Federal lands: 2,093,574 acres, 19.979%

Integration and Synthesis Summary: Bivalves

| Scientific Name: | Common Name: | Entity ID: |
|-------------------------|---------------------|-------------------|
| <i>Popenaias popei</i> | Texas hornshell | 2917 |

Family: Unionidae

VULNERABILITY

(Summary of status, environmental baseline and cumulative effects)

Status: Endangered

Distribution: Species/Populations neither constrained nor widespread; Sensitive to stochastic events (natural and/or anthropogenic)

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 Texas hornshell is native to the Rio Grande (known in Mexico as the Rio Bravo) drainage in Texas, New Mexico, and northern Mexico. Currently, five known populations of Texas hornshell remain: the Black River, Pecos River, Devils River, Lower Canyons of the Rio Grande, and the Lower Rio Grande near Laredo, Texas.

The Texas hornshell is threatened by habitat alterations such as stream bank channelization, impoundments, and diversions for agriculture and flood control; in particular, the proposed low-water diversion dam in the Rio Grande near Laredo, Texas, would eliminate the most robust population of the species. Additionally, contamination of water from the oil and gas industry, alterations in the natural riverine hydrology, and increased sedimentation from prolonged overgrazing and loss of native vegetation threaten the species and its habitat. Because of the nature and magnitude of the threats and the rarity of the species, we find that the Texas hornshell is warranted for listing throughout its range, and, therefore, find that it is unnecessary to analyze whether it is threatened or endangered in a significant portion of its range.

EB/CE Source: U.S. Fish and Wildlife Service (FWS). 2013. U.S. Fish and Wildlife Service Species Assessment and Listing Priority Assignment Form: Texas hornshell (*Popenaias popei*). New Mexico Ecological Services Field Office. Albuquerque, New Mexico. 19 pp.

Overall Vulnerability: ☒ High ☐ Medium ☐ Low

acres in species range: 15,184,753 acres

% of range in California (i.e., where CalPUR data is available): 0%

Range overlap with Federal lands: 2,865,551 acres, 18.871%



Integration and Synthesis Summary: Bivalves

| Scientific Name: | Common Name: | Entity ID: |
|-----------------------------|---------------------|-------------------|
| <i>Villosa choctawensis</i> | Choctaw bean | 4042 |

Family: Unionidae

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 habitats of freshwater mussels are vulnerable to habitat modification and water quality degradation from a number of activities associated with modern civilization. The primary cause of the decline of these eight mussels has been the modification and destruction of their stream and river habitat, with sedimentation as the leading cause. Their stream habitats are subject to pollution and alteration from a variety of sources including adjacent land use activities, in-water activities, effluent discharges, and impoundments. Because of their sedentary characteristics, mussels are extremely vulnerable to toxic effluents (Sheehan et al. 1989, pp. 139–140; Goudreau et al. 1993, pp. 216–227; Newton 2003, p. 2543). Descriptions of localized mortality have been provided for chemical spills and other discrete pointsource discharges; however, rangewide decreases in mussel density and diversity may result from the more insidious effects of chronic, low-level contamination (Newton 2003, p. 2543, Newton et al. 2003, p. 2554). Freshwater mussel experts often report chemical contaminants as factors limiting to unionids (Richter et al. 1997, pp. 1081–1093). They note high sensitivity of early life stages to contaminants such as chlorine (Wang et al. 2007 pp. 2039–2046), metals (Keller and Zam 1991, p. 542; Jacobson et al. 1993, pp. 879–883), ammonia (Augsburger et al. 2003, pp. 2571–2574; Wang et al. 2007 pp. 2039–2046), and pesticides (Bringolf et al. 2007a,b pp. 2089–2092, pp. 2096–2099). Pesticide residues from agricultural, residential, or silvicultural activities enter streams mainly by surface runoff. Agricultural crops locally grown within the range of these mussels associated with high pesticide use include cotton, peanuts, corn, and soybeans. Chlorine, metals, and ammonia are common constituents in treated effluent from municipal and industrial wastewater treatment facilities. A total of 62 municipal and 39 industrial wastewater treatment facilities are permitted in Alabama and Florida to discharge treated effluent into surface waters of the three river drainages (FDEP 2010a; ADEM 2010a). There is no information on the sensitivity of the Alabama pearlshell, round ebonyshell, southern kidneyshell, Choctaw bean, tapered pigtoe, narrow pigtoe, southern sandshell, or fuzzy pigtoe to aquatic pollutants. Current State and Federal regulations regarding pollutants are designed to be protective of aquatic organisms;

however, freshwater mussels may be more susceptible to some pollutants than test organisms commonly used in bioassay tests. A multitude of bioassay tests conducted on 16 mussel species (summarized by Augspurger et al. 2007, pp. 2025–2028) show that freshwater mussels are more sensitive than previously known to some chemical contaminants including chlorine, ammonia, copper, the pesticides chlorothalonil and glyphosate, and the surfactant MON 0818. For example, several recent studies have demonstrated that U.S. Environmental Protection Agency (EPA) criteria for ammonia may not be protective of freshwater mussels (Augspurger et al. 2003, p. 2571; Newton et al. 2003, pp. 2559–2560; Mummert et al. 2003, pp. 2548–2552). Ammonia is an important aquatic pollutant because of its relatively high toxicity and common occurrence in riverine systems. This has application to the expected sources of these chemicals in the environment. Significant sources of nutrient enrichment leading to elevated ammonia include industrial wastewater, municipal wastewater treatment plant effluents, and urban and agricultural runoff (chemical fertilizers and animal wastes) (Augspurger et al. 2007, p. 2026). Elevated copper in surface waters can result from natural runoff sources, but is more often associated with a private or municipal wastewater effluent. Pesticide residues enter streams from agricultural, residential, or silvicultural runoff. Environmental chlorine concentrations will

EB/CE Source: U.S. Fish and Wildlife Service (FWS). 2012. Endangered and Threatened Wildlife and Plants; Determination of Endangered Species Status for the Alabama Pearlshell, Round Ebonyshell, Southern Kidneyshell, and Choctaw Bean, and Threatened Species Status for the Tapered Pigtoe, Narrow Pigtoe, Southern Sandshell, and Fuzzy Pigtoe, and Designation of Critical Habitat; Final Rule. Federal Register. 77 (196): 61664-61719.

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

acres in species range: 8,867,858 acres

% of range in California (i.e., where CalPUR data is available): 0%

Range overlap with Federal lands: 539,942 acres, 6.089%

Integration and Synthesis Summary: Bivalves

| Scientific Name: | Common Name: | Entity ID: |
|----------------------------|---------------------|-------------------|
| <i>Elliptio lanceolata</i> | Yellow lance | 4074 |

Family: Unionidae

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: Declining population(s) – one or more populations declining

Pesticides noted ☐

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

The Yellow Lance is a freshwater mussel species native to the Atlantic Slope drainages in Maryland, Virginia, and North Carolina. The historical range of the yellow lance included streams and rivers in the Atlantic Slope drainages from the Patuxent River Basin south to the Neuse River Basin, with the documented historical distribution in 12 Management Units (MUs) within eight former populations. The yellow lance is presumed extirpated from 25 percent (3 of 12) of the historically occupied management units. Of the remaining nine occupied management units, 17 percent are estimated to have high resiliency, 8 percent moderate resiliency, and 67 percent low resiliency. At the population level, the overall condition of one of the eight populations (the Tar population) is estimated to have moderate resiliency, while the remaining six extant populations (Patuxent, Rappahannock, York, James, Chowan, and Neuse populations) are characterized by low resiliency. The Potomac population is presumed to be extirpated. An assessment of the habitat elements finds that 86 percent of streams that remain part of the current species' range are estimated to be in low or very low condition.

The largest threats to the future viability of the yellow lance are habitat degradation from stressors influencing water quality, water quantity, instream habitat, and habitat connectivity. The stressors we identified that have led to the degradation of the yellow lance habitat include development, agricultural practices, forest management, barriers such as dams and impoundments, and invasive species.

