Integration and Synthesis Summary for Bivalves (Mussels)

This Integration and Synthesis Summary includes our jeopardy analysis for any bivalve (mussel) species that we or EPA determined will "likely be adversely affected" by the proposed action. Our jeopardy analysis of the proposed action's impacts to listed species is split into three major factors: vulnerability, exposure, and toxicity. The tables below contain summaries of our rankings (high, medium, low) for vulnerability, exposure, and toxicity. Data and information used to determine each individual species' rankings, including environmental baselines, cumulative effects, exposure information, and expected toxic effect for all species, and a template worksheet to show how rankings were assessed and combined are in Appendix E. Status of the species for each species can be found in Appendix B.

Vulnerability

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

Our assessment of vulnerability focuses on six factors: (1) the species listing status and recent 5-year status review recommendation (if available), (2) distribution, (3) number of populations, (4) species population trends, (5) if pesticides have been noted as a threat, and (6) impacts from activities associated with environmental baseline and cumulative effects. We obtained the information to create the vulnerability summary from the Status of the Species accounts (Appendix B), the overarching Environmental Baseline section of this Opinion, 5-year species status reviews, species recovery plans, species status assessments, and other sources containing the best available scientific information for the species.

We scored each of the six vulnerability components with high, medium, or low scores. We assigned a high vulnerability ranking to a species if all vulnerability components were scored as medium or high. We assigned a medium vulnerability ranking if a species' scores were a mix of high, medium, and low (though exceptions were allowed for species that have a low status score or have an uplisting recommendation). We assigned a low vulnerability ranking to species with only low scores. Considerations regarding specific aspects of the species' vulnerability or beyond what was included in the vulnerability ranking were applicable for some species depending on unique aspects of their life history. This information is reflected in the rationales for conclusion below.

Exposure

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

Exposure to Agricultural Uses

We characterize the expected level of exposure using overlaps between the species' ranges and agricultural land uses where carbaryl is registered for use (i.e., overlaps), past carbaryl usage data (when available; the amount and location where carbaryl has been used in the past), any species-specific considerations such as life history information (e.g., habitat preferences, dispersal behavior), and existing protections or conservation actions (e.g., existing label measures, conservation measures from the action agency). Species with greater than 10% overlap between their range and agricultural carbaryl use sites are assigned a high overlap score, species with 5-10% overlap are assigned a medium overlap score, and species with less than 5% total overlap are assigned a low overlap score. In addition to range overlaps with carbaryl use sites, we considered past carbaryl usage data within a species' range to determine how much of a species' range we expect to be treated with carbaryl each year of the proposed action. Except where otherwise noted, usage data is provided by EPA applying data from their National and State Summary Use and Usage Matrix, as described in the Usage Analysis section of this biological opinion. Species that data indicate will have a large portion of their range (>10%) treated with carbaryl each year are assigned a high usage score. Species with 5-10% total usage are assigned a medium usage score, and species with less than 5% total usage are assigned a low usage score. Agricultural uses of carbaryl in the state of Hawai‘i are no longer registered; however, agricultural uses are still registered for other island territories.

We determine the overall exposure ranking by qualitatively considering both the total overlap and total usage, as well as any additional exposure considerations that might modify the level of exposure likely to occur. When overlap and usage scores are the same, we assign the overall exposure ranking the same score (e.g., if both overlap and usage is high, the overall exposure ranking is high). In cases where overlap is high and usage is medium or when overlap is medium and usage is low, we use the overlap score as the overall exposure ranking to maintain conservative exposure assumptions. (As usage is a subset of overlap, the overlap score will always be greater than the usage score). In cases where overlap is high, but usage is low, we anticipate a large portion of the range may be treated over the duration of the proposed action even if only a small portion of the range is treated in any given year (particularly if the areas treated occur in different locations each year), leading to an overall exposure ranking of medium. For all species, where there are additional exposure considerations, we adjust the overall exposure ranking to reflect this additional information, as appropriate.

Exposure to Non-Agricultural Uses

Carbaryl has several registered non-agricultural uses, including use sites within developed, open space developed, nurseries, rangeland, managed forests, and rights of way Use Data Layers (UDLs). Rights of way includes roadsides, and we refer to roadsides when applicable. In many cases, data provided by EPA indicate low to high levels of overlap between species' ranges and non-agricultural UDLs. However, UDLs for non-agricultural uses tend to be less defined than those for agricultural UDLs and may not accurately represent the actual footprint of these use sites on the landscape. As such, we assess exposure of species to non-agricultural uses of carbaryl in a qualitative manner, considering the life history of species, methods of application, carbaryl usage, and any existing conservation measures to reduce drift and runoff or otherwise limit exposure to species. To facilitate this analysis, for every species in this Appendix, we reviewed species' documents (e.g., 5-Year Reviews, recovery plans, listing rules) to determine if the species and their pollinators and seed dispersers could occur on non-agricultural carbaryl use sites (i.e., managed forests, rights of way, developed, open space developed, nurseries, or rangelands) and the manner in which they may rely on these sites.

For most species, we anticipate that non-agricultural uses will not meaningfully add to the overall effects considered in our analysis of agricultural uses and discuss each use in more detail in the *Overall Considerations for the Opinion* section of this Opinion. Briefly, we expect listed species are generally unlikely to be exposed to non-agricultural uses of carbaryl due to low levels of past usage and/or existing mitigation measures for these uses that are protective of listed species. Usage data summarized by the EPA indicate that all non-agricultural UDLs have very low levels of past usage (at most 2.5% treatable areas treated with carbaryl annually). Some use patterns, like rights of way, are particularly low usage areas, with less than 500 lbs of carbaryl applied nationally each year.

Additionally, based on application information, we anticipate carbaryl use in these UDLs are largely restricted to small treatment areas that are treated infrequently over long periods of time. Use patterns like forestry, rangeland, or rights of way may even be geographically restricted as available past usage data indicate carbaryl usage is only in certain areas of the country, such as the western conterminous United States. Available usage data from the U.S. Forest Service indicate that, over a five-year period (from 2016-2020), the Forest Service treated 322 acres of forests in California and 557 acres of forests across three Forest Service Regions (covering North Dakota, Montana, South Dakota, Idaho, Kansas, Nebraska, Colorado, Wyoming, Utah, and Nevada), with the majority of applications taking place in small areas (less than 1 acre in size). Similarly, usage data from the U.S. Department of Agriculture Animal and Plant Health Inspection Service (APHIS) show limited past carbaryl usage as well. From 2019-2023, APHIS treated 92,309 acres of rangeland in seven states (Arizona, Idaho, Montana, Nevada, Utah, Washington, Wyoming) and 25 counties. While this represents a large area overall, when distributed across the areas within the seven states where usage occurs, we anticipate only a small percentage of any species' range is likely to be treated for this use pattern. Additionally, all but one of these applications were made using carbaryl bait, which we expect has a much lower

risk profile as bait applications are not likely to cause off target exposures as there is no spray drift or contact exposure likely to occur.

Additionally, there are a number of existing conservation and mitigation measures for non-agricultural uses of carbaryl that will reduce the likelihood of exposure to listed species. For example, as a result of the 2022 FIFRA Proposed Interim Decision and the 2024 NMFS biological opinion for carbaryl, residential treatments, are limited to spot and crack treatments (defined as a 2 ft^2 area), crack-and-crevice treatment, or narrow perimeter bands around urban structures (from 1 inch to 6 feet). This limitation in application method renders off-site spray drift unlikely and greatly reduces the extent of area that can be treated in the developed, open space developed, and nurseries UDLs. Similarly, we anticipate all rangeland applications of carbaryl will be carried out in association with USDA APHIS as part of their grasshopper and Mormon cricket suppression program (USFWS 2024), which include many conservation measures that are meant to protect listed species from exposure. Examples of measures include a reduced agent area treatment strategy that minimizes the amount of pesticide applied within a treatment block, allowance of only one application per year, reduced application rates, minimized treatment area size within 500 feet and 1000 feet from listed species ranges for ground and aerial applications, respectively, and extended application buffers when applications are made near the listed species' habitat (e.g., up to 750 feet for some ground applications and up to a mile for some aerial applications).

To assess the likelihood of exposure to non-agricultural uses of carbaryl, we conducted a habitat assessment for each listed species, incorporating available information regarding habitat preferences, known occurrences, relevant life history traits or behaviors, as well as relevant available usage data (summarized in the above sections). For species whose habitat is known or presumed to occur in or adjacent to non-agricultural use sites, we consider, individually and qualitatively, the extent and manner of non-agricultural carbaryl usage within the species' range to generally determine whether a small, moderate, or large number of individuals are likely to be exposed and the expected level of adverse effects from non-agricultural exposure of carbaryl.

Conservation Measures

As part of the 2022 proposed interim decision for carbaryl, the technical registrants committed to a number of conservation measures for the protection of listed species, including a 48-hour rain restriction and mandatory 25-foot and 150-foot application buffers from aquatic habitats for all outdoor ground and aerial applications, respectively. We anticipate these measures will contribute to the protection of listed mussel species by reducing the amount of carbaryl residue that is transported off use sites and into the habitat of listed species.

Additionally, an existing letter of concurrence issued by the Service to USDA APHIS regarding carbaryl use in their rangeland grasshopper and Mormon cricket suppression program requires the implementation of numerous conservation measures for the protection of listed species. The USDA APHIS biological assessment considered grasshopper and Mormon cricket program

activities in states where their program is active, which include the implementation of conservation measures, and as a surrogate for usage in states where no programs exist greatly reducing the likelihood of exposure to the species from rangeland uses of carbaryl. Mussel mitigations from the USDA-APHIS grasshopper and Mormon cricket consultation are the following: a 2,500-foot buffer for all ultra-low volume aerial applications of carbaryl and a 300-foot buffer for all ground applications of carbaryl. For carbaryl bait aerial applications all mussels are protected by a 750-foot buffer for aerial applications and a 100-foot buffer for ground applications. These specific buffers apply for the following species that fall in the action area for the USDA-APHIS consultation: Higgins eye (pearlymussel), Neosho mucket, rabbitsfoot, scaleshell mussel, Texas fatmucket, Texas fawnsfoot, Texas hornshell, Texas pimpleback, and western fanshell. For the remaining mussels in this biological opinion that are outside of the action area for the grasshopper and Mormon cricket program, we anticipate there is a low likelihood of the need to apply these program measures as grasshopper and Mormon cricket populations do not reach the level where they would need to be suppressed in these areas. However, we anticipate the standard aquatic habitat buffers (500-foot buffer for aerial sprays, 200-foot buffer for ground sprays, and a 50-foot buffer for bait application) and other mitigation measures outlined in the USDA APHIS biological assessment would be applied if there were a need to use carbaryl applications for this reason within the remaining mussel species' habitats.

Toxicity

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

We consider estimated concentrations of carbaryl on the landscape or within the environment and effects reported in available toxicity studies to determine the level of direct and indirect adverse effects likely to occur to mussels. Because mussels are not very sensitive to carbamates at estimated environmental concentrations (see section *Effects to Aquatic Invertebrates* in the main body of the Opinion), we focus our assessment on indirect effects to mussels from effects to fish hosts and food resources. Mussels depend on host fish to accomplish their reproductive

[1] While our Opinion considers all consequences of the proposed action (per the definition of effects of the action at 50 CFR Part 402.02), the terms "direct" and "indirect" effects were used in EPA's BE, and are used in environmental risk assessment terminology in general, and do not have the same meaning as used in ESA regulations. As used in the effects analysis section, direct effects to species are those caused by the pesticide itself through dietary, dermal, or inhalation routes of exposure. Indirect effects occur when the pesticide acts on elements of the ecosystem that are required by the species, such as alterations to prey or shelter. Thus, in the effects analysis section, we may use these terms to link back to the analysis in EPA's BE.

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 will be reduced.

For some mussels in this Opinion, EECs may occur at levels that exceed the fish HC_{05} calculated by the EPA in their BE. We consider the HC_{05} a conservative threshold for qualitatively estimating anticipated mortality to listed fish as a wide breadth and variability of fish species are used to generate HC_{05} estimates. Since the maximum estimated environmental concentrations are well below the level where we anticipate 95% of fish species will not experience high levels of mortality, we anticipate there is a low likelihood that these species will experience high levels of mortality and subsequently impact the reproductive cycle of the mussel.

Where relevant, we also consider in our analysis if EECs exceed the threshold for sublethal effects on reproduction to the fish host or the mussel as carbaryl data indicate reduced fecundity can occur to fish and/or aquatic mollusks at EECs that may be observed in concentrations in lower flow or lower volume water bodies within the range for some mussels.

Concentrations of carbaryl can vary greatly among different regions and aquatic habitat types. We do not expect carbaryl to be persistent in the environment where it is able to dissipate or dilute quicky. Where carbaryl enters smaller streams or static waters (e.g., low flow/low volume waterbodies) from runoff or spray drift, we generally anticipate high levels of lethal and sublethal effects to individual host fish where exposure occurs. In larger waterbodies (e.g., where concentrations may be lower due to dilution or other factors as described in the *Effects of the Action* Section of the Biological Opinion), we expect lower levels of lethal and sublethal effects to host fish.

We determine the overall toxicity ranking for mussels by qualitatively assessing the expected levels of indirect adverse effects (e.g., mortality to host fish) and the relationship to the host fish for the mussel. Where listed mussel species are known to rely upon a variety of host fish species for glochidia attachment, we consider those species to be host fish generalists and assume a lower likelihood of adverse effects as these species are expected to be more tolerant of a decline in abundance of one or more host fish. For mussel species that rely on few species of host fish (1-2 species), we consider them to be host fish obligates or specialists and assume they are more susceptible to declines in abundance as there are fewer options for glochidia attachment. Where the host fish is unknown for a listed mussel species, we adopt the conservative assumption that they are host fish specialists in the absence of data to conclude otherwise. The following characteristics (i.e., toxicity modifiers) led us to increase toxicity rankings for mussel species when applicable: unknown host fish species, specialist host fish, host fish that occur in few aquatic habitat types where we expect carbaryl concentrations to be higher (i.e., low flow and/or low volume), and fish hosts that are uncommon or occur in small populations.

We also consider effects to dietary resources in our toxicity ranking. Mussels generally consume plant-based and microbial resources (e.g., zooplankton, algae, detritus). We anticipate high levels of mortality to some mussel dietary items (e.g., zooplankton) and mussel host fish prey (e.g., other smaller fish, invertebrates) in low flow or low volume waterbodies. Where localized effects (i.e., reductions in prey) occur from applications of carbaryl, we anticipate additional food resources from upstream sources will quickly recolonize affected areas. We do not anticipate phytoplankton and detritus will be impacted by carbaryl applications. Therefore, we do not anticipate significant reductions in food availability for mussels or host fish. As such, host fish mortality is the primary driver in determining the toxicity ranking for mussel species.