EB/CE Source:

U.S. Fish and Wildlife Service (FWS). 2018. Endangered and Threatened Wildlife and Plants; Determination of Threatened Species Status for the Yellow Lance; Final Rule. Federal Register. 83 (64): 14189-14198.

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

acres in species range: 6,052,155 acres

% of range in California (i.e., where CalPUR data is available): 0%

Range overlap with Federal lands: 257,329 acres, 4.25%

Integration and Synthesis Summary: Bivalves

| Scientific Name: | Common Name: | Entity ID: |
|-------------------------|----------------------|-------------------|
| <i>Elliptio spinosa</i> | Altamaha spinymussel | 4210 |

Family: Unionidae

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:

Survey efforts conducted prior to the Altamaha spinymussel's listing as endangered indicated that population numbers have declined from historic numbers across the mussels range. During the most recent Altamaha spinymussel surveys, conducted prior to listing, the existing populations of the Altamaha spinymussel were small and fragmented and no juvenile recruitment had been observed since prior to 1990.

The loss and modification of habitat is a significant threat to the Altamaha spinymussel. Degradation from sedimentation and contaminants threatens the habitat and water quality necessary to support the Altamaha spinymussel. Sediment from unpaved roads, kaolin mines, past and current agriculture practices, silviculture, and construction sites within the Altamaha River Basin can suffocate Altamaha spinymussels and make stable sandbars required by Altamaha spinymussels unstable or change the texture of the substrate, rendering them unsuitable for the species. Contaminants associated with industrial and municipal effluents (e.g., heavy metals, ammonia, chlorine, numerous organic compounds) may cause decreased oxygen, increased acidity, and other water chemistry changes that are lethal to mussels, particularly the highly sensitive early life stages of mussels; exposure to sub-lethal levels of toxic metals can alter growth, filtration efficiency, enzyme activity, and behavior. As a result we have determined that the present or threatened destruction, modification, or curtailment of the Altamaha spinymussel's habitat or range is a threat to the continued existence of the Altamaha spinymussel throughout its range.

EB/CE Source: U. S. Fish and Wildlife Service (FWS). 2011. Endangered and Threatened Wildlife and Plants; Endangered Status for the Altamaha Spinymussel and Designation of Critical Habitat; Final Rule. Federal Register. 76(196): 62928-62960.

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

acres in species range: 3,567,417 acres

% of range in California (i.e., where CalPUR data is available): 0%

Range overlap with Federal lands: 123,923 acres, 3.474%

Integration and Synthesis Summary: Bivalves

| Scientific Name: | Common Name: | Entity ID: |
|-----------------------------|---------------------|-------------------|
| <i>Epioblasma triquetra</i> | Snuffbox mussel | 5281 |

Family: Unionidae

VULNERABILITY

(Summary of status, environmental baseline and cumulative effects)

Status: Endangered

Distribution: Species/Populations widespread or wide-ranging

Number of Populations: Multiple populations (numerous)

Species Trends: Declining population(s) – one or more populations declining

Pesticides noted ☐

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

The snuffbox is a federally listed endangered species that is currently considered extant in 82 streams in Alabama, Arkansas, Illinois, Indiana, Kentucky, Michigan, Minnesota, Missouri, Ohio, Pennsylvania, Tennessee, Virginia, West Virginia, Wisconsin, and Ontario, Canada. Records indicate that the species historically occurred in at least 213 streams and lakes and also historically occurred in Iowa, Kansas, Mississippi, and New York. The species has been extirpated from the lower Missouri River System and now only occurs in seven streams in the upper Great Lakes sub-basin, ten streams in the lower Great Lakes sub-basin, four streams in the upper Mississippi River sub-basin, 49 streams in the Ohio River System, one stream in the Cumberland River System, six streams in the Tennessee River System, and five streams in the lower Mississippi River sub-basin.

Only five (6%) of the remaining populations are considered to be large and stable or improving. Four of these populations are strongholds (Bourbeuse River (MO), French Creek (PA), Clinch River (TN, VA), and Paint Rock River (AL)) and one is a significant population (St. Croix River (MN, WI)). Three of the seven stronghold populations are either declining in numbers or the trend is unknown. Of the 82 extant populations, only 17 (21%), including all seven of the strongholds and ten of the significant populations, are thought to be recruiting with a high potential for having viable populations. Of the 24 significant populations, only four are thought to be stable or improving in numbers. Also, there are only three of the 24 populations that are considered to be large and two of the three are declining in numbers. Of the 51 marginal populations, none are considered to be stable.

The verified snuffbox host fish are the logperch (*Percina caprodes*), blackside darter (*P. maculata*), rainbow darter, Iowa darter (*E. exile*), blackspotted topminnow (*Fundulus olivaceus*), mottled sculpin, banded sculpin (*C. carolinae*), Ozark sculpin (*C. hypselurus*), largemouth bass, and brook stickleback (*Culaea inconstans*).

Since listing, there has been no significant change in the species' spatial distribution, abundance, or historical range. One stream (Kankakee River (IL)) where the species was thought to be extant at the time of listing is now considered to be extirpated. The species was also thought to be extant in Willow Creek (WI), but a review of the only stream record has determined that the record was for another species that was misidentified as snuffbox. No other records exist to indicate that snuffbox historically occurred in Willow Creek. Four streams listed as extirpated in the final listing rule are now considered to have extant populations (Cussewago Creek (PA), West Fork River (WV), Meathouse Fork (WV), and South Fork Hughes River (WV)), though the size and viability of these populations is unknown. The Kanawha River (WV) population was considered to be extirpated at the time of listing by the West Virginia Department of Natural Resources, though this stream was not noted as an historical stream at that time. Due to the close proximity of these five newly discovered extant populations to other extant populations, these new records cannot be considered to be a range expansion for the species.

The overall snuffbox status has not improved since listing and threats have not been ameliorated. Threats persist for the remaining snuffbox populations, including habitat degradation and climate change. Only six percent of the extant populations are large and stable or improving. Although there are ongoing attempts to alleviate some threats, there appear to be no populations without current significant threats and many threats are without obvious or readily available solutions.

EB/CE Source:

U.S. Fish and Wildlife Service (FWS). 2019. Snuffbox (*Epioblasma triquetra*) 5-Year Review: Summary and Evaluation. Ohio Ecological Service Field Office. Columbus, Ohio. 60 pp.

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

acres in species range: 57,704,063 acres

% of range in California (i.e., where CalPUR data is available): 0%

Range overlap with Federal lands: 4,385,219 acres, 7.599%

Integration and Synthesis Summary: Bivalves

| Scientific Name: | Common Name: | Entity ID: |
|----------------------------|---------------------|-------------------|
| <i>Fusconaia mitchelli</i> | False Spike | 5380 |

Family: Unionidae**VULNERABILITY***(Summary of status, environmental baseline and cumulative effects)***Status:** Proposed 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 false spike is native to the Brazos, Colorado, and Guadalupe basins in central Texas (Howells 2010; Randklev et al. 2017c). It was thought to have historically occurred in the Rio Grande based on the presence of fossil and subfossil shells there (Howells 2010), but those specimens have now been attributed to *Sphenonaias taumilapana* Conrad 1855 (no common name; Randklev et al. 2017c; Graf and Cummings 2007).

Currently, the false spike occurs in four populations: In the Little River and some tributaries (Brazos River basin), the lower San Saba and Llano Rivers (Colorado River basin), and in the lower Guadalupe River (Guadalupe River Basin). False spike is presumed to have been extirpated from the remainder of its historical range throughout the Brazos, Colorado, and Guadalupe Basins of central Texas (reviewed in Randklev et al. 2017c).

The primary risk factors (i.e., threats) affecting the status of the Central Texas mussels are: (1) increased fine sediment, (2) changes in water quality, (3) altered hydrology in the form of inundation, (4) altered hydrology in the form of loss of flow and scour of substrate, (5) predation and collection, and (6) barriers to fish movement. These factors are all exacerbated by the ongoing and expected effects of climate change.

EB/CE Source:

U. S. Fish and Wildlife Service (FWS). 2021. Endangered and Threatened Wildlife and Plants; Endangered Species Status With Critical Habitat for Guadalupe Fatmucket, Texas Fatmucket, Guadalupe Orb, Texas Pimpleback, and False Spike, and Threatened Species Status With Section 4(d) Rule and Critical Habitat for Texas Fawnsfoot. Federal Register. 86 (163): 47916-48011.

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

acres in species range: 7,964,463.54 acres

% of range in California (i.e., where CalPUR data is available): 0%

Range overlap with Federal lands: 3,238.6 acres, 0.04%

Integration and Synthesis Summary: Bivalves

| Scientific Name: | Common Name: | Entity ID: |
|-------------------------|---------------------|-------------------|
| <i>Villosa fabalis</i> | Rayed bean (Mussel) | 6062 |

Family: Unionidae

VULNERABILITY

(Summary of status, environmental baseline and cumulative effects)

Status: Endangered

Distribution: Small, endemic, constrained, and/or isolated population(s); Sensitive to stochastic events (natural and/or anthropogenic)

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 rayed bean is a federally listed endangered species that, at the time of listing, was known from 31 streams and 1 lake in Indiana, Michigan, New York, Ohio, Pennsylvania, Tennessee, West Virginia, and Ontario, Canada. Three new populations have been discovered since 2012, two in New York and one in Michigan. All of these discoveries were the result of surveys for proposed projects including several pipeline crossings and a bridge maintenance project. Currently the species is known to exist in 34 streams and 1 lake. Records indicate that the species historically occurred in over 115 streams and lakes and also historically occurred in Illinois, Kentucky, and Virginia. The species has been extirpated from the Upper Great Lakes sub-basin and now occurs in 13 streams in the Lower Great Lakes sub-basin, 20 streams and 1 lake in the Ohio River System, and 1 stream in the Tennessee River System. Of the remaining populations, 5 (14 percent) are considered to be large and stable. This is unchanged since the species was listed. These five populations are the Sydenham River (ON), Swan Creek (OH), Blanchard River (OH), Allegheny River (PA), and French Creek (PA). Within these streams, the rayed 17 bean populations appear to be robust, with recent recruitment and harboring multiple year classes with no recent evidence of a decline in number.

At the time of listing, destruction, modification, and curtailment of the species range was considered to be a threat to the species. Several projects have adversely affected some rayed bean populations since the time of listing. Bridge projects that affected rayed bean occurred in Swan Creek (OH), Allegheny River (PA), and French Creek (PA). A petroleum spill remediation project also affected rayed bean in the Allegheny River (NY).

The rayed bean has experienced significant curtailment of its occupied range. The species has been eliminated from about 70 percent of the streams in which it historically occurred. This species has also been eliminated from long reaches of former habitat in hundreds of miles of the Maumee, Ohio, Wabash, and Tennessee Rivers, and from numerous stream reaches in their

tributaries. Furthermore, extant populations, with few exceptions, are highly fragmented and restricted to short stream reaches. The primary cause of range curtailment is modification and destruction of river and stream habitats, primarily by the construction of impoundments. Other factors contributing to the reduction in range include dredging and channelization, chemical contamination, oil and gas production, sand and gravel mining, and siltation.

EB/CE Source:

U.S. Fish and Wildlife Service (FWS). 2018. Rayed Bean (*Villosa fabalis*) 5-Year Review: Summary and Evaluation. Ohio Ecological Service Field Office. Columbus, Ohio. 27 pp.

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

acres in species range: 21,184,849 acres

% of range in California (i.e., where CalPUR data is available): 0%

Range overlap with Federal lands: 750,761 acres, 3.544%

Integration and Synthesis Summary: Bivalves

| Scientific Name: | Common Name: | Entity ID: |
|-------------------------|----------------|------------|
| <i>Fusconaia burkei</i> | Tapered pigtoe | 6534 |

Family: Unionidae

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: Declining population(s) – one or more populations declining

Pesticides noted ☐

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

The habitats of freshwater mussels are vulnerable to habitat modification and water quality degradation from a number of activities associated with modern civilization. The primary cause of the decline of these eight mussels has been the modification and destruction of their stream and river habitat, with sedimentation as the leading cause. Their stream habitats are subject to pollution and alteration from a variety of sources including adjacent land use activities, in-water activities, effluent discharges, and impoundments. Nonpoint-source pollution from land surface runoff originates from virtually all land use activities and includes sediments, fertilizer, herbicide and pesticide residues; animal wastes; septic tank leakage and gray water discharge; and oils and greases. Current activities and land uses that can negatively affect populations of these eight mussels include unpaved road crossings, improper silviculture and agriculture practices, highway construction, housing developments, pipeline crossings, and cattle grazing. These activities can result in physical disturbance of stream substrates or the riparian zone, excess sedimentation and eutrophication, decreased dissolved oxygen concentration, increased acidity and conductivity, and altered flow. Limited range and low numbers make these eight mussels vulnerable to land use changes that would result in increases in nonpoint-source pollution. A multitude of bioassay tests conducted on 16 mussel species (summarized by Augspurger et al. 2007, pp. 2025–2028) show that freshwater mussels are more sensitive than previously known to some chemical contaminants including chlorine, ammonia, copper, the pesticides chlorothalonil and glyphosate, and the surfactant MON 0818. For example, several recent studies have demonstrated that U.S. Environmental Protection Agency (EPA) criteria for ammonia may not be protective of freshwater mussels (Augspurger et al. 2003, p. 2571; Newton et al. 2003, pp. 2559–2560; Mummert et al. 2003, pp. 2548–2552).

EB/CE Source: U.S. Fish and Wildlife Service (FWS). 2012. Endangered and Threatened Wildlife and Plants; Determination of Endangered Species Status for the Alabama Pearlshell, Round Ebonyshell, Southern Kidneyshell, and Choctaw Bean, and Threatened Species Status for

the Tapered Pigtoe, Narrow Pigtoe, Southern Sandshell, and Fuzzy Pigtoe, and Designation of Critical Habitat; Final Rule. Federal Register. 77 (196): 61664-61719.

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

acres in species range: 4,070,764 acres

% of range in California (i.e., where CalPUR data is available): 0%

Range overlap with Federal lands: 89,045 acres, 2.187%

Integration and Synthesis Summary: Bivalves

| Scientific Name: | Common Name: | Entity ID: |
|---------------------------------|-----------------------|-------------------|
| <i>Pleuronaia dolabelloides</i> | Slabside pearlymussel | 6841 |

Family: Unionidae

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 slabside pearlymussel is currently known from approximately 1,300 river kilometers. The slabside pearlymussel is endemic to the Cumberland and Tennessee River drainage of the Ohio River Basin, and has been reported from Alabama, Kentucky, Mississippi, Tennessee, and Virginia. It is currently considered extirpated from the entire Cumberland River drainage, historically it was found in the main channel Cumberland River (TN) and its tributaries, Caney Fork River (TN) and the Red River (TN/KY) (Haag and Cicerello 2016). More widespread in the Tennessee River drainage, it was known to occur from headwaters in southwestern Virginia, downstream through Tennessee, Alabama, Mississippi, to, and including the Duck River (TN) (Parmalee and Bogan 1998; Williams et al. 2008). The species is thought to be extirpated from the Tennessee River mainstem and from numerous of its larger tributaries and has suffered substantial population losses and range reductions across the drainage. However, the slabside pearlymussel does continue to survive within the Tennessee River drainage, and is currently extant within the following tributaries (presented from upstream to downstream): Powell River (VA/TN); Clinch River (VA/TN) and its tributaries Plum Creek (VA), Little River (VA), and Copper Creek (VA); North Fork Holston River (VA) and its tributary Big Moccasin Creek (VA); Middle Fork Holston River (VA); Little River (TN); Nolichucky River (TN); Little Pigeon River (TN); Hiwassee River (TN); Sequatchie River (TN); Paint Rock River (AL) and its tributaries Estill Fork (AL), Larkin Fork (AL), and Hurricane Slabside Pearlymussel 5-Year Review 4 Creek (AL); Flint River (AL); Elk River (TN/AL); Bear Creek (AL/MS) and its tributary Cedar Creek (MS); and the Duck River (TN) and its tributaries Big Rock Creek (TN) and the Buffalo River (TN).