Experimental, non-essential populations

The EPA included the experimental, non-essential populations for the following species in the consultation: Alabama lampmussel, Appalachian monkeyface (pearlymussel), birdwing pearlymussel, clubshell, cracking pearlymussel, Cumberlandian combshell, Cumberland monkeyface (pearlymussel), Cumberland bean (pearlymussel), dromedary pearlymussel, fanshell, finerayed pigtoe, orangefoot pimpleback (pearlymussel), oyster mussel, purple cat's paw (pearlymussel), ring pink (mussel), rough pigtoe, shiny pigtoe, winged mapleleaf, and white wartyback (pearlymussel). We do not provide separate analyses or make jeopardy determinations for these populations independently. Rather, we treat any experimental and non-experimental populations as a single listed species for the purposes of conducting jeopardy analyses and making jeopardy determinations. By definition, a "non-essential experimental population" is not essential to the continued existence of the species. In cases where our assessment of the non-experimental population(s) of the species leads to a "not likely to jeopardize" determination, we generally assume any added effects to the experimental population will not change these determinations. However, we consider the role of the experimental population in the survival and recovery of the species and consider this information in our jeopardy analyses as appropriate.

Summary of Bivalves (Mussels) Conclusions

After reviewing the current status of the species, the environmental baseline for the action area, the effects of the proposed action, incorporation of conservation measures, and the cumulative effects, it is our biological opinion that the registration of carbaryl, as proposed, is not likely to jeopardize the continued existence of the 105 mussel species in this Appendix. Species that had the same or very similar rationales for their conclusion were grouped together, below, to increase efficiency and avoid repetition. Relevant information and data unique to each individual species was considered when assigning species to groups and incorporated into the rationales as appropriate. Species with rationales that did not fit in a group, or warranted additional discussion, have a separate rationale.

In our analysis below, some species that had the same or very similar rationales for their conclusions were grouped together, to increase efficiency and avoid repetition. Relevant information and data unique to each individual species was considered when assigning species to

groups and incorporated into the rationales as appropriate. Species-specific information (e.g., environmental baseline, cumulative effects, status of the species, exposure, and toxicity) was considered for all species, including those species in the grouped analyses, and are presented in full in Appendices B and E. Species with rationales that did not fit in a group, or warranted a separate rationale because of their life history, conservation status, or other information indicated that effects could be different, have an individual discussion to provide additional explanation. This approach allowed us to streamline our discussion in this Opinion by avoiding repeating our findings when species in the respective groupings would be expected to be affected similarly. The use of these groupings, therefore, does not mean that our evaluation failed to evaluate each individual species. On the contrary, our process and analysis for each species remained the same, regardless of the format of the discussion presented below.

Species proposed/recommended for de-listing

The following species are proposed/recommended for de-listing due to recovery. While we present some specific information about the species in Table 1 below, we provide additional information on vulnerability (including environmental baseline and cumulative effects), exposure, and toxicity in Appendix E. The status of the species account can be found in Appendix B.

Table 1. Species proposed/recommended for delisting.

Scientific Name	Common Name	Vulnerability Ranking	Exposure Ranking	Toxicity Ranking	Change in listing status	Determination
Amblema neislerii	Fat threeridge (mussel)	Low	High	Low	Proposed for delisting	No Jeopardy
Elliptio chipolaensis	Chipola slabshell	Low	High	Low	Proposed for delisting	No Jeopardy
Potamilus capax	Fat pocketbook	Low	High	Low	Recommend to delist due to recovery	No Jeopardy

Fat pocketbook: Fat pocketbook populations have been discovered and monitored across the St. Francis, Ohio, and Mississippi River drainages for the past three decades. In the Ohio and Wabash Rivers, populations have increased from locally rare in 1989 to locally common in the 2000s. A comparison of the past and recent collection history of the fat pocketbook indicates that the fat pocketbook is persisting, recruiting, and increasing in abundance in the St. Francis, Ohio, and Lower Mississippi Rivers and some of their tributaries. 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. 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. In the 2019 species review, we recommended the species for delisting (USFWS 2019).

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 (USFWS 2019).

The fat pocketbook is a host fish specialist and is likely to successfully reproduce only in the presence of the freshwater drum. Freshwater drum are common and abundant from the western slopes of the Appalachians to the eastern slopes of the Rockies. They are common throughout large rivers, lakes, and reservoirs and typically prefer large deep pool habitats in these systems. Although the mussel is limited to one fish host species, freshwater drums are relatively common and use all aquatic habitats available to them, so we anticipate low adverse effects to the reproductive cycle of the mussel. The fat pocketbook has a low vulnerability and we do not anticipate any direct adverse effects. We expect only low mortality to the fish host due to their preference for larger flowing and large volume water bodies. Thus, despite the high overlap in the species range (56%), we expect a small number of host fish will die from carbaryl exposure, and as such we anticipate low adverse effects to the reproductive cycle of the mussel. After adding the effects of the action and cumulative effects to the environmental baseline, and in light of the recommendation for delisting due to population rebounds (i.e., recovery), we have determined the proposed action is not expected to appreciably reduce the survival and recovery of the species in the wild. Thus, it is our biological opinion that the proposed action is not likely to jeopardize the continued existence of the fat pocketbook.

Fat threeridge (mussel): The fat threeridge (mussel) historically was found in five sub-basins in Georgia and Florida and is now found in two sub-basins in Florida and one sub-basin in Georgia: Apalachicola, Chipola, and Flint Rivers. In the Apalachicola and Chipola Rivers, fat threeridge (mussels) were the fourth most common species detected during mussel surveys. The Flint River, Georgia population was discovered in 2006 and only a few individuals were found. They are generally found in water depths less than 5 feet. Their distribution is highly restricted, and in 2007, populations showed little evidence of recovering from historical habitat losses without significant positive human intervention (USFWS 2007). In the 2019 recovery plan amendment, we mentioned that the Flint River population remained small, but the species was common in the Apalachicola and Chipola Rivers (USFWS 2019). By 2024, the species was more widely distributed and more abundant than when it was listed, and we proposed the species for delisting due to recovery and reduced threats (USFWS 2024).

The fat threeridge (mussel) is a host fish generalist and can likely use 23 species of fish as hosts 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). Because the fish host species are highly varied and found in multiple aquatic habitats, where the morality is low for most of the species, we expect a small number of host fish will die from carbaryl exposure. Therefore, we anticipate low adverse effects to the reproductive cycle of the mussel, despite the high overlap of carbaryl use sites with the species range (29.9%). After adding the effects of the action and cumulative effects to the environmental baseline, and in light of the proposal to delist due to recovery, we have determined the proposed action is not expected to appreciably reduce the survival and recovery

of the species in the wild. Thus, it is our biological opinion that the proposed action is not likely to jeopardize the continued existence of the fat threeridge (mussel).

Chipola slabshell: 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, Alabama in the Chattahoochee River system. Relative abundance of Chipola slabshell has likely always been low. In the 1930s, the species was found with a 24% occupancy rate and an average of 5.2 individuals per site of occurrence (USFWS 2003). We estimate that the Chipola slabshell is extirpated from about one-third of its historic range, but it is widespread within its range and common in some areas as of 2024. We believe the species occurs in low densities naturally, and it exhibits sufficient resiliency throughout its range. In 2024, we proposed the species for delisting due to recovery and reduced threats (USFWS 2024).

The Chipola slabshell is a host fish specialist and is likely to successfully reproduce only in the presence of sunfishes, like bluegill and redbreast sunfish. Sunfish are common throughout the range of the species and found in multiple aquatic habitats, where the mortality is low for most of the species, so we expect a small number of host fish will die from carbaryl exposure. Therefore, we anticipate low adverse effects to the reproductive cycle of the mussel, despite the high overlap of carbaryl use sites with the species range (45.7%). After adding the effects of the action and cumulative effects to the environmental baseline, and in light of the proposal to delist due to recovery, we have determined the proposed action is not expected to appreciably reduce the survival and recovery of the species in the wild. Thus, it is our biological opinion that the proposed action is not likely to jeopardize the continued existence of the Chipola slabshell.

Species with low exposure (informed by low overlap with agriculture)

The species in Table 2 are grouped together as they have low concern of adverse effects due to low exposure as informed by low overlap between the species' range and agricultural land uses where carbaryl is registered for use. While we present some specific information about the species in Table 2 below, we provide additional information on vulnerability (including environmental baseline and cumulative effects), exposure, and toxicity in Appendix E. The status of the species accounts can be found in Appendix B.

Table 2. Bivalve species with low exposure, informed by low overlap with agriculture.

Scientific Name	Common Name	Vulnerability Ranking	Exposure Ranking	Toxicity Ranking	Total Agricultural Use Overlap (% range))	Determination
Alasmidonta atropurpurea	Cumberland elktoe	High	Low	Low	2.8	No Jeopardy
Alasmidonta raveneliana	Appalachian elktoe	High	Low	Low	1.7	No Jeopardy
Arcidens wheeleri	Ouachita rock pocketbook	High	Low	Low	2.3	No Jeopardy
Dromus dromas	Dromedary pearlymussel	High	Low	Low	3.8	No Jeopardy
Epioblasma brevidens	Cumberlandian combshell	High	Low	Low	3.9	No Jeopardy
Epioblasma capsaeformis	Oyster mussel	High	Low	Low	3.2	No Jeopardy
Epioblasma florentina walkeri (=E. walkeri)	Tan riffleshell	High	Low	Low	0.3	No Jeopardy
Fusconaia cor	Shiny pigtoe	High	Low	Low	3.9	No Jeopardy
Fusconaia cuneolus	Finerayed pigtoe	High	Low	Low	3.2	No Jeopardy
Hamiota altilis	Finelined pocketbook	High	Low	Low	2.1	No Jeopardy
Hamiota perovalis	Orangenacre mucket	High	Low	Low	3.6	No Jeopardy
Lampsilis bergmanni	Guadalupe fatmucket	High	Low	Medium	1.2	No Jeopardy
Lampsilis bracteata	Texas fatmucket	High	Low	Medium	3.2	No Jeopardy
Lampsilis powellii	Arkansas fatmucket	High	Low	Low	0.5	No Jeopardy

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Scientific Name	Common Name	Vulnerability Ranking	Exposure Ranking	Toxicity Ranking	Total Agricultural Use Overlap (% range))	Determination
Lampsilis streckeri	Speckled pocketbook	High	Low	Low	0.1	No Jeopardy
Lemiox rimosus	Birdwing pearlymussel	High	Low	Low	3.1	No Jeopardy
Margaritifera marrianae	Alabama pearlshell	High	Low	Low	2.5	No Jeopardy
Medionidus acutissimus	Alabama moccasinshell	High	Low	Low	3.6	No Jeopardy
Medionidus conradicus	Cumberland moccasinshell	High	Low	Low	3.3	No Jeopardy
Medionidus parvulus	Coosa moccasinshell	High	Low	Low	2.2	No Jeopardy
Parvaspina collina	James spinymussel	High	Low	Low	2.3	No Jeopardy
Pleurobema athearni	Canoe Creek clubshell	High	Low	Low	1.7	No Jeopardy
Pleurobema decisum	Southern clubshell	High	Low	Low	3.4	No Jeopardy
Pleurobema furvum	Dark pigtoe	High	Low	Low	3.3	No Jeopardy
Pleurobema georgianum	Southern pigtoe	High	Low	Low	2.1	No Jeopardy
Pleurobema hanleyianum	Georgia pigtoe	High	Low	Low	2.4	No Jeopardy
Pleurobema oviforme	Tennessee clubshell	High	Low	Low	3.5	No Jeopardy
Pleurobema perovatum	Ovate clubshell	High	Low	Low	2.9	No Jeopardy
Pleurobema riddellii	Louisiana pigtoe	High	Low	Low	1.8	No Jeopardy
Popenaias popeii	Texas hornshell	High	Low	Medium	4.0	No Jeopardy
Potamilus amphichaenus	Texas heelsplitter	High	Low	Low	3.0	No Jeopardy
Potamilus inflatus	Inflated heelsplitter	Medium	Low	Low	3.7	No Jeopardy
Ptychobranchus greenii	Triangular kidneyshell	High	Low	Low	2.1	No Jeopardy
Quadrula cylindrica strigillata	Rough rabbitsfoot	High	Low	Low	0.9	No Jeopardy

Scientific Name	Common Name	Vulnerability Ranking	Exposure Ranking	Toxicity Ranking	Total Agricultural Use Overlap (% range))	Determination
Theliderma sparsa	Appalachian monkeyface (pearlymussel)	High	Low	Low	0.4	No Jeopardy
Villosa perpurpurea	Purple bean	High	Low	Low	0.7	No Jeopardy
Villosa trabalis	Cumberland bean (pearlymussel)	High	Low	Low	3.3	No Jeopardy

All the species listed in Table 2 have medium or high vulnerability rankings, indicating that they may not be able to withstand additional stressors in their environment, including reduced reproduction from mortality of host fish from carbaryl exposure. Some species are limited to a small number of populations (e.g., Coosa moccasinshell, dark pigtoe, Texas hornshell) and most are narrow endemics, have isolated or constrained populations, or occur in very low abundance (1-2 individuals in some populations) that make them particularly vulnerable to stochastic events or localized extirpations where a large proportion of a population(s) is impacted.

Experimental populations of Appalachian monkeyface (pearlymussel) (EXPN Entity ID 9487), birdwing (pearlymussel) (EXPN Entity IDs 8356 and 9488), Cumberland bean (pearlymussel) (EXPN Entity IDs 7512 and 9490), Cumberlandian combshell (EXPN Entity IDs 5715 and 9491), dromedary pearlymussel (EXPN Entity IDs 2192 and 9493), finerayed pigtoe (EXPN Entity IDs 3226 and 9495), oyster mussel (EXPN Entity IDs 1905 and 9497), and shiny pigtoe (EXPN Entity IDs 5833 and 9500) were established with unknown success. At least one experimental population for birdwing pearlymussel (Tennessee River downstream of Wilson Dam), dromedary pearlymussel (below Wilson Dam on the Tennessee River, Douglas Dam on the French Broad River, and Cherokee Dam on the Holston River), and oyster mussel (lower French Broad and Holston Rivers) were unsuccessful. Due to water quality concerns and unsuccessful reintroductions of other mussel species into the same locations, finerayed pigtoe and shiny pigtoe have never been reintroduced into the Tennessee, French Broad, or Holston Rivers.

Toxicity varies from low to medium for the mussel species in this group based on their relationship to host fish and predicted levels of carbaryl concentration in their waterbodies. Based on the estimated environmental concentrations in the aquatic habitats where these mussels are found, we do not anticipate direct mortality to mussels. For all species, exposure will result in mortality of a small number of host fish, host fish prey (e.g., other fish, invertebrates), and mussel prey (e.g., zooplankton) at some EECs in lower flow or lower volume aquatic habitats. Additionally, we anticipate exposed fish that do not die are likely to experience sublethal effects such as reduced growth and reduced reproductive success. For mussels with medium toxicity rankings only (e.g., Texas fatmucket, Guadalupe fatmucket, Texas hornshell), in addition to

effects to host fish and prey, we also expect sublethal effects based on the maximum EECs within their respective ranges exceeding the sublethal endpoint (significant decrease in fecundity) for mussels directly. Therefore, we anticipate low to medium adverse effects to the reproductive cycle of each mussel.