Reservoir construction has impounded and fragmented much of the habitat within the species' range; these habitat changes continue to have lasting effects through isolation of extant populations. Habitat degradation and water quality threats from land use activities (e.g., agriculture, development) continue at varying levels across the species' range. Additionally,

climate change, pathogens, and/or other undefined threats may be affecting the species or could affect the species in the future; however, we do not know which specific factor or combination of factors are most significant in the continued decline of the species. The recent die-offs in the Clinch River and the enigmatic declines that have occurred in other populations demonstrate the precarious status of these populations and reveal our poor understanding of the threats to the species.

EB/CE Source:

U.S. Fish and Wildlife Service (FWS). 2021. Slabside Pearlymussel (*Pleuronaia dolabelloides*) 5-Year Review: Summary and Evaluation. Tennessee Ecological Service Field Office. Cookeville, Tennessee. 20 pp.

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

acres in species range: 14,125,974 acres

% of range in California (i.e., where CalPUR data is available): 0%

Range overlap with Federal lands: 1,661,784 acres, 11.764%

Integration and Synthesis Summary: Bivalves

| Scientific Name: | Common Name: | Entity ID: |
|-------------------------|-----------------|------------|
| <i>Fusconaia masoni</i> | Atlantic pigtoe | 7048 |

Family: Unionidae

VULNERABILITY

(Summary of status, environmental baseline and cumulative effects)

Status: Proposed Threatened

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:

Historically, populations of the Atlantic pigtoe were delineated using the twelve river basins that mussels have historically occupied. This includes the James, Chowan, Roanoke, Tar, Neuse, Cape Fear, Pee Dee, Catawba, Edisto, Savannah, Ogeechee, and Altamaha River basins. Of twelve historical populations, seven populations have observations in the last 10 years, though the majority of occurrences were limited to a single location within the river basin. The Atlantic Pigtoe is presumed extirpated from the southern portion of the range.

The Atlantic Pigtoe has been documented in all major river basins in the Atlantic coastal drainages from the James River Basin in Virginia south to the Altamaha River Basin in Georgia. Johnston (1970) indicated the southernmost records were from the Ogeechee River Basin, however, recent curation of the H.D. Athearn collection uncovered valid specimens from the Altamaha River (NCSM 54068). The Atlantic Pigtoe has been documented from multiple physiographic provinces, from the foothills of the Appalachian Mountains through the Piedmont and into the Coastal Plain, in streams ranging in size from < 1 m wide up to some of the largest Atlantic Slope rivers within the species' range.

Aquatic systems face a multitude of natural and anthropogenic threats and stressors (Neves et al. 1997). State Wildlife Action Plans have identified several factors that have impacts on habitats. Generally, these factors can be categorized as either environmental stressors (e.g., development, agriculture practices, forest management, or regulatory frameworks) or systematic changes (e.g., climate change, invasive species, barriers, or conservation management practices). Current and potential future effects, along with current expected distribution and abundance, determine present viability and, therefore, vulnerability to extinction.

EB/CE Source: U.S. Fish and Wildlife Service. 2021. Species status assessment report for the Atlantic Pigtoe (*Fusconaia masoni*). Version 1.4. June, 2021. Atlanta, GA. **Overall**

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

acres in species range: 18,654,160 acres

% of range in California (i.e., where CalPUR data is available): 0%

Range overlap with Federal lands: 1,708,600 acres, 9.16%

Integration and Synthesis Summary: Bivalves

| Scientific Name: | Common Name: | Entity ID: |
|---------------------------|---------------------|-------------------|
| <i>Fusconaia escambia</i> | Narrow pigtoe | 7177 |

Family: Unionidae

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: Declining population(s) – one or more populations declining

Pesticides noted ☐

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

The narrow pigtoe is endemic to the Escambia River drainage in Alabama and Florida, and to the Yellow River drainage in Florida (Williams et al. 2008, p. 317).

The narrow pigtoe still occurs in much of its historic range, but may be extirpated from localized areas. In the Escambia River drainage, the narrow pigtoe occurs in nearly all of its historical range and is currently known from 28 locations. It was not detected at 3 out of 10 historical sites examined recently in the drainage. The species is rare in the Yellow River drainage; a total of 23 individuals from 4 locations have been collected since 1995.

McGregor (2004) considered the narrow pigtoe vulnerable to extinction because of its limited distribution, rarity, and susceptibility to habitat degradation, and classified it as a species of highest conservation concern in Alabama. Williams et al. (1993) considered the narrow pigtoe threatened throughout its range.

The habitats of freshwater mussels are vulnerable to habitat modification and water quality degradation from a number of activities associated with modern civilization. The primary cause of the decline of these eight mussels has been the modification and destruction of their stream and river habitat, with sedimentation as the leading cause. Their stream habitats are subject to pollution and alteration from a variety of sources including adjacent land use activities, in-water activities, effluent discharges, and impoundments. Nonpoint-source pollution from land surface runoff originates from virtually all land use activities and includes sediments, fertilizer, herbicide and pesticide residues; animal wastes; septic tank leakage and gray water discharge; and oils and greases. Current activities and land uses that can negatively affect populations of these eight mussels include unpaved road crossings, improper silviculture and agriculture practices, highway construction, housing developments, pipeline crossings, and cattle grazing. These activities can result in physical disturbance of stream substrates or the riparian zone, excess sedimentation and eutrophication, decreased dissolved oxygen concentration, increased acidity and conductivity, and

altered flow. Limited range and low numbers make these eight mussels vulnerable to land use changes that would result in increases in nonpoint-source pollution. A multitude of bioassay tests conducted on 16 mussel species (summarized by Augspurger et al. 2007, pp. 2025–2028) show that freshwater mussels are more sensitive than previously known to some chemical contaminants including chlorine, ammonia, copper, the pesticides chlorothalonil and glyphosate, and the surfactant MON 0818. For example, several recent studies have demonstrated that U.S. Environmental Protection Agency (EPA) criteria for ammonia may not be protective of freshwater mussels (Augspurger et al. 2003, p. 2571; Newton et al. 2003, pp. 2559–2560; Mummert et al. 2003, pp. 2548–2552).

EB/CE Source: U.S. Fish and Wildlife Service (FWS). 2012. Endangered and Threatened Wildlife and Plants; Determination of Endangered Species Status for the Alabama Pearlshell, Round Ebonyshell, Southern Kidneyshell, and Choctaw Bean, and Threatened Species Status for the Tapered Pigtoe, Narrow Pigtoe, Southern Sandshell, and Fuzzy Pigtoe, and Designation of Critical Habitat; Final Rule. Federal Register. 77 (196): 61664-61718.

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

acres in species range: 5,508,421 acres

% of range in California (i.e., where CalPUR data is available): 0%

Range overlap with Federal lands: 456,980 acres, 8.296%

Integration and Synthesis Summary: Bivalves

| Scientific Name: | Common Name: | Entity ID: |
|---------------------------|---------------------|-------------------|
| <i>Fusconaia rotulata</i> | Round ebonyshell | 7363 |

Family: Unionidae

VULNERABILITY

(Summary of status, environmental baseline and cumulative effects)

Status: Endangered

Distribution: Small, endemic, constrained, and/or isolated population(s); Sensitive to stochastic events (natural and/or anthropogenic)

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 round ebonyshell is known only from the main channel of the Escambia-Conecuh River and is the only mussel species endemic to the drainage (Williams et al. 2008). Due to recent survey data, its known range was extended downstream the Escambia River to Molino, Florida (Gangloff 2012 pers. comm.), and upstream in the Conecuh River to just above the Covington County line in Alabama (Williams et al. 2008).