While all the species in this grouping are highly vulnerable and some loss of host fish and prey items is expected, we anticipate, at most, a very small number of individuals will be exposed to carbaryl. The species listed in Table 2 have a low extent of total agricultural overlap between the action area and their ranges (overlaps are 0.1%-4.0%). Furthermore, the total overlap metric we use is a conservative estimate of exposure as it does not fully account for redundancy between use site layers, assumes exposure occurs in all possible overlapping areas, and does not consider information on past carbaryl usage. As such, we expect that exposure of these species to carbaryl will occur on an even smaller portion of the species' ranges than indicated by overlap with carbaryl use sites alone.

While we expect that some of these species may occur near non-agricultural use sites, we anticipate no more than a small number of individuals of each species will be exposed to carbaryl from non-agricultural uses. Of the species listed in Table 2, we expect that for example the tan riffleshell, Appalachian monkeyface, and Appalachian elktoe, among others, may co-occur within watersheds with rights of way, developed, open-spaced developed, and may be exposed to carbaryl runoff or spray drift through these uses. However, most applications made for nurseries and residential areas (developed UDL) are limited to spot and crack treatments or narrow perimeter bands around structures (as discussed above in the exposure section of this document) that limits the amount of runoff that may enter nearby aquatic habitats where these mussels may be found. In addition, available usage data indicate very little carbaryl usage is likely to occur in rights of way, with less than 500 pounds of carbaryl applied to roadways nationally on an annual basis. While this may result in a large treatment footprint if all rights of way usage were concentrated in one location or within one species' range, we expect this is highly unlikely to occur and rather expect rights of way usage is likely to be sporadic across the national landscape, with only small amounts, if any, used within the species' range. Available usage data indicate only low levels of past carbaryl usage occurred in open space developed areas (including golf courses) with, at most, up to 2.5% of open space developed areas receiving treatment each year nationally. As such, we anticipate no more than small numbers of individuals of these species will be exposed to non-agricultural uses of carbaryl.

For rangeland uses, mussel mitigations from the USDA-APHIS grasshopper and Mormon cricket consultation are the following: a 2500-foot buffer for all ultra-low volume aerial applications of carbaryl and a 300-foot buffer for all ground applications of carbaryl. For carbaryl bait applications all mussels are protected by a 750-foot buffer for aerial applications and a 100-foot buffer for ground applications. These specific buffers apply for the following species in this grouping that fall in the action area for the USDA-APHIS consultation: Texas fatmucket and Texas hornshell. For the remaining mussels in this grouping, we anticipate there is a low likelihood of the need to apply these program measures as grasshopper and Mormon cricket

populations do not reach the level where they would need to be suppressed in these areas. However, we anticipate the buffers and other mitigation measures outlined in the biological assessment would be applied if there were a need to use carbaryl applications for this reason within the remaining mussel species' habitats in the future. We expect these mitigation measures will be sufficient to result in no adverse effects or incidental take from future uses of carbaryl within rangeland areas that occur in the species' range. As such, we only expect a few individuals to be exposed and experience adverse effects as a result of rangeland uses of carbaryl under the proposed action.

Overall, we anticipate that over the duration of the proposed action, exposure from agricultural and non-agricultural uses of carbaryl will be limited to small portions of the species ranges and will impact very small numbers of the species in Table 2. Therefore, we determine the overall risk of adverse effects to these species will be low, and we do not anticipate that these adverse effects will have population- or species-level effects for any of the mussel species in Table 2.

After reviewing the current status of the species, environmental baseline for the action area, effects of the proposed registration of carbaryl, cumulative effects, and in light of the status of the species in Table 2, it is our biological opinion that the registration of carbaryl, as proposed, is not expected to jeopardize the continued existence of these species in the wild. As discussed, even though these species' vulnerability rankings are medium or high and for some, their toxicity rankings are medium, we anticipate the likelihood of carbaryl exposure to these mussel species, their host fish, and their prey is low. Thus, while we anticipate low levels of adverse effects to mussels from mortality of host fish, reduced fecundity to the mussel and mortality of fish host prey species, the proposed action is not expected to appreciably reduce the likelihood of survival and recovery of the species in Table 2 in the wild. We expect the proposed action will not jeopardize the continued existence of these bivalves.

Species with low exposure (informed by low past usage from USDA Census of Agriculture)

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

Table 3. Species with low exposure (confirmed by low past usage from U.S. Department of Agriculture's Census of Agriculture (CoA).

Scientific Name	Common Name	Vulnerability Ranking	Exposure Ranking	Toxicity Ranking	% Range Treated	Determination
Cyclonaias necki	Guadalupe orb	High	Low	Low	2.1	No Jeopardy
Epioblasma penita	Southern combshell	High	Low	Low	3.4	No Jeopardy
Fusconaia escambia	Narrow pigtoe	High	Low	Low	3.1	No Jeopardy
Fusconaia mitchelli	False spike	High	Low	Medium	3.0	No Jeopardy
Fusconaia subrotunda	Longsolid	High	Low	Low	3.7	No Jeopardy
Hemistena lata	Cracking pearlymussel	High	Low	Low	2.6	No Jeopardy
Lampsilis rafinesqueana	Neosho mucket	High	Low	Low	4.1	No Jeopardy
Lasmigona decorata	Carolina heelsplitter	High	Low	Low	2.8	No Jeopardy
Margaritifera hembeli	Louisiana pearlshell	High	Low	Low	3.8	No Jeopardy
Obovaria subrotunda	Round hickorynut	High	Low	Low	4.1	No Jeopardy
Pegias fabula	Littlewing pearlymussel	High	Low	Low	3.1	No Jeopardy
Pleurobema curtum	Black clubshell	High	Low	Low	2.6	No Jeopardy
Pleurobema taitianum	Heavy pigtoe	High	Low	Low	3.2	No Jeopardy
Pleuronaia gibber	Cumberland pigtoe	High	Low	Low	2.9	No Jeopardy
Ptychobranchus subtentus	Fluted kidneyshell	High	Low	Low	2.6	No Jeopardy

Scientific Name	Common Name	Vulnerability Ranking	Exposure Ranking	Toxicity Ranking	% Range Treated	Determination
Quadrula fragosa	Winged mapleleaf	High	Low	Low	1.3	No Jeopardy
Reginaia rotulata	Round ebonyshell	High	Low	Low	3.6	No Jeopardy
Theliderma intermedia	Cumberland monkeyface (pearlymussel)	High	Low	Low	2.7	No Jeopardy
Toxolasma cylindrellus	Pale lilliput (pearlymussel)	High	Low	Low	3.8	No Jeopardy

All the species listed in Table 3 have high vulnerability rankings, indicating that they may not be able to withstand additional stressors in their environment, including reduced reproductive capacity from carbaryl exposure. Some species are limited to a small number of populations (e.g., black clubshell). Many species are narrow endemics, have isolated or constrained populations, or occur in very low abundance (1-2 individuals in a population) that make them particularly vulnerable to stochastic events or localized extirpations where a large proportion of a population(s) is impacted.

Experimental populations of cracking pearlymussel (EXPN Entity IDs 2308 and 9489), Cumberland monkeyface (pearlymussel) (EXPN Entity IDs 5718 and 9492), and winged mapleleaf (EXPN Entity ID 7091) were established with unknown success. Due to water quality concerns and unsuccessful reintroductions of other mussel species into the same locations, Cumberland monkeyface (pearlymussels) have never been reintroduced into the Tennessee, French Broad, or Holston Rivers.

While these species have high vulnerability rankings we anticipate, at most, a very small number of individuals will be exposed to carbaryl from agricultural use as a low percent of their range has been treated with insecticides in the past based on CoA reporting (1.3-4.1%). Low CoA usage indicates that very little insecticide usage (of any type) occurred in the past on agriculture in the counties where these species' ranges occur. Given that this reporting includes all insecticide usage, we consider CoA data to be a conservative estimate of agricultural carbaryl usage. For these species, very little of the species' ranges are likely to be treated with carbaryl for agriculture.

Toxicity is low for most of the mussel species in this group based on their relationship to host fish and predicted levels of carbaryl concentration. Based on the estimated environmental concentrations in the aquatic habitats where these mussels are found, we do not anticipate direct adverse effects to mussels (including mortality or sublethal effects) for those with low toxicity rankings. The false spike has a medium toxicity ranking and, when exposed, may experience sublethal effects. For the species in Table 3 except the southern combshell, we expect exposure will result in some mortality of host fish, host fish prey (e.g., other fish, invertebrates), and

mussel prey (e.g., zooplankton). Additionally, we anticipate exposed fish that do not die are likely to experience sublethal effects such as reduced growth and reduced reproductive success.

Most of the mussel species in this grouping have multiple, common fish hosts these mussels can use to complete their reproductive cycle. Thus, while we anticipate some reduced fecundity for fish hosts in smaller volume and lower flowing aquatic habitats, we do not anticipate this will compromise the ability for these mussels to obtain host fish for their glochidia throughout their respective ranges. For those mussels where the fish host are few (e.g., 1-2 host fish species such as the Cumberland pigtoe and Cumberland monkeyface), the fish hosts for these mussels are common (e.g., telescope shiner, striped shiner and streamlined chub, blotched chub for the Cumberland pigtoe and Cumberland monkeyface, respectively) and abundant within their respective ranges as well. We do not anticipate carbaryl exposure will eliminate the ability of each mussel to successfully reproduce. Unlike the others in Table 3, the southern combshell mussel's fish host is unknown. However, the maximum EEC (61 µg/L) within their range is not anticipated to exceed any of the thresholds for mortality or sublethal effects for fish, or the mussel directly. Coupled with the low CoA data anticipated for this mussel as well (3.4%), we do not anticipate any effects to southern combshells from carbaryl exposure within its range.

The narrow pigtoe, fluted kidneyshell, Guadalupe orb, and false spike among others may co-occur within watersheds with non-agricultural carbaryl use sites, including utility rights of way, and may be exposed to carbaryl through this non-agricultural use. However, available data on past non-agricultural usage indicate that very little insecticides, in general, are applied to utility rights of way nationwide, indicating that there is a low likelihood of exposure to these mussels. Less than 500 pounds of carbaryl are applied along roadways nationally each year. While this may result in a large treatment footprint if all rights of way usage were concentrated in one location or within one species' range, we expect this is highly unlikely to occur and rather expect rights of way usage is likely to be sporadic across the national landscape, with only small amounts, if any, used within the species' range. Applications made for nurseries and residential areas (developed UDL) are mostly limited to spot and crack treatments or narrow perimeter bands around structures (as discussed above in the exposure section of this document) that limit the amount of runoff that may enter nearby aquatic habitats where these mussels may be found. Available usage data indicate only low levels of past carbaryl usage occurred in open space developed areas (including golf courses) with, at most, up to 2.5% of open space developed areas receiving treatment each year nationally. As such, we anticipate no more than small numbers of individuals of these species will be exposed to non-agricultural uses of carbaryl.

For rangeland uses, mussel mitigations from the USDA-APHIS grasshopper and Mormon cricket consultation are the following: a 2500-foot buffer for all ultra-low volume aerial applications of carbaryl and a 300-foot buffer for all ground applications of carbaryl. For carbaryl bait applications all mussels are protected by a 750-foot buffer for aerial applications and a 100-foot buffer for ground applications. These specific buffers apply for the following species in this grouping that fall in the action area for the USDA-APHIS consultation: Neosho mucket. As such, we expect non-agricultural usage of carbaryl will be low and not likely to result in the exposure

or death of the individuals. For the remaining mussels in this grouping, we anticipate there is a low likelihood of the need to apply these program measures as grasshopper and Mormon cricket populations do not reach the level where they would need to be suppressed in these areas. However, we anticipate the buffers and other mitigation measures outlined in the biological assessment would be applied if there were a need to use carbaryl applications for this reason within the remaining mussel species' habitats in the future. As such, we anticipate low exposure from rangeland use of carbaryl. We expect these mitigation measures will be sufficient to result in no adverse effects or incidental take from future uses of carbaryl within rangeland areas that occur in the species' ranges.

Overall, we anticipate that over the duration of the proposed action, exposure from agricultural and non-agricultural uses of carbaryl will be limited to small portions of the species ranges and will impact very small numbers of the species in Table 3. Therefore, we determine the overall risk of adverse effects to these species will be low and we do not anticipate that these adverse effects will have population- or species-level effects for any of the mussel species in Table 3.

After reviewing the current status of the species, environmental baseline for the action area, effects of the proposed registration of carbaryl, and cumulative effects, and in light of the status of the species in Table 3, it is our biological opinion that the registration of carbaryl, as proposed, is not expected to jeopardize the continued existence of these species in the wild. As discussed, even though these species' vulnerability rankings are high, toxicity rankings are low, we anticipate the likelihood of carbaryl exposure to these mussel species, their host fish, and their prey is low. Thus, while we anticipate low levels of adverse effects to mussels from mortality of host fish and prey species, the proposed action is not expected to appreciably reduce the likelihood of survival and recovery of the species in Table 3 in the wild.

Note: The cracking pearlymussel has two non-essential experimental populations (EXPN Entity IDs: 2308, 9489).

Species with moderate to high exposure and low toxicity

These species listed below have high vulnerability rankings, medium or high exposure rankings, and low toxicity rankings. While we present some specific information about the species in Table 4 below, we provide additional information on vulnerability (including environmental baseline and cumulative effects), exposure, and toxicity in Appendix E. The status of the species accounts can be found in Appendix B.

Table 4. Species with medium to high vulnerability and exposure and low toxicity.