The round ebonyshell has a very restricted distribution (Williams and Butler 1994), with its current range (based on live individuals and shell material) confined to approximately 144 km (89 mi) of the Escambia-Conecuh River main channel. The round ebonyshell is also considered to be extremely rare (Williams et al. 2008). Researchers collected a total of three live individuals during a 2006 dive survey (Shelton et al. 2007, unpub. report), and 4 more were collected during a dive survey in 2011 (Gangloff 2012 pers. comm). At stations where the species was present in the 2011 survey, 219 mussels were collected for every 1 round ebonyshell. Because its distribution is limited to the main channel of one river, the round ebonyshell is particularly vulnerable to catastrophic events such as flood scour and contaminant spills, and to activities that cause streambed destabilization like gravel mining, dredging, and desnagging for navigation. Due to its limited distribution and rarity, McGregor (2004) considered the round ebonyshell vulnerable to extinction, and classified it as a species of highest conservation concern in Alabama. Williams et al. (1993) considered the round ebonyshell as endangered throughout its range.

The habitats of freshwater mussels are vulnerable to habitat modification and water quality degradation from a number of activities associated with modern civilization. The primary cause of the decline of these eight mussels has been the modification and destruction of their stream and river habitat, with sedimentation as the leading cause. Their stream habitats are subject to pollution and alteration from a variety of sources including adjacent land use activities, in-water

activities, effluent discharges, and impoundments. Nonpoint-source pollution from land surface runoff originates from virtually all land use activities and includes sediments, fertilizer, herbicide and pesticide residues; animal wastes; septic tank leakage and gray water discharge; and oils and greases. Current activities and land uses that can negatively affect populations of these eight mussels include unpaved road crossings, improper silviculture and agriculture practices, highway construction, housing developments, pipeline crossings, and cattle grazing. These activities can result in physical disturbance of stream substrates or the riparian zone, excess sedimentation and eutrophication, decreased dissolved oxygen concentration, increased acidity and conductivity, and altered flow. Limited range and low numbers make these eight mussels vulnerable to land use changes that would result in increases in nonpoint-source pollution. A multitude of bioassay tests conducted on 16 mussel species (summarized by Augspurger et al. 2007, pp. 2025–2028) show that freshwater mussels are more sensitive than previously known to some chemical contaminants including chlorine, ammonia, copper, the pesticides chlorothalonil and glyphosate, and the surfactant MON 0818. For example, several recent studies have demonstrated that U.S. Environmental Protection Agency (EPA) criteria for ammonia may not be protective of freshwater mussels (Augspurger et al. 2003, p. 2571; Newton et al. 2003, pp. 2559–2560; Mummert et al. 2003, pp. 2548–2552).

EB/CE Source: U.S. Fish and Wildlife Service (FWS). 2012. Endangered and Threatened Wildlife and Plants; Determination of Endangered Species Status for the Alabama Pearlshell, Round Ebonyshell, Southern Kidneyshell, and Choctaw Bean, and Threatened Species Status for the Tapered Pigtoe, Narrow Pigtoe, Southern Sandshell, and Fuzzy Pigtoe, and Designation of Critical Habitat; Final Rule. Federal Register. 77(196): 61664-61718.

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

acres in species range: 3,538,100 acres

% of range in California (i.e., where CalPUR data is available): 0%

Range overlap with Federal lands: 119,553 acres, 3.379%

Integration and Synthesis Summary: Bivalves

| Scientific Name: | Common Name: | Entity ID: |
|---------------------------|---------------------|-------------------|
| <i>Plethobasus cyphus</i> | Sheepnose (mussel) | 7816 |

Family: Unionidae

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 sheepnose is a federally listed endangered species with records indicating the species historically occurred in at least 76 streams in 14 states, including Alabama, Illinois, Indiana, Iowa, Kentucky, Minnesota, Mississippi, Missouri, Ohio, Pennsylvania, Tennessee, Virginia, West Virginia, and Wisconsin. The May 2012 final rule identified extant populations to include 25 streams in all 14 states of historical occurrence. At the time of listing, the sheepnose was considered to be improving in 2 streams, stable in 10 streams, declining in 8 streams, and unknown in 5 streams. Currently, populations are considered to be stable to increasing in 2 streams, stable in 8 streams, declining in 4 streams, and unknown in 11 streams. Collectively, the last known and/or recent survey efforts have identified juvenile specimens in 10 of the 25 populations, from three of the five extant river basin.

Two of the extant basins, the Lower Missouri River Basin (Osage Fork Gasconade River) and the Lower Mississippi River Basin (Big Sunflower River), have not reported any new live or fresh dead specimens collected since 1999 and 2005, respectively, or recent evidence of recruitment (last known from the Big Sunflower River in 2003). The populations within these two basins are considered unknown due to the lack of new information. Should the populations in these two systems decline to the point of extirpation, the extant sheepnose range will be reduced from five to three occupied river basins (HUC2).

Since the time of listing, a larger abundance of sheepnose was identified within Pool 15 of the Mississippi River than previously known, representing the species' only "extra large" population, with evidence of recent recruitment (ESI 2017). This is the first evidence of sheepnose recruitment within the Mississippi River since 2001.

Reproducing populations have been documented above Lock and Dam 5 on the Green River (KY) and the Six Mile Dam on the Walhonding River (OH), with adult specimens identified

below each of the dams (Lewis 2019; ESII 2019). Both of these dams are currently being proposed for removal, resulting in the potential for range expansion within these two systems.

In addition to the sauger, 30 native host fish species have now been identified for the species, with indications that the sheepsnose is a cyprinid specialist (Hove et al. 2015). Refer to Section 2.3.1.1 for a full list of identified host fish species. The identification of new host fish species and ideal propagation conditions, including fish holding temperatures and techniques for identifying the reproductive condition of gravid sheepsnose females, improves our understanding of sheepsnose life history and will help promote increased juvenile production through propagation efforts (Hove et al. 2015).

The decline of the spectaclecase and sheepsnose in the eastern United States (described by Butler 2002a, entire; Butler 2002b, entire) is primarily the result of habitat loss and degradation (Neves 1991, p. 252). These losses have been well documented since the mid- 19th century (Higgins 1858, p. 550). Chief among the causes of decline are impoundments, channelization, chemical contaminants, mining, and sedimentation (Neves 1991, p. 252; Neves 1993, pp. 4–6; Neves et al. 1997, pp. 60, 63–75; Watters 2000, pp. 262–267; Williams et al. 1993, pp. 7–9). These stressors have had profound impacts on sheepsnose and spectaclecase populations and their habitat. The majority of the remaining populations of the spectaclecase and sheepsnose are generally small and geographically isolated (Butler 2002a, p. 27; 2002b, p. 27). The patchy distributional pattern of populations in short river reaches makes them much more susceptible to extirpation from single catastrophic events, such as toxic chemical spills (Watters and Dunn 1995, p. 257). Furthermore, this level of isolation makes natural repopulation of any extirpated population virtually impossible without human intervention. In addition, the fish host of spectaclecase is unknown; thus, propagation to reestablish the species in restored habitats and to maintain nonreproducing populations and focused conservation of its fish host are currently not possible. Although there are ongoing attempts to alleviate some of these threats at some locations, there appear to be no populations without significant threats, and many threats are without obvious or readily available solutions. Recruitment reduction or failure is a threat for many small spectaclecase and sheepsnose populations rangewide, a condition exacerbated by reduced range and increasingly isolated populations (Butler 2002a; b, p. 28). If these trends continue, further significant declines in total spectaclecase and sheepsnose population size and consequent reduction in long-term viability may soon become apparent. Various exotic species of aquatic organisms are firmly established in the range of the spectaclecase and sheepsnose. The exotic species that poses the most significant threat to the spectaclecase and sheepsnose is the zebra mussel. The invasion of the zebra mussel poses a serious threat to mussel faunas in many regions, and species extinctions are expected as a result of its continued spread in the eastern United States (Ricciardi et al. 1998, p. 618).

EB/CE Source: U.S. Fish and Wildlife Service (FWS). 2020. Sheepsnose (*Plethobasus cyphus*) 5-Year Review: Summary and Evaluation. Iowa Ecological Service Field Office. Moline, Illinois. 32 pp.

U.S. Fish and Wildlife Service (FWS). 2012. Endangered and Threatened Wildlife and Plants; Determination of Endangered Status for the Sheepsnose and Spectaclecase Mussels Throughout Their Range. Federal Register 77 (49): 14914-14949.