Scientific Name	Common Name	Vulnerability Ranking	Exposure Ranking	Toxicity Ranking	Maximum EEC range (µg/L)	Determination
Alasmidonta heterodon	Dwarf wedgemussel	High	High	Low	723.9-785.6	No Jeopardy
Alasmidonta triangulata	Southern elktoe	High	High	Low	41.8-138.3	No Jeopardy
Cumberlandia monodonta	Spectaclecase (mussel)	High	High	Low	61.1-103.8	No Jeopardy
Cyclonaias petrina	Texas pimpleback	High	High	Low	54.8-103.8	No Jeopardy
Cyprogenia aberti	Western fanshell	High	High	Low	54.8-103.8	No Jeopardy
Cyprogenia sp. cf. aberti	Ouachita fanshell	High	High	Low	54.8-103.8	No Jeopardy
Cyprogenia stegaria	Fanshell	High	High	Low	54.8-103.8	No Jeopardy
Elliptio lanceolata	Yellow lance	High	High	Low	61.1-103.8	No Jeopardy
Elliptio spinosa	Altamaha spinymussel	High	Medium	Low	41.8-103.8	No Jeopardy
Elliptoideus sloatianus	Purple bankclimber (mussel)	High	Medium	Low	41.8-103.8	No Jeopardy
Epioblasma florentina curtisii	Curtis pearlymussel	High	High	Low	723.9-785.6	No Jeopardy
Epioblasma obliquata	Purple Cat's paw (=Purple Cat's paw pearlymussel)	High	Medium	Low	61.1 – 103.8	No Jeopardy
Epioblasma perobliqua	White catspaw (pearlymussel)	High	High	Low	723.9-785.6	No Jeopardy
Epioblasma rangiana	Northern riffleshell	High	High	Low	723.9-785.6	No Jeopardy

Appendix C-A3. Bivalves (Mussels): Integration and Synthesis Summaries

Scientific Name	Common Name	Vulnerability Ranking	Exposure Ranking	Toxicity Ranking	Maximum EEC range (µg/L)	Determination
Epioblasma triquetra	Snuffbox mussel	High	High	Low	723.9-785.6	No Jeopardy
Fusconaia burkei	Tapered pigtoe	High	High	Low	41.8-103.8	No Jeopardy
Fusconaia masoni	Atlantic pigtoe	High	Medium	Low	41.8-103.8	No Jeopardy
Hamiota australis	Southern sandshell	High	Medium	Low	647.7-785.6	No Jeopardy
Lampsilis abrupta	Pink mucket (pearlymussel)	High	Medium	Low	54.8-103.8	No Jeopardy
Lampsilis higginsii	Higgins eye (pearlymussel)	High	High	Low	61.1 – 103.8	No Jeopardy
Lampsilis virescens	Alabama lampmussel	High	Medium	Low	723.9-785.6	No Jeopardy
Lasmigona subviridis	Green floater	High	Medium	Low	61.1-103.8	No Jeopardy
Leptodea leptodon	Scaleshell mussel	High	High	Low	54.8-103.8	No Jeopardy
Medionidus penicillatus	Gulf moccasinshell	High	High	Low	41.8-138.3	No Jeopardy
Medionidus simpsonianus	Ochlockonee moccasinshell	High	High	Low	41.8-138.3	No Jeopardy
Medionidus walkeri	Suwannee moccasinshell	High	High	Low	41.8-103.8	No Jeopardy
Obovaria choctawensis	Choctaw bean	High	Medium	Low	41.8-103.8	No Jeopardy
Obovaria retusa	Ring pink (mussel)	High	High	Low	54.8-103.8	No Jeopardy
Parvaspina steinstansana	Tar River spinymussel	High	High	Low	41.8-103.8	No Jeopardy
Plethobasus cicatricosus	White wartyback (pearlymussel)	High	High	Low	54.8-103.8	No Jeopardy
Plethobasus cooperianus	Orangefoot pimpleback (pearlymussel)	High	High	Low	54.8-103.8	No Jeopardy
Plethobasus cyphyus	Sheepnose mussel	High	High	Low	61.1-103.8	No Jeopardy
Pleurobema clava	Clubshell	High	High	Low	723.9-785.6	No Jeopardy
Pleurobema plenum	Rough pigtoe	High	Medium	Low	54.8-103.8	No Jeopardy

Scientific Name	Common Name	Vulnerability Ranking	Exposure Ranking	Toxicity Ranking	Maximum EEC range (µg/L)	Determination
Pleurobema pyriforme	Oval pigtoe	High	Medium	Low	41.8-103.8	No Jeopardy
Pleurobema strodeanum	Fuzzy pigtoe	High	Medium	Low	41.8-103.8	No Jeopardy
Pleuronaia barnesiana	Tennessee pigtoe	High	Medium	Low	54.8-103.8	No Jeopardy
Pleuronaia dolabelloides	Slabside pearlymussel	High	High	Low	41.8-103.8	No Jeopardy
Ptychobranchus jonesi	Southern kidneyshell	High	Medium	Low	647.7-785.6	No Jeopardy
Quadrula cylindrica cylindrica	Rabbitsfoot	High	High	Low	723.9-785.6	No Jeopardy
Simpsonaias ambigua	Salamander mussel	High	High	Low	54.8-103.8	No Jeopardy
Truncilla cognata	Mexican fawnsfoot	High	Medium	Low	54.8-103.8	No Jeopardy
Villosa fabalis	Rayed bean	High	High	Low	723.9-785.6	No Jeopardy

The species in Table 4 have high vulnerability rankings, indicating that they may not be able to withstand additional stressors in their environment, including reduced reproduction from mortality of host fish from carbaryl exposure. Some species are limited to a small number of populations (e.g., Alabama lampmussel, rayed bean, fuzzy pigtoe) and most are narrow endemics, have isolated or constrained populations, or occur in very low abundance (e.g., 1-2 individuals in some populations) that make them particularly vulnerable to stochastic events or localized extirpations where a large proportion of a population(s) is impacted.

The species in Table 4 have low toxicity rankings as we expect direct effects to mussels will not occur at estimated environmental exposures. Based on maximum concentrations in the aquatic habitats where these mussels are found, we expect that exposure will result in some reduced fecundity to host fish, mortality to host fish prey (e.g., other fish), and mussel prey (e.g., zooplankton). In particular, we expect carbaryl to reach concentrations where sublethal effects are expected for the fish hosts at maximum EECs for the white catspaw (pearlymussel), Alabama lampmussel, Curtis pearlymussel, clubshell, dwarf wedgemussel, northern riffleshell, rabbitsfoot, snuffbox mussel, rayed bean, southern sandshell, and southern kidneyshell. However, carbaryl residues in aquatic habitats where these mussels and their host fish species occur will vary depending on the crops treated as application rates will vary across use sites. Estimated environmental concentrations of carbaryl will further vary based on environmental conditions where individuals are exposed (e.g., water body size, flow rate). We anticipate maximum estimated environmental concentrations within these species' habitats will range from 41.8-785.6 µg/L. Given these estimates, we expect that some of the carbaryl concentrations will result in

reproductive effects to the fish hosts. Based on known habitat preferences of these listed species and the land uses with the highest overlaps with each of the species' ranges, we expect most exposures will result in, at most, exposure to a small number of individuals and low levels of adverse effects.

Furthermore, despite these effects at maximum concentrations, we expect effects to be low for the mussel species in this group based on their relationship to host fish (i.e., ability to use many fish species or common fish species). The White catspaw (pearlymussel), Alabama lampmussel, Curtis pearlymussel, clubshell, dwarf wedgemussel, northern riffleshell, rabbitsfoot, snuffbox mussel, and rayed bean are all fish host generalists that rely on several species of fish that are also common throughout the ranges of these mussels. Therefore, we do not expect mortality or reduced reproduction in fish hosts for some of the mussels in Table 4, as described above, to impact overall host fish availability, and as such, do not expect the opportunity for glochidia to attach to a fish host to be impeded. The southern kidneyshell and the southern sandshell have unknown fish hosts but the hosts are likely darters and sunfish, which are also common throughout the range of these mussel species, respectively, based on similar species within their respective genera. We therefore conclude a similar effect as that described above for those mussel species that are fish host generalists, such that we do not expect the opportunity for glochidia to attach to a fish host is hindered based on the low potential for reduced reproductive success in some fishes.

These species have a large percent overlap between the action area and their ranges and have medium to high levels of usage based on state-level survey data. While we expect that some of these species may occur on non-agricultural use sites, we do not anticipate more than a small number of individuals of each species will be exposed to carbaryl through non-agricultural uses for the species in Table 4. Some species in Table 4 may co-occur within watersheds with rights of way, developed, and open-space developed areas, and they may be exposed to carbaryl runoff or spray drift through these uses. However, available data on past non-agricultural usage indicate that very little insecticides, in general, are applied to utility rights of way nationwide, indicating that there is a low likelihood of exposure to these mussels. Less than 500 pounds of carbaryl are applied along roadways nationally each year. While this may result in a large treatment footprint if all rights of way usage were concentrated in one location or within one species' range, we expect this is highly unlikely to occur and rather expect rights of way usage is likely to be sporadic across the national landscape, with only small amounts, if any, used within the species' range. In addition, most applications made for nurseries and residential areas (developed UDL) are limited to spot and crack treatments or narrow perimeter bands around structures (as discussed above in the exposure section of this document) that limits the amount of runoff that may enter nearby aquatic habitats where these mussels may be found. Available usage data indicate only low levels of past carbaryl usage occurred in open space developed areas (including golf courses) with, at most, up to 2.5% of open space developed areas receiving treatment each year nationally.

For rangeland uses, mussel mitigations from the USDA-APHIS grasshopper and Mormon cricket consultation are the following: a 2,500-foot buffer for all ultra-low volume aerial applications of carbaryl and a 300-foot buffer for all ground applications of carbaryl. For carbaryl bait applications, specific mussels within the program action area are protected by a 750-foot buffer for aerial applications and a 100-foot buffer for ground applications. These specific buffers apply for the following species in this grouping that fall in the action area for the USDA-APHIS consultation: Higgins eye (pearlymussel), rabbitsfoot, scaleshell mussel, Texas pimpleback, and western fanshell. As such, we anticipate no more than a small number of individuals of each species will be exposed to carbaryl from rangeland uses. For the mussels in this grouping that are outside of the action area for the grasshopper and Mormon cricket program, we anticipate there is a low likelihood of the need to apply these program measures as grasshopper and Mormon cricket populations do not reach the level where they would need to be suppressed in these areas. However, we anticipate the buffers and other mitigation measures outlined in the biological assessment would be applied if there were a need to use carbaryl applications for this reason within the remaining mussel species' habitats in the future. We expect these mitigation measures will be sufficient to result in no adverse effects or incidental take from future uses of carbaryl within rangeland areas that occur in the species' range. As such, we anticipate low exposure from rangeland use of carbaryl.

While these species have high vulnerability rankings and medium to high exposure, we anticipate, at most, a very small number of individuals will be impacted from carbaryl exposure because the concentrations of carbaryl in the aquatic habitats where they and their host fish species are found are not high enough to cause sublethal effects to mussels or host fish mortality. For the species in Table 4, we anticipate that over the duration of the proposed action, very small numbers of the species in a limited portion of the species' ranges will be adversely affected by carbaryl exposure. After adding the effects of the action and cumulative effects to the environmental baseline, and in light of the status of the species, we have determined the proposed action is not expected to appreciably reduce the likelihood survival and recovery of these species in the wild. We determine the overall risk of adverse effects to these species will be low and we do not anticipate that these adverse effects will have population- or species-level effects for any of the mussel species in Table 4. Thus, it is our biological opinion that the proposed action is not likely to jeopardize the continued existence of these species.

Note: The Alabama lampmussel (EXPN Entity ID: 1680), purple cat's paw (EXPN Entity ID: 8349), white wartyback (pearlymussel) (EXPN Entity ID: 9501), orangefoot pimpleback (pearlymussel) (EXPN Entity ID: 9496), rough pigtoe (EXPN Entity ID: 9499), ring pink (mussel) (EXPN Entity ID: 9498), clubshell (EXPN Entity ID: 1897), and fanshell (EXPN Entity ID: 9494) and have non-essential experimental populations.

Species with Individual Integration and Synthesis summaries

For the species in Table 5, our preliminary exposure and toxicity rankings indicated that the proposed action may result in moderate to high adverse effects, or their high vulnerability warranted further analysis as even low exposure and toxicity may result in outsize adverse effects to the overall species. As such, we discuss each species in more detail in individual Integration and Synthesis summaries below. In some cases, we modified initial exposure and toxicity rankings due to additional information regarding exposure and effects for individual species, as described below. For species that had a jeopardy determination in the draft Opinion, EPA incorporated species-specific conservation measures that the registrants agreed to incorporate into the description of the action to minimize exposure to the species. When relevant, we retained our evaluation that led to our Preliminary Conclusion and the need for species-specific measures and added an updated Final Conclusion to reflect the impacts of these species-specific measures.

Additional information on vulnerability (including environmental baseline and cumulative effects), exposure, and toxicity can be found in Appendix E. The status of the species accounts can be found in Appendix B.

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

Scientific Name	Common Name	Determination
Hamiota subangulata	Shinyrayed pocketbook	No Jeopardy
Truncilla macrodon	Texas fawnsfoot	No Jeopardy
Fusconaia iheringi	Balcones spike	No Jeopardy

Integration and Synthesis Summary: Shinyrayed pocketbook

Scientific Name:	Common Name:	Entity ID:
Hamiota subangulata	Shinyrayed pocketbook	373

Species Overview

In reviewing the status of the species, the environmental baseline, and cumulative effects for the action area, we determined that the species' vulnerability is high. In our evaluation of the effects of the proposed action to the species, we determined there was high overlap of the action area with the species' range, and low past usage of carbaryl within the species' range, indicating a moderate extent of exposure within the action area across the species' range (Figure 1). Exposed individuals are unlikely to die but some in low flow or low volume waterbodies are likely to experience sublethal effects and indirect effects resulting from loss of reproductive host species. We do not anticipate any significant reductions in food availability, as any localized reductions in zooplankton as a food source will be quickly replenished by upstream sources. Because exposure was medium and toxic effects are expected to be high in low flow/low volume waterbodies where the mussel and its host fish are found, we determined the risk of adverse effects to the species was medium. As such, we expected a moderate number of individuals would experience sublethal effects and reduced reproductive success from the proposed action.

Because of the effects described in our preliminary evaluation and conclusion, EPA and the applicant agreed to incorporate the species-specific conservation measures as part of the action. We now expect exposure for the shinyrayed pocketbook to be low. After incorporating conservation measures into the proposed action, adding the effects of the action and cumulative effects to the environmental baseline, and in light of the status of the species, we determined the proposed action is not likely to appreciably reduce the survival and recovery of the species. Thus, it is our biological opinion that the proposed action is not likely to jeopardize the continued existence of the shinyrayed pocketbook.

Species range

Based on range map dated: 4/7/2022; Wherever found; *States within the range:* AL, FL, GA.

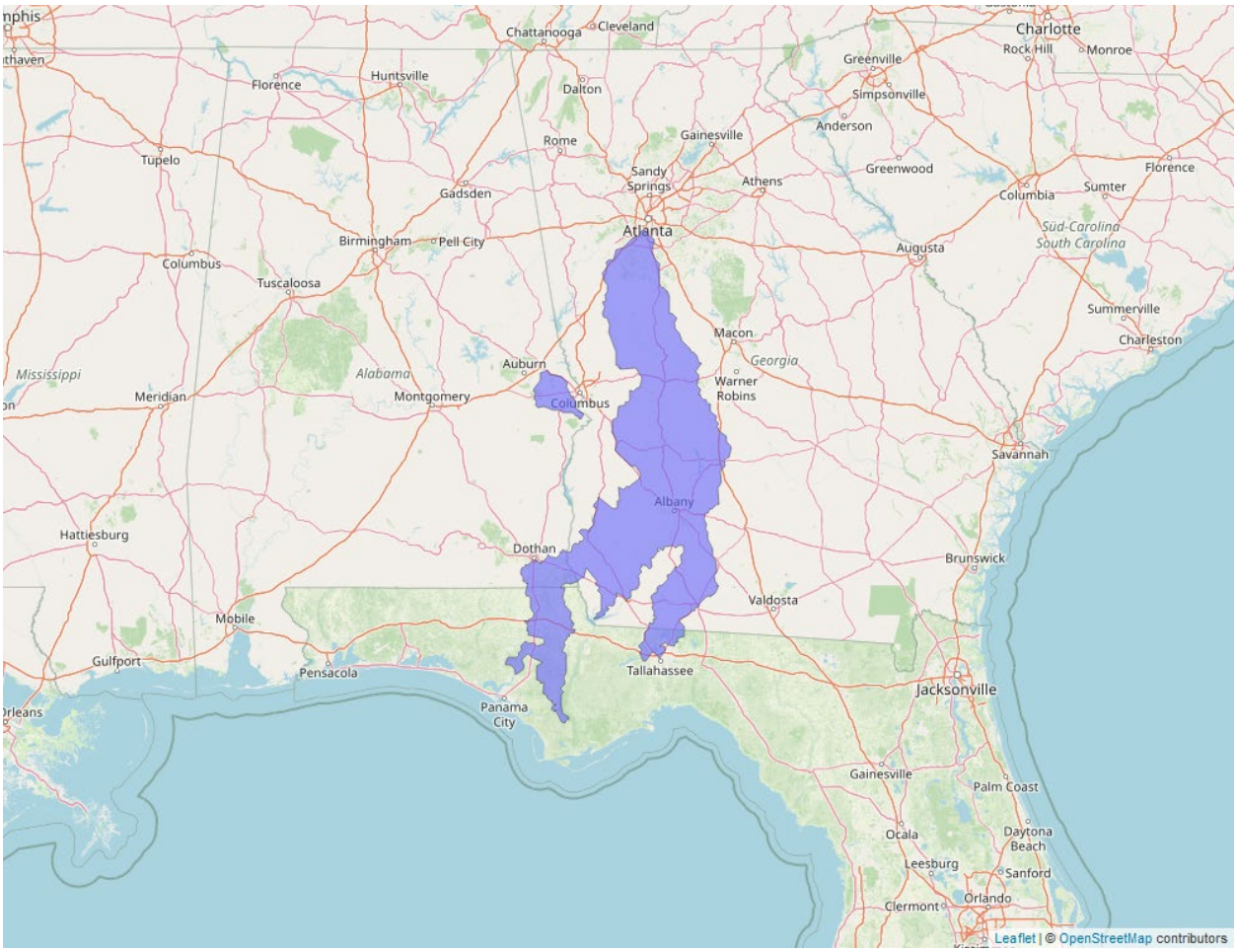

Figure 1. Range map of shinyrayed pocketbook (blue polygons). Range map accessed at https://ecos.fws.gov/ecp/species/6517. depicts the species' range.

Vulnerability

As mentioned above, vulnerability considers the present condition of the species to determine its vulnerability to additional stressors. Here, in making our jeopardy determination, vulnerability of the species is a function not only of its status, but also the environmental baseline and cumulative effects, as summarized below.

Summary of status

Listing status: Endangered

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

Most recently completed 5-Year Review: 9/17/2020

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

Number of populations: Multiple populations (few)

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

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

Environmental Baseline/Cumulative Effects (EB/CE) Summary

The shinyrayed pocketbook historically occurred in 11 sub-basins and currently occupies ten in Alabama, Georgia, and Florida: Chipola, Middle Chattahoochee, Lower Chattahoochee, Upper Flint, Middle Flint, Lower Flint, Kinchafoonee, Ichawaynochaway, and Spring. It now also occurs in the Econfina sub-basin in Florida, which was not initially included in its historical range. Mussel distribution varies by sub-basin with decreases (Upper Flint), a few increases (Chipola, Middle Chattahoochee, and Lower and Middle Flint), and potential stability in others (Spring, Lower Chattahoochee, and Ichawaynochaway). Populations in the Lower Chattahoochee, Spring, and Chipola sub-basins have evidence of recruitment, are limited in distribution, and 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 including possible extirpation in the Upper Ochlockonee River. Overall, this species distribution remained stable from 2007 to 2020 (USFWS 2020).

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. These impacts have decreased water quality, changed natural flow regimes, increased isolation, and directly altered riverine habitat. Droughts and agricultural water withdrawals decrease water quantity in several of these systems. Many of the threats that lead to the listing of these species continue today (USFWS 2020).

Overall Vulnerability: High

Effects of the Action: Exposure

Overlap

We do not expect listed bivalve species will occur on-field, and thus expect exposure will only result from off-field transport via spray drift or runoff. Given that the ranges for listed aquatic species are generally delineated using the relevant HUC 12 watersheds, we anticipate that all residues that leave use sites will be collected in the waterbodies within the species range where individuals occur regardless of how residues leave treated sites or where in the range they are deposited. As such, we do not extend overlap metrics off-field as this will not functionally change the expected exposures that listed aquatic species are likely to experience. We expect up to 27.7% of the species range will contain carbaryl use sites (Table 6).

Usage

Past usage data indicate that up to 4.8% of the species' range has been treated with carbaryl annually. Use layers with the highest usage include other row crops (13.3%) and other orchards (3.3%) (Table 6).

Table 6.Overlap and usage data for the shinyrayed pocketbook.

Use Layer	Use Site Overlap (% range)	% Range Treated
Alfalfa	<0.01	< 0.01
Citrus	< 0.01	< 0.01
Corn[2]	7.0	0.7
Grapes	0.01	0.01
Other Crops	2.2	2.2
Other Grains	1.3	0.05
Other Orchards	3.3	0.6
Other Row Crops	13.3	1.2
Soybeans	1.6	0.7
Vegetables and Ground Fruit	0.6	0.2
Total	**27.7**	**4.8**

Non-agricultural Uses

In addition to agricultural use sites, we anticipate some non-agricultural carbaryl use sites also occur within the species' range, including managed forests, rangeland, developed, open space developed, nurseries, and rights of way uses. U.S Forest Service usage data indicate that only ~800 acres of managed forests within several western states have been treated with carbaryl over a 5-year period (2016-2020). We do not anticipate treated acres of managed forests occur within the shinyrayed pocketbook range. Furthermore, treatments are made using ground-based sprayers directed to lower parts of the tree (i.e., the trunk) (which will limit the extent of off-site transport and exposure to individuals). As such, we anticipate a low likelihood of forest carbaryl usage in the range, and that if usage did occur, exposure to the shinyrayed pocketbook would be minimal. For rangelands, Alabama, Florida, and Georgia are not included in the USDA APHIS grasshopper/Mormon cricket suppression program because it is not one of the 17 states within the action area for this program, indicating that carbaryl usage on rangelands is not expected to occur in Alabama, Florida, or Georgia where the shinyrayed pocketbook is found. The USDA-APHIS grasshopper and Mormon cricket consultation includes the following mitigations applied to any waterbody and are thus protective for this mussel should applications be made in their

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

range in the future: 500-foot buffer for aerial sprays, 200-foot buffer for ground sprays, and a 50-foot buffer for bait applications.

Similarly, available usage data indicate very little carbaryl usage is likely to occur in rights of way, with less than 500 pounds of carbaryl applied to roadways nationally each year. While this may result in a large treatment footprint if all rights of way usage were concentrated in one location or within one species' range, we expect this is highly unlikely to occur and rather expect rights of way usage is likely to be sporadic across the national landscape, with only small amounts, if any, used within the species' range. Available usage data indicate only low levels of past carbaryl usage occurred in open space developed areas (including golf courses) with, at most, up to 2.5% of open space developed areas receiving treatment each year nationally. Finally, most developed (e.g., residential) uses are completed using hand-held equipment on cracks and crevices, indicating a low level of off-site transport.

As such, we do not anticipate non-agricultural carbaryl uses will result in exposure to more than a few individuals of the species.

Exposure Summary

A large portion of the species range could be exposed to carbaryl given the overlap between agricultural use sites and the species' range (27.7%). Based on past usage data, we expect a small portion of the range is likely to be treated with carbaryl (4.8% annually) for agricultural purposes, suggesting a moderate portion of the range will likely experience exposure over the duration of the action. Based on the low likelihood of usage for non-agricultural purposes, we do not anticipate more than a few individuals will be exposed from non-agricultural uses.

Overall Exposure: Medium

General Conservation Measures

Rain restriction: Carbaryl is prohibited from being applied within 48 hours of a forecasted rain event or when soil in the treatment area is saturated. This rain restriction reduces the concentration of carbaryl in aquatic habitats by providing time for carbaryl to degrade before runoff into aquatic habitats can occur, decreasing the likelihood of exposure and risk. We have incorporated this mitigation measure in the information we provide in Table 7, which lists the maximum predicted EEC from the highest overlap use site within the species range.

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

We anticipate that in many cases, these buffers will significantly reduce exposure to the shinyrayed pocketbook and subsequent indirect risk from effects to host fish.

Label measures limit many residential uses of carbaryl to spot, crack-and-crevice, or narrow perimeter bands around urban structures (from 1 inch to 6 feet in width), which we expect will substantially reduce the likelihood of exposure to the species from developed uses.

Effects of the Action: Toxicity

Direct Effects:

Based on available toxicity data for mollusks, we do not expect exposures of carbaryl at most predicted environmental concentrations are likely to cause adverse effects. Shinyrayed pocketbooks that experience 1,000 µg/L or greater concentrations of carbaryl may experience sublethal effects (e.g., reduced fecundity). We expect >1,000 µg/L of carbaryl to occur only in low flow/low volume waterbodies subject to runoff from land uses within the Other Orchards use layer.

Indirect Effects:

Within the regions and aquatic habitats that the shinyrayed pocketbook occupies, EPA's aquatic exposure modeling indicates that predicted environmental concentrations of carbaryl will likely be from 41 to 2,454 µg/L, depending on the type of habitat and region (Table 7). We expect exposed host fish will die or have reduced fecundity at concentrations above 1,000 µg/L and fish may experience reduced fecundity at lower concentrations (i.e., above 680 µg/L). Availability of some fish hosts needed for successful reproduction will decrease in waterbodies that experience these levels of carbaryl or greater. The shinyrayed pocketbook is a host fish generalist and can likely use a variety of fish species as hosts, including the spotted bass (*Micropterus punctulatus*), eastern mosquitofish (*Gambusia holbrooki*), guppy (*Poecilia reticulata*), and bluegill (*Lepomis macrochirus*). Recently under laboratory conditions, shinrayed pocketbook glochidia were able to successfully transform with shoal bass (*Micropterus cataractae*), redeye bass (*Micropterus coosae*) and largemouth bass (*Micropterus salmoides*) (USFWS 2020). The fish host species are varied and common, and we do not expect mortality of all potential fish hosts within the aquatic habitats where the shinyrayed pocketbook is found. In particular, we expect some fish host mortality in low flow/low volume waterbodies subject to runoff from Other Orchards land uses. We do not expect fish mortality in high flow/large volume waterbodies.

Table 7. Maximum estimated environmental concentrations of carbaryl associated with the highest overlapping use layers within the shinyrayed pocketbook range.

Use layer	Habitat	Max EEC (µg/L)
Other Row Crops	Low flow/low volume waterbodies	648

Use layer	Habitat	Max EEC (µg/L)
Other Row Crops	High flow/large volume waterbodies	41
Corn	Low flow/low volume waterbodies	724
Corn	High flow/large volume waterbodies	104
Other Orchards	Low flow/low volume waterbodies	2,454
Other Orchards	High flow/large volume waterbodies	139

Similarly, we anticipate some host fish that do not die may experience sublethal adverse effects (i.e., reduced fecundity) in low flow/low volume waterbodies subject to runoff from use sites within the Other Row Crops, Corn., and Other Orchards use layers. We expect the loss of and sublethal effects to host fish will affect the reproductive success of the mussel. Individual host fish that are exposed in high flow or large volume waterbodies are not likely to experience sublethal adverse effects as estimated environmental concentrations within these areas are well below levels where toxicity studies have observed adverse effects in fish.

While non-agricultural uses of carbaryl may contribute to the overall exposure of the shinyrayed pocketbook, estimated environmental concentrations associated with all non-agricultural uses (including developed, open space developed, nursery, managed forests, rangeland, and rights of way uses) will not exceed 959 µg/L. This non-agricultural carbaryl exposure is well below levels where available toxicity studies in fish have observed any adverse effects to survival, but those levels may still impact reproduction.

While we expect some reductions in zooplankton from carbaryl exposure, based on carbaryl's low persistence in water and planktonic drift, we anticipate any localized reductions in zooplankton as a food source will be quickly replenished by upstream sources. We do not expect any adverse effects from carbaryl exposure to detritus or any other aquatic debris on which mussels feed.

Toxicity Summary

Maximum estimated environmental concentrations in parts of the species' habitat (i.e., low flow or low volume waterbodies) will be high enough to cause sublethal effects to mussels and host fish mortality and sublethal effects. While the shinyrayed pocketbook can likely use a variety of fish species as hosts and not all the fish will die or will experience reduced fecundity, we anticipate some fish and the mussel itself may occupy areas of low flow waterbodies where sublethal and indirect effects (i.e., effects to reproduction through loss of host fish) will be

moderate. We do not anticipate any indirect adverse effects to plant food resources are likely to occur.

Overall Toxicity Ranking: Medium

Effects of the Action Summary

The shinyrayed pocketbook has a moderate exposure ranking as there is a high extent of overlap between agricultural use sites and the species' range and a low level of past agricultural usage within the range. As such, we anticipate a moderate number of individuals are likely to be exposed over the duration of the proposed action. Based on available usage data and existing conservation measures for non-agricultural uses, we do not anticipate more than a small number of individuals will be exposed and die from non-agricultural uses.

The shinyrayed pocketbook has a medium toxicity ranking. The conservation measures on the label will reduce runoff and drift of carbaryl into the aquatic waterbodies where this mussel is found but not enough for some uses to eliminate adverse effects to the fish host or mussel (corn, other row crops, other orchards). Estimated environmental concentrations of carbaryl may cause mortality and reduced fecundity for some host fish species depending on the aquatic water bodies, particularly in low flow or low volume areas within the species' habitat. We also expect some sublethal effects to the mussels in these low flow/low volume waterbodies. We do not anticipate any indirect adverse effects to food resources because the species primarily relies on plant-based food resources that are not likely to be adversely affected by carbaryl exposure.

While we anticipate a large number of individuals are likely to experience exposure, we anticipate a high level of mortality to host fish and sublethal effects to the mussel and host fish in the lower flow or lower volume aquatic habitats but not in all water bodies where the mussel or its host fish may be found. We do not anticipate any indirect effects to the dietary items the mussel relies on. As such, we anticipate the overall risk of adverse effects to the species is medium.

Preliminary Conclusion

The shinyrayed pocketbook is listed as endangered and its range includes 11 sub-basins across Alabama, Florida, and Georgia, including one in Florida that was not included in its historical distribution. One population is believed to be decreasing, four are believed to be increasing, and three are believed to be stable. We believe it is extirpated from the Upper Ochlockonee River sub-basin. All populations are threatened by decreased water quality, decreased water quantity, changed water flow regimes, increased isolation, and habitat alteration.

The shinyrayed pocketbook inhabits small to medium-sized creeks, to rivers in clean or silty sand substrates in slow to moderate current. Specimens are often found in the interface of stream channel and sloping bank habitats, where sediment particle size and current strength are

transitional. Clench and Turner (1956) noted it preferred small creeks and spring-fed rivers (USFWS 2007).