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

acres in species range: 56,625,775 acres

% of range in California (i.e., where CalPUR data is available): 0%

Range overlap with Federal lands: 5,102,672 acres, 9.011%

Integration and Synthesis Summary: Bivalves

| Scientific Name: | Common Name: | Entity ID: |
|------------------------------|----------------------|------------|
| <i>Ptychobranthus jonesi</i> | Southern kidneyshell | 7949 |

Family: Unionidae

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 southern kidneyshell (*Ptychobranthus jonesi*, van der Schalie 1934) is a medium-sized freshwater mussel known from the Escambia and Choctawhatchee River drainages in Alabama and Florida, and the Yellow River drainage in Alabama (Williams et al. 2008). The southern kidneyshell is elliptical and reaches about 72 mm (2.8 in.) in length. Its shell is smooth and shiny, and greenish yellow to dark brown or black in color, sometimes with weak rays. The shell interior is bluish white with some iridescence (Williams and Butler 1994, p. 126; Williams et al. 2008). The southern kidneyshell was described by H. van der Schalie (1934) as *Lampsilis jonesi*. Following the examination of gills of gravid females, Fuller and Bereza (1973) determined it belonged in the genus *Ptychobranthus*. When gravid, the marsupial gills form folds along the outer edge, a characteristic unique to the genus *Ptychobranthus* (Williams et al. 2008).

Very little is known about the habitat requirements or life history of the southern kidneyshell. It is typically found in medium creeks to small rivers in firm sand substrates with slow to moderate current (Williams et al. 2008). A recent status survey in the Choctawhatchee basin in Alabama found its preferred habitat to be stable substrates near bedrock outcroppings (Gangloff and Hartfield 2009). The southern kidneyshell is thought to be a long-term brooder, with females gravid from autumn to the following spring or summer. Preliminary reproductive studies found that females release their glochidia in small conglomerates that are bulbous at one end and tapered at the other (Alabama Aquatic Biodiversity Center 2006, unpub. data). Host fish for the southern kidneyshell are currently unknown; however, darters serve as primary glochidial hosts to other members of the genus *Ptychobranthus* (Luo 1996; Haag and Warren 1997).

The southern kidneyshell is endemic to the Escambia, Choctawhatchee, and Yellow River drainages in Alabama and Florida (Williams et al. 2008), but is currently known only from the

Choctawhatchee River drainage. Since 1995, the southern kidneyshell has been detected at only 10 locations within the Choctawhatchee River drainage. The species appears to have been

common historically (in 1964, H. D. Athearn collected 98 individuals at one site on the West Fork Choctawhatchee), but it is currently considered one of the most imperiled species in the United States (BlalockHerod et al. 2005; Williams et al. 2008). In addition to a reduction in range, its numbers are very low. A 2006–2007 status survey in the Alabama portion of the Choctawhatchee basin found the southern kidneyshell was extremely rare. A total of 13 were encountered alive, and the species comprised less than 0.3 percent of the total mussel assemblage (Gangloff and Hartfield 2009). It is classified as a species of highest conservation concern in Alabama by McGregor (2004), and considered threatened throughout its range by Williams et al. (1993).

The habitats of freshwater mussels are vulnerable to habitat modification and water quality degradation from a number of activities associated with modern civilization. The primary cause of the decline of these eight mussels has been the modification and destruction of their stream and river habitat, with sedimentation as the leading cause. Their stream habitats are subject to pollution and alteration from a variety of sources including adjacent land use activities, in-water activities, effluent discharges, and impoundments. Nonpoint-source pollution from land surface runoff originates from virtually all land use activities and includes sediments, fertilizer, herbicide and pesticide residues; animal wastes; septic tank leakage and gray water discharge; and oils and greases. Current activities and land uses that can negatively affect populations of these eight mussels include unpaved road crossings, improper silviculture and agriculture practices, highway construction, housing developments, pipeline crossings, and cattle grazing. These activities can result in physical disturbance of stream substrates or the riparian zone, excess sedimentation and eutrophication, decreased dissolved oxygen concentration, increased acidity and conductivity, and altered flow.

EB/CE Source: U.S. Fish and Wildlife Service (FWS). 2012. Endangered and Threatened Wildlife and Plants; Determination of Endangered Species Status for the Alabama Pearlshell, Round Ebonyshell, Southern Kidneyshell, and Choctaw Bean, and Threatened Species Status for the Tapered Pigtoe, Narrow Pigtoe, Southern Sandshell, and Fuzzy Pigtoe, and Designation of Critical Habitat; Final Rule. Federal Register. 77 (196): 61664-61719.

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

acres in species range: 7,181,166 acres

% of range in California (i.e., where CalPUR data is available): 0%

Range overlap with Federal lands: 202,756 acres, 2.823%

Integration and Synthesis Summary: Bivalves

| <i>Scientific Name:</i> | <i>Common Name:</i> | <i>Entity ID:</i> |
|----------------------------|-----------------------|-------------------|
| <i>Pleurobema athearni</i> | Canoe Creek clubshell | 9222 |

Family: Unionidae

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

Status: Proposed 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 Canoe Creek clubshell is a narrow endemic mussel that is only known from Big Canoe Creek, a western tributary to the Coosa River in St. Clair and Etowah counties, Alabama (Williams et al. 2008; MRBMRC 2010). Current records and a paucity of museum records suggests that this species has always been uncommon to rare (Gangloff et al. 2006; MRBMRC 2010; Shelton-Nix 2017; Fobian et al. 2017).

The Canoe Creek clubshell occurs within approximately 32 km of the Big Canoe Creek mainstem, from approximately 6 km NE of Springville to 1 km NW of Ashville; and within approximately 15 km of the Little Canoe Creek (west), 9 km SE of Springville, to its confluence with Big Canoe Creek. The Canoe Creek clubshell is also known to occur within approximately 5 km of Little Canoe Creek (east) due east of Steele, Alabama (along the St. Clair and Etowah County line). In total, the Canoe Creek clubshell is extant in less than 52 km of river within the Big Canoe Creek watershed. Two subpopulations were delineated using Hydrologic Unit Code (HUC) 12 watershed boundaries and tributaries leading to the Coosa River (Neely Henry Reservoir), which includes a western subpopulation near Springville and Ashville and an eastern subpopulation near Steele. The two subpopulations are isolated from one another by a stretch of unsuitable habitat, and as a result, no genetic exchange is thought to be occurring between these two subpopulations.

The primary factors influencing the Canoe Creek clubshell includes sedimentation, water quality, climate events (especially drought), connectivity, and conservation efforts. Development and climate change were the two primary sources of these factors that we identified. In addition, having small subpopulation sizes (few numbers of collections despite survey efforts) and a lack of recent recruitment puts the Canoe Creek clubshell at greater risk of extirpation from stochastic events.

EB/CE Source: U.S. Fish and Wildlife Service. 2019. Species Status Assessment Report for the Canoe Creek Clubshell (*Pleurobema atearni*), Version 1.1. February 2020. Atlanta, GA. 106 pp.

Overall Vulnerability: ☒ High ☐ Medium ☐ Low

acres in species range: 35,993,270 acres

% of range in California (i.e., where CalPUR data is available): 0%

Range overlap with Federal lands: 1,716,464 acres, 4.77%

Integration and Synthesis Summary: Bivalves

| Scientific Name: | Common Name: | Entity ID: |
|----------------------------|---------------------|-------------------|
| <i>Lampsilis bracteata</i> | Texas fatmucket | 10038 |

Family: Unionidae

VULNERABILITY

(Summary of status, environmental baseline and cumulative effects)

Status: Proposed 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 Texas fatmucket was previously thought to occur in both the Colorado and Guadalupe River basins of the east-central portions of the Edwards Plateau ecoregion, known as the “Hill Country” of Central Texas. However, following genetic analyses by Inoue et al. (2019), populations of the Texas fatmucket from the Colorado River basin are now considered a separate and distinct species from the populations in the Guadalupe River basin, which are now known as the Guadalupe fatmucket (*Lampsilis bergmanni*).