The species range occurs near agricultural carbaryl use sites (27.7% overlap) and a small portion of the range has experienced carbaryl usage in the past (4.8% annually). Therefore, we considered the species to have a medium exposure ranking. Though we do not expect direct mortality of mussels from carbaryl exposure, we expect sublethal effects to mussels where carbaryl concentrations rise above 1,000 µg/L, and we expect mussels to be indirectly affected through impacts to their host fish when carbaryl concentrations rise above 680 µg/L. The shinyrayed pocketbook is a host fish generalist and can likely use a variety of fish species as hosts such as spotted bass, eastern mosquitofish, guppy, bluegill for reproduction. The shinyrayed pocketbook occurs in small to medium-sized creeks in slow to moderate current, while its host fish can occur in low to high flow and small to large volume waterbodies. We do not expect carbaryl concentrations (up to 154 µg/L) in medium to large flow/volume waters to cause adverse effects to mussels or fish. The mussel and its host fish also occur in low flow/low volume waterbodies where carbaryl concentrations range from 720-2,727 µg/L; here, mussels may experience sublethal effects, host fish may die, and host fish that do not die may experience sublethal effects. Larvae and juvenile fish, life stages that are not typically parasitized by glochidia, are more likely to be exposed to carbaryl in low flow/low volume waterbodies where they go to avoid predation. Even though the host fish for the shinyrayed pocketbook are common throughout the range of the mussel and use various components of aquatic habitat throughout their life cycles, we expected high overall adverse effects to host fish and some sublethal effects to the mussel directly before incorporating species-specific conservation measures. We did not anticipate significant reductions in food availability, as any localized reductions in zooplankton as a food source would be quickly replenished by upstream sources.

Shinyrayed pocketbooks have high vulnerability and medium exposure. In our draft opinion, before incorporating species-specific conservation measures, we expected high levels of sublethal effects to mussels and high levels of fish mortality and sublethal effects in low flow/low volume habitats such as small creeks with slow current that are occupied by the species. A moderate number of shinrayed pocketbooks would be adversely affected over the duration of the action without incorporating species-specific measures.

Final Conclusion (with Species-Specific Conservation Measures)

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

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

The PULA for the shinyrayed pocketbook will be developed as described in the Description of the Proposed Action section of the main Opinion and Appendix A-1. EPA is currently considering public comments received on the Draft Insecticide Strategy. If additional mitigation

options become available during finalization of the Insecticide Strategy or in the future, this might warrant re-initiation to incorporate those measures into the action (i.e., additional options and mitigations for end users). In that case, EPA will provide documentation that these measures provide equivalent conservation for listed species, including reduction in off-site transport. Upon confirmation by the Service, those options will be added to the acceptable mitigations listed for end users of carbaryl.

We anticipate that with the measures described above, pathways of exposure will be greatly limited and result in exposure of very low numbers of individuals over the course of the action. After reviewing the current status of the species, environmental baseline for the action area, cumulative effects, and effects of the action (including the species-specific conservation measures that are now incorporated into the proposed action), we determined the proposed action is not likely to appreciably reduce the survival and recovery of the species. Thus, it is our biological opinion that the registration of carbaryl, as proposed, is not likely to jeopardize the continued existence of the shinyrayed pocketbook.

References

U.S. Fish and Wildlife Service. 2020. Shinyrayed pocketbook (*Lampsilis subangulata*) 5-Year Review: Summary and Evaluation. Athens, Georgia. 25 pp.

U.S. Fish and Wildlife Service. 2007. Recovery plan for Endangered fat threeridge, shinyrayed pocketbook, Gulf moccasinshell, Ochlockonee moccasinshell, oval pigtoe, and threatened Chipola slabshell, and purple bankclimber. Panama City, Florida. 149 pp..

Integration and Synthesis Summary: Texas fawnsfoot

Scientific Name:	Common Name:	Entity ID:
Truncilla macrodon	Texas fawnsfoot	9967

Species Overview

In reviewing the status of the species, the environmental baseline, and cumulative effects for the action area, we determined that the species' vulnerability is high. In our evaluation of the effects of the proposed action to the species, we determined there was high overlap of the action area with the species' range, and low past usage of carbaryl within the species' range, indicating a medium extent of exposure within the action area across the species' range (Figure 2). Exposed individuals are unlikely to die but some in low flow or low volume waterbodies are likely to experience sublethal effects and indirect effects resulting from loss of reproductive host species. We do not anticipate any significant reductions in food availability, as any localized reductions in zooplankton as a food source will be quickly replenished by upstream sources. Because exposure was medium and toxic effects are expected to be high in low flow/low volume waterbodies where the mussel and its host fish are found, we determined the risk of adverse effects to the species was medium. As such, we expected a moderate number of individuals was likely to experience sublethal effects and reduced reproductive success from the proposed action.

Because of the effects described in our preliminary evaluation and conclusion, EPA and the applicant agreed to incorporate the species-specific conservation measures as part of the action. We now expect exposure for the Texas fawnsfoot to be low. After incorporating conservation measures into the proposed action, adding the effects of the action and cumulative effects to the environmental baseline, and in light of the status of the species, we have determined the proposed action is not likely to appreciably reduce the survival and recovery of the species. Thus, we anticipate that the proposed action will not jeopardize the continued existence of the Texas fawnsfoot. We discuss our rationale for this conclusion for the species in the sections below.

Species range

Based on range map dated: 11/17/2020; Wherever found; *States within the range:* TX. Figure 2 depicts the species' range.

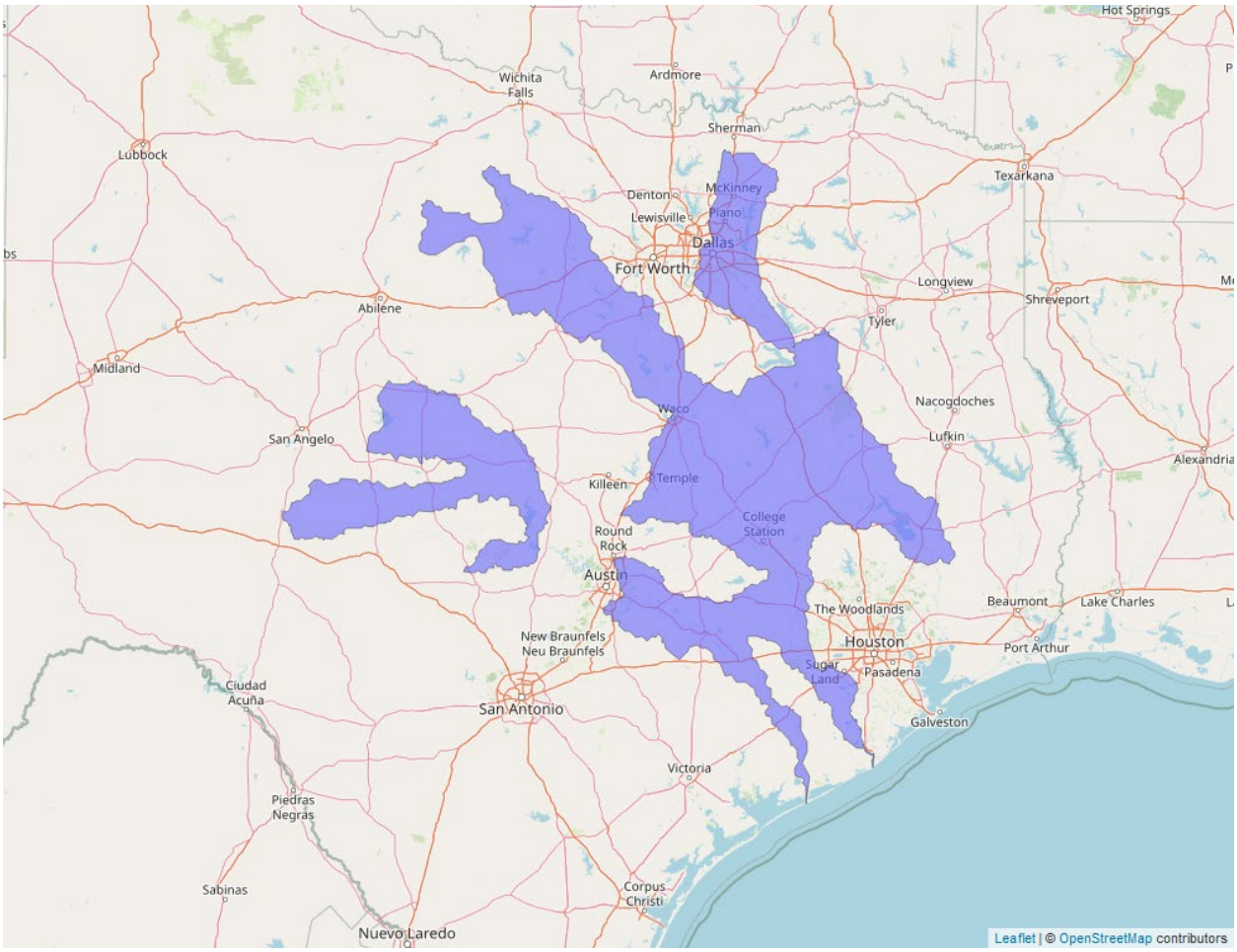

Figure 1. Range map of Texas fawnsfoot (blue polygons). Range map accessed at https://ecos.fws.gov/ecp/species/8965.

Vulnerability

As mentioned above, vulnerability considers the present condition of the species to determine its vulnerability to additional stressors. Here, in making our jeopardy determination, vulnerability of the species is a function not only of its status, but also the environmental baseline and cumulative effects, as summarized below.

Summary of status

Listing status: Threatened

Most recent 5-Year Review recommendation: N/A

Most recently completed 5-Year Review: N/A

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

Number of populations: Multiple populations (few)

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

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

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

The Texas fawnsfoot was historically distributed throughout the Colorado and Brazos River basins and in the Trinity River basin. Texas fawnsfoot occurs in the lower reaches of the Colorado and Brazos Rivers, and in the Trinity River 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. It is extirpated from the Leon River and was not found in the Llano, San Saba, or Pedernales Rivers during surveys. Isolated individuals not considered part of functioning populations have been found in the Little River. As of 2019, Texas fawnsfoot inhabited 659.7 stream miles, which is 18.7% of its historical range. They are found in medium- to large-sized streams and rivers with flowing waters and mud, sand, and gravel substrates. Known populations are all small, with some only including one individual, and all are considered “moderately unhealthy” or “unhealthy” (USFWS 2019).

The species decline was primarily from habitat loss and degradation, effects of impoundments, sedimentation, dewatering, sand and gravel mining, and chemical contaminants. Agricultural contaminants include ammonia, 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. Over-enriched conditions are exacerbated by low flow stream conditions, such as those experienced during typical summer season flows. Excessive nitrogen concentrations can be detrimental to adult mussels. In addition, elevated concentrations of pesticides frequently occur in streams due to 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 their vulnerability to pesticides. Little is known regarding the effect of currently used pesticides to freshwater mussels, but some may adversely affect the species (USFWS 2011) and should be investigated further as applicable. As of 2019, primary threats are habitat degradation (e.g., increased fine sediment, changes in water quality, hydrological changes), invasive species and predation, barriers to movement (e.g., through effects to host fish and mussel reproduction), climate change, and land management. Water quality is threatened by point and nonpoint source discharges, including hazardous spills, industrial wastewater, municipal effluents, and agricultural runoff. These sources contribute

organic compounds, trace metals, pesticides, ammonia, and a wide variety of newly emerging contaminants (e.g., pharmaceuticals) that comprise some 85,000 chemicals in commerce today that are released to the aquatic environment (USFWS 2019).

Overall Vulnerability: High

Effects of the Action: Exposure

Overlap

We do not expect listed bivalve species will occur on-field, and thus expect exposure will only result from off-field transport via spray drift or runoff. Given that the ranges for listed aquatic species are generally delineated using the relevant HUC 12 watersheds, we anticipate that all residues that leave use sites will be collected in the waterbodies within the species range where individuals occur regardless of how residues leave treated sites or where in the range they are deposited. As such, we do not extend overlap metrics off-field as this will not functionally change the expected exposures that listed aquatic species are likely to experience. We expect up to 12.3% of the species range will contain carbaryl use sites (Table 8).

Usage

Past usage data indicate that up to 4.4% of the species' range has been treated with carbaryl annually. Use layers with the highest usage include other crops (3.0%), other gains (0.7%), and corn (0.4%) (Table 8).

Table 8. Agricultural use overlap and annual usage data (% Range Treated) for the Texas fawnsfoot.

Use Layer	Use Site Overlap (% range)	% Range Treated (On-field)
Alfalfa	< 0.01	< 0.01
Citrus	< 0.01	< 0.01
Corn[3]	4.8	0.4
Grapes	< 0.01	< 0.01
Other Crops	3.0	3.0
Other Grains	4.0	0.7
Other Orchards	0.5	0.1

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

Use Layer	Use Site Overlap (% range)	% Range Treated (On-field)
Other Row Crops	0.04	0.04
Soybeans	0.5	0.04
Vegetables and Ground Fruit	0.04	0.04
Total	**12.3**	**4.4**

Additional Exposure Considerations

The Texas fawnsfoot is found in medium- to large-sized streams and rivers with flowing waters and mud, sand, and gravel substrates. Adults are most often found in bank habitats and occasionally in backwater, riffle, and point bar habitats with low to moderate velocities that appear to function as flow refuges during high flow events (USFWS 2022).

Non-agricultural Uses

In addition to agricultural use sites, we anticipate some non-agricultural carbaryl use sites occur within the species' range, including managed forests, rangeland, rights of way, developed, open space developed, and nurseries.

U.S Forest Service usage data indicate that only ~800 acres of managed forests have been treated with carbaryl over a 5-year period (2016-2020), and we do not anticipate treated acres of managed forests occur within the range of the Texas fawnsfoot. Furthermore, treatments are made using ground-based sprayers directed to lower parts of the tree (i.e., the trunk), which will limit the extent of off-site transport and exposure to individuals. As such, we anticipate a low likelihood of forest carbaryl usage in the range, and that if usage did occur, exposure to the Texas fawnsfoot would be minimal. For rangelands, mussel mitigations from the USDA-APHIS grasshopper and Mormon cricket consultation are the following: a 2,500-foot buffer for all ultra-low volume aerial applications of carbaryl and a 300-foot buffer for all ground applications of carbaryl. For carbaryl bait applications, specific mussels within the program action area are protected by a 750-foot buffer for aerial applications and a 100-foot buffer for ground applications. These specific buffers apply to the Texas fawnsfoot. Similarly, available usage data indicate very little carbaryl usage is likely to occur in rights of way, with less than 500 pounds of carbaryl applied to roadways nationally each year. While this may result in a large treatment footprint if all rights of way usage were concentrated in one location or within one species' range, we expect this is highly unlikely to occur and rather expect rights of way usage is likely to be sporadic across the national landscape, with only small amounts, if any, used within the species' range. Available usage data indicate only low levels of past carbaryl usage occurred in open space developed areas (including golf courses) with, at most, up to 2.5% of open space developed areas receiving treatment each year nationally. Finally, most developed (e.g., residential) uses are completed using hand-held equipment on cracks and crevices, indicating a low level of off-site transport.

As such, we anticipate no more than small numbers of individuals are likely to be exposed through non-agricultural uses of carbaryl.

Exposure Summary

A high portion of the species range could be exposed to carbaryl given the overlap between agricultural use sites and the species' range (12.3%). Based on past agricultural usage data, we expect a low portion of the range is likely to be treated with carbaryl (4.4% annually). Based on the low likelihood of usage within non-agricultural uses, we do not anticipate non-agricultural uses of carbaryl will expose more than a small number of individuals of Texas fawnsfoot. Adult Texas fawnsfoot mussels are most often found in bank habitats and occasionally in backwater, riffle, and point bar habitats with low to moderate velocities that appear to function as flow refuges during high flow events (USFWS 2022). As such, we expect adult mussels will disproportionately experience higher concentrations of carbaryl in these low flow or low volume habitats. Overall, we anticipate a medium portion of the range and thus a moderate number of individuals will likely experience exposure from the proposed action.

Overall Exposure: Medium

General Conservation Measures

Rain restriction: Carbaryl is prohibited from being applied within 48 hours of a forecasted rain event or when soil in the treatment area is saturated. This rain restriction reduces the concentration of carbaryl in aquatic habitats by providing time for carbaryl to degrade before runoff into aquatic habitats can occur, decreasing the likelihood of exposure and risk. We have incorporated this mitigation measure in the information we provide in Table 9, which lists the maximum predicted EEC from the highest overlap use site within the species range.

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

We anticipate that in many cases, these buffers will significantly reduce exposure to the Texas fawnsfoot and subsequent indirect risk to host fish.

Label measures limit many residential uses of carbaryl to spot, crack-and-crevice, or narrow perimeter bands around urban structures (from 1 inch to 6 feet in width), which we expect will substantially reduce the likelihood of exposure to the species from developed uses.

Effects of the Action: Toxicity

Direct Effects:

Based on available toxicity data for mollusks, we do not expect exposures of carbaryl at most predicted environmental concentrations are likely to cause adverse effects. Texas fawnsfoot mussels that experience 1,000 µg/L or greater concentrations of carbaryl may experience sublethal effects (e.g., reduced fecundity). We expect >1,000 µg/L of carbaryl to occur only in low flow/low volume waterbodies subject to runoff from Other Grains land uses.

Indirect Effects:

Within the regions and aquatic habitats that the Texas fawnsfoot occupies, EPA's aquatic exposure modeling indicates that predicted environmental concentrations of carbaryl will likely be from 12 to 1,398 µg/L, depending on the type of habitat and region (Table 9). We expect exposed host fish will die or have reduced fecundity at concentrations above 1,000 µg/L and fish may experience reduced fecundity at lower concentrations (i.e., above 680 µg/L). Availability of some fish hosts needed for successful reproduction will decrease in waterbodies that experience these levels of carbaryl or greater. The fish host for the Texas fawnsfoot is unknown but likely the freshwater drum. Freshwater drum are common and abundant from the western slopes of the Appalachians to the eastern slopes of the Rockies. They are common throughout large rivers, lakes, and reservoirs and typically prefer large deep pool habitats in these systems. Although the mussel is limited to one fish host species, freshwater drum are relatively common and use all aquatic habitats available to them. We do not expect mortality of all potential fish hosts within the aquatic habitats where the Texas fawnsfoot is found. In particular, we expect some mortality to host fish and host fish prey in low flow/low volume waterbodies subject to runoff from Other Grains land uses. We do not expect fish mortality in high flow/large volume waterbodies.

Table 9. Maximum estimated environmental concentrations of carbaryl associated with the highest overlapping use layers within the Texas fawnsfoot range.

Use layer	Habitat	Max EEC (µg/L)
Other Grains	Low flow/low volume waterbodies	1,398
Other Grains	High flow/large volume waterbodies	16
Corn	Low flow/low volume waterbodies	724
Corn	High flow/large volume waterbodies	32
Other Crops	Low flow/low volume waterbodies	786

Use layer	Habitat	Max EEC (µg/L)
Other Crops	High flow/large volume waterbodies	12

Similarly, we anticipate some individual freshwater drum exposed in low flow or low volume waterbodies that do not die may experience sublethal adverse effects (i.e., reduced fecundity) in low flow/low volume waterbodies subject to runoff from Corn and Other Crops. We expect the loss of and sublethal effects to host fish will affect the reproductive success of the mussel. Individual host fish that are exposed in high flow or large volume waterbodies are not likely to experience sublethal adverse effects as estimated environmental concentrations within these areas are well below levels where toxicity studies have observed adverse effects in fish. We anticipate some mortality to aquatic invertebrate prey for the fish host as well in the aquatic habitats where the mussel and its fish host may be found.

While non-agricultural uses of carbaryl may contribute to the overall exposure of the Texas fawnsfoot, estimated environmental concentrations associated with all non-agricultural uses (including developed, open space developed, nursery, managed forests, rangeland, and rights of way uses) will not exceed 959 µg/L. This non-agricultural carbaryl exposure is well below levels where available toxicity studies in fish have observed any adverse effects to survival but may still impact reproduction.

While we expect some reductions in zooplankton from carbaryl exposure, based on carbaryl's low persistence in water and planktonic drift, we anticipate any localized reductions in zooplankton as a food source will be quickly replenished by upstream sources. We do not expect any adverse effects from carbaryl exposure to detritus or any other aquatic debris on which mussels feed.

Toxicity Summary

Maximum estimated environmental concentrations in parts of the species' habitat (i.e., low flow or low volume waterbodies) will be high enough to cause sublethal effects to mussels and host fish mortality and sublethal effects. While the Texas fawnsfoot's presumed host fish (i.e., freshwater drum) is abundant and common across the mussel's range, we anticipate some fish and the mussel itself, will experience high levels of sublethal and indirect effects. This is likely to occur to host fish and adult mussels that prefer bank habitats and occasionally backwater, riffle, and point bar habitats which are considered areas of low flow where sublethal and indirect effects (i.e., effects to reproduction through loss of host fish) will be high. We expect some mortality to host fish prey (aquatic invertebrates) to occur in all the different habitats where the mussel and host fish may be found. We do not anticipate any indirect adverse effects to food resources for the mussel are likely to occur.

Overall Toxicity Ranking: Medium

Effects of the Action Summary

The Texas fawnsfoot has a medium exposure ranking. There is a high extent of overlap between agricultural use sites and the species' range and a low level of past agricultural usage within the range. In addition, based on available usage data and existing conservation measures for non-agricultural uses, we do not anticipate more than a small number of individuals will be exposed and die from non-agricultural uses. As such, we anticipate a moderate number of individuals are likely to be exposed over the duration of the proposed action.

The Texas fawnsfoot has a medium toxicity ranking. We do not anticipate mortality to the Texas fawnsfoot, though we anticipate some reduced fecundity in low flow or low volume aquatic habitats. Although they occur in medium to large streams, adults are most commonly found in bank habitats, riffles, and other slower-moving waters that serve as flow refuges during high flow events. We anticipate mortality to exposed fish hosts, particularly in low flow/low volume waterbodies where we expect reproductive phase (i.e., adult) mussels to be found. Mussels depend on host fish to accomplish their reproductive lifecycle. Glochidia 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. The fish hosts for the Texas fawnsfoot are unknown but believed to be freshwater drum, which are common in higher-flow waterbodies. The conservation measures on the label will reduce runoff and drift of carbaryl into the aquatic waterbodies where this mussel is found. However, estimated environmental concentrations of carbaryl may cause mortality and reduced fecundity for some host fish species depending on the aquatic water bodies, particularly in low flow or low volume areas within the species' habitat. We expect some reductions in zooplankton from carbaryl exposure but anticipate that any localized reductions in zooplankton as a food source will be quickly replenished by upstream sources.

While we anticipate a moderate number of individuals are likely to experience exposure, we anticipate a medium level of mortality and sublethal effects in areas where the species likely occurs. As such, we anticipate the overall risk of adverse effects to the species is medium.

Preliminary Conclusion (with General Conservation Measures)

The Texas fawnsfoot is listed as threatened and occurs in the Colorado, Brazos, and Trinity River systems in Texas. Abundance is low and it is extirpated from nearly 80% of its historical range. As of 2019, Texas fawnsfoot only occur in about 660 stream miles. All populations are considered "moderately unhealthy" or "unhealthy." Threats to the species include habitat degradation, decreases in water quality (including from pesticide use and runoff), invasive species, barriers to fish movement, and climate change.

The species range occurs near agricultural carbaryl use sites (27.7% overlap) and a small portion of the range has experienced carbaryl usage in the past (4.8% annually). Therefore, we considered the species to have a medium exposure ranking. Though we do not expect direct

mortality of mussels from carbaryl exposure, we expect sublethal effects to mussels where carbaryl concentrations rise above 1,000 µg/L, and we expect mussels to be indirectly affected through impacts to their host fish when carbaryl concentrations rise above 680 µg/L. The Texas fawnsfoot has an unknown host fish, but we presume it uses the freshwater drum. Although Texas fawnsfoot mussels occur in medium to large streams, adults are most commonly found in bank habitats, riffles, and other slower-moving waters that serve as flow refuges during high flow events We do not expect mortality in high flow/large volume waterbodies where we expect carbaryl concentrations up to 13 µg/L. The mussel more commonly occurs in low flow/low volume waterbodies where carbaryl concentrations range from 804-1,535 µg/L; here, mussels may experience sublethal effects, host fish may die, and host fish that do not die may experience sublethal effects. Larvae and juvenile fish, life stages that are not typically parasitized by glochidia, are more likely to be exposed to carbaryl in low flow/low volume waterbodies where they go to avoid predation. Even though the presumed host fish for the Texas fawnsfoot are common throughout the range of the mussel and use various components of aquatic habitat throughout their life cycles, we expected high overall adverse effects to host fish and some sublethal effects to the mussel directly before incorporating species-specific conservation measures. We did not anticipate significant reductions in food availability, as any localized reductions in zooplankton as a food source would be quickly replenished by upstream sources.

Texas fawnsfoot mussels have high vulnerability and medium exposure. In our draft opinion, before incorporating species-specific conservation measures, we expected high levels of sublethal effects to mussels and high levels of fish mortality and sublethal effects in several low flow / low volume habitats occupied by the species. A moderate number of Texas fawnsfoot mussels would be adversely affected over the duration of the action without incorporating species-specific measures.

Final Conclusion (with Species-Specific Conservation Measures)

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

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

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

We anticipate that with the measures described above, pathways of exposure will be greatly limited and result in exposure of very low numbers of individuals over the course of the action. After reviewing the current status of the species, environmental baseline for the action area, cumulative effects, and effects of the action (including the species-specific conservation measures that are now incorporated into the proposed action), we determined the proposed action is not likely to appreciably reduce the survival and recovery of the species. Thus, it is our biological opinion that the registration of carbaryl, as proposed, is not likely to jeopardize the continued existence of the Texas fawnsfoot.

References

U.S. Fish and Wildlife Service 2022. Species Status Assessment Report for the Central Texas Mussels: False Spike, Balcones Spike, Texas Fatmucket, Texas Fawnsfoot, Texas Pimpleback, Guadalupe Fatmucket, Guadalupe Orb. Version 2.1, Albuquerque, N.M. 267 pp.

Integration and Synthesis Summary: Balcones spike

Scientific Name:	Common Name:	Entity ID:
Fusconaia iheringi	Balcones spike	11676

Species Overview

In reviewing the status of the species, the environmental baseline, and cumulative effects for the action area, we determined that the species' vulnerability is high. In our evaluation of the effects of the proposed action to the species, we determine there is high overlap of the action area with the species' range, and low past usage of carbaryl within the species' range, indicating a medium extent of exposure within the action area across the species' range (Figure 3). Exposed individuals are unlikely to die but some in low flow or low volume waterbodies are likely to experience sublethal effects and indirect effects resulting from loss of reproductive host species. We do not anticipate any significant reductions in food availability, as any localized reductions in zooplankton as a food source will be quickly replenished by upstream sources. Even though toxic effects are expected to be high in low flow/low volume waterbodies where the mussel and its host fish are sometimes found, exposure is low based on past usage data and we determine the risk of adverse effects to the species is low. As such, we expect a small number of individuals are likely to experience sublethal effects and reduced reproductive success from the proposed action. After adding the effects of the action and cumulative effects to the environmental baseline, and in light of the status of the species, we have determined the proposed action is not expected to appreciably reduce the survival and recovery of the species in the wild. Thus, it is our biological opinion that the proposed action, the registration of carbaryl, as proposed, is not likely to jeopardize the continued existence of the Balcones spike.

Species range

Based on range map dated: 11/17/2020; Wherever found; *States within the range:* TX. Figure 2 depicts the species' range.

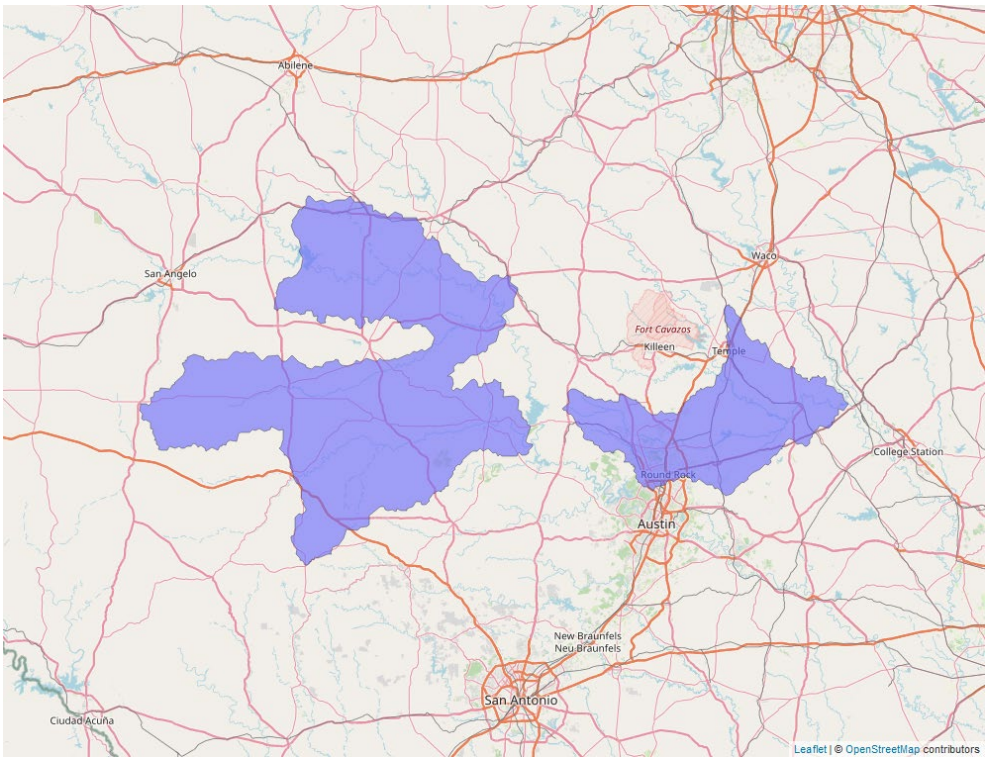

Figure 3. Range map of Balcones spike (blue polygons). Range map accessed at https://ecos.fws.gov/ecp/species/10909.