The Texas fatmucket once existed with historical populations in at least 14 rivers in the upper Colorado River basin of the east-central portions of the Edwards Plateau ecoregion, known as the “Hill Country” of Central Texas. In the Colorado River, it ranged from Travis County upstream approximately 320 kilometers (km) ((200 miles (mi))) to Runnels County. It was also found in many tributaries including the Pedernales, Llano, San Saba, and Concho Rivers, and Jim Ned, Elm, and Onion Creeks (Howells et al. 1996). Howells (2004) noted that no live unionids (native freshwater mussels) were reported from Elm Creek or from the Colorado River near Ballinger, Texas, in August 2003.

Strecker (1931) described Texas fatmucket as being “especially common in the San Saba and Llano rivers” and attaining high densities in the Concho River and notes locations on Cypress Creek (Blanco County), San Saba River in Menard and McCulloch Counties, Llano River in Mason County, Colorado River in Runnels County, and South Concho River in Tom Green County.

Texas fatmucket appears to be currently restricted to upper reaches of major tributaries within the Colorado River Basin (Randklev et al. 2017). The total current distribution of Texas fatmucket, summed across the five populations from the Colorado River basin, is a combined stream length of approximately 295 miles. This current distribution represents approximately 20% of the total presumed historic range of 1,444 stream miles. This approximate range

reduction assumes the species continuously occupied its entire historical range, which is unlikely given the species' specialized habitat preferences.

Current and ongoing threats to the species includes accretion of fine sediments, the loss of flowing water, changes in hydrology, including floods, leading to scour and subsequent substrate insuitability, inundation under reservoirs, the degradation of water quality, predation, collection, disease, and invasive species.

EB/CE Source: U.S. Fish and Wildlife Service. 2019. Species status assessment report for the Central Texas Mussels, Version 1.5. December 2019. Albuquerque, NM. 244 pp.

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

acres in species range: 15,925,958 acres

% of range in California (i.e., where CalPUR data is available): 0%

Range overlap with Federal lands: 73,053 acres, 0.459%

Integration and Synthesis Summary: Bivalves

| Scientific Name: | Common Name: | Entity ID: |
|----------------------------|------------------|------------|
| <i>Obovaria subrotunda</i> | Round Hickorynut | 10837 |

Family: Unionidae

VULNERABILITY

(Summary of status, environmental baseline and cumulative effects)

Status: Proposed threatened

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

Number of Populations: Multiple populations (numerous)

Species Trends: Declining population(s) – one or more populations declining

Pesticides noted ☒

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

The current range of the round hickorynut extends over nine States, including Alabama, Indiana, Kentucky, Michigan, Mississippi, Ohio, Pennsylvania, Tennessee, and West Virginia; the species is now considered extirpated in Georgia, Illinois, and New York. This range encompasses five major river basins (Great Lakes, Ohio River, Cumberland River, Tennessee River, and Lower Mississippi River). Round hickorynut representation in the Cumberland River basin is restricted to two linear populations within two management units, while it exists in the Lower Mississippi River basin in a single population. Therefore, while the species currently maintains representation from historical conditions, it is at immediate risk of losing 40 percent (2 of 5 basins) of its representation due to these small, isolated populations under a high degree of threats that have resulted from habitat loss and water quality degradation.

Overall, the round hickorynut has lost an approximate 232 of 297 known populations (78 percent), and 104 of 138 management units (75 percent). This includes 25 populations in the Great Lakes basin, 150 populations in the Ohio River basin, 23 populations in the Cumberland River basin, 29 populations in the Tennessee River basin, and 9 populations in the Lower Mississippi River basin (see Appendix B in the SSA report (Service 2019)). Of the current populations, 4 (6 percent) are estimated to be highly resilient, 16 (23 percent) are estimated to be moderately resilient, and 45 (69 percent) are estimated to have low resiliency.

Factors currently affecting the round hickorynut include those that are systemic and contribute to the greatest threats impacting the species and its resource needs across its range, including: habitat loss and alteration, water quality impairment, and more site-specific threats, such as invasive species.

Impacts to freshwater mussels and benthic riverine aquatic organisms, in general, often involve multiple interrelated actions, involve compounded stressors, and rarely lack a single causative

agent; therefore, they are not easy to observe and may be difficult to quantify after they occur. While factors such as climate change, host fish availability, disease, or predation may affect the species, the best available information does not suggest they are currently acting as significant contributors to round hickorynut decline. Commercial harvest was likely a significant threat that previously/historically contributed to species decline, but it is not currently affecting the round hickorynut, and is unlikely to be a future threat.

The current resiliency, redundancy, and representation of the round hickorynut is directly tied to population and habitat fragmentation by the construction of impoundments throughout the species range. Habitat loss and alteration from dam operations continue to impact populations specifically in the Ohio, Tennessee, and Cumberland basins. Impoundments fragment and isolate populations from one another, prevent dispersal that reduces gene flow, and compounds stressors such as the introduction of contaminants and pollution.

Across all basins in which the round hickorynut currently occurs, there are one or more threats to the species, which results in effects to individuals and populations at a more rapid rate. The combined impacts of dams and barriers, resource extraction, agricultural activities, and nonnative species have led to localized extirpations of the round hickorynut, and a cumulative loss of 80 percent of its populations compared to its historical distribution. Overall, the greatest threats currently to the round hickorynut are habitat alteration and loss, water quality degradation, nonnative species, and genetic isolation, which affect resource and demographic needs for the species.

A variety of stressors contribute to these threats, which may vary in intensity and duration based on temporal and spatial considerations, but similar prevalent impacts have been observed on the round hickorynut resiliency, redundancy, and representation of the species throughout its range. In the Great Lakes basin, the primary stressors are nonnative species, impoundments, and genetic isolation. In the Ohio River basin, the primary stressors are impoundments, resource extraction, and agricultural activities. In the Cumberland River basin, the primary stressors are impoundments, resource extraction, and agricultural activities. In the Tennessee River basin, the primary stressors are impoundments, agricultural activities, and urbanization. In the Lower Mississippi River basin, the primary stressors are genetic isolation, agricultural activities, and impoundments.

Throughout the species range, impacts of contaminants and mussel die-offs are difficult to measure and almost impossible to predict, but have been documented in the Fish Creek in the Great Lakes basin and Big Darby Creek in the Ohio basin, and other secondary factors such as predation and climate change are increasingly concerning as small populations become more isolated.

EB/CE Source:

U.S. Fish and Wildlife Service. 2020. Endangered and Threatened Wildlife and Plants; 12-Month Finding for Purple Lilliput; Threatened Species Status with Section 4(d) Rule for Longsolid and Round Hickorynut and Designation of Critical Habitat; Proposed Rule; Announcement of 12-Month Finding. Federal Register. 85 (189): 61384-61458.

U.S. Fish and Wildlife Service (Service). 2019. Species Status Assessment Report for the Round Hickorynut Mussel (*Obovaria subrotunda*), Version 1.0. Asheville Ecological Services Field Office, Asheville, North Carolina.

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

acres in species range: 23,864,360 acres

% of range in California (i.e., where CalPUR data is available): 0%

Range overlap with Federal lands: 2,024,941 acres, 8.49%

Integration and Synthesis Summary: Bivalves

| Scientific Name: | Common Name: | Entity ID: |
|-----------------------------|---------------------|-------------------|
| <i>Fusconaia subrotunda</i> | Longsolid | 10838 |

Family: Unionidae

VULNERABILITY

(Summary of status, environmental baseline and cumulative effects)

Status: Proposed threatened

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

Number of Populations: Multiple populations (numerous)

Species Trends: Declining population(s) – one or more populations declining

Pesticides noted ☒

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

The longsolid's current range extends over nine States, including New York, Pennsylvania, West Virginia, Ohio, Kentucky, Virginia, Tennessee, North Carolina, and Alabama; the species is now considered extirpated in Georgia, Illinois, and Indiana. This range encompasses three major river basins (the Ohio, Cumberland, and Tennessee basins); the species now no longer exists in the Great Lakes basin (loss of six historical populations and four management units). In addition, its representation in the Cumberland River basin is currently within a single population and management unit (loss of nine historical populations and eight management units). Overall, the longsolid is presumed extirpated from 63 percent (102 of 162 populations) of its historically occupied populations, including 6 populations (the entirety) in the Great Lakes basin, 65 populations in the Ohio River basin, 9 populations in the Cumberland River basin, and 26 populations in the Tennessee River basin (see Appendix B in the SSA report (Service 2018)). Of the current populations, 3 (5 percent) are estimated to be highly resilient, 9 (15 percent) are estimated to be moderately resilient, and 48 (80 percent) are estimated to have low resiliency.