Vulnerability

As mentioned above, vulnerability considers the present condition of the species to determine its vulnerability to additional stressors. Here, in making our jeopardy determination, vulnerability of the species is a function not only of its status, but also the environmental baseline and cumulative effects, as summarized below.

Summary of status

Listing status: Endangered

Most recent 5-Year Review recommendation: N/A

Most recently completed 5-Year Review: N/A

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

Number of populations: Multiple populations (few)

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

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

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

The Balcones spike (*Fusconaia iheringi*) was described in 2020 as a separate species distinct from false spike. Balcones spike is known to occur within two river systems: the Brazos River basin and the San Gabriel River. The Colorado River basin has two known populations: the lower San Saba River and Llano River populations. These two populations are small and isolated from one another and considered to be in unhealthy condition overall, corresponding to low resiliency. The species is presumed to be extirpated from the entire mainstem Brazos River. They ideally occur in riffle and run habitats with gravel and cobble substrates and low evidence of excessive sedimentation. The species was believed to also occur in the Brazos and Colorado basins but is now considered a different species from the false spike *(Fusconaia mitchelli*).

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. Water quality degradations include the presence of excessive nutrients such as ammonia, which is highly toxic to aquatic organisms, other chemicals including chlorine, pollutants including heavy metals (Cu, Cd, Hg), dissolved salts (salinity), and organic contaminants like pesticides and herbicides, and may affect each life stage of freshwater mussels. These factors are all exacerbated by the ongoing and expected effects of climate change.

Overall Vulnerability: High

Effects of the Action: Exposure

Overlap

We do not expect listed bivalve species will occur on-field, and thus expect exposure will only result from off-field transport via spray drift or runoff. Given that the ranges for listed aquatic species are generally delineated using the relevant HUC 12 watersheds, we anticipate that all residues that leave use sites will be collected in the waterbodies within the species range where individuals occur regardless of how residues leave treated sites or where in the range they are deposited. As such, we do not extend overlap metrics off-field as this will not functionally change the expected exposures that listed aquatic species are likely to experience. Currently, we do not have overlap or usage data for the Balcones spike. Due to the similarities in life history as well as the species range, we use the overlap and usage data from the false spike for the Balcones spike. We expect up to 9.9% of the species range will contain carbaryl use sites (Table 10).

Usage

Past usage data indicate that up to 3.5% of the species' range has been treated with carbaryl annually. Use layers with the highest usage include other grains (1.7%), corn (0.9%), and other crops (0.6%) (Table 10).

Table 10. Agricultural use overlap and annual usage data (% Range Treated) for the Balcones spike.

Use Layer	Use Site Overlap (% range)	% Range Treated (On-field)
Alfalfa	< 0.01	< 0.01
Citrus	< 0.01	< 0.01
Corn[4]	4.6	0.9
Grapes	< 0.01	< 0.01
Other Crops	0.6	0.6
Other Grains	4.2	1.7
Other Orchards	0.6	0.3
Other Row Crops	0.02	0.02
Soybeans	0.2	0.10
Vegetables and Ground Fruit	0.04	0.04
Total	**9.92**	**3.5**

Additional Exposure Considerations

The Balcones spike occurs in larger creeks and rivers with sand, gravel, or cobble substrates, and with slow to moderate flows. They are not known from deep waters (USFWS 2024). They likely brood eggs and larvae from early spring to late summer. Census of Agriculture data for the false spike indicate that up to 3% of the range has been treated with insecticides annually in the past.

Non-agricultural Uses

In addition to agricultural use sites, we anticipate some non-agricultural carbaryl use sites occur within the species' range, including managed forests, rangeland, rights of way, developed, open space developed, and nurseries.

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

U.S. Forest Service usage data indicate that only ~800 acres of managed forests have been treated with carbaryl over a 5-year period (2016-2020) nationally, and we do not anticipate treated acres of managed forests occur within the Balcones spike range. Furthermore, treatments are made using ground-based sprayers directed to lower parts of the tree (i.e., the trunk), which will limit the extent of off-site transport and exposure to individuals. As such, we anticipate a low likelihood of forest carbaryl usage in the range, and that if usage did occur, exposure to the Balcones spike would be minimal. For rangelands, there has been no historical usage of carbaryl in the state of Texas, so we expect exposure to the Balcones spike from rangeland uses of carbaryl to be, at most, minimal over the duration of the action. Similarly, available usage data indicate very little carbaryl usage is likely to occur in rights of way, with less than 500 pounds of carbaryl applied to roadways nationally each year. While this may result in a large treatment footprint if all rights of way usage were concentrated in one location or within one species' range, we expect this is highly unlikely to occur and rather expect rights of way usage is likely to be sporadic across the national landscape, with only small amounts, if any, used within the species' range. Available usage data indicate only low levels of past carbaryl usage occurred in open space developed areas (including golf courses) with, at most, up to 2.5% of open space developed areas receiving treatment each year nationally. Finally, most developed (e.g., residential) uses are completed using hand-held equipment on cracks and crevices, indicating a low level of off-site transport. As such, we anticipate no more than small numbers of individuals are likely to be exposed through non-agricultural uses of carbaryl.

Exposure Summary

A high portion of the species range could be exposed to carbaryl given the overlap between agricultural use sites and the species' range (9.9%). Based on past agricultural usage data from the Census of Agriculture, we expect a low portion of the range is likely to be treated with any insecticide (3% annually). Based on the low likelihood of usage within non-agricultural uses, we do not anticipate non-agricultural uses of carbaryl will expose more than a small number of individuals of Balcones spike. Overall, we anticipate a low portion of the range and thus a small number of individuals will likely experience exposure from the proposed action.

Overall Exposure: Low

General Conservation Measures

Rain restriction: Carbaryl is prohibited from being applied within 48 hours of a forecasted rain event or when soil in the treatment area is saturated. This rain restriction reduces the concentration of carbaryl in aquatic habitats by providing time for carbaryl to degrade before runoff into aquatic habitats can occur, decreasing the likelihood of exposure and risk. We have incorporated this mitigation measure in the information we provide in Table 11 which lists the maximum predicted EEC from the highest overlap use site within the species range.

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

We anticipate that in many cases, these buffers will significantly reduce exposure to the Balcones spike and subsequent indirect risk to host fish.

Label measures limit many residential uses of carbaryl to spot, crack-and-crevice, or narrow perimeter bands around urban structures (from 1 inch to 6 feet in width), which we expect will substantially reduce the likelihood of exposure to the species from developed uses.

Effects of the Action: Toxicity

Direct Effects:

Based on available toxicity data for mollusks, we do not expect exposures of carbaryl at most predicted environmental concentrations are likely to cause adverse effects. Balcones spike mussels that experience 1,000 µg/L or greater concentrations of carbaryl may experience sublethal effects (e.g., reduced fecundity). We expect >1,000 µg/L of carbaryl to occur only in low flow/low volume waterbodies subject to runoff from Other Grains land uses.

Indirect Effects:

Within the regions and aquatic habitats that the Balcones spike occupies, EPA's aquatic exposure modeling indicates that predicted environmental concentrations of carbaryl will likely be from 55 to 1,398 µg/L, depending on the type of habitat and region (Table 11). We expect exposed host fish will die or have reduced fecundity at concentrations above 1,000 µg/L and fish may experience reduced fecundity at lower concentrations (i.e., above 680 µg/L). Availability of some fish hosts needed for successful reproduction will decrease in waterbodies that experience these levels of carbaryl or greater. The fish host for the Balcones spike is unknown but likely similar to the false spike fish hosts which are the red shiner (*Cyprinella lutrensis*) and blacktail shiner (*Cyprinella lutrensis*). Both species of shiner are common and abundant throughout large rivers, streams, and lakes. Although the mussel is limited to two fish host species, both shiners are abundant within the range of the Balcones spike. We do not expect mortality of all potential fish hosts within the aquatic habitats where the Balcones spike is found. In particular, we expect some mortality to host fish and host fish prey in low flow/low volume waterbodies subject to runoff from Other Grains land uses. We do not expect fish mortality in high flow/large volume waterbodies.

Table 11. Maximum estimated environmental concentrations of carbaryl associated with the highest overlapping use layers within the Balcones spike range based on the range of the false spike.

Use layer	Habitat	Max EEC (µg/L)
Other Grains	Low flow/low volume waterbodies	1,398
Other Grains	High flow/large volume waterbodies	77
Corn	Low flow/low volume waterbodies	724
Corn	High flow/large volume waterbodies	104
Other Crops	Low flow/low volume waterbodies	786
Other Crops	High flow/large volume waterbodies	55

Similarly, we anticipate some individual red or blacktail shiner exposed in low flow or low volume waterbodies that do not die may experience sublethal adverse effects (i.e., reduced fecundity) in low flow/low volume waterbodies subject to runoff from Corn and Other Crops. We expect the loss of and sublethal effects to host fish will affect the reproductive success of the mussel. Individual host fish that are exposed in high flow or large volume waterbodies are not likely to experience sublethal adverse effects as estimated environmental concentrations within these areas are well below levels where toxicity studies have observed adverse effects in fish. We anticipate some mortality to aquatic invertebrate prey for the fish host as well in the aquatic habitats where the mussel and its fish host may be found.

While non-agricultural uses of carbaryl may contribute to the overall exposure of the Balcones spike, estimated environmental concentrations associated with all non-agricultural uses (including developed, open space developed, nursery, managed forests, rangeland, and rights of way uses) will not exceed 959 µg/L. This non-agricultural carbaryl exposure is below levels where available toxicity studies in fish have observed any adverse effects to survival but may still impact reproduction.

We expect some reductions in zooplankton from carbaryl exposure, based on carbaryl's low persistence in water and planktonic drift, but we anticipate any localized reductions in zooplankton as a food source will be quickly replenished by upstream sources. We do not expect any adverse effects from carbaryl exposure to detritus or any other aquatic debris on which mussels feed.

Toxicity Summary

Maximum estimated environmental concentrations in parts of the species' habitat (i.e., low flow or low volume waterbodies) will be high enough to cause sublethal effects to mussels and host fish mortality and sublethal effects. However, the Balcones spike's presumed host fishes (i.e., red shiner, blacktail shiner) are abundant and common across the mussel's range. We anticipate some fish and the mussel itself will experience sublethal and indirect effects in low flow and low volume water bodies. We expect some mortality to host fish prey (i.e., aquatic invertebrates) to occur in all habitats where the mussel and host fish may be found. We do not anticipate any indirect adverse effects to food resources for the mussel are likely to occur.

Overall Toxicity Ranking: Medium

Effects of the Action Summary

The Balcones spike has a low exposure ranking. We anticipate agricultural usage of carbaryl within the range of the species to be low based on past usage data for a species with a similar range, the false spike. Based on available usage data and existing conservation measures for non-agricultural uses, we do not anticipate more than a small number of individuals will be exposed and die from non-agricultural uses. As such, we anticipate a small number of individuals are likely to be exposed over the duration of the proposed action.

The Balcones spike has a medium toxicity ranking. We do not anticipate mortality to the Balcones spike, though we anticipate some reduced fecundity in low flow or low volume aquatic habitats. We anticipate mortality to exposed fish hosts, particularly in low flow/low volume waterbodies. Mussels depend on host fish to accomplish their reproductive lifecycle. Glochidia 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. The conservation measures on the label will reduce runoff and drift of carbaryl into the aquatic waterbodies where this mussel is found. The red darter and blacktail darter are common host fish throughout the range of the Balcones spike, however, estimated environmental concentrations of carbaryl may cause mortality and reduced fecundity for some host fish species depending on the aquatic water bodies, particularly in low flow or low volume areas within the species' habitat. We expect some reductions in zooplankton from carbaryl exposure but anticipate that any localized reductions in zooplankton as a food source will be quickly replenished by upstream sources.

While we anticipate a small number of individuals are likely to experience exposure, we anticipate a medium level of mortality and sublethal effects in areas where the species likely occurs. As such, we anticipate the overall risk of adverse effects to the species is medium.

Conclusion

The Balcones spike is listed as endangered and potentially occurs in two river systems in Texas: Brazos River basin and San Gabriel River. The population in the Brazos River is presumed extirpated. They ideally occur in riffle and run habitats. Threats include increased sediment, changes in water quality, altered hydrology, predation, collection, and barriers to fish movement.

We do not have overlap information for the Balcones spike, so we used the overlap and usage data for a similar mussel (i.e., surrogate) that is found in the same general area of Texas, the false spike. The surrogate species' range occurs near agricultural carbaryl use sites (9.9% overlap) and a small portion of the range has experienced any insecticide usage in the past (3% annually) according to the Census of Agriculture. Therefore, we consider the species to have a low exposure ranking. Though we do not expect direct mortality of mussels from carbaryl exposure, we expect sublethal effects to mussels where carbaryl concentrations rise above 1,000 µg/L, and we expect mussels to be indirectly affected through impacts to their host fish when carbaryl concentrations rise above 680 µg/L. The Balcones spike's host fish are unknown, but we believe they are similar to those of the false spike, which include red shiners and blacktail shiners. Both shiners are common and abundant throughout the larger rivers, streams, and lakes. The mussel itself is known in larger creeks and rivers with low to moderate flows. We do not expect mortality in high flow/large volume waterbodies where we expect carbaryl concentrations up to 104 µg/L. The mussel also occurs in low flow/low volume waterbodies where carbaryl concentrations range from 724 - 1,398 µg/L; here, mussels may experience sublethal effects, host fish may die, and host fish that do not die may experience sublethal effects. Larvae and juvenile fish, life stages that are not typically parasitized by glochidia, are more likely to be exposed to carbaryl in low flow/low volume waterbodies where they go to avoid predation. However, the host fish are common and abundant across the species' range and use various components of aquatic habitat throughout their life cycle. We do not anticipate any significant reductions in food availability, as any localized reductions in zooplankton as a food source will be quickly replenished by upstream sources.

Even though Balcones mussels have high vulnerability, this mussel has low exposure and medium toxicity rankings. After incorporating the general conservation measures identified above, a small number of Balcones spike mussels will be adversely affected over the duration of the action, and we expect the proposed action will not measurably reduce the reproduction, numbers, and distribution of the species. After reviewing the current status of the listed species, environmental baseline for the action area, effects of the proposed action, cumulative effects, and general conservation measures, we have determined the proposed action is not likely to appreciably reduce the survival and recovery of the species. Thus, it is our biological opinion that the registration of carbaryl, as proposed, is not likely to jeopardize the continued existence of the Balcones spike

References

U.S. Fish and Wildlife Service. 2024. Species Status Assessment Report for the Central Texas Mussels: False spike (*Fusconaia mitchelli*) Balcones spike (*Fusconaia iheringi*) Texas fatmucket (*Lampsilis bracteata*) Texas fawnsfoot (*Truncilla macrodon*) Texas pimpleback (*Cyclonaias*

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