Factors currently affecting the longsolid include those that are systemic and contribute to the greatest threats to the species throughout its range: habitat loss and alteration, water quality impairment, and more site-specific threats, such as invasive species.

Impacts to freshwater mussels, and benthic riverine aquatic organisms in general, often involve multiple interrelated actions, involve compounded stressors, and rarely lack a single causative agent, therefore they are not easy observe and may be difficult to quantify after they occur. While factors such as climate change, host fish availability, disease, or predation may affect the species currently or in the future, we do not have sufficient data or information to suggest that these are currently contributing to longsolid decline. Commercial harvest was likely a significant threat which previously contributed to species decline, but it is not currently directly affecting the longsolid, and is unlikely to be a future threat.

The current resiliency, redundancy, and representation of the longsolid is directly tied to population and habitat fragmentation by the construction of impoundments throughout the species' range. Hypolimnetic discharges downstream from dams continue to impact populations specifically in the Tennessee and Cumberland river basins. Impoundments fragment and isolate populations from one another, prevent dispersal which reduces gene flow, and compounds stressors such as the introduction of contaminants and pollution; whether the result of mining, oil and gas exploration, agricultural runoff, or untreated or poorly treated wastewater discharges.

The threats to the longsolid are synergistic, and result in effects to individuals and populations at a more rapid rate. The combined impacts of dams and barriers, resource extraction, agricultural activities, and non-native species have led to localized extirpations of the longsolid, and a cumulative loss of 63% of its formerly occupied range.

EB/CE Source:

U.S. Fish and Wildlife Service. 2020. Endangered and Threatened Wildlife and Plants; 12-Month Finding for Purple Lilliput; Threatened Species Status with Section 4(d) Rule for Longsolid and Round Hickorynut and Designation of Critical Habitat; Proposed Rule; Announcement of 12-Month Finding. Federal Register. 85 (189): 61384-61458.

U.S. Fish and Wildlife Service (Service). 2018. Draft Species Status Assessment Report for the Longsolid Mussel (*Fusconaia subrotunda*), Version 1.X3. Asheville Ecological Services Field Office, Asheville, North Carolina.

Overall Vulnerability: ☒ High ☐ Medium ☐ Low

acres in species range: 15,126,300 acres

% of range in California (i.e., where CalPUR data is available): 0%

Range overlap with Federal lands: 1,807,805 acres, 11.95%

Integration and Synthesis Summary: Bivalves

| Scientific Name: | Common Name: | Entity ID: |
|-------------------------|---------------------|-------------------|
| <i>Cyclonaias necki</i> | Guadalupe orb | 11577 |

Family: Unionidae

VULNERABILITY

(Summary of status, environmental baseline and cumulative effects)

Status: Proposed 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 Guadalupe orb was previously recognized as a “small variety” of the Texas pimpleback (*Cyclonaias petrina*) occurring in the Guadalupe River basin of Central Texas (Howells 2002b). However, following the morphological and genetic analyses by Burlakova *et al.* (2018), it is now recognized to be a separate species. For this reason, what are now considered Guadalupe orb populations are referred to as Texas pimpleback in the literature documenting its occurrences prior to 2018.

Although previously identified as Texas pimpleback, Guadalupe orb historically occurred throughout most of the length of the Guadalupe and Blanco Rivers (Horne and McIntosh 1979; Howells 2010e; OSUM 2011d; Randklev *et al.* 2017c) within the Guadalupe River basin. In the Guadalupe River, the species ranged from Comal, Guadalupe, Kendall, Kerr, and Victoria Counties (Randklev *et al.* 2017b).

Guadalupe orb is known from the Guadalupe River basin. Given the presumed historical distribution of the species the Guadalupe orb currently occupies about 54% of its potential historical range. The Guadalupe orb is currently found in 276 river miles of a presumed historical range of 506 stream miles. This approximate range reduction assumes the species continuously occupied its entire historical range, which is unlikely given the species’ specialized habitat preferences.

Two populations of the Guadalupe orb are known: one in unhealthy condition in the upper reaches of the Guadalupe River and another in moderate condition in the lower Guadalupe River, which also extends upstream into the San Marcos River.

Our analysis of the past, current, and future influences on what the Central Texas mussels need for long term viability revealed that there are three influences that pose the largest risk to the future viability of the species. These risks are primarily related to habitat changes: the accretion

of fine sediments, the loss of flowing water, and degradation of water quality; these are all exacerbated by climate change. Overall threats to the species include accretion of fine sediments, the loss of flowing water, changes in hydrology including floods leading to scour and subsequent substrate insuitability, inundation under reservoirs, the degradation of water quality, predation, collection, disease, and invasive species.

EB/CE Source: U.S. Fish and Wildlife Service. 2019. Species status assessment report for the Central Texas Mussels, Version 1.5. December 2019. Albuquerque, NM. 244 pp.

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

acres in species range: 6,182,067 acres

% of range in California (i.e., where CalPUR data is available): 0%

Range overlap with Federal lands: 35,940 acres, 0.58%

Integration and Synthesis Summary: Bivalves

| Scientific Name: | Common Name: | Entity ID: |
|-------------------------|---------------------|------------|
| <i>Cyclonaias necki</i> | Guadalupe fatmucket | 11578 |

Family: Unionidae

VULNERABILITY

(Summary of status, environmental baseline and cumulative effects)

Status: Proposed 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 Guadalupe fatmucket (*Lampsilis bergmanni*) was previously assigned to the same species as the Texas fatmucket (*Lampsilis bracteata*). However, following genetic analyses (Inoue et. al. 2019), it is now recognized as a separate and distinct species occurring within the Guadalupe River. For this reason, what we now consider Guadalupe fatmucket populations are referred to as the Texas fatmucket in the literature documenting its occurrences prior to 2018.

In the Guadalupe River basin, the Guadalupe fatmucket occupied approximately 240 km (150 mi) of the Guadalupe River, from Gonzalez County upstream to Kerr County, including the North Guadalupe River, Johnson Creek, and the Blanco River. Strecker (1931) reported what would now be considered a Guadalupe fatmucket from a lake in Victoria County in the lower Guadalupe River drainage, but this is probably a misidentified Louisiana fatmucket (*L. hydiana*), which is known to occur in lakes and impoundments (Howells, 2010c).

Guadalupe fatmucket appears to be currently restricted to one population in the Guadalupe River basin (Randklev et al. 2017). The total current distribution of Guadalupe fatmucket, summed across the Upper Guadalupe River population is a combined stream length of approximately 53 miles. This current distribution represents approximately 16.8% of the total presumed historic range of 317.5 stream miles. This approximate range reduction assumes the species continuously occupied its entire historical range, which is unlikely given the species' specialized habitat preferences.

Our analysis of the past, current, and future influences on what the Central Texas mussels need for long term viability revealed that there are three influences that pose the largest risk to the future viability of the species. These risks are primarily related to habitat changes: the accretion of fine sediments, the loss of flowing water, and degradation of water quality; these are all exacerbated by climate change. Overall threats to the species include accretion of fine sediments,

the loss of flowing water, changes in hydrology including floods leading to scour and subsequent substrate insuitability, inundation under reservoirs, the degradation of water quality, predation, collection, disease, and invasive species.

EB/CE Source: U.S. Fish and Wildlife Service. 2019. Species status assessment report for the Central Texas Mussels, Version 1.5. December 2019. Albuquerque, NM. 244 pp.

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

acres in species range: 1,864,024 acres

% of range in California (i.e., where CalPUR data is available): 0%

Range overlap with Federal lands: 10,514 acres, 0.56%
